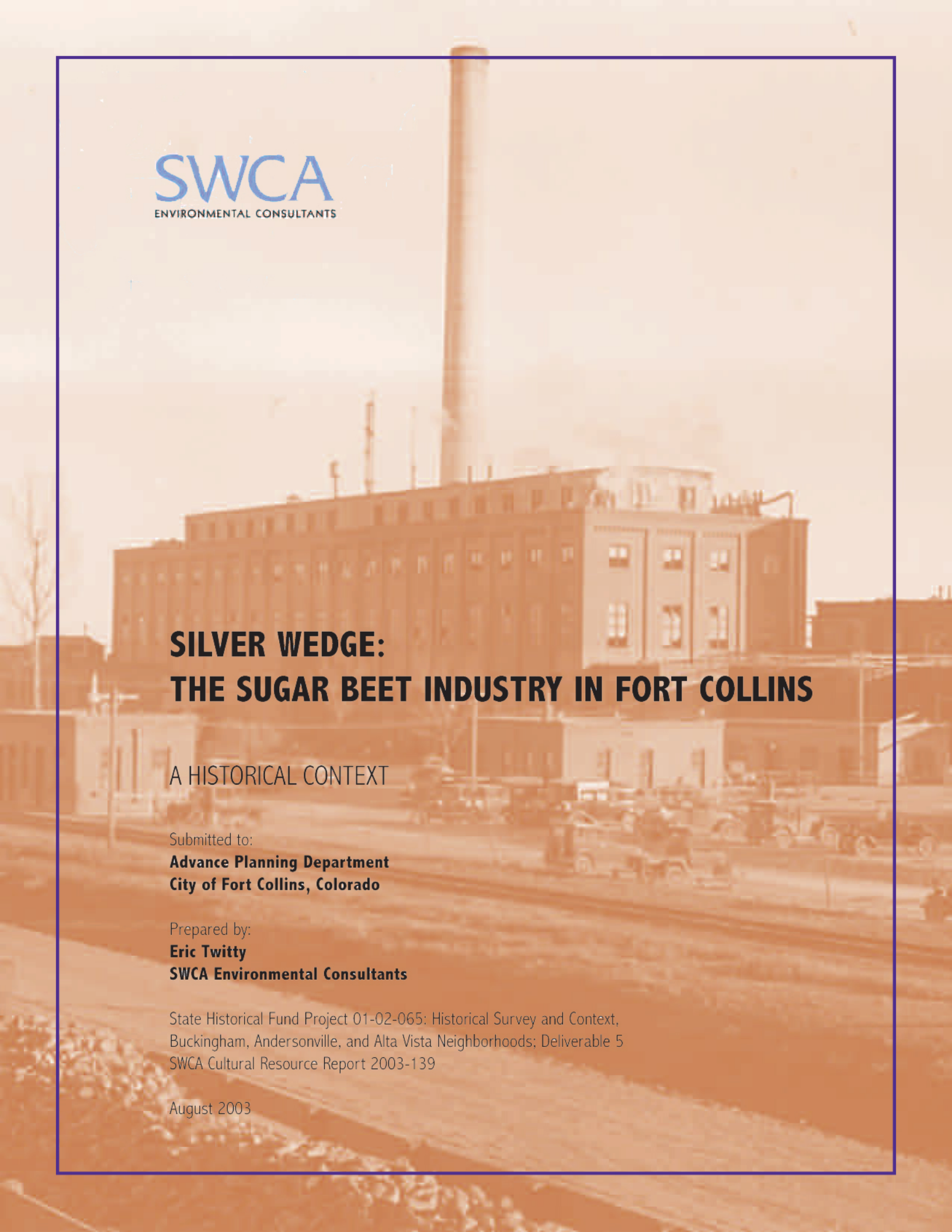

SWCA
ENVIRONMENTAL CONSULTANTS

SILVER WEDGE:
THE SUGAR BEET INDUSTRY IN FORT COLLINS

A HISTORICAL CONTEXT

Submitted to:
Advance Planning Department
City of Fort Collins, Colorado

Prepared by:
Eric Twitty
SWCA Environmental Consultants

State Historical Fund Project 01-02-065: Historical Survey and Context, Buckingham, Andersonville, and Alta Vista Neighborhoods; Deliverable 5
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TABLE OF CONTENTS

FIGURES AND TABLES

On the Cover:
The Great Western Sugar Company's beet sugar refinery in Fort Collins on November 24, 1932. *(Courtesy, Fort Collins Public Library)*

INTRODUCTION

Colorado's Front Range area is rich in history. Native American cultures, predominated by the Arapaho and Cheyenne, thrived on the plains for hundreds of years before Euro-Americans arrived in significant numbers. Beginning in the 1820s, fur trappers made forays in the Rocky Mountains, and westward immigrants used the area as a stop over on their journey to the California gold fields during the California Gold Rush beginning in 1849. The Front Range became the scene of the Pikes Peak Gold Rush ten years later, which proved to be the pivotal moment when Euro-Americans came to settle permanently.

At first, the search for gold commanded the attention of the new arrivals; however, during subsequent decades prospectors made alarmingly rich strikes of silver and other metals throughout the Rocky Mountains. The development of what became one of the world's greatest mining industries rested on a variety of industries that grew on the plains at the base of the mountains. Agriculture and ranching, which provided goods for mining and other industries, were of prime importance, and these businesses left a legacy important to Front Range communities today. Many Front Range towns, founded by agriculture and ranching, still retain ambiance and character from this important history.

Pressures from land development, population growth, and shifts in economies from agriculture, ranching, and heavy manufacturing to commercialism and information technologies are currently changing the character of Front Range communities. The loss of historic places and ambiance lies at the center of the change. In this context, the City of Fort Collins developed aggressive public history and historic preservation programs in an effort to manage the changing nature of the city's character. As part of its historic programs, the City contracted with SWCA Incorporated, Environmental Consult firm, to produce a historic context of the sugar beet industry, which played a significant role in the region's development. This publication serves as the historic context of the region's important sugar beet industry, and while it focuses on the Front Range, the industry must be discussed statewide.

Figure 1.
Because of its profound contribution to Colorado's economy, the sugar beet was often referred to as "white gold" or the "silver wedge." *(Great Western Sugar Company, 1916)*

This historical context addresses the set of primary factors that made up or influenced the Front Range's sugar beet industry. The factors include the physical setting; how farmers grew sugar beets; how sugar companies extracted sugar from beets; and the sugar

This project was paid for in part by a State Historical Fund grant from the Colorado Historical Society.

industry's history. The beet sugar industry did not exist in a vacuum, so other historical trends are woven into the context, such as regional history, economics, and politics.

Producing a context woven together with different aspects of history required a research strategy capable of accounting for a wide array of information sources. Ten general topics served as research targets for the context, and they are defined as:

1. Physical Setting: The physical factors that influenced the Front Range's sugar industry, such as weather, climate, water, and soils.
2. Regional History: Historical trends and events that provide a framework for the evolution of the Front Range sugar industry.
3. Irrigation: Sugar beet farming required irrigation water, and the spread of beet farming fostered the further development of irrigation systems on the Colorado plains.
4. History of Colorado's Sugar Industry: Historical trends, development, and evolution of Colorado's sugar industry, including companies, labor, and politics.
5. History of the Sugar Industry: Historical trends, development, and evolution of the sugar industry, with an emphasis on the United States.
6. Sugar Industry Economics and Legislation: General economic trends and key legislation that influenced the sugar industry, especially beet sugar, in the United States.
7. Labor: Trends in terms of demographics, economics, and living conditions of the labor necessary to Colorado's sugar industry.
8. Growing: Methods and technology for growing sugar beets, and those specific to Colorado and the Front Range.
9. Manufacturing: Methods and technology for extracting sugar from beets, and those specific to Colorado and the Front Range.
10. Biographical Information: Biographical information from people important and influential to Colorado's sugar beet industry.

To obtain information pertaining to above topics, Colorado's prime archival institutions were perused. For a list of the institutions and the materials they offered, see Table 1 on the next page.

The catalogs of most of the libraries are available on the Internet, and hence the Internet served as the primary vehicle to search the targeted research institutions. Lists of all relevant materials were assembled based on the catalog searches, and organized by topic, then research institution. The potential sources were then arranged according to importance in terms of the information they contained. Three institutions offered the greatest bodies of materials, and they included the Norlin, Engineering, and Business libraries at the University of Colorado at Boulder, the Morgan Library at Colorado State University at Fort Collins, and the Denver Public Library. Many of the other libraries featured materials repetitive with those in the three primary institutions.

Two publications provided indispensable coverage of Colorado's sugar industry. John May's 1989doctoral dissertation, *The Great Western Sugarlands: the History of the Great Western Sugar Company and the Economic Development of the Great Plains*, was published. In 1980, Dena Sabin Markoff wrote another doctoral dissertation entitled *The Beet Sugar Industry in Microcosm: The National Sugar Manufacturing Company,*

1899 to 1967. Markoff's dissertation focuses on the history of the National Sugar Manufacturing Company and includes aspects of the beet sugar industry in southeastern Colorado for context.

May's and Markoff's important works did not discuss in detail how farmers grew beets, and how sugar companies converted the beets into sugar. To address these issues, historic texts and government reports proved to be the best sources. The texts and reports also offered information regarding economics, politics, labor, and industry history. An abundance of both primary and secondary research sources are available concerning the beet sugar industries of Colorado and other areas of the nation.

Table 1. Archival Institutions and Research Materials

Institution	Materials	Visited
Boulder Public Library	regional history, physical setting, inter-library loans	yes
Bureau of Land Management	none	yes
Colorado Historical Society: Stephen Hart Library	historic photographs	yes
Colorado Office of Archaeology and Historic Preservation	none	yes
Colorado State Archives	sugar company history	no
Colorado State University	regional history, sugar industry history, sugar company history, beet farming, sugar manufacturing	yes
Denver Public Library Western History Collection	regional history, sugar industry history, sugar company history, beet farming, sugar manufacturing, historic photographs	yes
Fort Collins Public Library	regional history, sugar industry history, sugar company history	yes
Grand Junction Public Library	regional history, sugar industry history, sugar company history	yes
Pueblo Public Library	regional history, sugar industry history, sugar company history	yes
University of Colorado at Boulder	regional history, sugar industry history, sugar company history, beet farming, sugar manufacturing, physical setting	yes
U.S. Department of Agriculture	agricultural statistics	no
U.S. Geological Survey	physical setting	no

CHAPTER 1

The Physical Enviornment: One of America's Best Sugar Beet Regions

The Great Plains, which extended east from the toe of the Rocky Mountains into the Midwest, held a unique place in the geography of North America. From an elevation of around 5,500 feet above sea level at the base of the Rockies, they sloped gently east and featured an almost unbroken expanse of grassland dissected by minor stream channels. Early in the history of the American West, the plains presented Euro-Americans with a formidable obstacle, and Euro-Americans saw the plains as a trial to be endured on their journeys to areas beyond.

The Lewis and Clark expedition, Zebulon Pike's 1806 expedition, and Major Stephen Long's 1820 expedition were the first Euro-American attempts to quantify and characterize the territories west of the Mississippi River. All agreed that the Great Plains were tantamount to an inhospitable desert unfit for settlement. The conclusions of Long's expedition illustrate how Euro-Americans would view the plains for decades:

> In the summer of 1820, for example, Major Stephen H. Long of the United States Topographical Engineers led a scientific expedition of twenty people up the Platte River from its junction with the Missouri. Like the expedition of Lewis and Clark in the previous decade, these explorers were looking to see what the West held of value to the United States. The terrain was grim. Botanist Edwin James compared the plains of western Nebraska to the 'dreary solitude of the ocean,' finding it 'tiresome to the eye and fatiguing to the spirit.' His account of the journey refers repeatedly to the 'inhospitable deserts of the Platte,' a 'barren and ungenial district' of 'naked sand.' The country upriver, in the northeast corner of present-day Colorado, was even worse, more sterile, more monotonous. In Long's report of the expedition appears the famous evaluation of the entire central plains as a Great American Desert.[1]

Immigrants travelling overland to Oregon and the California gold fields confirmed that the plains were a Great American Desert. Wealth seekers that came to Colorado in 1858 and 1859 – then recognized as part of the Kansas Territory – were skeptical that the agricultural crops and methods then in use could be applied to the hostile, dry environment of the plains. As late as the 1870s, settlers along the Front Range, which is the range of mountains extending from Laramie, Wyoming, to Pikes Peak, Colorado, felt the area could not be farmed on a significant scale. When Horace Greeley visited the region in the late 1860s, he described the plains as "a land of starvation."[2]

Despite the predominating perspective that the plains were a Great American Desert, in the several decades following the Pikes Peak Gold Rush, settlers on the Front Range proved some fruits and vegetables could be successfully farmed on lands near the major streams and rivers. The ground that farmers plowed up consisted of what today's biolo-

gists recognize as *short grass prairie*, which is a grassy mat. In actuality, the plains along the Front Range feature two *life zones*, which are biological definitions of plant and animal communities. The *plains life zone* occupies the relatively flat ground east of the mountains, and it grades into the *foothills life zone*, which begins near the mountains' base. Grassland ecosystems, featuring as many as 50 to 75 species of grass in a single area, with little other vegetation, defines the plains zone, while grasses mixed with dense scrub forms the foothills zone. Native grasses include Colorado blue stem, buffalo grass, wiregrass, and others; sagebrush and cacti grow on well-drained soil. The scrub often consists of Gambel oak, mountain mahogany, juniper, and pinion pines. In contrast to the seemingly barren grasslands, narrow bands of riparian communities grew along the drainages that featured water all year. From afar, settlers could have recognized the drainages by stands of cottonwood trees, willows, wild rose, and currant bushes. The settlers brought with them non-native species that grew at first in areas they disturbed and later invaded the native plant communities. Weeds including Russian thistle, cheat grass, foxtail barley, and tumble grass proliferated on the grasslands, and box elder trees, elms, and Russian olives found a receptive environment amid the riparian areas. Little did the early settlers realize that the ground they cultivated was one of the best regions in the world for growing sugar beets, and that thousands of acres of beet fields would occupy the Great American Desert.[3]

The plains possessed all of the fundamental physical characteristics necessary for the successful cultivation of sugar beets, and as a plant, the sugar beet was ideally suited for the environment of the plains along the Front Range. The sugar beet consists of three components that work in a balanced fashion to permit it to thrive in climates such as that on the Front Range. The beet features a large, *central root* that grows immediately below ground surface. A deep taproot extends over inches down to draw nutrients and moisture up into the central root, and a network of rootlets extends outward for the same function. The *beet top* consists of a crown of leafy greens that sprout out of the central root. Agriculturalists defined the ideal beet as weighing two pounds, with the top comprising between one-half and two-thirds of the plant mass.[4]

Together, the beet's three components acted in concert to manufacture sugar. The roots brought minerals and moisture into the central root, which passed the materials into the leaves. There, fueled by photosynthesis, the plant recombined the chemical elements into sugar in a reaction. The plant combined CO_2 with H_2O to produce $C_6H_{12}O_6$, which is a monosaccharide sugar, and $C_{12}H_{22}O_{11}$, which is a disaccharide sugar. The reaction also produced O_2 given off as a byproduct. A monosaccharide is the simplest sugar molecule and is commonly known as *glucose* or *grape sugar*. Slight variations include *fructose* and *fruit sugar*. When two monosaccharide molecules are combined, they form a disaccharide molecule.[5]

Left alone, the beet grows the first year and flowers in the second, so it stores the sugars in the root for the second year. The sugar-laden root became the focus of the sugar beet industry, which found a sugar content of around 12 percent by mass to be necessary to profitably process beets. The optimum balance of minerals, water, and abundant sunlight permitted the beet to maximize the manufacture of sugar, and the plains along the Front Range possessed something close to the optimum balance. Here, much to the delight

of Colorado's sugar industry, beets commonly featured 15 percent sugar, and in some areas featured an alarmingly high 17 percent.

The plains along the Front Range are relatively high in altitude, and range from around 5,500 feet above sea level near the mountains to around 4,500 feet at Greeley. Colorado's Eastern Plains begin around Greeley and extend east. In terms of north-south boundaries, the plains along the Front Range extend from the Palmer Divide between Denver and Colorado Springs to the Colorado-Wyoming border. From afar, the plains appear flat; however, a traveler traversing the region would conclude otherwise. While the plains feature little abrupt topographical variation, a dendritic pattern of drainages dissects the region, forming a series of broad, shallow valleys separated by low mesas. The South Platte River emerges from mountains southwest of Denver, flows northeast to Greeley, curves east and flows to Brush, then resumes a northeast direction and leaves Colorado in the state's northeast corner. Just outside of Colorado, the South Platte joins the North Platte, which exits the Northern Rocky Mountains near Casper, Wyoming, and flows southeast. On the plains along the Front Range, several important mountain rivers and streams join the South Platte River. From south to north, Clear Creek joins the South Platte north of Denver; Boulder Creek and the Saint Vrain River join the South Platte near Longmont; the Big Thompson joins near Loveland; and the Poudre River, the largest tributary, joins near Greeley. While the list of major drainages seems substantial, in reality the waterways are small and their flows seasonal. Regardless of their limited volumes, the drainages that dissect the plains made possible sugar beet farming.

The Euro-Americans that characterized the plains as a Great American Desert were not far from scientific fact. The plains' average rainfall is 15 to 20 inches per year, while 10 inches officially defines an area as true desert. Therefore, the beet industry relied on the above waterways for irrigation. While the plains were dry, beet farmers found the distribution of the plains' rainfall ideal for growing beets. During the winter, much of the plains' rainfall is snow, which moistens the soil. Much also falls in May (a month after farmers typically planted beet seed) that watered the plants at the right time. June is dry and sunny; 2 inches of rain usually falls in July; and another inch falls in August when the beets need water for maturing. September through November is very dry. In sum, the patterns of rain and snowfall were well coordinated with the life cycle of beets.

In addition to rainfall, other aspects of the plains' weather were conducive for growing beets. During the growing season, most days are sunny, and at the height of summer, 12 hours of sunlight per day are not uncommon. The temperature in spring ranges from the 50 to 70 degrees Fahrenheit (F) during the day, and occasional storms usher in low temperatures in the 30s F. In summer the temperature reaches the 80s and 90s F during the day, and cools off at night. With the approach of fall, the temperatures return to spring patterns, and drop into the 40s F in November. The plains offered around 300 sunny and 150 frost-free days, and beets were tolerant of the minor freezes that occurred from time to time. Like rainfall, the rise and fall of temperatures were coordinated with the beets' growing cycle. The coming warmth of spring nurtured the seedlings; the dryness, heat, and abundant sunlight of summer permitted the plant to manufacture sugar; and the coolness

of fall arrested the plant's growth during a state of maximum sugar content. The dryness of the plains also offered farmers the benefit of discouraging diseases and pests.[6]

Much to the dismay of farmers, the plains were not always conducive to growing sugar beets. While the climate was often predictable at times, environmental conditions became so hostile they threatened the very existence of Colorado's sugar industry. The Front Range lies at the intersection of three weather systems, and their impact to the plains is – to a degree – a function of the Rocky Mountains. One system lies west of the Rockies, and during the first months of winter, powerful storms blow in from the west, bringing notoriously heavy winds while contributing little snow. Another system lies north, and during the first half of winter storms creep down, bringing extreme cold, often below 0 degrees F. The third system lies southeast, and during the last half of winter, upslope storms deposit heavy, wet snows. During the spring and fall, the three systems reach stability, resulting in calm weather. However, during summer they shift, creating thunderstorms.

Western environmental historian Donald Worster defined the plains climate as being outright unpredictable and subject to serious drought every 30 years. In the 1930s and 1950s, drought combined with summer instability and the fierce winds of early winter to create conditions indelibly imprinted on American history as the Dust Bowl. Storms created during summer instability also spawned tornadoes and hail storms that destroyed not only entire crops but also farms and towns. On a smaller scale, the high winds and heavy rainfall during spring and summer had the capacity to blow and wash away soil and beet seeds, and lacerate seedlings with blowing sand, all of which ruined crops. The destruction of crops not only threatened the livelihood of farmers, but also sugar factories that depended on the crops raised by farmers.[7]

The other principal physical characteristic suited for beets possessed by the plains was the soil. While traditional fruit and vegetable crops grew best in soils rich with organic matter, agriculturalists found that beets thrived in loam, which was a blend of clay, silt, and sand with some organic material. Geologists and sedimentologists found three principal types of soil in the South Platte drainage, including *aridisols*, *entisols*, and *mollisols*. Further, the three soil types fell under the umbrella of a category known as *pedocal* soils. Aridisols are typically yellow to medium-brown sandy loams, well-drained, and form on high areas from weathered sedimentary rock and alluvium. Entisols are similar and tend to feature more silt and loam. Mollisols are often medium to dark brown, high in silt, clay, and some organic matter, and form on hills in the foothills life zone. Because of the plains' lack of rainfall, water does not leach out the mineral content of the soils, which is good for beets and bad for vegetables and fruits. The soils not only retain mineral nutrients, but also they retain a relatively high degree of alkaline minerals, which form a layer 16 to 20 inches below the ground surface. Traditional crops were not suited to the mineral-rich, organic deficient plains soils, while sugar beets, which tolerate alkaline conditions well, found a ready home on the plains.[8] Regarding the plains soils and farming, one agriculturalist stated: "The soil of the country is quite fertile, and as a rule, whenever it is watered sufficiently at the proper time – either by rainfall or irrigation – abundant harvests are reaped."[9]

CHAPTER 2

Growing and Harvesting Sugar Beets

Sugar beets were unlike any other agricultural crop. Contrary to most other forms of produce, beets were an industrial crop grown not for direct consumption by people or animals but as raw material to be processed in technologically advanced factories. In marked contrast to the application of science and technology to process beets, their cultivation and harvest continued to rely on primitive, labor-intensive methods long after mechanization came to other crops. Growing beets required more capital, engendered a greater economic risk, and necessitated a higher standard of skill and attention than other crops, but farmers were amply rewarded. The labor-intensive nature of beet farming ensured that they remained costly to raise; however, beets provided an income higher than anything else that could be grown on the plains. Because sugar beets were very capital-intensive, sugar companies – reliant on successful cultivation – subsidized willing farmers with loans and equipment. Further, to ensure the farmer harvested beets with a maximum sugar content, they often provided agriculturalists versed in the science of beet farming.

Preparing the Beet Field

Whether the farmer broke ground afresh for beets or planted previously plowed agricultural acreage, the general sequence of steps for seeding, cultivating, and harvesting was the same. In Colorado, farmers seeded beet fields in April so they could mature by November for harvest. When the time for planting arrived, beet fields had to be well prepared so the beet seedlings could thrive. The first stage of preparation involved leveling the ground by planing down high spots and filling in low areas, which ensured an even distribution of the irrigation water necessary for beets. After the farmer leveled the field, he groomed the soil by plowing and harrowing. The goal was to loosen and aerate the soil, maximize its water absorption potential, and pulverize clods for a uniform texture. Agriculturalists recommended plowing during the late fall after the field's previous crop was harvested; however, they could not agree on how deep the farmer should plow. Some suggested a depth of 8 inches for land never planted with beets, and some recommended 12 to 14 inches. If the field was previously planted with alfalfa, agriculturalists recommended plowing the land 4 inches deep, followed by immediate harrowing, which prevented the aggressive alfalfa from re-establishing itself.[10]

Until the 1940s, plowing a field was extremely hard work, which required much time. Agricultural equipment manufacturers offered a variety of plowing implements, and all were based on a similar premise. Two or more steel blades were fixed to an iron frame supported by several steel wheels, which was

pulled across the field by a team of draft animals. The farmer rode the plow on an iron seat and used levers or pedals to lower the blades to the desired depth. As the team labored in the harnesses, the blades bit into the soil and overturned it. Exposed to the elements, the farmer and team traversed the field, back and forth, until all land was plowed to the desired depth. Such an arduous task had the potential to consume much time, and one farmer manipulating a four-horse team required 8 to 12 days to plow and harrow a 10-acre field.[11]

As early as the 1880s, a few well-capitalized farming outfits employed tractors instead of teams of animals, which permitted the preparation of greater acreages and deeper plowing in less time. The first tractors were steam-powered behemoths, far beyond the financial means of most farmers. With tractors, farming outfits were able to plow their fields to depths ranging from 12 to 24 inches. By the 1910s, tractors powered by small gasoline engines became available and grew in popularity during the 1920s; however, they did not become common until the 1930s. In 1920, only 8 percent of all farmers used tractors, by 1930 20 percent used the machines, and by 1940 37 percent relied on tractors.[12]

Plowing the land had the effect of breaking up and overturning ground that settled and compacted during the previous year's crop cultivation. More work was necessary to smooth the field's rugged surface and pulverize clods of earth, and farmers used one of two types of harrows to finish the field's preparation. Some employed a *disc harrow*, which consisted of one or more sets of steel discs attached to a frame like that of a plow. Others used a *spring toothed harrow*, which had the appearance of a gigantic comb attached to a frame. The comb's teeth were made of spring steel. As the team dragged the implement across the field, the teeth bit into the earth. Whether a harrow featured discs or spring teeth, it broke up clods; flattened the earthen ridges created by the plow; and filled the depressions between.

While many of Colorado's farmers followed the advice of sugar beet experts, some failed to plow during the fall, claiming inadequate time as the reason. Those Front Range plains farmers that did conduct fall plowing took great care to properly prepare their fields, which resulted in fine crops of beets. Common practice dictated harrowing twice after plowing, and one more time after leveling the field. Experienced Front Range beet farmers, wise to the high winds of winter, were careful not to break the soil down into a fine texture until spring, lest the precious material blow away.[13]

Because the soils along the Front Range were deficient in organic matter, many farmers plowed in varying amounts of fertilizer. Coupled with the naturally occurring high mineral content, the introduced fertilizer contributed to the growth of beets with some of the world's highest sugar contents. Farmers faced a selection of fertilizers; however, only a few were well suited to the plains soils. The first type of fertilizer was *stall manure*, which had to be judiciously applied at the risk of over-nutrifying the soil. The second type was known as *green manure*, which was vegetable matter, often in form of beet tops. The third type was *humus*, and the fourth was *sugar mill wastewater*, which was available only near sugar mills. *Commercial fertilizers* constituted the last type.[14]

As late as the 1930s, agricultural experts unanimously suggested both green and stall manures and recommended against commercial fertilizers, as their impact was poorly understood. Along the Front Range, some farmers used green manure, while most

plowed in stall manure. Continued farming depleted the soils, so farmers became increasingly dependent on fertilizers; until by the latter half of the nineteenth century, they applied the material as a matter of course. By the 1950s, the dramatic shift in technology ensured that farmers had to use commercial fertilizers. Specifically, the widespread use of automobiles and trucks for common transportation at the expense of horses, and the use of tractors on the farm, resulted in the loss of stall manure sources. In parallel, the chemical industry made available an abundance of commercial fertilizers, which fostered what, became known as the "Green Revolution."[15]

Fall plowing was important because it permitted the soil to aerate, receive moisture, and integrate the fertilizer introduced by farmers. But over the winter, the soil settled, hardened, and crusted over, necessitating a second preparation immediately prior to planting. During March, farmers on the Front Range dragged their plows and harrows out to fields; plowed the fields to depth of 4 inches; harrowed the soil until it was fluffy and fine; and let the fields stand for a week.[16]

Seeding the Beet Field

Seeding the field was of the utmost importance and directly impacted the success of the beet crop. Prior to the 1930s farmers generally used team-drawn seeding machines that laid rows of seeds, and over time they sprouted in an abundance of beet plants. After the 1930s, tractor-mounted seed machines became common. Seed machines featured a set of small plows that opened the soil, two or four chutes that delivered the seeds, and another set of steel blades that covered the seeds over. On the Front Range, farmers typically used seeding machines capable of planting four rows. Farmers had to account for several variables when seeding, including how deep the seeds had to be planted, how much soil they should be covered with, and how far apart the rows should be spaced. Soil type, how well the farmer groomed the field, and the climate governed the above factors. Warm, calm weather meant that little soil was needed to cover the seeds, and abundant rainfall permitted rows to be closely spaced. To maximize the crop's yield per acre, it was in the farmer's best interest to determine just how closely rows could have been planted without crowding the beets, which resulted in a debilitating competition for nutrients and moisture.

One last variable some farmers had to take into account was the type of seed used. Until the 1940s, American beet farmers depended on European sources for their seeds. While farmers often produced their own seeds for other crops, producing beet seeds required too much time, labor, and capital, so the American beet sugar industry left it to the domain of European agricultural experts. With their lengthy experience, European agricultural experts developed a science around breeding sugar beets and produced the world's finest supply of seed. Further, they developed a variety of strains adapted to different soils, climates, and desired yields. World War II disrupted European seed production, and the lack of seeds inspired – even necessitated – that the American beet sugar industry develop its own breeding programs. The Great Western Sugar Company, based on the Front Range, was a prime force in the seed development movement and conducted much work at its Longmont experimental station. The Agricultural College located in Fort Collins

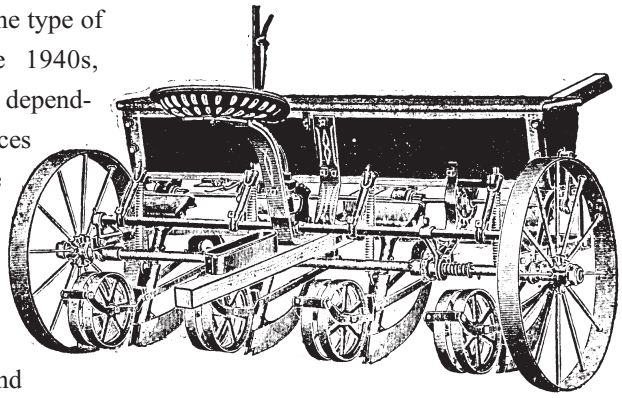

Figure 2.
Four-row beet seeder. *(From Harris, The Sugar-Beet in America)*

also played an important role in the development of sugar beet seeds.

Usually, sugar companies selected the seed best adapted to a specific region, and supplied the farmer, removing the problem of the seed as a variable. Agricultural experts generalized how farmers should plant beet seed. They suggested that farmers use between 12 and 14 pounds of seed per acre, laying the seed in rows spaced between 18 and 30 inches apart. A region's rainfall, soil type, and climate dictated the exact spacing between rows and depth of seeding. Dry weather and poor soil required greater spacing between rows, so the beets would not have to compete for moisture and nutrients.[17]

On the Front Range, farmers planted between 15 and 20 pounds of seed per acre, and spaced their rows approximately 20 inches apart. By burying the seeds deeper in drier areas, farmers ensured that the beet sprouts had an easier time tapping moisture, and the overlying soil protected them against the Front Range's notorious winds. To this last factor, one beet expert recommended planting a quick-growing crop – such as barley – between the beet seedlings as windbreaks. Planting 10 acres obliged the farmer to around 20 hours of work.[18]

On the Front Range, farmers almost always planted their beet fields between April 1 and April 10, depending on how spring unfolded. During the six to 12 days, the beet seedlings required to sprout, the farmer could turn his attention toward other fields. After this period, the farmer had to devote considerable attention to the beet field. First, if the field remained devoid of life after ten days, the farmer had to use a broad *roller* – pulled either by a team or a tractor – to soften the ground surface so the beet seedlings could break through. Once the seedlings demonstrated that they were firmly established, the farmer used a *cultivator* to destroy weeds and stir the soil between the beet rows. A cultivator featured thin steel blades mounted to a frame on wheels. The farmer adjusted the blades to a desired depth and spacing that corresponded to the gaps between the rows of beets. On the Front Range, farmers cultivated their fields frequently.[19]

Thinning and Blocking

When a farmer surveyed a beet field approximately a week after seeding, he saw raised rows of densely spaced, deep green seedlings separated by troughs of barren soil. The high density of seedlings would have prevented any single beet plant from attaining the desired two-pound size, so they required thinning. No machinery could have adequately thinned the excess seedlings without destroying the entire crop, so the farmer had to rely on human labor to accomplish the task. Because thinning required much more time than the farmer could afford, he hired laborers to accomplish the work.

Thinning beet fields was a grueling, backbreaking task. Workers – exposed to intense sun, wind, cold, and rain – used hoes, and slowly progressed along each beet row until they thinned the entire acreage. Allocating a labor pool able to meet the demands of beet cultivation proved to be no easy task. Laborers had to devote exclusive attention to beet fields for brief and intense episodes from April to November, with idle periods between the episodes of work. To accomplish key tasks such as thinning quickly, time was very important, so laborers often worked 12 hours per day. Yet, the workers had to be willing to accept low wages lest the costs of beet production exceed the crop's value. To ease the task of obtaining a labor pool willing to accept the unique conditions of beet cultivation, sugar companies often

recruited workers desperate for jobs and money. The sugar industry found a willing work force in the form of immigrants, which are discussed in greater detail in Chapter 4.

While sugar companies allocated the work force, labor management fell under the farmer's responsibility. The farmer had to explain exactly how the crops should be attended and when the work needed to be accomplished, as well as providing wages. Between the 1890s when Colorado's sugar industry began and the 1920s, the system that farmers used to pay workers evolved according to inherent problems. Between the 1890s and around 1910, farmers paid workers by the day, with thinners receiving $0.75 and board and experienced workers receiving as much as $1.25 and board per day. The problem with a daily wage was that workers felt little allegiance to any single farm, and a farmer ran the risk of being without workers at critical times. By the 1910s, farmers contracted with groups of workers and paid them by the acre. The wages fluctuated with changes in the price of beets paid the farmer by sugar companies. While contracting locked workers into tending specific acreages, they had little incentive to produce the highest and richest yield possible. Farmers solved this last problem by contracting with workers for the tonnages of beets they tended, beginning in the mid 1920s.[20]

Thinning the beet seedlings was only the first stage of an on-going process whose end result was the selection of the healthiest plants for cultivation. Following an initial pass with hoes along the rows of seedlings, workers conducted additional thinning once the plants matured further. The process still left too many beets for the given space. After the initial thinning, the farmer cultivated the troughs between the rows, and let the plants mature until they featured four to five healthy leaves each. At this point, they required one last thinning – known as *blocking* – in which workers crept along the rows on hands and knees, using a short hoe to remove excess plants. Each pass for thinning required around 27 man-hours of hard labor per acre, and final blocking required more, for a total of between 30 and 60 hours per acre. Workers often had to devote another 150 to 200 hours for weeding during the subsequent months.[21] By blocking, workers left only the best plants spaced between six and twelve inches apart, with inches being common.[22]

The beet industry constantly sought ways to reduce the cost of growing beets, especially since labor constituted most of the cost. During the 1940s, agricultural experts revolutionized beet farming by developing a seed that almost without fail produced a single, healthy sprout. Farmers were able to inject their fields with these seeds at regular intervals, which produced ready-spaced plants requiring little thinning and blocking. While such advanced technology eliminated many jobs, it also reduced the costs of beet farming, rendering beet sugar more competitive with other forms of sugar.[23]

After blocking, workers and the farmer engaged in periodic maintenance, including mechanized cultivation and weeding, until the crop was harvested in November. On the arid plains, maintenance included periodic irrigation, usually accomplished by the workers. As with most of the other logistics necessary to farm beets, the farmer was responsible for developing the irrigation system on his land. For decades, farmers in various regions employed six common systems. The agriculture industry recognized the first as *flooding by pipe*. To irrigate crops, workers laid one or more parallel pipelines from a source – often a delivery ditch – to the far end of a field. The pipelines' ends were open, and water poured

forth onto the ground. When a portion of the field received sufficient water, workers progressively removed sections of the pipeline toward the source, permitting the water to pour onto dry areas of the field. While flooding by pipe was materials- and labor-intensive, it efficiently and directly applied water, which was a sound practice where water was scarce. The *contour check system* required the mass flooding of a flat field. Such a system was wasteful of water and necessitated that the farmer expend time and money grading fields almost totally flat, (but with enough pitch) to permit excess water to drain off. For the *ditch system*, workers dug shallow distribution ditches from a source into the field. Like the contour check system, ditches could only be effectively used on fields that featured little topographic variation. The *underflow system* was another capital-intensive means of irrigation, effective for areas where water was precious. Workers constructed a buried network of perforated pipes under fields, which directly supplied plant roots with water. The *subirrigation system* relied on soil stratigraphy found in only a few regions. The concept behind subirrigation involved raising the watertable underlying a field to bring water within reach of plant roots. The field had to feature a layer of permeable topsoil overlying a substrate of impermeable material such as clay or hardpan. By flooding ditches surrounding the field, the water invaded the permeable soil and formed a high watertable. Subirrigation could only be practiced where fields were flat and water abundant. The last means of irrigation was the *furrow system*, which required little capital and could be readily adapted to plowed fields. Farmers merely had to orient the furrows created by plowing 90 degrees to the predominant slope and flood the field. The water flowed between the furrows and soaked into the high areas surrounding the plant roots. Most of the above systems tapped water from *delivery ditches* that supplied many farms.[24]

Because the furrow method offered the greatest efficiency for the least capital, beet farmers on the Front Range heavily employed it. Examination of agricultural fields on the Front Range today reveals that some farmers also used the ditch system, probably for the same reasons. If water was very scarce, they may have opted for the slip pipe and underflow systems. While the furrow and ditch systems were inefficient with water, farmers found them acceptable because beets required only periodic irrigation. Agricultural experts suggested farmers irrigate beet fields only several times per year, and more if yellowed leaves appeared, which was caused by dehydration. In fact, tests demonstrated that irrigation late in the growing season reduced the sugar content of beets.[25]

Advances in mechanical technology and the Rural Electrification Program instituted during the Great Depression made possible one additional type of irrigation system, which proliferates today. Ever since the early days of farming on the Front Range, farmers and ranchers relied on wind-powered pumps to draw water from wells to irrigate small plots of land and livestock, but the devices could never hope to supply the extensive acreages planted with sugar beets. At the same time, machinery manufacturers, responding primarily to the needs of the mining industry, developed powerful pumps (first driven by steam and by then electric motors) by the 1900s. Most farmers had neither the capital to install steam plants or available electricity, so the pumps remained out of reach until the Rural Electrification Program made electricity available. By the 1950s, electricity became common enough so that

farmers were able to pump groundwater and plant beets where none had been grown before. By the 1960s, agricultural equipment manufacturers began offering rotary sprinkling systems that pivoted around wells, which made efficient use of water.[26]

Another form of maintenance that farmers engaged in during the growing season was pest management. Disease and insects had the potential to wreck a beet crop, and farmers had to contend with up to 150 types of pests and fungi. The dreaded *curly top disease* proved to be the worst and most destructive problem, in part because its pathology eluded even agricultural experts for years. As early as 1897, beet farmers in Lehi, Utah noticed that some of their beets began exhibiting unusual characteristics, especially the curling of leaves and a stunted, unproductive root. For several decades, curly top outbreaks ravaged fields in Utah and Idaho, threatening the livelihood of farmer and sugar company alike. Yet, because the problem seemed to remain mostly in Utah and Idaho, it drew limited attention from the sugar industry. Then, in the early 1920s, curly top became an epidemic that impacted much of the West. During World War I, in response to a high demand for wheat, farmers planted vast acreages, which they abandoned following the war's conclusion. The fields became overgrown with weeds favored by a tiny white fly known as *eutettix*. The flies preferred the weeds, as well as some native vegetation, and when drought killed these host plants, the flies moved on to beet fields, which farmers kept well watered. By themselves, the flies did little damage to the beets; however, they injected a virus that caused curly top.[27]

During the early 1920s, the problem reached epidemic proportions and ruined so many crops that 22 of the West's 43 beet sugar mills had to suspend operations for want of beets. With the failure of vast acreages and a sugar milling industry on the brink of financial ruin, bankers became reluctant to lend money to farmers and sugar companies, which exacerbated the economic conditions. During the 1920s, the beet sugar industry rallied its resources and initiated a campaign to identify the problem, eradicate the flies, and breed resistant beets.

In addition to curly top, farmers faced other pests that threatened beet crops. On the Front Range, not only did farmers suffer from curly top during the early 1920s, but also grasshoppers caused significant damages, such as the swarms that struck Fort Collins in the 1930s. *Nematodes* proved to be a significant problem, in part because they were highly mobile and difficult to eradicate. Nematodes, also known as eel worms, found ready transportation on agricultural equipment and even in the digestive systems of draft animals. When they were on animal feed, nematodes entered the digestive system and passed out onto beet fields where the animals worked. Front Range farmers experienced epidemics in 1921, 1924, 1928, and 1932. The last outbreak was so severe that Erie farmers were forced to plow up entire crops and suffer the financial consequences.[28] Other pests included blister beetles, potato beetles, web worms, leaf hoppers, army worms, flea beetles, and woolly aphids.[29]

While farmers had the unfortunate task of diagnosing their pest problems, they entrusted the workers to implement solutions. Usually workers applied a variety of insecticides and herbicides to beet crops to stem pest outbreaks, and for decades, their exposure to the poisons went unregulated. Farmers generally used several of five insecticides in com-

bination, which killed through ingestion, on contact, or inhalation. Some also repelled pests. *Paris green* was an arsenate compound of arsenous acid, acetic acid, and copper oxide. Farmers applied it either as a very light dusting or as a liquid consisting of 1 pound of powder mixed with 200 gallons of water. *Bordeaux mixture* consisted of 45 gallons of water, 4 pounds of quicklime, and 4 pounds of copper sulfate. When mixed with London purple, it also acted as a fungicide. *London purple* was a by-product of dye manufacture and consisted of arsenite of lead or lime. The last substance that farmers applied to fields was a mixture of tobacco and kerosene, which adhered to the plant in wet weather.[30]

Harvesting Sugar Beets

By October, if all went well, the beet crop matured and was ready for harvesting. Usually, the sugar company dispatched a regional expert to test a sample of the farmer's beets, who recommended exactly when they should actually be harvested. To avoid problems stemming from early freezes, farmers on the Front Range began the first stages of the harvest between September 20 and October 10. At this time, the labor-intensive nature of the harvest hinged on the back-breaking labor of the farmer's work force.[31]

The process began when the farmer brought out a mechanized *beet lifter*, which loosened, but not extracted, the beet's central root. A beet lifter featured two steel blades fixed onto an iron frame supported by wheels. The blades were spaced far enough apart to avoid cutting the central root, but close enough to pull it slightly out of the ground. Until the 1930s, many farms relied on teams to pull the lifter though the fields, after which tractors were used. The farmer directed the lifter across each row of plants, followed by a group of laborers that pulled the beets out of the ground.

The reason why the lifter only loosened the beets and did not pull them up lay with the next series of crucial steps. Workers known as *pickers* followed the beet lifter; they yanked the beets out of the ground; and stacked them in piles. Another group of workers known as *toppers* then used long knives to slice the tops off every beet. Topping was of the utmost importance because the beet's sugar content lay in the root, while the root's crown and the greens featured high concentrations of alkaloid and other minerals, which interfered with sugar processing. Therefore, if the topper cut far below the root's crown, precious sugar-bearing material was lost. If the topper left a portion of the crown intact, the farmer might be accused of providing inadequately dressed beets. Topping each beet was a custom affair, yet workers had to treat thousands of beets in a timely manner. The topper had the choice of perpetually stooping or working on hands and knees. Last, *loaders* followed the toppers and used pitchforks or their hands to load the roots onto a slow-moving wagon.

Mechanized harvesting was long in coming. As early as the 1920s, a few agricultural equipment makers attempted to sell mechanical harvesters that loosened and pulled the beets and deposited them in rows. Mechanical topping was not perfected until the 1940s. The problem centered around the delicate, individualistic nature of topping each beet. Mechanical toppers cut large beets too low, wasting the valuable root material, and cut small beets too high, leaving the mineral-laden crown. During the 1920s, agricultural equipment manufacturers began selling another imple-

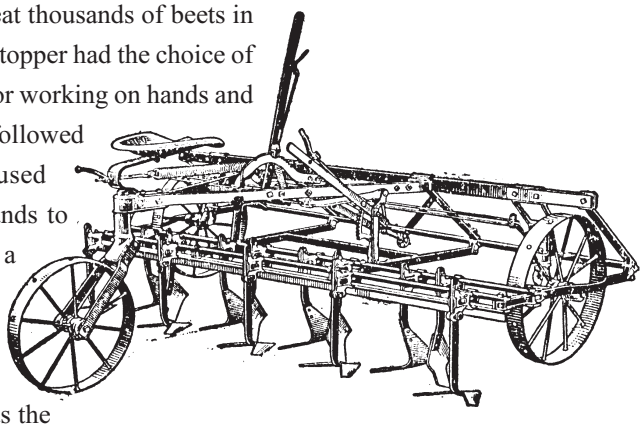

Figure 3.
Four-row beet cultivator with pivot axle and frame leveling lever. *(From Harris,* The Sugar-Beet in America*)*

ment designed to load topped beets onto an adjacent wagon, and at this time, some farmers replaced wagons with trucks. However, until the 1940s, many farmers relied on crews of workers that acted, in essence, as a large machine-mass producing dressed beet roots.[32]

The outbreak of World War II set in motion a chain of events that dramatically changed sugar beet farming. As the nation turned its attention to mobilizing for the war effort, labor became very scarce. Workers that traditionally labored in beet fields used the high demand for labor to move into better paying, more stabile jobs, leaving the beet farming industry without the human machine that pulled, topped, and loaded beets. In response, the industry turned toward mechanization, which permitted a few workers to produce large volumes of beets. The products of this movement were tractor-drawn and tractor-mounted machines that efficiently conducted the harvesting steps previously completed by manual labor. Developed in California and Colorado, harvesters loosened, pulled, topped, and loaded beets into adjacent trucks. Automated harvesters typically featured a split steel blade that loosened the beets; a spiked wheel that lifted the beets into the topping device; and a conveyor that shuttled them to a truck. In a single day, harvesters were able to process up to 20 acres and 500 tons of beets per day compared to manual labor that required 20 to 30 days for the same quantity. Workers required 15 to 20 minutes to load a truck with pitchforks, while automated loaders completed the task in between 3 and 5 minutes.[33]

The change from manual labor to mechanization was irreversible, and when the need for labor declined following the war's end, many beet workers found they were no longer needed. The 1940s saw most beet farms convert, and nearly all farms relied on harvesters by 1950. The change from manual labor to mechanization held an important and unforeseen impact on farms. Purchasing the necessary equipment required more capital than many independent farmers possessed, creating an environment where large, corporate farms squeezed out small farms.[34]

Figure 4.
Workers harvest and top sugar beets by hand near Gill, Colorado. *(Courtesy, Colorado Historical Society)*

Transporting and Storing Sugar Beets

Because beets began loosing their sugar content shortly after harvest, sugar companies strongly recommended that farmers send them directly to a point of transfer. Farmers and beet experts found that distances of 10 miles or less were economical to transport beets by wagon or truck; however, in their efforts to secure maximum acreages, sugar companies contracted with farmers farther away than the 10-mile limit. Therefore, to effectively transport beets from distant farms, many sugar companies built railroad spurs to their factories and established *beet dumps* along the railroad lines where farmers delivered their loads. Once the farmer received verification of delivery from a sugar company representative, he was absolved of further responsibility.

Beet dumps were much more involved than an open field where farmers simply

deposited their loads. Beet dumps included scales where a sugar company representative weighted a farmer's load, screens that sorted out dirt and debris, a means of transferring the beets into railroad cars, and an area for storage. When the farmer arrived with a loaded wagon or truck, the vehicle was weighed. The farmer then dumped the beets onto a grizzly, which was a screen made of iron bars and sorted out debris. In regions where farmers brought loads mixed with much dirt, the grizzly featured a trap at bottom that collected the unwanted soil, which was loaded back into the wagon or truck, and the vehicle weighed again to determine its tare. This elaborate process permitted the sugar company to record only the weight of the beets, and prevented farmers from charging for useless soil.

On the Front Range, the Great Western Sugar Company, which was the only sugar company in the region, constructed four types of beet dumps. The *platform type* consisted of an earthen ramp that terminated over a rail siding. Farmers backed their wagons or trucks up and emptied the contents onto a grizzly, which directed the beets into a rail car. With the *endless belt type*, farmers dumped their loads into a hopper, and a conveyor belt shuttled the beets into a rail car. The *circle type* relied on a large framed wheel that scooped beets from a pile and dumped them into a chute descending to the rail car. The most primitive system was the *shovel dump*, where farmers parked their vehicles on a dock adjacent to the rail line and shoveled the beets into rail cars. All of the above systems relied on gravity to permit the beets to move through the unloading and screening steps and into rail cars. By the 1950s, automation came to beet dumps and the farm, and sugar companies employed two means of transferring the roots into rail cars or trucks that shipped the material to the factory. Farmers delivered beets in trucks, and after weighing the load, parked adjacent to a portable conveyor that emptied the truck and sorted out the debris. In some cases, front-end loaders transferred the beets directly from the truck.[35]

Often, when many farms in a region simultaneously harvested their beets, they delivered a greater quantity than a factory could process. Consequently, the sugar company had to arrange for storage, which presented problems. In some cases, the sugar company requested the farmer store his beets on site, requiring additional labor. On the Front Range, the issue of storage became contentious as farmers demanded compensation for the extra work, and the Great Western Sugar Company ultimately acquiesced. To minimize the loss of the beets' sugar content, Great Western's experts recommended several means of storage, including loosening but leaving the beets in the ground, provided the weather was warm enough to prevent the ground from freezing. Great Western's experts otherwise recommended that the farmer store his beets in a *beet silo*, which was a bunker 12 feet high and 22 feet long excavated in the ground.

In most cases, however, the sugar company stored the beets in massive piles at the beet dumps or near the factory. Experience dictated that when beets were piled high, the pile's interior warmed, and some beets spoiled while others sprouted. Piles between four and six feet high proved best, and generated enough heat to minimize freezing while maintaining the beets' integrity. Further, some piles featured perforated pipes that afforded ventilation, and coverings that fended off rain, snow, and cold.

In sum, sugar beets were unlike any other agricultural crop raised in Colorado. They required more capital and attention than traditional crops, and engendering more risk, but they provided the farmer with a greater income per acre than almost anything else that could have been raised in Colorado's harsh plains climate. For example, in Colorado during the 1900s, an acre of beets cost around $35 to cultivate. Yields of 15 tons per acre were common, and at the value of $4.50 per ton, the farmer could have realized around $68, while grains and fodder fetched less than $15 per acre. In some cases, yields ran as high as 25 tons per acre. Yet, poor farming practices, natural disasters, and impoverished soils had the potential to reduce yields to as low as 8 tons per acre. History indicates that high yields were the norm; otherwise, farmers would not have planted enough acreage to supply the 22 sugar factories that operated in Colorado.[36]

Some agricultural experts touted beet farming as offering many benefits aside from financial returns for a region's agricultural industry. They claimed that successful cultivation required the farmer to learn exacting practices that he carried over to the rest of his crops, resulting in a net improvement in the farmer's income and the development of superior techniques.[37] In addition, agricultural experts proved that rotating beets with other crops benefited the soil, which manifested in high yields all around. They demonstrated that the beets' lengthy taproots brought nutrients up from the depths of the soil and deposited them near the surface. When the beets were harvested, the tap and other roots were left in the ground to decay, acting in essence as fertilizer, and the roots left channels in the soil that promoted aeration and loosening.[38]

Yet, growing beets presented the farmer with problems that could have been avoided with other crops. First was the risk of loosing substantial sums of capital in the event natural disasters or pests destroyed beet crops. Second, cultivating beets and maintaining the crop's health required much time, attention, and knowledge. Last, the farmer had to coordinate logistics associated with hired labor and the schedule of planting, cultivation, and harvesting with the needs of his other crops. Managing labor proved to be difficult, as workers had to be productive, efficient, and complete the necessary tasks in a qualitative fashion. Based on the success of Colorado's sugar industry, farmers on the Front Range proved themselves adept at meeting the challenges of raising beets.

CHAPTER 3

Manufacturing Sugar from Beets

In stark contrast to the primitive, labor-intensive nature of beet farming, manufacturing sugar from beets relied on advanced technology and the careful application of chemistry and physics. Without highly-efficient processes and the use of fine engineering, sugar made from beets would not have been cost competitive with cane sugar. Manufacturing sugar from beets required a complex series of steps in which beets were processed physically, then chemically. In addition to the machinery directly involved in the conversion of plant matter into sugar, factories also featured components necessary for the facility's function. Many beet sugar factories rivaled the largest manufacturing facilities that the industrial revolution had to offer in terms of size, complexity, and capital investment. Further, for a sugar company to operate on a profitable basis, the factory had to process beets in economies of scale. Since one beet yielded approximately 14 teaspoons of sugar, the factories had to be able to process hundreds of tons of roots per day.[39]

Delivering the Beets

The process of converting beets into sugar began well outside the factory. Every beet factory featured a vast beet dump consisting of numerous rows of beets delivered either by train, by farmers' wagons, or both. During the first half of the twentieth century, flumes flushed the beets from the dumps into the factory. Hence, the rows of beets flanked the flumes. In keeping with industrial revolution engineering, gravity was used to transfer the beets from the rail cars into the flumes, and trains arrived on elevated tracks and discharged the beets into hoppers or a shed adjacent to the flumes. A dozen workers walked along side the flumes and shoveled the beets into the moving water, or manipulated gates that regulated the beets' descent. At some factories, grizzlies separated out debris and dirt.

Most flumes were made of planks and were between 18 and 24 inches wide and 30 inches deep. Workers built them at a pitch steep enough to permit a rapid flow of water. Powerful pumps siphoned water warmed from the factory's processes and discharged it into the flumes' heads. Once the beets became immersed, the water immediately began diffusing the sugar content, so time was of the essence. While beet dumps (and sometimes the sheds) featured grizzlies that removed debris, waste materials inadvertently made their way into the flumes, which fouled machinery when not removed. Therefore, the flumes featured additional screens and barbed hooks that snagged light material and traps in the flume floors that captured rocks. Because the beets were lighter than the rocks, they washed over the tops of the traps, while the heavier rocks dropped in. Workers who monitored the flumes had to clean the traps on a regular basis through hatches in the traps' walls,

accessed underneath the flumes.[40]

While the flumes removed much of the dirt that clung to the beets, they had to be absolutely clean prior to processing. Therefore, the flumes delivered the beets into a chamber that lay at the base of a battery of special *washing tanks*. Either *bucket lines*, *wheels with baskets*, or giant rotating *feed screws* lifted the beets out of the chamber and dumped them into the tanks. The Dyer washer was the oldest model and consisted of a large rectangular tank equipped with paddles that rotated, agitating the beets. While washer designs improved, most were based on the Dyer model, and some featured a spray that played across the beets as they slid down a chute toward the tanks. By the 1950s, many factories installed Silver Beet Washers, which consisted of high-powered sprays of water that blasted the beets upward along a bed of rollers.[41]

The paddles in the washers pushed the beets up and out of the tanks into a second washer that rinsed them a second time, and they were ejected either into a hopper or a chute that delivered the beets into slowly rotating, perforated drums that drained excess water. The beets tumbled out of the drum's mouths onto an elevator, usually in the form of either a bucket line or screw, which lifted them into a hopper high in the factory. There, a worker weighed batches of beets and another worker sampled the beets periodically, which were assayed for their sugar content. Weighing and assaying proved to be of great importance, because the sugar company calculated how much sugar the incoming beets represented, and they compared the results with how much sugar the factory actually realized. Significant discrepancies between the two figures meant that a problem, and hence a loss of profits, lay somewhere in the processing steps.[42]

Physical Reduction: Slicing the Beets and Sugar Extraction

Locating the hoppers high in the factory permitted the use of gravity to draw the beets through the stages of physical reduction and treatment. The hoppers fed the beets into vertical tubes that were part of cutting machines. Each tube held a column of beets, and the column's weight pressed the bottom beet against a rapidly spinning, corrugated blade that shaved off V-shaped slices known as *cossettes*. The slices dropped out the side of the cutter and fell onto a conveyor that delivered the cossettes to another scale, where they were weighed again with the intent of tracking sugar recovery.[43]

From the weigh station, the cossettes were transported to the *battery of diffusion cells*, where hot water extracted the sugar content, forming what factory workers termed *juice*. Nearly all batteries featured between 11 and 14 individual tanks usually arranged in line, which had to be loaded with 3 to 6 tons of cossettes each. As can be surmised, diffusion cells were large, often two stories high, and half as large in diameter. For decades, sugar companies employed three basic forms of diffusers in their factories. The *true cylinder* was a large cylindrical vessel with either a conical or curved bottom, and the symmetry of the shape permitted a uniform flow of juice through the interior. The *sloped floor* model featured a floor that sloped from one side of the vessel to the other, where a drain perforated the wall. While the design provided superior draining, the sloped floor inhibited a uniform flow of juice. Last, the *tapered* model featured walls that constricted toward the vessel's bottom. The true cylinder was the most popular model.[44]

All diffusers shared common features

necessary for their function. To admit and drain juice, diffusers featured input and output pipe couplings fitted with valves and stopcocks that permitted displaced air to escape while the vessels were being filled. Pressure gauges and thermometers permitted workers to monitor the vessel's interior conditions; a port on top facilitated loading fresh cossettes; and another port at bottom allowed a worker to extract spent cossettes and clean the interior. Because diffusers operated under pressure, the ports featured hatches closed by levers against stout seals. Diffusers also featured small taps that permitted workers to sample the juice for quality-control testing. In the interior, a heavy screen suspended the load of cossettes above the floor, and intermediary chains helped maintain space, as well as buttressing the vessel's walls.

The exact operation of the diffusion battery varied with each individual factory, and it depended on variables such as the beets' sugar content, water temperature and quality, and associated equipment. However, all diffusion batteries functioned according to the same basic principal. After workers loaded each diffusion cell with cossettes, the cells were filled with hot water, which broke down the beet material's cellular walls, and the sugar *diffused* into the water. To maximize sugar extraction, the juice in the last diffuser was piped to the first, and the juice circulated through the units in between. When the transfer of liquid was complete, a worker closed the valves and let the cossettes steep for approximately one hour. The process was repeated as many times as there were diffusers in the battery. To facilitate the flow of what became a thick liquid, plumbing linked the cells in series. The plumbing featured valves to stop the flow of liquid between diffusers; check-valves that prevented the liquid from backwashing; and a powerful pump to power the system. Last, the line that delivered fresh water passed through a heat exchanger where steam pipes heated the water.[45]

Delivering the soggy, unwieldy cossettes into the diffusion tanks presented a major problem. In Europe, sugar factories solved the problem by arranging the battery of vessels in a circle on a giant turntable. A conveyor stationed overhead loaded the first diffuser; a worker rotated the turntable until the next vessel was in position and could be loaded; and so on until all were filled. Arranging the diffusers on a turntable presented costly engineering hurdles in terms of coupling them with water input and drainage lines, and steam lines to power the pump. American beet sugar factories arranged their batteries in line, as noted above. To load each vessel, a large rake on an overhead gantry dragged loads of cossettes from the slicer and dumped them into mobile chutes that directed the material into the vessel's tops.[46]

Once the diffusion process came to completion, workers had to clean the spent cossettes out of the vessels. They poured the material from each vessel into a flume that carried it off to a rotating screen where hot air dried the cossettes. The material dropped out of the screens into tubes where more hot air propelled it into a warehouse. There, workers weighed the material and sacked it as animal feed.[47]

One of the inefficiencies inherent in the diffusion process was that the system had to be stopped when the fresh cossettes were loaded and again when the spent material was removed. Such stoppages limited the quantity of material that could be processed. To maximize production, sugar companies began employing new *continuous feed diffusion processes* in the 1940s. Many companies scrapped the old diffusers and installed the continuous feed systems where water circu-

lated in one direction and the cossettes in the opposite direction. Fresh water flowed into the system's head and juice flowed out the end, while fresh cossettes entered the end, and spent cossettes exited the head. The *Silver Continuous Diffuser* was one type of system, and it consisted of a giant series of serpentine tubes. A chain, driven by sprockets, dragged the cossettes through against the flow of liquid. The *slope diffuser* featured a spiral feed screw that rotated the cossettes through a long, narrow tube. The *scroll diffuser* consisted of a series of tanks, and wheels with screen baskets scooped the cossettes from one tank and dumped them into the next, while the juice circulated in the opposite direction. Like the original diffusion process, the spent cossettes were dried and sacked as feed.[48]

Chemical Treatment: Liming and Carbonation

The juice produced by the diffusion battery not only featured a high sugar content, but also it was laden with liquefied beet matter and other impurities that had to be removed. Here, chemistry played an important role. Pipes conveyed the juice from the diffusion battery into *liming machines*, which introduced lime into the liquid. The machines were enclosed and featured agitators that blended the juice with the lime, turning the liquid basic in terms of pH. Sugar factories often manufactured their own lime by roasting lime rock in a coke oven, and those that lacked such a facility purchased the material in bags. Sugar company chemists found that coke was the only acceptable fuel because it was the cleanest burning. When in solution, the lime reacted chemically and mechanically with many of the unwanted impurities created by diffusion. Chemically, the lime neutralized acids and formed solid precipitates, and mechanically, the lime coated solid impurities.[49]

At this point, the juice was a thick, basic, opaque liquid. Some of the large solid precipitates settled out, but much fine material remained suspended. To remove the remaining particulates, pumps forced the juice into *filter presses* under pressure, which captured solid matter while permitting liquid to pass through. Most filters were up to 16 feet long. Great Western used *Kelly filters*, where the juice flowed into hollow frames and passed out through perforations. From the frames, the juice entered chambers enclosed by heavy cloth that collected the precipitates. A worker *dressed* the filter by installing the cloth barriers, and removed them to scrape off the *filter cake* after the juice passed through. Another worker washed the filter cake to dissolve any sugar that may have remained and sent the rinseate back for filtration. The lime was separated out for reuse, and the wastes were shunted out to lagoons.[50]

While the juice no longer contained solid matter, it still remained a base. From the filter presses, pipes carried the juice through heat exchangers that kept it liquefied and on to *carbonation tanks*. In the vessels, carbonic acid gas bubbled through the juice, balancing the pH and removing the dissolved lime. The CO_2 molecules in the gas combined with the calcium (Ca) of the lime to form calcium carbonate ($CaCO_2$), which was a solid material. To remove the calcium carbonate, pumps forced the juice through another set of filter presses. To ensure that all impurities were removed, the juice flowed through another set of carbonation tanks and filter presses. Last, pumps propelled the juice through more heat exchangers and on to the *sulfur station*, where another machine boiled the liquid and added sulfurous acid, balancing the pH and ultimately bleaching the sugar. The liquid was

filtered one last time, becoming what sugar companies recognized as *standard liquor*.[51]

Crystallizing the Sugar

With a sugar content between 50 percent and 65 percent, the standard liquor neared the end of processing. To enable the thick liquid to flow to the next step, the standard liquor passed through another set of heat exchangers that kept the mass solvent. The liquor flowed into a set of five *evaporators* where it was boiled with the intent of driving off excess water, which collected in cooled *condensers* for reuse in the factory. Vacuum pumps reduced the pressure within the evaporators, which promoted volitization of the water. The liquor flowed from one evaporator to the next, becoming increasingly concentrated. Sugar factories commonly employed evaporators that were 10 by 13 feet in area and 11 feet high. The evaporators consisted of a cast iron housing and an arched roof, clad with hardwood planks. The interior featured heat exchangers made with brass plumbing. Steam entered the bottom rear of the exchanger, exited through the top front, and proceeded to the next evaporator.[52]

When the liquor neared a state of super saturation, a worker admitted it into one of several *vacuum pans* where the sugar finally crystallized out. The vacuum pans kept the liquor boiling to maintain its liquid state. At this point, the liquor was inherently unstable, kept liquid only by great heat. Typical vacuum pans were cylindrical with a steam heat coil at center and slowly rotating agitators that kept the mass from settling. Great Western employed pans 10 to 14 feet in diameter, with a conical bottom and domed top, sided with hardwood planks.[53]

While the vacuum pans promoted crystallization of sugar, the process was in actuality a function of the expert supervision of workers. When pumps decreased the pressure within the vacuum pans to the right degree and the liquor boiled to a determined state of super saturation, a worker *shocked* the liquor by injecting a small quantity of manufactured sugar. The injected sugar crystals acted as seeds that promoted crystallization of the sugar content in the liquor. After three hours 45 percent to 50 percent of the mass crystallized, and the remainder crystallized over the course of 48 to 72 hours. During the latter stages, under the watchful eye of workers, the vacuum pans cooled, which aided the formation of sugar crystals. What remained in the vacuum pans was a combination of crystals; kept loose by the pans' agitators; in a matrix of syrup from which no additional crystals could be coaxed.[54]

Separating the Sugar

A worker transferred the blend of syrup and crystals, known both as *white massecuite* and *fillmass*, into large, V-shaped tanks with agitators that kept the mass from settling. Another worker activated a battery of centrifuges, and when the baskets reached the optimum speed of around 1,000 revolutions per minute, he opened a valve that permitted the fillmass to slowly pour in. The centrifuges employed by Great Western featured baskets with perforated sides between 30 and 40 inches in diameter and 24 inches deep. Under great centrifugal force, what the sugar industry recognized as *green syrup*, which was actually brown in color, drained out the baskets' perforated sides and flowed through pipes to holding tanks, leaving white sugar in the baskets. A worker sprayed the sugar in the spinning baskets with hot water to wash off any residual syrup. Because the rinse water dissolved some of the sugar, a worker opened valves that piped the rinseate to a different holding tank.[55]

When the centrifuges came to a stop after between seven and ten minutes, a worker engaged a mechanism that dumped the sugar out of the pans into hoppers. Feed screws sent it to the *graining station*, where the sugar tumbled in trommel screens under hot air. The trommel screens were horizontal, cylindrical tubes with perforated sides that classified the sugar by grain size as they rotated. The hot air dried the sugar, promoting classification. The dry sugar slowed trickled out of the trommel screens into hoppers, and feed screws sent the finished product to be packaged.

In their attempts to maximize the recovery of sugar, factories usually sent the green syrup, now known as *high green*, and the centrifuge rinseate, known as *high wash*, back through the boiling and crystallization steps for treatment. Both were processed separately and only after enough material accumulated in the holding tanks. Pumps forced the high green back to the boiling pans that concentrated the sugar content, while the high wash, which already featured pure sugar, was piped directly to the vacuum pans for crystallization. When the vacuum pans were empty, a worker introduced the high green, which a worker shocked with manufactured sugar. Because the high green contained impurities and material that resisted crystallization, the process required a lengthy three to five days, resulting in less sugar per volume. The fillmass was piped into the V-shaped tanks and on to a different set of centrifuges. The end products of the centrifuges were brown sugar and molasses, from which the traditional vacuum pans could extract no further sugar.[56]

As a product, many industries found uses for molasses. The cattle and pork industries used molasses to supplement feed; the distilling industry used it to make liquor, consumers used it as a sweetener; and it served as an ingredient in processed foods and medicines. Sugar companies, however, saw the high sugar content of molasses as a loss, and they experimented with ways of extracting white sugar from the thick syrup. By the 1900s, sugar industry chemists developed the *Steffen process*, which achieved success. Many sugar mills erected Steffen houses where they treated molasses, which had to be piped from the mill in a heated, liquid state. The Steffen process required diluting molasses to 6 percent concentration, and as the liquid cooled, it was subjected to high quantities of lime in *batch lime machines*. When the lime interacted with the dilute molasses, it formed insoluble tri-calcium saccharate solids, which precipitated out of solution. Pumps forced the liquid through filter presses, workers cleaned out the filter cake; and the remaining liquid was heated to around 170 degrees F, causing another saccharate to precipitate out. The saccharates were subjected to intense carbonation, which formed calcium carbonate and sugar. By the 1950s, the remaining liquid, known as *concentrated Steffen filtrate*, became the raw material for the manufacture of mono-sodium glutamate (MSG).[57]

Sugar Factories

As can be surmised, sugar factories featured a maze of pipes, machines, flumes, and tanks. Further, because sugar companies had to produce sugar in economies of scale, multiple and duplicate sets of equipment were necessary. Engineers relied on gravity to draw the materials through the various processes, which required the use of vertical space. To enclose the assemblages of equipment and provide vertical and horizontal space for the various manufacturing stages, factories were massive edifices standing amid a complex of outbuildings, roads, railroad

Figure 5.
Great Western's sugar factory in Fort Collins, November 24, 1932, at the height of the beet harvest. *(Courtesy, Fort Collins Public Library.)*

spurs, and flumes.

The factory at Fort Collins; erected in 1903 by the Fort Collins Sugar Manufacturing Company; serves as an example typifying a moderate-sized complex. In total, the factory featured over seven buildings, beet sheds adjacent to railroad trestles, six flumes, and a 150-foot-high brick smokestack on 120 acres of land. The company built the mill adjacent to the Poudre River (which supplied water) on the north end of town. Railroad trains delivered beets to long sheds that were served by the flumes. A tare room, 31 by 34 feet in area, weighed incoming vehicles, and a scale room weighed loads of beets. The central building was 70 by 300 feet in area and four stories high, and featured various floors that supported the machinery. Workers constructed the building with brick walls over stout stone masonry foundations, and a steel frame supported the walls and concrete slab floors. A 70-by-200-foot warehouse where sugar was stored stood on the central building's east side. Nearby stood a power plant, 55 by 215 feet in area, which enclosed a battery of 10 boilers, a steam engine, and coal bins. The company manufactured its own lime in a lime house that measured 77 by 100 feet, which featured a coke oven for roasting lime rock. Molasses generated during sugar refining was treated in a Steffen house that measured 75 by 180 feet, and a silo stored spent beet pulp.[58]

Operating a sugar factory required a substantial source of inexpensive, consistent power. Like most industrial facilities built prior to the 1920s, steam reigned supreme as the motive and heat source for sugar factories. Many of the sugar refining processes required heat to keep liquids fluid; pumps that propelled liquids though plumbing were often steam-driven; and a central and other

independent steam engines powered much of the factory's machinery. In keeping with traditional industrial technology, engineers equipped sugar factories with a battery of boilers that supplied the necessary steam. Until the 1920s, many industrial facilities relied on *return-tube* boilers for steam power. A return-tube boiler consisted of an iron tank usually 5 feet in diameter and 16 feet long that featured open tubes extending through the tank. A brick setting enclosed the boiler tank and a firebox, and super-heated flue gases traveled from the firebox, under the tank's belly, back through the open tubes, and out a smokestack. In terms of permanent power plants, return tube boilers were inexpensive to build and maintain, but they were somewhat inefficient. If left unattended, they could have exploded.

Instead of installing return-tube boilers, the Great Western engineers employed *water-tube boilers*, which were costly to build but were much more fuel-efficient and less prone to explosion. A water-tube boiler featured an overhead water tank and an underlying cluster of water-filled tubes suspended over a firebox. The tubes afforded the water maximum surface area, so relatively little fuel was required to convert it into steam. Water-tube boilers were the most advanced and efficient source of steam power available prior to the 1920s. The Great Western tended to equip its factories with Babcock & Wilcox units, which were the most popular form of water-tube boilers, and they also used some Sterling units as well as Erie City Boilers at its Greeley plant.[59]

The Fort Collins sugar factory's powerhouse was similar to those at other modestly sized sugar plants. To supply the machinery and heating systems with sufficient steam, the powerhouse featured a monumental battery of ten water-tube boilers, most of which were kept under fire. The simultaneous operation of most of the ten units required the coordinated logistics of feeding coal to the fireboxes, supplying the boilers with feed-water, and extracting ash and clinker. To minimize high labor costs associated with maintaining batteries of boilers, the Great Western mechanized aspects of fueling and removing ash from the boilers at many of its plants. Railroad cars delivered tons of coal to banks of coal bins located near the boilers. A conveyor fed coal to crushers, which reduced the cobbles to 1-inch nodules. Mechanical stokers fed the crushed coal into the fireboxes, and as it disintegrated, it dropped through boiler grates into ash pits underneath. There, flumes of water carried the waste off.[60]

The steam produced by the boilers had to be harnessed and converted into mechanical action. According to conventional industrial technology, factories of various types featured up to several powerful central steam engines that set in motion a complex system of overhead driveshafts. Huge belts passed from the engine to the driveshaft system, suspended by bearings in the building's frame, and additional belts passed from the driveshafts to specific machines. Workers engaged or disengaged machines by lever-activated clutches and belt transfer guides. Most engineers followed convention when designing the power systems for sugar factories and installed systems of driveshafts to power the various refining machines. Again, the Fort Collins factory represents the typical sugar factory, and its aggregate power consumption totaled approximately 3,000 horsepower, much of which a massive steam engine supplied. By the 1900s, electrical technology became practical, and engineers installed motors to drive some of the smaller machines. Overhead driveshafts and motors were impractical to power pumps, which

abounded in sugar factories. These important appliances usually featured small, integral steam engines.[61]

Sugar factories presented the workers with a raw industrial work environment. Most factories featured a staff of between 300 and 500 workers, and they had to be attentive to the many unregulated dangers.[62] Workers had to be careful to keep loose clothing out of the belting associated with the overhead driveshaft systems and away from the moving parts of machinery, and steam pipes and pressure valves offered workers an opportunity to burn themselves. In fact, at the Fort Collins factory one of the sugar graining screens malfunctioned, and five workers began to investigate the problem. The screen consisted of a trommel and several heating drums, which the workers began disassembling after shutting off the steam. The hot water in one of the drums did not drain completely, and when workers undid bolts holding the drum, some of the water poured out. Two workers, Charles Anderson and Nesbit Elmore, were drenched and seriously injured, while three others were splattered. After many agonizing hours, Anderson and Elmore died from their burns.[63] Sugar factories offered other hazards such as open catwalks and scaffolds, areas of low headroom, and exposure to caustic chemicals.

As a working environment, the factories also possessed characteristics merely unpleasant. The floors and some of the machinery around the evaporating, crystallizing, filtering, and centrifuge stations were at times sticky, and the ambient temperature was hot, especially during summer. The decay of effluent and beet matter in plumbing and flumes produced noxious odors, and the operating machinery and pressurized plumbing created a din that filled the cavernous building. By comparison, the work environment at sugar factories differed little from that at other large industrial facilities. Few workers questioned the hazards, and they were happy to have gainful employment.

Operating a sugar factory on a profitable basis presented problems that required attention to maximize sugar recovery. First, the millions of beets had to be adequately dressed prior to delivery and thoroughly cleaned at the factory. The crown of the beet root featured a concentration of alkaloid minerals that interfered with the chemistry of sugar extraction, so they had to be removed. Sugar companies relegated the removal of root crowns to the responsibility of the farmer, and if not carried out, could have rejected the farmer's beets. Residual dirt likewise impaired the chemistry, and sugar factories had to ensure that the washing and liming stages adequately removed such substances. Rocks, which were often similar in size and appearance to beets, had the potential to wreck cutting machines and had to be captured in the flumes and washing machinery. Sugar factories engendered other annoying problems that required time and manpower to deal with. Debris that passed through screens in the flumes fouled washing and cutting machinery. Dirty, sandy water wore pump bearings and seals quickly, and prevented valves from sealing properly. Sewers and flumes became clogged with sand, dirt, and debris.

Determining the efficiency of the sugar extraction processes proved to be one of the most significant aspects of operating a sugar factory. Sugar company chemists had to sample and assay batches of incoming beets to calculate how much sugar they theoretically

contained. The quantity sugar represented by the beets should have balanced with the quantity of the factory's white and brown sugars and molasses. In reality, due to inefficiencies inherent in the refining processes, the quantity of incoming sugar was slightly higher than the output, and a significant disparity between the two figures meant that a problem existed. Sugar factory chemists identified two major sources of inefficiencies. First, from the moment that the delivered beets entered the warm water in the transportation flumes, the sugar content began dissolving. To minimize this, factories attempted to balance the flow of materials through all of refining stages, lest problems or bottlenecks with any single stage cause the entire factory to temporarily stop. Second, chips and fragments of beet roots, known as *tailings*, too small or oddly shaped to flow through washing machines, conveyors, and cutting machines could have cumulatively constituted a considerable volume of raw material. Difficult to capture, lost tailings proved to be inefficiency difficult to mitigate. Last, dull knives in the cutting machines failed to slice beets properly, resulting in chunks of beet matter with less than optimum surface area.

One additional problem associated with sugar factories lays with their environmental impact. For a time, sugar companies piped factory effluent rife with biological and chemical wastes into local waterways. Biological wastes resulted an explosion of bacteria that created toxins and over nutrified the water, allowing algae to consume available oxygen. The chemical wastes, which included spent lime mud, boiler ash, and acids, upset the water's natural pH and created toxic compounds. For example, the Great Western's Johnstown plant piped its effluent into the adjacent Big Thompson River; riverfront water users as far downstream as Evans complained about water quality problems.[64] Even sugar factory engineers and chemists acknowledged the detrimental characteristics of factory effluent, stating: "In all cases where it is possible to keep the pulp-water separate from the bulk of the sewer water this should be done, because pulp-water is the most objectionable water of a beet-sugar factory, with the exception of Steffen, and osmose waste water." Further, "This water is directly poisonous to fish, etc., and especially so after it has started to ferment."[65]

Some sugar factories piped effluent into containment lagoons, where the water content evaporated, leaving a thick sludge. Even this solution held problems, illustrated during a severe drought that struck Colorado's southern plains during the 1950s. The National Beet Sugar Company, which operated a factory at Sugar City, piped its effluent into several lagoons. Between water conservation measures taken by the company, the high temperatures, and dry conditions, the lagoons began to dry. The exposed, decaying organic wastes produced a stench so foul and pervasive that it inundated nearby Sugar City, and residents found no refuge, even in buildings.[66]

In sum, by erecting factories, sugar companies brought heavy industry to otherwise rural, agricultural towns. Further, the establishment of a sugar factory provided hundreds of stable jobs, a market for an area's beet farmers, and an economic boost through the injection of capital, wages, and commerce. The factories were sprawling, complex facilities that required exacting engineering and the application of chemistry and physics. The sugar refining process involved numerous steps effectively completed only through the use of advanced technology.

CHAPTER 4

The Colorado Sugar Industry

During the nineteenth century, Colorado became known worldwide for its gold and silver mining industry. In a sense, the industry served as the vehicle for much of the development and settlement of the state, and many of Colorado's subsidiary businesses grew around the mining trade. The principal problem with the mining industry, however, lay with the fact that it relied on the extraction of perishable natural resources. While the sugar beet industry remained little known, it had an impact on Colorado almost as great as the mining industry. Further, in his doctoral dissertation entitled *The Great Western Sugarlands: the History of the Great Western Sugar Company and the Economic Development of the Great Plains*, William May claims that the industry produced more money than the mining industry. In contrast to mining, the sugar beet industry lent stability because it relied on sustainable farming for its raw material, rather than depletable natural resources.

The sugar industry offered significant benefits and served as an engine for the development of industries, economies, settlement, politics, and infrastructures on the plains. First, the sugar industry had a stabilizing effect on an otherwise seasonal agricultural economy. Sugar factories employed hundreds of workers throughout the year, and the substantial income earned by beet farmers carried them through the off-season. In addition, sugar companies contracted with beet farmers in advance, creating a known, quantified income. Second, sugar factories improved the economy of many agricultural towns through commerce, the distribution of wages, and the dissemination of capital. Third, beet farming required cultivation practices superior to those of other crops. By growing beets, farmers improved their practices, which they carried over to other crops, fostering greater net yields. Fourth, many farmers invested their surplus incomes from growing beets into their farms. Fifth, beet tops, spent beet pulp, and molasses became feed for livestock, which helped foster the cattle and hog industries at a time when farming began subsuming range land. Last, and of great consequence, growing beets required water, necessitating the development of irrigation systems where none existed prior to Colorado's sugar industry. The expansion of irrigation systems permitted farmers to plant more acreages than in times prior to the sugar industry.

Conversely, the sugar industry also had detrimental effects. The expansion of farming brought great acreages of native prairie under the plow, altering the natural environment. Fall plowing that left thousands of acres barren through the winter set the stage for the Dust Bowls of the 1930s and 1950s, which were several of the plains' greatest disasters. Colorado's sugar industry fell under control

of a Sugar Trust, which quashed competition and formed an indomitable barrier to farmers seeking equitable returns for their efforts. Many communities along the South Platte and Arkansas rivers based their economies on the sugar industry, and when it began to decay during the 1950s, the communities suffered. Some never recovered, and a few became ghost towns. Many towns, however, persevered, and diversified their economies, becoming the vibrant communities that exist on the plains today.

The Beginnings of America's Beet Sugar Industry

When the sugar industry came to Colorado in the 1890s, extracting sugar from beets was nothing new. Cultures in the Far and Middle East prized sugar cane for its sweetness, and European traders and invaders brought it home to European nations. The British, French, and Spanish all cultivated sugar cane in the Caribbean and South Pacific as early as the 1500s, producing enough sugar to render it a valuable commodity. Due to political instability, wars, and the high cost of imported sugar, early chemists and agriculturalists began seeking alternatives to cane sugar. In 1747, German chemist Andreas Marggraf was the first to successfully extract sugar from beets, which grew well in the European climate. Marggraf pulverized dried beet samples, added six ounces of alcohol to eight ounces of beet powder, and boiled the mass. He filtered the liquid into flask and let it stand for several weeks, during which sugar crystals formed. Due to the lack of necessary technology and economic interest, Marggraf's efforts remained experimental. Franz Karl Achard, one of Marggraf's pupils, resuscitated interest in extracting sugar from beets nearly 40 years later. Achard interested French and Prussian capitalists, who funded a small experimental refinery. Because the technology and chemistry remained crude, the plant failed and the capitalists lost interest. Ultimately, the proponents of beet sugar established a small industry centered in France and Germany by the mid-nineteenth century.[67]

Around the same time the French began successfully manufacturing sugar from beets, American capitalists attempted to establish a native sugar industry. Trial refineries were built in Michigan and Massachusetts during the 1830s, and they promptly met with failure. Curiously, one of the earliest American beet sugar companies formed in the West, long in advance of the Westward Movement. In the early 1850s, John Taylor served as a Mormon missionary in France, where he learned of beet sugar. When he returned to Utah, Taylor convinced Mormon capitalists to form the Deseret Manufacturing Company, ordering a complete sugar factory from France. Even though beet sugar factories at this time were relatively small, shipping the machinery and equipment to Salt Lake City from the Missouri River was no easy undertaking. After a great effort erecting the plant, it proved to be a failure. By the 1860s and 1870s, other enterprises, mostly German, attempted to manufacture sugar from beets on the northern plains and California. Like the Mormon effort, all were failures due to the fact that farmers were reluctant to grow the unconventional crop of sugar beets; refining technology was insufficient; and the factories were poorly situated.[68]

By the 1880s, European beet sugar companies, especially in France and Germany, became an economic force and manufacturing the commodity became well understood. In addition, chemists experimented with extracting sugar from corn, palms, melons, sorghum, and milk. Due to the numerous fail-

ures of beet sugar companies and the relatively low cost of cane sugar, American interest lagged far behind. Still, a few visionaries held optimism that sugar could be economically manufactured from beets in the United States. Edward H. Dyer, one such visionary, pioneered several attempts in Alameda, California during the 1870s. Four times Dyer tried and four times he failed. Unwavering, Dyer acquired a defunct sugar factory in Alvarado in 1879, improved the facility, and finally succeeded. His small factory was the first to manufacture sugar in economic quantities in North America, and set a precedent for others to follow.[69]

The lure of the California Gold Rush drew Claus Spreckles west, and he realized his fortune not from gold, but from sugar. While in the West, Spreckles traveled to Hawaii and became familiar with the islands' sugar cane trade with California. Realizing the potential for profits, Spreckles began importing cane to San Francisco. In 1863, he organized the Spreckles Sugar Company around a cane sugar refinery. Intrigued by sugar refining, Spreckles returned to his native Germany to study both cane and beet sugar manufacturing. Confident that he could profit from beet sugar, in 1888 Spreckles organized the Western Beet Sugar Company at Watsonville, which was a coastal agricultural town. He dispatched Head Engineer William C. Waters to Germany to study the manufacture of beet sugar, and in the same year, Spreckles and Waters erected North America's second successful beet sugar factory.[70]

Meanwhile, the Oxnard brothers also contemplated the viability of manufacturing sugar from beets. Like Spreckles, the Oxnard family became firmly established in the sugar industry by refining sugar cane. Impressed with the success of Dyer and Spreckles, the Oxnards traveled to Europe to learn how to profitably extract sugar from beets during the late 1880s, and they devised a plan to strategically locate several factories near viable markets. In 1890, the Oxnards built a plant at Grand Island, Nebraska, and in the following year they built plants at Norfolk, Nebraska, and at Chino, California. In so doing, the Oxnards became the first to pioneer sugar manufacturing on the plains.[71]

On the other side of the Rocky Mountains in Utah, Mormon interests refused to let their failures of the 1850s discourage them from establishing a sugar industry. Northern Utah featured a climate and soils conducive to growing beets, which regional farmers proved by growing beets with high sugar content. In 1889 capitalists formed the Utah Sugar Company with the intent of imitating E.H. Dyer's success in California. For two years, the Utah Sugar Company floundered and could not get its factory to yield sugar. Around 1890, the company hired Dyer to bring their ineffective mill into production, which he did by 1891. While separated by great distances, the Utah Sugar Company had a major impact on Colorado's sugar industry. Not only did the company help set the precedent of manufacturing sugar in the heart of the nation, but many figures involved in the establishment of Colorado's industry gained their experience with Utah Sugar.[72]

All of the above factories were successful due to a combination of factors. First, they were located in regions with climates conducive to growing beets. Second, the regions already featured established agricultural communities willing to growing the unusual crop. Third, the factories were located in areas with favorable economic and industrial geographies. Nearby markets provided outlets for

sugar, and the proximity to commercial centers and the presence of developed transportation networks made available necessary supplies and machinery.

The Beet Sugar Industry Begins in Colorado

While the Grand Island and Norfolk factories demonstrated that the plains held the potential to support a sugar industry, the idea had been afloat in Colorado since the 1860s. Peter Magnes came to Colorado's Front Range with the Pikes Peak Gold Rush during the late 1850s. Finding more profit in supplying miners with food than panning gold, Magnes established a farm where, in 1866, he grew an experimental plot of sugar beets. After harvest, Magnes found the beets to be of an unusually high quality, and familiar with attempts elsewhere to extract sugar from beets, he began promoting a local industry. Jacob Shirmir, the superintendent of the Denver Mint, took an interest in Magnes' promotional efforts and attempted to prove that the Front Range was an excellent beet-growing region. Shirmir sent samples of Magnes' beets to the United States Department of Agriculture. Tests indicated that they contained 15 percent sugar, which was substantially higher than beets from Germany, then the recognized beet sugar capital of the world. Further, based on the harvest from Magnes' test plot, Shirmir calculated that an acre on the Front Range could yield 50 tons of beets. In light of the information, the Department of Agriculture officially recognized Colorado as holding much potential for growing beets.[73]

Between attempts on the northern plains to manufacture beet sugar and Magnes' and Shirmir's proof that excellent beets could be grown on the Front Range, members of the Union Colony, which was an agricultural community at present-day Greeley, became interested. In 1870, with the support of the colony, founder Nathaniel Meeker petitioned the Department of Agriculture to fund experiments on the Front Range. Funds were not forthcoming, and the movement abated. Thirty years later, Meeker and the Union colonists were vindicated when Greeley became the site of one of Colorado's earliest and largest beet sugar factories.[74]

Visionaries in Colorado continued to promote the concept of producing beet sugar. During the 1870s, the Colorado Territorial Legislature passed a bounty bill that authorized an award of $10,000 to the organization or individual that produced the first 200 barrels of sugar from Colorado beets. A *bounty bill* or *bounty act* was an economic incentive offered by government agencies to entice a particular industry to manufacture a product, in this case beet sugar. The problem with the territorial legislature's bounty lay with the fact that, as of the 1870s, all previous domestic beet sugar factories were failures. The promotional efforts in Colorado continued through the next decade. During the 1880s the State Agricultural College in Fort Collins experimented with growing sugar beets, and in 1888 the state governor arranged for Grand Junction farmer M.L. Allison grow a batch of beet seeds sent by Oxnard interests. When Oxnard chemists tested the Grand Junction beets, they found the beets' sugar content superior and declared that the region had the potential for high profits.[75]

Despite several decades of promotional activity on the Front Range, the focus on Colorado's potential for sugar beets shifted to Grand Junction. In the early 1890s, the Oxnards proposed building a sugar factory in Grand Junction, and local government and beet promoters greeted the news with accolades. However, it was not to be, due to the

influence of several factors. At various times during the nineteenth century, the federal government first instituted, then renewed, tariffs on foreign sugar. The motives were twofold. Tariffs were used as a means of generating income for the government, and they provided economic protection for the domestic sugar industry. Foreign cane sugar companies in Cuba, the Caribbean, the Philippines, and elsewhere were able to produce high volumes of inexpensive sugar, primarily because the costs of labor in these regions were extremely low. In 1890, as part of the widespread reform movement that swept the nation, the federal government repealed the tariffs, which opened the door for inexpensive foreign sugar. At the same time, to mollify the protests of the domestic sugar industry, the federal government passed the Sugar Bounty Act of 1890, which authorized the payment of 2 cents per pound of beet sugar.[76] The bounty proved to be insufficient, and the tariff repeals created uncertainty for domestic sugar manufactures, including the Oxnards. As if this was not enough, in 1893 reformists in the federal government repealed the Silver Purchase Act, which demonetized silver and caused the price per ounce to plummet by around half. The repeal of the act wrecked the mining industry in the West, which precipitated a national economic depression that lasted for years. Between the uncertainties of the sugar market and the following depression, the Oxnards naturally were reluctant to build a factory in the Grand Junction area.

The Oxnards' proposal to establish a sugar beet industry in Grand Junction fomented excitement that could not be stopped. Despite setbacks, the Mesa County commissioners offered a bounty of $1 per ton of beets for the first 1,000 tons grown in the region, in hopes of establishing a record of large-scale farming. In response with the help of the Utah Sugar Company, a group of local businessmen organized the Grand Valley Beet Sugar Company in 1893 to coordinate efforts of the farmers. At the end of the growing season, Grand Valley saw three railroad cars loaded with beets leave Grand Junction bound for Utah Sugar Company's factory. Utah Sugar reported that Grand Valley's beets were highly profitable to process; however, the significant distance between Grand Junction and Lehi discouraged regular shipments.[77]

Five years elapsed before Grand Junction promoters engaged in another campaign to establish a local sugar industry. They revived the Grand Valley Beet Sugar Company in 1898 and dispatched H.J. Holmes to Denver – the economic hub of the Rocky Mountains – to secure capital for a sugar plant. By this time, the political and economic climate changed for the better, finally making beet sugar attractive. After four years without sugar tariffs, the domestic sugar industry exhibited signs of stress. Further, the inexpensive imports significantly impacted the industry in Hawaii, which fell under domestic domain. In fact, a drop in sugar prices destabilized the Hawaiian economy to the extent that the people revolted and established the Republic of Hawaii. In response to the above factors, the federal government reestablished a tariff in 1894 and repealed the sugar bounty. Dissatisfied with the 1894 tariff, the Senate and House of Representatives began deliberating improvements that favored the domestic sugar industry in the pro-business atmosphere of the McKinley administration. The Dingley Act of 1897 passed with ease, mandating a heavy tax on foreign sugar and paving the way for an explosion of the domestic sugar industry.[78]

Holmes was unable to secure the necessary capital, and the Grand Valley Beet Sugar

Company lost momentum. At the same time, the aggressive Charles N. Cox attempted to organize his own Grand Junction beet sugar company and was better equipped to do so than the officials associated with the Grand Valley company. Cox was born in Ohio, the son of a Secretary of the Interior and Ohio governor. He served as the manager of the Wisconsin Central Railroad until 1883, when he came to Colorado due to poor health. Cox became highly influential in the commerce of the Grand Junction area by the 1890s, and he invested heavily in mining, cattle, and fruit farming. In 1898 Cox first laid the foundation necessary to establish a beet sugar factory. He obtained a donation of 1,500 acres for the facility and pledges from farmers for 3,000 acres of beets, which was the minimum needed for a plant to operate. Next, Cox approached silver mining magnate John Campion, who discussed the potential of a sugar factory with his fellow capitalists.[79]

Between the efforts of Cox and Campion, a grand panel of capitalists formed the Colorado Sugar Manufacturing Company in 1899. The capitalists were actually members of an investment syndicate, which included Charles Boettcher, John F. Campion, James R. McKinnie, Charles Mitchell, George Trimble, Eben Smith, and J. J. Brown. Boettcher immigrated from Prussia in 1869 and began life in the West as a hardware merchant in Cheyenne, Greeley, Fort Collins, and then Boulder in the 1870s. Boettcher moved his business to Leadville in 1879, where he became interested first in banking, and naturally gravitated to mining. By 1890, Boettcher was part owner of both the Carbonate National Bank and the Ibex Mining Company and invested in other Leadville mines. When Boettcher moved to Denver, he branched out into other forms of business. He organized the Ideal Cement Company, the Western Packing Company, and became part owner of the Denver National Bank.[80]

Campion and Charles Trimble were both close associates of Boettcher and members of his investment syndicate, serving as part owners of the Carbonate National Bank. Trimble invested in and Campion acted as general manager of the Ibex Mining Company, and during the 1890s and 1900s, Campion served as the president of Denver Chamber of Commerce.[81]

James McKinnie was also a member of Boettcher's investment syndicate. McKinnie made a small fortune in the mining industry through ownership of the McKinnie Mine in Cripple Creek, one of the district's most significant producers and investments in other district mines. McKinnie also served as the vice president of Exchange National Bank of Colorado Springs, which was one of the Cripple Creek district's principal financial institutions.[82]

The capitalists had the necessary funding and business acumen to turn efforts to establish a sugar industry in the Grand Junction area into reality. In 1899, they contracted with the E.H. Dyer Company to build a factory, and at that point, the Dyer company had the most experience with beet sugar technology. In general, the beet sugar industry informally referred to Dyer as the "father of the American sugar beet industry." Dyer studied the manufacture of beet sugar in Europe, built North America's first profitable factory in California, engineered the Utah Sugar Company's mill in 1891, and afterward built other factories. In 1899, the Colorado Sugar Manufacturing Company's Grand Junction factory began operations, but trouble quickly developed. Apparently, the region's farmers had difficulty growing enough beets and delivering them on time. In addition, the

company's management squabbled among themselves and with the farmers. After a short time, the panel of investors sold out to a new organization consisting of George F. Nagle, H.M. Barnett, Fred W. Geddes, J.F. McFarland, and James McKinney. Most of the above individuals were local capitalists, and they brought the company into profitability.[83]

With the improved general economy and the Dingley Act in effect, Colorado was ready to host a sugar industry. Around the same time, Charles Cox perused Denver's elite for capital, and the Oxnard brothers laid plans to expand their existing beet sugar interests to the as yet unclaimed plains. Once again, the Front Range went ignored, as the Oxnards turned toward the lower Arkansas River Valley east of the steel and smelting town of Pueblo. Perhaps the intense promotional efforts of George Washington Swink persuaded the Oxnards. Swink was one of Colorado's early residents, having walked west 100 miles from the end of the Kansas Pacific Railroad, where he helped establish the agricultural community of Rocky Ford in 1871. At that time, the settlement lay far from anything, and to attract other farmers and businesses, Swink took it upon himself to serve as the region's promoter. When the Atchison, Topeka, and Santa Fe Railroad graded a line near but not through Rocky Ford in 1877, Swink donated land to permit the town to move to the railroad. During the 1890s, Swink courted the Oxnards and promoted the Arkansas River Valley's potential to provide enough high-quality beets to feed a sugar factory.[84]

Two separate events unfolded that resulted in the establishment of the first sugar factory on Colorado's plains. First, during the late 1890s the Equitable Life Assurance Company owned and foreclosed on much agricultural acreage near irrigation canals in the Arkansas River Valley. Second, the Oxnards consolidated their beet sugar interests under the umbrella of the American Beet Sugar Company. Realizing that all of the ingredients were in place, the two firms organized the Arkansas Valley Sugar Beet and Irrigated Land Company (with W.M. Wiley acting as president) as a joint venture with the intent of establishing a beet sugar industry in the region. The company possessed enough irrigated acreage to fuel a sugar factory, and only needed farmers to grow the beets. Farmers quickly materialized, and in 1900 the American Beet Sugar Company quickly built a factory at Rocky Ford.

The Oxnards were not the only capitalists interested in the Arkansas River Valley. Based in Buffalo, New York, The Buffalo Loan, Trust, and Safe Deposit Company owned significant acreages of agricultural lands and some irrigation canals in the Arkansas River Valley. To increase the value of its lands, the company charged James Roberts with organizing the Twin Lakes Land and Water Company and the Twin Lakes Reservoir Company with the intent of expanding the extant irrigation systems. Beginning in 1896, the Twin Lakes Reservoir Company began building the Twin Lakes Reservoir on a tributary of the Arkansas River near Leadville. The Twin Lakes Land and Water Company acquired the water rights for the reservoir's precious liquid and distributed it to its agricultural lands through the Colorado Canal. Aware of Colorado's potential for growing sugar beets, Pierre Van Alstyne, of Ohio, educated in the sugar industry, discussed with Roberts a scheme to bring the Buffalo company's irrigated lands into beet production, which could then supply a sugar factory. After difficulties convincing

the Buffalo company's financiers that a sugar factory would pay and securing additional capital, Roberts finally succeeded. In 1899, Roberts, the Buffalo company's financiers, and Van Alstyne organized the National Beet Sugar Company and built a factory, the second on Colorado's plains at the instant mill town of Sugar City in 1900.[85]

The Beet Sugar Boom Arrives on the Front Range

The Boettcher syndicate intently watched the developments in the Arkansas River Valley. While they were dissatisfied with their experience at Grand Junction, the syndicate knew that the manufacture of beet sugar on the Front Range was only a matter of time and that they would realize handsome profits if they could build one of the first factories there. In 1900, after the syndicate sold the Grand Junction factory, they decided to organize another company to tap the as yet unutilized resources on the Front Range. Everything required to operate a sugar factory already lay in place on the Front Range: Water, land, commerce, transportation, and a mature agricultural industry. In either 1900 or 1901, the syndicate formalized their efforts and organized the Great Western Sugar Company and began laying the groundwork to erect a factory. Unfortunately for the syndicate, other interests were already courting several Front Range communities. In 1899, Charles Cox, representing the Colorado Sugar Manufacturing Company, met with a group of Loveland farmers organized by W.D. Hoover to build a factory there. Cox negotiated a deal in which he would obtain the necessary capital to build a factory in exchange for 1,500 acres for a site, contracts for 3,500 acres of beets, and a commission of $10,000. At the same time, the Utah Sugar Company, which had a record of nine years' success in Utah, also sought to fill the vacuum on the Front Range. Utah Sugar also targeted Loveland and began arranging for a factory. An associate of Campion's in the Colorado Sugar Manufacturing Company informed Campion about Utah's growing interest, which caused a stir among Boettcher's syndicate. Feeling a need to act, the syndicate exercised force over Cox, and he relinquished his designs on Loveland. The syndicate subsumed the arrangements made by Cox.

Loveland was a natural location for a beet sugar factory. During the first several decades following the Pikes Peak Gold Rush of 1859, farmers established themselves along the Front Range's waterways, including the Big Thompson River. When the Colorado Central Railroad graded a line north from Denver in 1877, its point of crossing over the Big Thompson River became a natural center for commerce and transportation. The town of Loveland was platted there in the same year and named after William A.H. Loveland, one of Colorado's founding fathers.[86]

In haste, the Boettcher syndicate drew in additional investors to assemble the necessary $500,000 to build a factory. Remaining within Denver's high society, Boettcher and Campion interested David H. Moffat, William Jackson Palmer, and Eben Smith, who constituted another of Colorado's capitalist syndicates. Eben Smith and Moffat were associates, and Smith invested in some of Moffat's interests. In the early 1890s, Smith added to his fortune by acquiring with Moffat most of the most profitable mines in the Creede Mining District. David Moffat was a key Colorado figure and followed a path to prominence like Campion and Boettcher. Moffat was born in New York in 1839 and became involved in the banking

business there, as well as in Iowa and Nebraska. Understanding that he could profit more from business than mining, Moffat came to Denver in 1860 during the Pikes Peak Gold Rush as a merchant. By the mid-1860s, he became the head cashier of the First National Bank of Denver and president of the institution in 1880. Using his personal relationships, capital, and knowledge of mining, Moffat at first invested in mines in Leadville, and subsequently acquired some of the richest properties in Creede and Cripple Creek. However, Moffat earned notoriety as a railroad magnate by helping to finance both the Denver & Pacific Railroad and the Denver, South Park, & Pacific Railroad in the 1860s and 1870s. In addition, he served as president of the Denver & Rio Grande Railroad during the 1880s.[87]

William Jackson Palmer was as significant to the development of Colorado as Moffat. Palmer was born in Delaware in 1836, and at age 23 became secretary of the Pennsylvania Railroad. He migrated west and served as the treasurer of the Kansas Pacific Railroad between 1865 and 1870. Palmer went further west to Colorado in 1870 and immediately founded the Denver & Rio Grande Railroad. He acted as director between 1870 and 1883, when Moffat replaced him. The Denver & Rio Grande opened Colorado's interior, permitting the mining industry to flourish. Palmer was also instrumental in the establishment of the city of Colorado Springs, mostly because it served as the base of the Denver & Rio Grande. Later, Palmer became president of the Rio Grande Western Railroad, which linked Colorado with Salt Lake City.[88]

With the capital in place, the two investment syndicates organized the Great Western Construction Company to administer the logistics of bringing the sugar factory into production, and they organized the Loveland Construction Company to grade a railroad spur to the factory site from the Colorado Central Railroad's main line. Great Western obtained a quarter section of land northeast of Loveland from George Foote and contracted with the Kilby Manufacturing Company to build the factory. After a hasty construction schedule, the first sugar factory on the Front Range began production in 1901. Repeating the experience of the Grand Junction factory, Great Western's first year was disastrous. The inexperience of the farmers manifested as poor crop yields; the factory was beset with mechanical problems; and the factory workers, supplied by Kilby, left something to be desired. Not only were they incapable of handling the necessary tasks, but they also tended to be unruly, at times drunken. The Boettcher syndicate immediately set about correcting the problems and brought in Mark Austin as an adviser, who had ten years of experience with the Utah Sugar Company.[89]

Great Western set a precedent for other capitalists to build sugar factories in other likely locations. When the Boettcher syndicate effectively cut off Utah Sugar Company interests from Loveland, the company turned its attention to the town of Greeley. Like Loveland, Greeley was an ideal location for a factory, being located on the Poudre River. Greeley possessed railroad connections and was surrounded by a mature agricultural community. In 1900, C.A. Granger, associated with Utah Sugar, contacted a local committee to make arrangements to build a factory there. The committee supplied Granger with all he needed, including water rights, contracts for 5,000 acres of beets, land for a factory, and a railroad right-of-way. In 1901, Granger organized the Greeley Sugar Company and used financing from Utah Sugar and capitalists in Michigan (which fea-

tured its own sugar industry) to build a handsome factory.[90]

At the same time, promoters in the town of Eaton, a short distance north of Greeley, formed a committee that aggressively sought a sugar factory. The committee met with Charles Cox, forced out of Loveland by the Boettcher syndicate, and he allocated the necessary capital. The committee presented Cox with land for a factory and contracts for 5,000 acres of beets, and Cox hired the Kilby Manufacturing Company to build the factory. In 1902, the Eaton Sugar Company began operating the third active Front Range sugar factory.[91]

Caught up in the excitement of the Front Range's growing sugar industry, Dr. E.I. Raymond and H.C. Branch began promoting a factory at Windsor, located between Greeley and Fort Collins, to the west in 1901. They formed a committee, incorporated the Windsor Sugar Company the following year, and obtained the necessary requirements for a mill and beets. Apparently, Raymond and Branch had ulterior motives in mind. They actually hoped that the Windsor Sugar Company would merely threaten the existing sugar companies with competition and hence be targeted for acquisition. Much to the dismay of Raymond and Branch, no one wanted to buy Windsor, and they had to scramble to allocate capital to build the factory, lest they defaulted on their contracts. In 1902, Raymond and Branch found ready investors among Michigan's sugar industry, and the factory went online in 1903.[92]

Impressed by Great Western's Loveland factory, local businessmen in the town of Fort Collins realized that their region was also prime for a factory. Among all of the Front Range's agricultural settlements, Fort Collins was particularly well suited for a factory. Settlers lured by the Pikes Peak Gold Rush first settled the Fort Collins area in 1858 to farm and to guide and to trade with prospecting expeditions. They organized the Colona townsite on the Poudre River near the foot of the mountains, and they reorganized it as Laporte. To protect settlers and prospectors on the northern plains from Indian hostilities, which were rare, the 11th Volunteer Ohio Cavalry, under the command of Colonel W.L. Williams, established near Laporte a post known as Camp Collins in 1864. The camp was moved downstream and officially became Fort Collins. It served as the nucleus of a small, permanent agricultural settlement. When the cavalry abandoned the post in 1866, the settlement remained, but the land was still under military domain. In 1867, Jack Dow and Norman Meldrum surveyed and platted the small town in a triangle of streets. The thoroughfares were laid out parallel to the river and at an angle to the military compound. In 1870, the military opened the territory to homesteading, and a few more settlers arrived. Responding to the availability of the land, R.A. Cameron, who established the Union Colony at Greeley, made plans for a second colony to settle the new land at Fort Collins. In 1870, Cameron organized the Larimer County Land Improvement Company, which laid claim to property adjacent to the original settlement around Fort Collins. Cameron hired Franklin C. Avery, who surveyed the town of Greeley, to plan and locate the new town of Fort Collins. Avery established a north/south grid of streets and blocks on the south edge of the original settlement, and colonists and merchants began moving in.[93]

During the next three decades, Fort Collins developed into a significant town strategic to a number of industries. The Colorado Central Railroad graded its main line through town in 1877, and the Colorado

& Southern Railroad graded a line to Cheyenne, rendering the town an important transportation node. In 1873, a rock quarry began producing building stone, and other quarry companies quickly followed. The region lent itself well to ranching. To this last point, Fort Collins became home to the Agricultural College in 1878, which invested great effort studying and promoting sugar beets. As a testament to the town's growing urbanism, a municipal water system was installed by 1883, and an electric plant, one of the West's earliest, went on line in 1887.[94]

Building a sugar factory at Fort Collins required the staggering sum of $1,000,000, so a local committee organized the Fort Collins Sugar Manufacturing Company to begin making the necessary arrangements at the end of 1901. B.F. Hottel owned a local grain elevator and a flour mill. C.R. Welch was an early and successful Fort Collins merchant. Abner Loomis was president of the Poudre Valley Bank. Peter Anderson served as the president of the Fort Collins National Bank. T.A. Gage was the vice president of the Fort Collins National Bank. Franklin C. Avery served as the president of the First National Bank. James B. Arthur worked with Loomis and was the vice president of the Poudre Valley Bank and held interests in cement plants at Loveland and Florence. James A. Brown was a rancher of regional importance. William Bennett also was a prominent rancher, as well as a Larimer County commissioner. Fred C. Baker was serving as Fort Collins mayor. The above committee members furnished some of the capital, and they solicited most of the funds from sugar interests in the East, who would shortly change Colorado's sugar industry.[95]

In January 1902, the committee began a series of rallies intended to foment public support, which was important for the establishment of a sugar factory. During the rallies, the committee secured contracts for 5,000 acres of beets. Afterward, the committee traveled to the Michigan sugar region, toured several factories, and contracted at first with the Penoyer Brothers to build the factory. Because the Eastern sugar interests fronted most of the capital, they countermanded the contract with the Penoyers and insisted that the Kilby Manufacturing Company build the factory instead. With the capital in place, the Kilby company arrived in 1902 and began construction on 120 acres on the north edge of Fort Collins on the Poudre River's north bank, and the east side of Linden Street. A crew of 350 transient, rowdy construction workers descended upon the ordinarily quiet and conservative Fort Collins, and they erected one of the most advanced facilities on the Front Range. Because the factory would not be finished until 1903, the Fort Collins sugar company transferred the 1902 beet contracts to the Windsor and Greeley factories.[96]

After troublesome delays, *sugar day*, a beet farming town's holiday, arrived on January 6, 1904, when the factory began operations. Plant workers opened the valves admitting water into the flumes that carried beets from the beet sheds into the plants, which the factory announced with the shriek of steam whistles. Unfortunately, because the factory started up two months after the beet harvest, most of the beets had already been sent to the Greeley and Windsor plants again, and the factory had little to process. However, the company included a Steffen house amid the complex, which extracted sugar from the molasses produced by the Greeley, Windsor, and Eaton factories.[97]

The Front Range saw the establishment of one last sugar factory in the first several years of the twentieth century. Local inter-

ests, including Chester S. Morey, organized the Longmont Beet Sugar Company in 1902. After securing the necessary beet contracts, land, and water rights, the company built what became one of the Front Range's largest factories east of Longmont. Morey was a member of Denver's elite, being the owner of the lucrative Morey Mercantile Company of Denver. Like most of the Front Range's other factories, the Kilby company built the complex at Longmont. A.V. Officer, who gained experience with the Utah Sugar Company, acted as manager, and W.A. Dixon served as secretary.[98]

During the early 1900s, the decades' long efforts of sugar beet promoters known in the industry as *sugar cranks* came to fruition, and Colorado underwent a beet boom. More than 40 plains towns vied for factories, and the population in areas proximal to existing factories soared by up to 500 percent, with an influx of factory workers, farmers, and migrant laborers. The growing momentum of Colorado's sugar industry began changing the economics, demography, and physical environment of the plains. Because sugar beets were a lucrative crop, land values near factories and beet dumps increased, and the money associated with farming and manufacturing made its way into the region through wages, capital investments, commerce, and property improvements. The growth of the sugar industry set in motion one additional change to plains agriculture: the arrival of big agribusiness.[99]

The Sugar Trust Comes to Colorado

The 1880s were an era in American history when powerful capitalists and the leaders of industry formed trusts to monopolize industries and services. Amassing fortunes was one goal, while exerting control and displaying power was equally important. Most trusts operated according to a common strategy. The boards of directors representing a given industry's largest companies met behind closed doors and hammered out a plan to dominate their industry. They did so through both vertical and horizontal integration. Vertical integration involved acquiring most of the businesses related to supplying raw materials, manufacturing, transportation, and distribution of the final product. Some trusts went so far as to acquire tangential businesses. Horizontal integration involved either acquiring competitor companies outright or drawing them into the trust. When a competing company resisted a buyout or the dictums of a trust, the trust often attempted to destroy the competitor through price wars, subsuming sales or supply contracts, and acquiring the competitor's materials suppliers. The sugar industry was no exception. As J.P. Morgan was to banking, and DuPont was to explosives, the American Sugar Refining Company was to sugar.

The American Sugar Company began in 1887 when Henry O. Havemeyer quietly consulted with the directors of other large sugar companies, which, at this time, manufactured cane sugar. Together, Havemeyer, Joseph B. Thomas, William Dick, and Julius Sturseberg tacitly cooperated and formed the administrative committee of the Sugar Trust (Trust), while Theo Havemeyer, Charles Senff, F.O. Matthiessen, and Charles Foster formed the manufacturing committee. Trust-busting reformists in the East discovered Havemeyer's efforts and brought suit against American Sugar. To maintain its supremacy, the Trust's members merely dissolved the New York company and reorganized it in New Jersey. The Trust did not limit itself to sugar companies in the East, where most business was based. They approached Claus Spreckles, who ran the Spreckles Sugar

Company in San Francisco, in the late 1880s. Spreckles resisted at first, and the Trust launched a vicious price war. Given the scale of the trust, it was able to operate at a loss long enough to bring Spreckles into submission. When the beet sugar industry began showing the promise of both substantial profitability and the ability to compete with cane sugar in the 1890s, the Trust decided it must dominate the beet sugar industry, including that in Colorado.[100]

The Trust gained its first foothold in the beet sugar industry by default when it drew in Spreckles, who operated one of California's first beet sugar factories. The Trust then focused its attention on Michigan's beet sugar industry during the 1890s, which quickly succumbed. The Rocky Mountain region, with its infant industry, remained the last bastion of independent companies. In 1901, the Trust deemed the time right to exert its control in the Rocky Mountain region, mostly because the industry was young and featured only handful of companies which could be easily dominated. The Trust's plan was clever and involved a multi-layered approach in hopes of causing a panic and economic distress among the beet sugar companies. Part of the plan hinged on the contracting system that beet sugar companies used to secure necessary acreage of beets. Beet sugar companies contracted with farmers a year in advance, basing the contract value on the current price of sugar. If the price of sugar fell during the year, the sugar companies had to honor the value of the contracts, even if it meant reduced profits. Therefore, when the Trust dumped inexpensive sugar on the Rocky Mountain market as the first phase of its plan, the profits of Colorado's beet sugar evaporated. Second, when the sugar companies attempted to offer discounted sugar to their regular customers, they found that Trust agents already supplied the customers with inexpensive cane sugar. Ultimately, the beet sugar companies were not able to sell their product and had to warehouse it, while the companies' directors had to finance on-going operations.[101]

The Trust was not able to sustain its economic war for long, and the beet sugar companies held fast. In 1901, the companies in business including the Utah Sugar in Utah, Great Western at Loveland, Colorado Sugar in Grand Junction, National in the Arkansas River Valley, and American Beet Sugar in the Arkansas River Valley and Nebraska stood shaken but warily resumed business. Following its failure to subdue the Rocky Mountain industry with brute force, the Trust pursued a more subtle approach through finance. The Utah Sugar Company was the first to fall to the Trust's new tactics. Utah Sugar, which was the only beet sugar company in Utah, had long desired to acquire the American Sugar Refining Company a short distance north in Idaho. The two companies could not come to terms, and the Trust saw Utah Sugar's interest as an opportunity to gain some control over the two companies. Havemeyer met with Utah Sugar's president, Thomas Cutler, and offered a deal. The Trust would provide one-half of the capital required to acquire the Idaho company if Utah Sugar agreed to join the Trust. Cutler agreed, the three sugar interests consummated the deal; and Utah Sugar absorbed the Idaho manufacturer to form the Utah-Idaho Sugar Company, which was formalized in 1907.[102]

While the Trust negotiated with Utah Sugar, it turned its attention to Colorado and employed both overt aggressive action and subversive tactics. When local investors sought financing for the wave of sugar companies on the Front Range, they solicited out-

side sources, often unknowing the sources were actually associated with the Trust. By supplying capital for the Fort Collins, Eaton, and Windsor factories between 1901 and 1902, the Trust gained some tacit influence over the companies' decision making. This would become important when the companies reacted to the next stage of the Trust's plan. In 1902, to frighten the Colorado beet sugar companies with competition, the Trust dispatched Henry Neise, the Trust's superintendent of factory construction, to the Front Range to began making arrangements for new factories. Around the same time, the Trust launched a second price war, again ruining the profitability of Colorado's sugar industry. The combination of the lost profits and the threat of persistent competition from Trust factories proved too much for nearly all of Colorado's independent factories, and one by one, they began either selling out to or joining the Trust. The Fort Collins factory fell first in 1902, and the directors sold their holdings, followed by the Greeley and Eaton factories. The directors of the Greeley factory including Chester Morey, gladly sold out to the Trust, and Havemeyer quietly appointed Morey as the Trust's Colorado representative. Great Western remained the only independent company on the Front Range, and National and American Beet Sugar survived in the Arkansas River Valley.[103]

Fully comprehending the financial risks, the Boettcher syndicate determined to dispose of their stock, and members began selling blocks to the Boettchers as early as 1901. Boettcher could not acquire all that came available, and under the guise of individual investors, members of the Trust purchased remaining stock, thereby gaining control over Great Western by 1904. After acquiring most of the independent companies and gaining control over Great Western, the Trust's horizontal integration of most of the Rocky Mountain region's sugar industry became complete.[104]

Over the course of the following year, the Trust began the logistics of reshaping Colorado's sugar industry. First, it divided the Colorado market into specific regions and assigned them to the various factories. While National Sugar remained independent, the Trust left the region around the factory as a free market area. Each factory had to respect the regions of the others at the risk of suffering penalties, which was a policy common to trusts of other industries. The Trust also regulated the acreages of beets available to the factories according to geographic *beet districts*. A factory could not increase its beet acreage by invading another factory's district, but could entice farmers in its district to plant more beets. To this end, the Trust appointed beet district representatives and factory region representatives whose tasks were to maximize the efficiencies of farming and sugar refining, thereby using capital and materials wisely. The Trust technically trained the representatives in agriculture, business, economics, technology, human resources, and the physical environment. Last, the Trust and Colorado's companies cooperated to set sugar prices. In sum, the Trust almost converted the Colorado sugar industry into a coordinated sugar-manufacturing machine, which it loosely balanced with its sugar sources elsewhere in the United States.[105]

While the Trust dominated the Colorado sugar industry, it was not in complete control; rather, it was like a regulatory umbrella over Colorado's sugar companies. The Trust neither owned outright nor controlled all Colorado sugar companies, since many individual stockholders and other prominent figures retained large blocks of stock and assets.

Some dissenters were not in agreement with each other or the Trust. To maintain some semblance of an independent industry to divert the attention of Trust Busters, the Trust left the names of the sugar companies and their brands as they were prior to the campaign for control.

The Great Western Consolidation and the Beet Boom

Some of the administrations of the Front Range factories felt that the internal bickering, poor management, and difficulties of coordination resulted in a lack of profitability. In 1905, Chester Morey the Trust's Colorado representative took over the management of the Greeley factory, and others agreed that an outright consolidation could solve their problems. Morey traveled to New York and met with Havemeyer, where they discussed the nature of the problems and a consolidation as the solution. Satisfied with the extant system, Havemeyer declined administering to such a consolidation at first but agreed in the end. In 1905, Great Western's original charter was cancelled, the company reformed as a New Jersey corporation, and the factories at Fort Collins, Longmont, Greeley, Eaton, and Windsor were absorbed.[106]

The Oxnard brothers – a force to be reckoned with – controlled the American Beet Sugar factories in Grand Junction and Rocky Ford, Colorado, and in Nebraska; they strongly disapproved of the Trust. Because the Oxnards held great power in both the cane and beet sugar industries, the Trust was not able to easily subdue them, and they reigned supreme in the Arkansas River Valley. W.M. Wiley acted as the company's coordinator for the vast acreages of farmland it owned; he proposed expanding factories to strengthen its position on the Arkansas River. Wiley began making arrangements for American Beet Sugar to build another factory at Holly, Colorado, located on the Arkansas River near the Kansas border. Company management strongly disagreed and determined to build the factory at Lamar, which lay west of Holly. In response, with the necessary contracts, land for a factory, and water rights in place, Wiley quit and organized his own independent company, the Holly Sugar Company, which built the factory at Holly. The rise of Holly Sugar during the next two decades suggests that the Trust probably offered Wiley capital for his venture. Despite Wiley's defection, American Beet Sugar continued its expansion plans, dismantling the factory at Norfolk, Nebraska, and reassembling it at Lamar, Colorado, in 1905. In contrast with the consolidation of Colorado's sugar industry on the Front Range, by 1905 the Arkansas River Valley featured three independent companies: National, American Beet Sugar, and now Holly Sugar.[107]

With control over the American cane and beet sugar industries, the Trust and its members had every reason to see the reinforcement of existing protection for the American sugar market. In 1906, the federal government passed another tariff, supported by lobbying from Trust members who posed as sugar company directors. The tariff created an environment of economic security, which fostered an expansion of the beet sugar industry. The expansion also relied in part on an increase in sugar consumption, which the Trust fomented through organized promotion. In Colorado, the sound market for sugar and an increase in demand provided the conditions for a huge expansion.

Between 1906 and 1910, Great Western's aggressive management decided not only to utilize the agricultural capacity in the South Platte River Valley east of

Figure 6.
Great Western 10-pound bags of granulated sugar changed through the decades. *(Great Western promotional material)*

Greeley, but also it branched into the North Platte River Valley. In 1906, Great Western acquired a factory built in Sterling, located on the South Platte in the northeast corner of Colorado. Local capitalists had organized a company of unknown name and built the factory in 1905. In the same year, Great Western built factories at Brush and Fort Morgan, two adjacent towns also on the South Platte. In an effort to extend its growing plains sugar empire into the North Platte Valley, Great Western's management acquired a factory in Billings, Montana from the Billings Sugar Company, which erected the facility in the same year. To avoid rousing the suspicion of anti-trust activists, Great Western operated the mill under its original name. In 1910, Great Western built another factory at Scottsbluff, in northwest Nebraska.[108]

Great Western could not claim the only expansion of Colorado's sugar industry. In the rivalry and hostility between American Beet Sugar directors and Wiley, the Trust saw an opportunity to gain at least some influence in the Arkansas River Valley. To provide American Beet Sugar with direct, heated competition, Wiley proposed that Holly Sugar build a second plant at a location almost adjacent to and east of American Beet Sugar's Rocky Ford plant. In 1906, Wiley solicited Denver's elite for capital, including William Jackson Palmer, David C. Dodge, and Spencer Penrose. The former two were sympathetic to the Trust and already owned stock in Great Western. Through Dodge and Palmer, the Trust provided Wiley with some of the capital to build the factory, which began operations in 1906. American Beet Sugar continued its expansion in the Arkansas River Valley and built another mill at Las Animas, located between Rocky Ford and Lamar in 1907. Colorado saw one last independent company come to life at this time in a location the other companies overlooked. In 1909, W.D. Hoover and other capitalists local to Monte Vista in the San Luis Valley organized the Monte Vista Beet Sugar Company, and they spent the next several years acquiring capital. After securing beet contracts, water rights, and land, they built the plant in 1911, and after five years, terminated the company.[109]

During its first period of expansion, Great Western not only achieved a degree of horizontal integration of the sugar industry on the Front Range, but also it established some vertical integration, as well. Great Western established experimental agricultural stations and farms at Fort Collins and Longmont, which served six principal purposes: studies of beet breeding, farming, pest control, disease control, the effects of irrigation, and economics. To supply its factories with materials necessary to process beets, Great Western's directors acquired interests in regional coal mines, and in 1908 began quarrying lime rock at Horse Creek, Wyoming and Ingleside, Colorado.[110]

To facilitate the movement of raw materials, supplies, and sugar between the various factories, Great Western maintained its own railroad, which kept transportation costs in house. The railroad was actually in existence prior to Great Western's 1905 consolidation, having been organized in 1901. When the Boettcher syndicate established the original Great Western Sugar Company, it carried with it lessons learned from its Grand Junction experience. Conventional wagon transportation limited economic beet farming to within ten miles of a factory, and if Great Western wanted beets from greater distances,

it would have to build a railroad. In 1901, the Boettcher syndicate organized the Loveland Construction Company to build a railroad, and the Great Western Railroad to operate the system. Their intent was to grade lines that linked Loveland with Berthoud, and on to Denver.[111]

Under Chief Engineer J.F. Frankenberger, who designed the Switzerland Trail railroad in mountainous western Boulder County, construction crews began laying rails in 1901. The construction crew originally consisted mostly of Japanese workers, and they lived in a camp consisting of several circus tents. By 1903, workers completed a J-shaped line, which extended east from Loveland to a station known as Officer, named after A.V. Officer, director of the railroad, and it curved southeast to Johnstown. From there, the line curved west and passed the Buda Beet Dump, and it terminated at the settlement of Welty, where another beet dump lay. The railroad never reached Berthoud.[112]

When Great Western's directors began capitulating to the Trust, Boettcher, who owned much of the railroad's stock, sold half to the Trust in 1903 for more capital to lengthen the track into other potential beet growing areas. When Great Western consolidated the Front Range's sugar factories, the Trust purchased the remainder of the stock to better manage the railroad. With funding, workers graded a new line east from Johnstown to Milliken in 1904, and from Milliken to Windsor and Eaton in 1905. At the same time, workers graded another line from Milliken southwest to Longmont. By 1906, Great Western effectively linked its factories with a railroad that traversed some of Colorado's most productive beet farms. Between 1909 and 1910 the sugar company linked the railroad to the main lines extending north from Denver.[113]

In its first several years, the railroad leased engines and rolling stock from the Colorado & Southern Railroad. In 1904, the railroad acquired its first locomotive, followed by a used engine from the Colorado Midland Railroad. As freight business increased with the new lines, the railroad purchased additional engines and rolling stock, which consisted primarily of hopper cars. While Morey justified the railroad as a means of bringing distant farms into beet production, the railroad's directors decided to institute passenger service to improve public relations. In 1904, a few coaches were purchased and service began; however, because the passenger trains were beholden to the freight trains, adhering to the passenger schedules proved impossible. Railroad patrons complained bitterly to the Public Utilities Commission, which mandated that Great Western improve its service. In response, the railroad replaced the coaches with motorcars, but the poor service remained the same until 1917.[114]

Colorado's beet sugar industry enjoyed great prosperity into the 1910s, and the boom on the Front Range carried farming and sugar refining as a wave eastward into Nebraska. While the Great Western Railroad and other rail carriers permitted farms increasingly distant from the factories to grow beets, they could not have done so without precious water for irrigation. When settlers and prospectors came to what became Colorado during the Pikes Peak Gold Rush, a quick examination of the arid landscape told them that water was scarce. A few early farmers interested in growing fruits and vegetables succeeded primarily by excavating primitive ditches that tapped Front Range streams and

rivers. G.R. Sanderson excavated one of Colorado's first irrigation ditches in 1859 or 1860 west of Fort Collins for his small farm. As more farmers settled the Front Range during the gold rush, they organized cooperative efforts designed to deliver water to groups of farms. Such an organization formed the Big Thompson Ditch Company to irrigate fields near what became Loveland in 1861, and Benjamin H. Eaton pioneered the Eaton Ditch near Greeley. When agricultural colonies settled Greeley, Fort Collins, and Longmont during the early 1870s, they financed the construction of systems of ditches with their subscription funds. The characteristics shared by these early irrigation projects were that they were relatively small, local, and served only those farms associated with a community.[115]

Through the 1870s and 1880s, the demand for agricultural produce in cities and the mountains increased, enticing independent farmers to settle the Front Range. They brought the bottomlands of the Front Range's drainages under the plow, and extended their fields onto adjacent grasslands. The growing number of independent farmers created a greater need for irrigation systems to move water from rivers and streams onto the adjacent grasslands, which fostered a small boom of irrigation companies intended to serve the farmers. When the value of irrigated land soared, shrewd capitalists organized irrigation and land companies, which constructed irrigation systems that watered vast tracts of land sold or leased on a speculative basis. As part of this movement, the Colorado Mortgage and Investment Company graded the 50-mile Larimer and Weld Canal which drew water from the Poudre River; the Loveland and Greeley Canal which shipped water from the Big Thompson River north; and the 71-mile High Line Canal which sent water from the South Platte River northeast of Denver. In the Arkansas River Valley, George Washington Swink organized the Rocky Ford Ditch Company in the 1880s, and the Equitable Life Assurance Company graded the Colorado Canal. Other capitalists constructed the Fort Lyon Canal, Catlin Ditch, and others. The development of the irrigation systems and growth of farming parallels the expansion of Colorado's railroads. Because the irrigation systems permitted farmers to produce more fruits and vegetables than Colorado could consume, the railroads permitted farmers to ship their produce to distant markets.[116]

The boom of irrigation systems created problems in terms of appropriation rights. According to European tradition, those with lands closest to the streams possessed primary water rights; those adjacent received secondary rights, those twice removed were granted tertiary rights; and so on. After those with land closest to a waterway satisfied their needs, only then could those farther away draw off water. The colonists that settled North American brought this system with them, and it functioned in the East where abundant rainfall permitted farmers on lands away from streams to cultivate certain crops without irrigation. In Colorado, the establishment of water rights followed a different course, which permitted irrigation companies to thrive. Like other portions of the West, Colorado's first users of water were miners, who required the precious liquid for industrial purposes and settlements located away from streamsides. Following the system established first in the Southwest by the Spanish, and second by placer miners in California, mining companies and speculators in Colorado employed the appropriation system of *first in time, first in right*, where the chronology of applicants defined the hierarchy of users, no matter their geographic loca-

tion. Therefore, the earliest applicants could remove enough water to satisfy their needs, which they had to specify in units of measure, usually *miner's inches* or *cubic feet per second*. Applicants farther down the order of rights removed their portions afterward, and so on.

In 1875 the Colorado Constitutional Convention sanctioned the first in time, first in right appropriation system to settle water disputes and defined the types of users that took priority. The conventioneers stated that domestic uses took precedent; agriculture was second; and other purposes third. The rest of the West followed Colorado's example and termed the system the *Colorado Doctrine*. To administer to the needs of farmers and irrigation companies, agriculturalists and water rights experts in Fort Collins and Greeley devised a strategy to divide Colorado into irrigation districts based on drainage systems. The state government adopted the plan and appointed a state engineer to oversee the irrigation districts; it also amended state water laws as needed for special circumstances in each district.[117] On the Front Range, the area north of Greeley and east of Fort Collins became the Greeley-Poudre Irrigation District, and the area between Fort Lupton and Greeley became the Denver-Greeley Valley Irrigation District.[118]

The growing irrigation systems and water laws served as a foundation for a growth of farming away from the river and stream valleys and east out onto the plains. To support the farming and irrigation movements, in 1894 the federal government passed the Carey Act, sponsored by Wyoming Senator Joseph Carey. The Act authorized the federal government to transfer up to one million acres of land to any western state that could supply enough irrigation to bring the land under the plow. The states had to then sell the farmland and apply the proceeds to its irrigation projects. While the Act was largely ineffective, it did foster some expansion of irrigation and farming on the plains. In 1902, President Teddy Roosevelt signed the Newlands Reclamation Act into law, which was monumental legislation that changed the West. Under the newly created Bureau of Reclamation, the Newlands Act provided funds for 16 Western states to develop massive irrigation infrastructures. Under the Act, existing ditches and canals were enlarged, storage reservoirs dammed, and diversion tunnels and canals driven.[119] According to beet historian John May: "Irrigation opened a frontier that supposedly had been 'closed' in 1890." The Act had a significant impact on the plains, and directly benefited Colorado's beet sugar industry. The Act enabled farmers to plant more acreages of beets than before, which fostered the boom of Colorado's beet sugar industry between 1905 and the early 1910s.[120]

The Second Beet Boom

In contrast to the benefits the Newlands Act granted the beet sugar industry, the government passed unrelated legislation that created unstable economic conditions detrimental to the beet sugar industry. In 1913, reformists that opposed the Sugar Trust proposed the Underwood-Simmons Act, which reduced the tariff on foreign sugar by 25 percent and lifted quotas on imported Cuban and Philippine sugar. The price of sugar fell and profits among American companies shrank, casting the beet sugar industry into a dark time. Beet sugar, which was costly to produce, had a difficult time competing with the inexpensive foreign sugar. Naturally, Great Western vehemently protested the Underwood-Simmons Act and rallied its beet farmers to oppose the legislation, earning

them recognition as "petition parasites."[121]

The condition of Colorado's beet sugar industry decayed, and Great Western sought ways to cut costs. One of the company's greatest expenditures was the price it paid farmers for their beets. Until around 1920, most beet sugar companies paid farmers five dollars per ton of beets, provided the sugar content surpassed 12 percent. When the cost of refined sugar was high, the rate increased. In the wake of the Underwood-Simmons Act, Great Western not only attempted to pay farmers less, but also the company requested that farmers store their surplus beets in underground silos. The farmers angrily disagreed on both accounts, claiming that siloing beets actually increased their production costs through additional handling. As a result of Great Western's approach, relations between the company and farmers plummeted to an all time low. To make matters worse for Great Western, Trust Busters in the federal government began investigating the company for violations of the Sherman Antitrust Act of 1890.[122]

While the beet sugar industry precipitously poised on the brink of grave financial danger, World War I raged in Europe, setting in motion events that resulted in another boom. Until World War I, one-half of the world's sugar came from Europe's beet sugar industry. The war disrupted Europe's production as workers left factories and fields for the battlefields; countries' industrial supplies were redirected to their war efforts; and their economies suffered. As a result, the demand for sugar from other sources, including America, soared. Further, as shipping companies mobilized to serve the needs of the war, less imported sugar from other nations and overseas American possessions made its way into the domestic market, bringing beet sugar into high demand.

As the demand materialized, the beet sugar industry found difficulty in quickly responding due to its debilitated state. Because of this and lobbying by American sugar industry protectionists, the federal government repealed the Underwood-Simmons Act during the war. In its place, the government constructed a plan where a substantial portion of Cuban sugar normally sold in the United States was diverted to Europe, and domestic cane beet sugar filled the deficit. In addition, the new plan reinstituted tariffs.[123]

Boom times returned to Colorado's beet sugar industry, and to meet the increased demand, the companies on the plains expanded once again. Great Western used the opportunity to push its sugar empire farther east and north, contributing four of the fourteen factories built in the United States at this time. In 1916 and 1917, the company constructed factories in Bayard and Gering, Nebraska, Lovell, Wyoming, and Brighton, Colorado. The American Beet Sugar Company also expanded its empire both in and outside of Colorado, and it built a factory in Delta, near Grand Junction. The Holly Sugar Company bought and built factories outside of Colorado in Texas, California, and Montana. The economic conditions created by World War I not only permitted Colorado's existing companies to built factories, but also two new independent sugar companies went into business. With the support of farmers irked by Great Western's attempts to reduce contract values, R.E. Jones established the Industrial Sugar Company in Fort Morgan in 1919 to bring direct competition against Great Western's factory built there in 1906. In 1920, an unknown company built a factory at Fort Lupton (located south of Greeley in the heart of Great Western's territory) with the same intent. Great Western was the last sugar company to build a factory

before the World War I boom came to a crashing end. When Great Western built the Scottsbluff, Nebraska plant, farmers responded by planting significant acreages with beets. The success of beet farming in the Scottsbluff area roused the interest of farmers in nearby Mitchell. For years Mitchell farmers petitioned Great Western to build a factory there, but the poor economic environment in the wake of the Underwood-Simmons Act prevented Great Western from such expansion. When the domestic market improved during the war, Great Western finally was able to justify building the Mitchell factory in 1920.[124]

The 1920s Depression and Recovery

The beet boom fostered by World War I came to an abrupt halt in 1920. As Europe's economy and manufacturing stabilized following armistice, and normalcy returned to shipping, the price of sugar collapsed, as did the high demand experienced by American companies. The dismal sugar market was also a function of an overall economic depression that struck the United States in the early 1920s. If the poor economic conditions were not enough for the beet sugar industry to contend with, an outbreak of the dreaded *curly top* blight decimated beet crops across the West. Great Western represented the state of many other sugar companies, and its stock fell by 25 percent while its earnings collapsed to 50 percent of what they were during the boom.[125]

Alarmed by the rapidly declining domestic sugar industry undoubtedly with prodding from sugar industry lobbyists the federal government passed the Emergency Tariff Act in 1921, which raised the duty on Cuban sugar one cent per pound. Cuban sugar companies immediately protested; however, its pleas fell on deaf ears, for in 1922 the government passed the Fordney-McCumber Tariff, which raised the duty to 1.77 cents per pound of sugar. This last increase was based in part on a study that indicated Cuban sugar cost 1.16 cents per pound to produce, which was less than the cost of producing it within the United States. The intent of the Acts was satisfied, as they stimulated domestic cane and beet sugar production. In the wake of the Acts, Cuba still supplied 53 percent of the sugar consumed in the United States; Hawaii furnished 12 percent; Puerto Rico provided 9 percent; and the Philippines supplied 8 percent. Domestic companies, primarily beet sugar refiners, filled the remaining 18 percent.[126]

Farmers who relied on their beet tonnages for income were particularly hard hit by the beet depression. Not only did they face a lower demand for their crops, but also Great Western again tried to cut the rate per ton of beets. The hard times created a ground swell of organization among farmers, and in 1922 a consortium of farmers' associations passed the *Loveland Resolutions*, which was a statement proclaiming that Great Western's contract values were unfair. To validate the importance of fair contracts, businesses across northern Colorado signed the accord, supposedly including nearly all in Fort Collins and most in Greeley and other towns on the South Platte. In response to Great Western's refusal to pay adequate values for beets, many farmers turned to other crops. As tensions between Great Western and farmers heated, the state legislature passed the *Cooperative Marketing Law* in 1923, which officially recognized growers' associations as legal entities. With the backing of businesses and the state government, Great Western consented and increased the value of contracts from $21 per ton of beets to $23.

Caught between Great Western's attempts to cut the value of a ton of beets and

the low yields caused by curly top, farmers called for a revision in their contracting systems. Until the early 1920s, beet sugar companies typically paid farmers a set amount per ton of beets in a system known as the *flat rate*. They made adjustments for the inferior or superior sugar content of beets and for increases in the price of sugar. Great Western and the growers' associations came to a compromise in 1924 known as the *50-50 plan*. Under this system, Great Western paid farmers a minimum of $8 per ton, and split the profits from the sale of sugar. Colorado's other beet sugar companies followed suit and the 50-50 plan became standard.[127]

With the Fordney-McCumber Tariff protecting the domestic sugar industry and the national economy in a state of recovery, Colorado's beet sugar industry once again experienced a small boom. Great Western built three new factories in 1926 and acquired the independent Fort Lupton factory in 1924. The 1926 factories went up at Lyman, Nebraska, and at Ovid and Johnstown, Colorado. Great Western began construction of the Johnstown factory in 1920, but during the onset of the beet depression, suspended further work. With little need for another sugar factory in the region, Great Western completed the plant as a molasses refinery. By the mid-1920s, Colorado's sugar beet industry attained a state of maximum density,

Table 2. Great Western Sugar Company Plants

Plant Name	Plant Location	Plant Builder	Year Built	Year Acquired	Year Closed
Loveland	Loveland, Colo.	Great Western Sugar Co.	1901	1901	n/a
Greeley	Greeley, Colo.	Greeley Sugar Co.	1902	1905	operating
Eaton	Eaton, Colo.	Eaton Sugar Co.	1902	1905	1970s
Longmont	Longmont, Colo.	Longmont Beet Sugar Co.	1903	1905	1975
Ft. Collins	Ft. Collins, Colo.	Ft. Collins Sugar Mfg. Co.	1903	1905	1960
Windsor	Windsor, Colo.	Windsor Sugar Co.	1903	1905	1968
Brush	Brush, Colo.	Great Western Sugar Co.	1905	1906	1970s
Sterling	Sterling, Colo.	Unknown	1905	1906	1985
Ft. Morgan	Ft. Morgan, Colo.	Great Western Sugar Co.	1906	1906	operating
Billings	Billings, Mont.	Billings Sugar Co.	1906	1906	n/a
Scottsbluff	Scottsbluff, Neb.	Great Western Sugar Co.	1910	1910	n/a
Gering	Gering, Neb.	Great Western Sugar Co.	1916	1916	n/a
Lovell	Lovell, Wyo.	Great Western Sugar Co.	1916	1916	n/a
Bayard	Bayard, Neb.	Great Western Sugar Co.	1917	1917	n/a
Brighton	Brighton, Colo.	Great Western Sugar Co.	1917	1917	1978
Mitchell	Mitchell, Neb.	Great Western Sugar Co.	1920	1920	n/a
Ovid	Ovid, Colo.	Great Western Sugar Co.	1924	1924	1985
Johnstown	Johnstown, Colo.	Great Western Sugar Co.	1926	1926	n/a
Ft. Lupton	Ft. Lupton, Colo.	Industrial Sugar Co.	1919	1926	1948
Lyman	Lyman, Neb.	Great Western Sugar Co.	1926	1926	n/a
Goodland	Goodland, Kan.	Great Western Sugar Co.	1970s	1970s	n/a

Table 3. Other Beet Sugar Company Plants

Plant Name	Plant Location	Plant Builder	Year Built	Year Closed
Grand Island	Grand Island, Neb.	American Beet Sugar Co.	1890	1964
Norfolk	Norfolk, Neb. Moved to Lamar, Colo.	American Beet Sugar Co.	1891	1900
Grand Junction	Grand Junction, Colo.	Colorado Sugar Mfg. Co.; acquired by American Beet Sugar Co.	1899	n/a
Rocky Ford	Rocky Ford, Colo.	American Beet Sugar Co.	1900	n/a
Sugar City	Sugar City, Colo.	National Beet Sugar Co.	1900	1967
Lamar	Lamar, Colo,	American Beet Sugar Co.	1905	n/a
Holly	Holly, Colo.	Holly Sugar Co.	1905	n/a
Swink	Swink, Colo.	Holly Sugar Co.	1906	n/a
Las Animas	Las Animas, Colo.	American Beet Sugar Co.	1907	1921
Sheridan	Sheridan, Wyo.	Holly Sugar Co.	1910s	n/a
Monte Vista	Monte Vista, Colo.	San Luis Valley Beet Sugar Co.	1911	1916
Delta	Delta, Colo.	American Beet Sugar Co.	1910s	n/a
Hardin	Hardin, Mont.	Holly Sugar Co.	After 1930	n/a

represented in part by the lack of expansion in the Arkansas River Valley, and the conversion of the Johnstown facility into a molasses refinery.[128]

Labor

The 1920s saw a series of changes to Colorado's sugar beet industry. Dramatic economic fluctuations, boom periods, and the expansion of irrigation systems brought the industry to a state of build out. The period also saw a major shift in labor, which had a lasting impact on the demography of the plains communities. One of the most significant problems the beet sugar industry faced was that beet farming was labor intensive. Unlike sedentary jobs, cultivating and harvesting beets was seasonal, and workers had to devote exclusive attention to beet fields for brief and intense episodes from April to November. Laborers often worked 12 hours per day with hand tools, often stooping or on hands and knees, in all weather. To keep the costs of production low, farmers were unwilling to pay laborers more than $.75 per day and board for unskilled work and up to $1.25 for skilled work.[129] In addition, the successful harvest of beets rich in sugar required experience and a sound work ethic. Because of the demanding and seasonal nature of fieldwork, in the early years the beet sugar industry found able workers difficult to secure.

Beet sugar companies found that their profitability depended on the success of the farmer, and so they took measures to ensure the farmer had the necessary work force. When the Colorado Sugar Manufacturing Company began operations in Grand Junction, its first year was almost a disaster because the region's farmers and their laborers were inexperienced with beet cultivation and harvest. The company's directors, primarily John Campion, realized that experienced workers would be of great benefit, so they turned toward European farmers who had much experience with sugar beets. Specifically, they targeted Germans from Russia and attempted to lure them to Grand Junction. While Colorado Sugar's efforts

proved fruitless when Campion and the rest of the Boettcher syndicate organized Great Western, they made a second attempt at providing farmers with German-Russian laborers. They found a ready work force among the Germans from Russia already in Nebraska and Utah and enticed some of them to labor in Colorado's beet fields on a seasonal basis.

When the initial boom of the beet sugar industry began on the plains, sugar companies and farmers employed seasonal workers of other ethnicities, as well. Until 1909, of the 10,000 migrant workers recorded on the Front Range, 5,900 were of German-Russian origin, 2,200 were Japanese immigrants, and 1,000 were Hispanic, mostly Mexican immigrants. While the Japanese and Hispanics were willing to work for less, farmers quickly found that the German-Russian workers netted higher yields per acre. Having proven themselves, farmers favored the German Russians primarily because of their economic benefit, but also due to the commonality of their European origin. With the precedent set, sugar companies began actively recruiting German Russians to Colorado.[130]

While the sugar companies provided farmers with workers, it was up to the farmers to pay and house them. Because farmers were unwilling to spend any more than was necessary on seasonal laborers, they usually provided housing that ranged from poor in quality to abysmal. Even when farmers wished for better housing for their workers, they were barely able to afford even basic necessities. Known as a *beet shack*, the typical workers' accommodations consisted of a frame building sided with one layer of planks clad with tarpaper or corrugated sheet iron, which made for a drafty interior. In some cases farmers erected adobe buildings or wall tents. The better shacks had plank floors, while many had earthen floors, and they usually featured one or two rooms. The shacks had one coal stove, and almost none had electricity or plumbing. Between six and 12 occupants, often single families, resided in such buildings.[131]

Figure 7.
A German-Russian family pauses for this photograph while they harvest sugar beets by hand on a Fort Collins-area farm. *(Courtesy, Fort Collins Public Library)*

In some cases, sugar companies organized colonies for the immigrant workers, and they were mostly inhabited by Germans from Russia, who had a propensity to settle. Since experienced labor was dear, this behavior increased the farmers' and sugar companies' preference for German Russians. Like the rest of the beet sugar industry, the Fort Collins Sugar Manufacturing Company actively recruited Russian Germans and provided land for them near the factory. On one of his Fort Collins parcels, Boulder banker Charles Buckingham and the sugar company organized the colony of Buckingham Place for the workers in 1902. There, the company built 13 flimsy frame houses, which measured 12 by 12 feet each. Andersonville, named after Peter Anderson, the first Fort Collins farmer to employ Germans from Russia, grew nearby. Apparently, the German Russians kept the primitive settlement clean and orderly, which won approval of the residents of Fort Collins.[132]

While Colorado's beet sugar industry favored German-Russian workers, during the industry's early years companies actively recruited Japanese, who came from Wyoming's coal mines and railroad crews. In addition to nationalized Japanese, sugar companies also solicited Japanese immigrants. Like the Germans from Russia, the Japanese displayed an excellent work ethic and worked around 33 percent more acreage per person than other ethnicities. Because they tended to be clannish and almost acted as an informal union, farmers did not embrace the Japanese as they did the German Russians. When immigration stopped in 1907, the Japanese influence in the beet farming industry began to decline.[133]

One trait shared by both ethnic groups was a penchant to better their livelihoods. Through frugal living, participation in group efforts, and a strong desire for settlement, both the Germans from Russia and Japanese were upwardly mobile. After several generations had labored in the fields, some families accumulated the recourses necessary to become landowners, and they became farmers that in turn hired groups of immigrant workers. Some moved into industrial jobs, exemplified by the significant numbers of German Russians that worked the National Sugar Manufacturing Company's factory by the 1910s. During the 1910s, Germans from Russia also owned 25 percent of the total beet acreage that served National.[134]

During the 1910s, the labor pool available to beet farmers underwent a dramatic shift. A federal immigration block against Japanese in 1907 reduced the numbers of these laborers, and the outbreak of World War I disrupted the immigration of Germans from Russia. Because both ethnicities were upwardly mobile, families that left the labor pool had to be replaced by more workers. To fill the void, Colorado's sugar industry turned to Hispanics, which was the other immigrant group present in significant numbers during the 1910s. Until around 1910, Colorado sugar companies recruited nationalized Hispanics from the Trinidad area, the upper Rio Grande valley, and northern New Mexico. When fewer workers were willing to travel north, Colorado companies, primarily Great Western, dispatched recruiting agents far afield to Texas, which was the principal point of entry for Mexican immigrants. With the German-Russian and Japanese labor pool ebbing during the 1910s, Hispanics came to predominate. By 1924, of the 24,000 workers in the beet fields, 7,600 were German Russians; 175 were Japanese; and 14,300 were Hispanic, primarily Mexican immigrants. Through the 1920s, the numbers of German Russians continued to decline, and Hispanics increased.[135]

In contrast to the other immigrant groups employed in the beet fields, Hispanics were not as upwardly mobile. While they were hardworking, farmers tolerated the Hispanics as a necessity, and stereotyped them as indolent and of limited intellect. Because they were ostracized, Hispanics had little opportunity to acculturate, receive formal education, and branch out into other forms of employment. These reasons coupled with low wages practically locked the Hispanic workers into a life of beet field labor. The beet sugar companies saw the seeming permanency of Hispanics as a valuable asset because they possessed the experience necessary to competently raise beets. To entice Hispanics to remain as a permanent work force, sugar companies developed several programs to improve their conditions. First, they assisted farmers in providing improved housing and developed several colonies where families could purchase homes for reasonable prices.

By the mid-1920s, Great Western erected colonies where factories or beet farms existed in Fort Collins, Brush, Kersey, Johnstown, Hudson, Orchard, Ovid, Sedgewick, and in Nebraska. In later years, Great Western added colonies in Wyoming and Montana. Second, the companies offered workers credit to help see them through the idle seasons. Hispanic workers served as a foundation of beet farming until they were phased out by mechanization during the 1950s.[136]

The Great Depression

The prosperity and growth of Colorado's beet sugar industry came to an abrupt halt in 1929, when the Great Depression brought the nation to its knees. As the economy collapsed, the demand for sugar went with it, and sugar companies found their warehouses full of sugar they could not sell, beginning the downward spiral. The price of sugar fell from over ten cents per pound to five cents. Like the beet depression of the early 1920s, Colorado's beet sugar companies attempted to cut costs by reducing payments to farmers, and in response, farmers planted fewer acreages. In hopes of increasing the price of sugar, factories curtailed production to reduce the supply. However, without income, consumers unable to buy sugar at the Depression prices certainly were unwilling to pay more, so demand remained low.[137]

In 1930, the beet sugar industry was on the verge of genuine ruin, and the federal government scrambled to save it. Legislators passed the Hawley-Smoot Tariff, which raised the duty on Cuban sugar to two cents per pound in hopes of stimulating domestic production. In actuality, sugar manufacturers in the oversees American possessions, Hawaii, Puerto Rico, and the Philippines, increased production to fill the void, leaving the domestic industry in a torpid state. The tariff resulted in other unintended consequences. With the Cuban sugar industry also on the brink of ruin and the economy under duress, the tariff exacerbated the conditions to point where the Cuban people revolted.[138]

For two years the beet sugar industry struggled, and out of desperation, sugar industry and company representatives met in Washington, D.C. in 1933 to find solutions to their economic and market problems. The results of the meeting permanently changed the sugar industry, allowing it to survive. The industry and company representatives drew up the *Sugar Stabilization Plan* and proposed it as a guide for government legislation. The plan essentially called for a Trust that spanned the nation and oversees possessions, sanctioned and regulated by the federal government. In the plan, industry representatives recommended a minimum price for sugar and production quotas for each manufacturer. While the federal government had no better plan, to avoid the public perception that the government followed the will of the business sector, the government overtly rejected it. However, Secretary of Agriculture Henry Wallace tacitly accepted the plan with modifications requiring production quotas and protections for farmers. In the same year, sugar industry lobbyists and senators and representatives from beet sugar states petitioned the government to include the plan in the Agricultural Adjustment Act, which the Roosevelt Administration was developing. Including the plan in the Agricultural Adjustment Act seemed natural, since the Act was an umbrella that included a variety of programs to protect farmers, the agricultural industry, and stabilize agricultural markets. Sponsored by Colorado Senator Edward P. Costigan, the plan became law in 1934 as the Jones-Costigan Amendment of the Agricultural Adjustment Act.[139]

Known as the Jones-Costigan Act, the final amendment accomplished several goals. First, it assured American consumers a supply of sugar at reasonable prices. Second, it struck a balance that protected the domestic industry while encouraging foreign trade. A significant aspect of this was limiting Cuba's imports. Third, the Act fostered some competition. To carry out the Act's policies, the Secretary of Agriculture had to estimate the total domestic sugar consumption, and Congress divided it into market shares. Of the total market, 55 percent was divided among domestic producers and 45 percent was reserved for foreign producers. The Secretary of Agriculture then set a base price for sugar according to the general cost of living, with allowances for regional variables. The Act also provided some regulation for the value of beets paid to farmers. Before the Act, farmers often received 40 percent of the value of the sugar content for their beets; afterward the farmer received 62 percent.[140]

While the Jones-Costigan Act stabilized the sugar industry, Colorado had additional worries during the Great Depression. In 1930, drought struck America's southeastern states and shifted to Montana and the Dakotas in 1931. By 1934, the drought shifted again and settled on the plains, creating conditions that featured little rainfall, great heat, and desiccating winds. A heat wave struck and temperatures soared above 110 degrees F, and the cumulative conditions rendering farming almost impossible. The soil dried to depths of three feet, and as the winds whipped across barren fields, it created an effect the United States will always remember as the *Dust Bowl*. The plains became a scene of desolation, and the conditions created two types of dust storms. *Dusters* were walls of blowing dust 8,000 feet high carried in on the brunt of weather fronts, and *sand blows*, which were the most destructive, were the constant laminar flows of sand and dust across the landscape, resulting in blow-out depressions and dunes. The dust storms were so intense that dust mobilized on the plains rose into the jet stream and fell out onto cities in the Northeast.[141]

In Colorado, farmers in the Arkansas River Valley suffered most, and those in Kansas and Nebraska faired no better. Unable to sustain years of Dust Bowl conditions, many farmers went bankrupt, and those unable to obtain government relief migrated elsewhere. Destitute and in search of work, some farmers migrated to Colorado where they found jobs in beet fields; however, they proved no match for the experienced Hispanics. According to beet sugar industry historian John May: "In the early 1930s, with the country in the Great Depression, Americans tried to get employment in the beet fields, but most reportedly did not work out."[142] To reserve Colorado jobs for state residents, Governor Edwin C. Johnson instituted the *bum blockade*, where state officers patrolled the borders and pressured migrants to turn away.[143]

The drought nearly ruined the beet sugar industry in the Arkansas River Valley, and the industry in northern Colorado was only slightly better off, in part because the Front Range usually received more water, which was distributed through the irrigation systems. To ensure the availability of water for beets and other crops, a variety of interested parties Great Western, regional railroads, the Colorado Agricultural College, and agricultural industry representatives organized the Northern Colorado Water Users Association in 1934 to lobby for systems that diverted water from across the Great Divide.

Successful, the lobby initiated the Colorado-Big Thompson Project in 1937, which involved driving a 13-mile tunnel under the Great Divide to tap the waters of Grand Lake and funnel them into the Big Thompson River. However, farmers on the Front Range only realized the benefits after the drought broke.[144]

While Colorado's farmers and the beet sugar industry battled the drought, the Agricultural Adjustment Act came under attack, threatening to throw the sugar industry back into chaos. In 1936, the Supreme Court declared the taxes that funded the Act's administration outside of the laws, spurring the Act's supporters to reorganize the programs. In 1937, the Agricultural Adjustment Act was redrawn and signed into law in 1938, and the Jones-Costigan Act became the *Sugar Act*, to the relief of the sugar industry. The new Act mirrored the old except for the provision raising farmers' incomes four dollars per acre for beets. The Act would see few changes for decades.[145]

The Decline of the Beet Sugar Industry

Relief from the drought for farmers and Colorado's beet sugar industry finally arrived in 1941 at the same time the United States entered World War II. In contrast to the boom World War I stimulated among Colorado's beet sugar industry, World War II presented the sugar industry with complications. Like the previous world war, World War II decimated the European economy, almost completely stopped sugar production, and interrupted shipping. This, and America's mobilization for war, resulted in a high domestic demand for sugar. However, the price controls instituted by the same Sugar Act that saved the industry during the Depression limited profits. Since beet sugar companies could not pay farmers premium prices for beets, farmers turned to other crops that were in high demand as a result of the war. In addition, labor became scarce as workers entered the military or found stabile, well-paying jobs. Without inexpensive labor, farmers had even greater incentive to turn to other crops. The net result was that many sugar companies, including those in Colorado, found themselves squeezed between debt left from the Great Depression, a lack of profits, labor problems, and a lack of beets. Great Western strongly protested the price caps on sugar, which it saw as the foundation for its problems, but its pleas went unheard.

The end of the war and the return to normalcy spelled some relief for the sugar industry; however, the Sugar Act ensured Colorado's industry would remain relatively static. As the cost of living increased, the Secretary of Agriculture permitted the sugar industry to increase the price of sugar accordingly, perpetuating the industry's state. Confined, Colorado's sugar industry attained a moribund state during the 1950s, and in the face of limited profits and fixed production, Great Western closed its Fort Lupton factory in 1948. Drought returned in 1950, creating another Dust Bowl on the plains. Again, the Arkansas River Valley suffered and the sugar companies there curtailed production due to a lack of beets. The drought continued unabated, forcing the National Sugar Manufacturing Company at Sugar City to temporarily suspend operations.[146]

The fall of Cuba proved to be of benefit to the American sugar industry. In the context of hostile relations between the United States and Cuba, in 1960 the federal government passed legislation limiting the imports of Cuban sugar with the provision that Cuba's market share be divided among domestic pro-

ducers. Further, the legislation lifted restrictions on the acreages of beets originally instituted by amendments to the Sugar Act. Some degree of profitability returned to the sugar industry, but the price caps of the Sugar Act still maintained the industry's poor state. The most significant means of increasing profits available to the sugar industry given the restrictions was to employ technology to reduce the costs of farming and refining. As a result of the labor shortage during World War II, farmers increasingly mechanized cultivation and harvesting, and during the 1950s, their reliance on technology came to completion. Not only did farmers employ machines which attended to the tasks formerly completed by workers, but also they applied fertilizers and pesticides to increase their yields per acre. At the same time, many sugar companies improved their factories to reduce the costs of production. In this context, Great Western made various contributions in terms of beet farming machinery and sugar refining. During the 1960s, Great Western upgraded its transportation systems to cut costs and increase efficiency. The company finally replaced the steam engines on the Great Western Railroad, one of America's last industrial steam railroads, with diesel engines, and employed trucks. Still, the poor conditions in the industry pervaded, and Great Western closed its Fort Collins factory in 1960, followed by the Windsor plant in 1968. American Beet Sugar closed its Grand Island, Nebraska factory in 1964, and National Sugar declared bankruptcy in 1967.[147]

The 1970s saw the sun set on Colorado's beet sugar industry. High production costs, a low value for sugar, economic inflation, and outbreaks of disease and pests made beet farming and refining unattractive. A high value for other crops which required less time and capital, such as wheat and corn, drew farmers away from beets. When conditions in the beet sugar industry looked poor, they turned bleak in 1974 when, for the first time in 40 years, the federal government failed to renew the Sugar Act. With no protectionism, inexpensive foreign sugar once again invaded the market, and costly beet sugar became uncompetitive. In the context of the industry's dismal state, Great Western announced it would close nearly all of its plants and began suspending operations at many facilities over the course of five years. Just when Great Western's management contemplated selling the entire company, the world-wide failure of cane crops brought reprieve to the beet sugar industry. In response to a high demand, Great Western and other companies increased production, and Great Western built a new factory at Goodland, Kansas to fill the refining void in the region. However, instability returned to the sugar industry in the late 1970s, as cane sugar returned and corn sweeteners began to compete with sugar for use in products. In response to the volatile sugar market, the government passed the *Farm Bill* around 1980, which brought stability back to the industry.[148]

Great Western's management finally sold the company, including its $112 million debt and $300 million loans, to the Hunt brothers. The Hunts realized a fortune from Texas oil, and in 1974 began buying Great Western stock with the intent of dominating the beet sugar industry and exerting influence over the sugar market. The Hunts, inexperienced with sugar, mismanaged the company until 1985, when Great Western failed, along with their investment. In 1985, Tate and Lyle, an English sugar company, formed the Western Sugar Company and purchased

some of Great Western's factories that held the potential of profitable operations, including those at Greeley and Fort Morgan, Scottsbluff and Baird in Nebraska, Lovell, Wyoming, and Billings, Montana. Tate and Lyle bought other plants in Nebraska and Montana. Western Sugar continued to manufacture sugar from beets through the 1980s, competing against foreign sugar, but experienced profitable times. As of the year 2002, exactly 100 years after the Greeley factory fired up its boilers, Western continues to operate the Greeley and Fort Morgan factories, despite slim profits in the sugar market. While the Front Range's beet sugar industry is currently a shadow of what it was, interest and tradition remain strong amid agricultural communities on the plains, all but assuring the beet sugar industry a continued role in the Front Range's history.[149]

CONCLUSION

Between the 1900s and 1940s, Colorado was one of the world's most important beet sugar producing regions. While the Grand and the upper Rio Grande River valleys featured a few beet sugar factories, Colorado's industry hinged primarily on the Front Range plains (including Fort Collins) and secondarily on the lower Arkansas River Valley. Colorado possessed environmental conditions for growing beets that were superior to nearly all other regions in North American, enabling farmers on the Front Range and Grand Valley to produce beets with some of the highest sugar contents in the world. Curiously, farmers and the United States Department of Agriculture acknowledged that Colorado's superior climate produced beets of unusual quality; however, in the beet sugar industry's early years, capitalists built factories in regions almost surrounding, but not focusing on, Colorado. During the early 1890s, companies built beet sugar factories in California in the distant the west and Michigan in the distant the east. Shortly after, beet sugar companies built factories closer to Colorado, in Utah and Nebraska.

During this time, sugar manufacturers tantalized Colorado with talk of building factories, but nothing materialized until regional interests established the Colorado Sugar Manufacturing Company in Grand Junction. Why capitalists selected Grand Junction remains mysterious, because the region remained obscure and remote during the 1890s, and transportation costs were high. By contrast, promoters attempted to secure a sugar industry on the Front Range for decades, and proved that the conditions fostered some of the world's best beets. By 1900, Colorado's capitalists finally recognized this and began a wave of factory building. Capitalists associated with the sugar industry in the East also recognized Colorado's potential. Seeking to control the beet sugar industry, they either acquired or gained control over nearly all Colorado Front Range sugar manufactures through their Sugar Trust by 1905. Out of the three sugar companies in the Arkansas River Valley, which operated approximately a half-dozen factories there, only the Holly Sugar Company clearly succumbed to the Trust, while the Oxnard brothers, who owned plants throughout the West, were able to resist.

Through the 1900s and into the 1910s, Colorado rose to a position of world wide prominence in the sugar industry. Colorado's ascension up to and after the 1910s was beset by surges and industry depressions, which were primarily functions of legislation. Protectionism and tariffs permitted the industry to thrive, while markets open to inexpensive foreign sugar impeded the industry. Both world wars also dramatically effected Colorado's sugar industry. During the 1910s, beet sugar companies primarily in Germany,

Russia, and Austria-Hungary satisfied almost one-half of the world's sugar.[150] World War I not only disrupted European sugar production, but also constraints on shipping limited the amount of sugar brought to the United States from foreign sources. Colorado's beet sugar industry enjoyed unparalleled prosperity fueled by the high demand. By contrast, World War II damaged Colorado's beet sugar industry. During the depths of the Great Depression, interested parties constructed a plan adopted by the Roosevelt Administration in 1934, which instituted total government regulation of the industry. Therefore, the policies that saved the sugar industry in the 1930s had the opposite effect during the 1940s. Price caps along with production and market quotas ensured that the beet sugar industry would profit little during World War II or during the prosperous times the rest of the nation enjoyed following the war's conclusion. While the application of modern technology permitted the beet sugar industry to survive for decades, de-regulation and competition from other sweeteners hastened the industry's decline, until only a handful of 22 sugar factories in Colorado, and a few more in Kansas, Nebraska, and Wyoming, currently remain operating on a profitable basis.

The impact that the industry, let alone a single factory, had on a specific community, such as Fort Collins, is difficult to surmise, since many complex variables were involved. The beet sugar industry had an enormous impact on Colorado, changing the environment, economics, agriculture, and demography of the plains. The changes carry over to specific communities in varying degrees through their association with the plains and state geographies, economies, politics, and industries. The beet sugar industry established the precedent of the dominance of big agribusiness and government intervention in Colorado's agricultural industry and politics. Sugar beet farming lent itself well to being influenced by agribusiness since sugar beets can almost be viewed as an industrial crop, rather than one for consumption through traditional markets. Instead of use as a food, sugar companies bought beets in huge volumes and refined them into sugar with sophisticated technological processes. Large businesses in Colorado, primarily the Great Western, both benefited and had negative impacts on farming. Because sugar companies relied on the farmer for beets, they provided for many of the farmers' needs: labor, education regarding cultivation, soil analyses, and information concerning when to harvest and when to plant. However, in the wake of the consolidation of the sugar industry on the Front Range, farmers found only one large, well-organized buyer for their beets, Great Western. Great Western attempted to set prices for beets, and when farmers deemed the prices unfair, they had difficulties battling against the only buyer. As a result, the 1900s and 1910s saw the rise of farmers' cooperatives and associations, which fought, on the farmers' behalf. Yet, since beets were more profitable than most other crops that would grow on the plains, despite the struggles, farmers continued to plant them.

The beet sugar industry greatly benefited Colorado's economy. Until the 1910s, a significant portion of the economy was based on hardrock mining, which underwent boom and bust cycles that caused ripple effects. Mining in the state abruptly declined during the 1910s with the exhaustion of rich ores, and the rise of the sugar industry at this time reversed what would have become economic hardship. Further, the development of farm-

ing technology and irrigation for beets carried over to other types of crops, fostering a greater emphasis on agriculture. While the sugar industry experienced boom and bust cycles like mining, beets were a renewable resource, so the cycles were temporary. The capital investment and expenditures such as wages, acquisition of goods and supplies, and property improvements certainly enriched Colorado's economy. Last, the sugar industry brought industry and jobs to communities based on agriculture and provided stability to their otherwise seasonal economies.

The rise of the beet sugar industry changed the nature of Colorado's agricultural industry. First, in response to the high demand for beets, farmers planted them where crops had not grown before. Since beets required water, cooperatives and companies expanded irrigation systems to meet the farmers' needs. Therefore, the sugar industry resulted in a significant increase in irrigated acreages, which farmers planted with other crops in addition to beets. The net result was the overall growth of agriculture in an eastward wave onto the plains in both the South Platte and Arkansas River valleys. Second, successfully raising beets with an acceptable sugar content required exacting cultivation, soil stewardship, and economics. When farmers applied the superior practices required for beets to their other crops, they realized much greater yields. In addition, when beets were rotated with other crops, the nature of the plant's biology also improved yields. Last, beet tops sliced off during harvest and spent beet pulp and molasses generated by sugar factories became a nutritious feed for raising livestock especially cattle.

The beet sugar industry played a key role in changes to Colorado's environment on the plains and Front Range. First, to plant beets farmers plowed up thousands of acres of prairie and converted the land into earthen patches. Second, to permit the beets to grow, elaborate irrigation systems siphoned water out of natural drainages and redistributed it to the fields, where some soaked in and much evaporated. The result was a change to some riparian habitats and the decimation of others. Because the irrigation ditches carried water on a seasonal basis, they were unable to foster replacement habitats. Third, when farmers plowed fields in the fall and left them exposed through the winter, winds carried off much of the rich soil, especially during the Dust Bowls of the 1930s and 1950s. To grow beets, farmers then had to fertilize their fields with chemicals, which contaminated groundwater and surface water systems. The application of pesticides and herbicides had a similar impact. Last, numerous sugar factories ejected their effluents into local waterways, which had detrimental effects.

Prior to the rise of Colorado's sugar industry, peoples of Northern European ancestry predominated the populations of the Front Range and the Arkansas River Valley. Because beet farming required inexpensive labor, sugar companies imported at first Germans from Russia and Japanese, then Hispanics during the 1910s. Within several generations, the German Russians and Japanese rose into positions primarily of farm ownership, then in industry and commerce. By contrast, many Hispanics remained primarily as the agricultural workers absolutely necessary for growing beets and other crops. Over time, they too branched out into other forms of employment and became a force in plains communities. In terms of demographics, the beet sugar industry helped bring the three ethnic groups to Colorado in numbers.

The exact influence that the beet sugar industry had on the town of Fort Collins is difficult to define. In its early years, Fort Collins was primarily an agricultural community, but as the nineteenth century progressed into the twentieth, the economy became increasingly diversified. The town saw the development of quarrying, ranching, cement manufacturing, and a variety of fruit and vegetable growing. The town was the crossroads of several railroads, and because it lay at the center of an otherwise rural setting rich with natural resources, the town naturally served as a point of commerce, banking, and education. Yet, because Fort Collins was strongly tied to agriculture, it benefited from the factors offered by the beet sugar industry, cited above. The sugar factory on the north edge of town certainly lent an element of heavy industry, and when the factory closed, the town felt the impact; however, the well-diversified economy readily absorbed the loss. Changes in Fort Collins' economy and appearance in the 40 years since the sugar factory closed obscured but did not erase the lasting legacy left by the sugar industry. The town's population features people descended from the German Russians, Japanese, and Hispanics brought to labor in the beet fields around the sugar factory. The ethnic groups once inhabited the neighborhoods proximal to the area where the factory stood, and many Hispanics still reside there. The neighborhoods also possess architecture and collectively retain some integrity left from the time when they were colonies of immigrant workers. While the beet sugar industry had an impact on Fort Collins, the town likewise had a great impact on the industry. Fort Collins agriculturalists were instrumental in devising the system of water rights and irrigation systems that permitted the beet farming industry to flourish. The Agricultural College made important contributions to beet cultivation, harvest, mechanization, and the development of a domestic seed stock. The influence of the beet sugar industry remains largely unknown today, yet this important chapter of history contributed greatly to the fabrics of Fort Collins and Colorado.

NOTES

1. Abbott, et al, 1994:3.

2. May, 1989:203.

3. Kershaw, et al, 1998:14; Mutel and Emerick, 1984:15, 30, 33; Worster, 1982:71-72.

4. US Beet Sugar Association, 1936:35.

5. Harris, 1919:276; Kahn, 1920:10; US Beet Sugar Association, 1936:5; USBA, 1959:5.

6. Gritzbaugh, 1933:25, 29; Mutel and Emerick, 1984:27; Nuckols and Summers, 1921; Payne, 1905.

7. Nuckols and Summers, 1921:6; Worster, 1982:12, 70.

8. Gilmore, et al, 1999:18-21; Heil, et al, 1977; Mutel and Emerick, 1984:27; Nuckols and Summers, 1921:3; Worster, 1982:67-68.

9. Payne, 1905.

10. Adams, 1913:19; E.H. Dyer Co., 1903:5; Faurot, 1903:5; Harris, 1919:104-107; Mendelson, 1916:7-11; Palmer, 1909:11; US Beet Sugar Association, 1936:41.

11. Mendelson, 1916:4.

12. May, 1989:192.

13. Faurot, 1903:5.

14. Adams, 1913:74.

15. Faurot, 1903:16; Gritzbaugh, 1933:16; Nuckols and Summers, 1921:21; McGinnis, 1971:8.

16. Adams, 1913:21; E.H. Dyer Co., 1903:5; Faurot, 1903:6; Harris, 1919:106; McGinnis, 1971:8.

17. Adams, 1913:23-27; E.H. Dyer Co., 1903:6; Mendelson, 1916:12; US Beet Sugar Association, 1936:43.

18. E.H. Dyer Co., 1903:6; Faurot, 1903:9; Gritzbaugh, 1933:12, 14; Mendelson, 1916:4; Nuckols and Summers, 1921:20-21.

19. E.H. Dyer Co., 1903:9; Faurot, 1903:10; Gritzbaugh, 1933:22; Mendelson, 1916:14.

20. May, 1989:366-367, 386.

21. Marvine and Barmington, 1943; Mendelson, 1916:4.

22. Adams, 1913:35; Faurot, 1903:10; Harris, 1919:119; US Beet Sugar Association, 1936:43; USBA, 1959:36.

23. McGinnis, 1971:8; USBA, 1959:36.

24. Adams, 1913:51; Harris, 1919:130.

25. Faurot, 1903:13; May, 1989:210; McGinnis, 1971:18.

26. McGinnis, 1971:18.

27. Arrington, 1966:101-102; Gritzbaugh, 1933:28; Harris, 1919:184.

28. Gritzbaugh, 1933:29-30.

29. Adams, 1913:115; Harris, 1919:186-198; Maxson, 1920:38-123.

30. Adams, 1913:115; Harris, 1919:186; Gillette, 1906.

31. Gritzbaugh, 1933:24; Harris, 1919:150; Mendelson, 1916:19.

32. Harris, 1919:154; May, 1989:192; US Beet Sugar Association, 1936:46.

33. Arrington, 1966:152; McGinnis, 1971:21.

34. Arrington, 1966:153; May, 1989:198; McGinnis, 1971:19; USBA, 1959:32-33.

35. Gritzbaugh, 1933:69; McGinnis, 1971:91, 94.

36. Adams, 1913:4; Faurot, 1903:18; Harris, 1919:234.

37. Harris, 1919:152; Palmer, 1909:10.

38. Adams, 1913:86; Harris, 1919:87; Palmer, 1909:11; US Beet Sugar Association, 1936:28, 31; USBA, 1959:22-23.

39. USBA, 1959:3.

40. Great Western, 1920:19, 22; Kahn, 1920:21; McGinnis, 1971:115; Ware, 1905:37, 55.

41. Harris, 1919:260-261; Kahn, 1920:21; Murke, 1921:5; McGinnis, 1971:113, 117-119; Ware, 1905:59.

42. Kahn, 1920:21; Murke, 1921:6; Ware, 1905:87-88.

43. Harris, 1919:261; McGinnis, 1971:125; Murke, 1921:7, 10; Ware, 1905:90-91.

44. Ware, 1905:145.

45. Kahn, 1920:22; Murke, 1921:11, 14; Ware, 1905:136, 139.

46. Ware, 1905:140.

47. Harris, 1919:262; Kahn, 1920:22; Murke, 1921:19.

48. McGinnis, 1971:143-144, 191.

49. Great Western, 1920:60, 188-189; Harris, 1919:262; Kahn, 1920:18; 29; McGinnis, 1971:121; Murke, 1921:26-28; Ware, 1905:305, 308; USBA, 1959:48.

50. Great Western, 1920:75-77; Kahn, 1920:18, 24; Harris, 1919:262; McGinnis, 1971:121; Murke, 1921:35.

51. Great Western, 1920:64; Kahn, 1920:24; McGinnis, 1971:121; Murke, 1921:44; USBA, 1959:50.

52. Great Western, 1920:94-95; Harris, 1919:264; Kahn, 1920:19, 25; McGinnis, 1971:122; Murke, 1921:26, 52; USBA, 1959:50.

53. Great Western, 1920:143; Kahn, 1920:19; Murke, 1921:73.

54. Great Western, 1920:144; McGinnis, 1971:122; Murke, 1921:77.

55. Great Western, 1920:177-178; Kahn, 1920:26; McGinnis, 1971:121; Murke, 1921:85-88, 96; USBA, 1959:50-51.

56. Great Western, 1920:151, 181; Kahn, 1920:27; McGinnis, 1971:123.

57. Great Western, 1920:216-217; Kahn, 1920:19, 28; McGinnis, 1971:124.

58. Dyer, 1903:32; *Fort Collins Weekly Courier*, 3/4/03, 9/16/03.

59. Great Western, 1920:257.

60. Great Western, 1920:257.

61. *Fort Collins Weekly Courier*, 9/16/03.

62. Austin, 1928:24.

63. *Fort Collins Weekly Courier*, 12/18/05.

64. May, 1989:305.

65. Murke, 1921:19.

66. Markoff, 1980:325.

67. Austin, 1928:11-12; Harris, 1919:9-10; Jodidi, 1911:1; US Beet Sugar Association, 1936:14-15; USBA, 1959:8-9.

68. Austin, 1928:17; Harris, 1919:16-18; Jodidi, 1911:7; McGinnis, 1971:726; US Beet Sugar Association, 1936:22; USBA, 1959:15; discussed at length by Taylor, 1944.

69. Austin, 1928:17; Harris, 1919:19; McGinnis, 1971:728-729; US Beet Sugar Association, 1936:24; USBA, 1959:16.

70. Harris, 1919:19; McGinnis, 1971:729-730; US Beet Sugar Association, 1936:24; USBA, 1959:17.

71. Harris, 1919:19; Markoff, 1980:18; McGinnis, 1971:726,732; US Beet Sugar

Association, 1936:24.

72. Arrington, 1966:6, 10-11; McGinnis, 1971:733-734.

73. May, 1989:1-2.

74. May, 1989:27.

75. Jessen, 1984:4; May, 1989:3.

76. Abbott, 1934:16; Harris, 1919:19.

77. May, 1989:4.

78. Austin, 1928:21; Harris, 1919:19; Johnson, 1974:7; May, 1989:59.

79. May, 1989:6.

80. Abbott, et al, 1994:364; Leonard and Noel, 1990:126; May, 1989:7.

81. Leonard and Noel, 1990:49, 111; Canfield, 1893:17; May, 1989:6, 7.

82. Abbott et al, 1994:181; May, 1989:7.

83. Arrington, 1966:6; May, 1989:8, 13; McGinnis, 1971:733-734.

84. Markoff, 1980:33-38.

85. Markoff, 1980:58-63.

86. Morris, 1985:58.

87. Abbott, et al, 1994:376, May, 1989:20.

88. Abbott, et al, 1994:377; Leonard and Noel, 1990:38; Markoff, 1980:25.

89. May, 1989:21, 24, 116, 384.

90. May, 1989:35.

91. May, 1989:35, 57.

92. May, 1989:41, 57; Shwayder, 1987:18.

93. Fleming, 1985:21-23, 31; Fort Collins Chamber of Commerce; Morris, 1985:36, 38; Peterson, 1972:13, 41, 55.

94. Fleming, 1985:61, 65, 70; Fort Collins Chamber of Commerce; Morris, 1985:36; Peterson, 1972:59, 63.

95. *Fort Collins Weekly Courier*, 12/5/01.

96. *Fort Collins Weekly Courier*, 1/9/02, 1/30/02; 4/9/02;

97. *Fort Collins Weekly Courier*, 9/16/03; 1/6/04.

98. May, 1989:38; Markoff, 1980:21; Shwayder, 1987:18.

99. May, 1989:13, 431.

100. Darley, 1913:11; May, 1989:44.

101. Markoff, 1980:120; May, 1989:45.

102. Arrington, 1966:6; May, 1989:50.

103. May, 1989:51-57.

104. May, 1989:58-59.

105. May, 1989:161.

106. Abbott et al, 1994:182; Darley, 1913:54; May, 1989:64.

107. Markoff, 1980:19, 25; McGinnis, 1971:729.

108. May, 1989:284-285, 310, 325; Shwader, 1987:15-16.

109. Markoff, 1980:19, 25; McGinnis, 1971:729; Shwader, 1987:15.

110. Gritzbaugh, 1933:69; May, 1989:167;Shwayder, 1987:16.

111. May, 1989:117-118; Jessen, 1984:6; Shwayder, 1987:22.

112. Jessen, 1984:7; Morris, 1985:13; Markoff, 1980:21; *Unofficial Items of Interest*, 1955:5.

113. Jessen, 1984:8; May, 1989:119-120; *Unofficial Items of Interest*, 1955:6-7.

114. Jessen, 1984:8, 14-17; *Unofficial Items of Interest*, 1955:1, 12.

115. For Collins Chamber of Commerce; May, 1989:35; Peterson, 1972:66.

116. Abbott, et al, 1994:164-165.

117. Abbott, et al, 1994:167-168; May, 1989:207.

118. Clason, 1908.; McWilliams and McWilliams 1985

119. Abbott, 1994:179; May, 1989:208; Reisner, 1986:114, 118.

120. May, 1989:207.

121. Arrington, 1966:80; Austin, 1928:22; Darley, 1913:43; May, 1989:245; McGinnis, 1971:742.

122. Cottrell, 1952:232; May, 1989:73,

84.

123. Arrington, 1966:82; May, 1989:253; McGinnis, 1971:742.

124. Harris, 1919:20-21; May, 1989:87, 284-285, 316; Shwayder, 1987:15-16.

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126. Arrington, 1966:80, 129; Johnson, 1974:22; May, 1989:265; Markoff, 1980:235.

127. Cottrell, 1952:232-235; May, 1989:112.

128. May, 1989:87, 300-306, 323; Shwayder, 1987:16.

129. May, 1989:386.

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131. Abbott, 1934:5; *Child Labor*, 1923:65; Roskelly, 1940:4.

132. Morris, 1985:9.

133. May, 1989:393-398; Shwayder, 1987:13.

134. Markoff, 1980:168-169.

135. Abbott et al, 1994:325; Markoff, 1980:237; May, 1989:381.

136. Abbott et al, 1994:325; May, 1989:399-422.

137. Gritzbaugh, 1933:57; Markoff, 1980:261.

138. Arrington, 1966:129; Johnson, 1974:23; May, 1989:267.

139. Arrington, 1966:130; Markoff, 1980:271; May, 1989:270-271; McElvain, 1993:148.

140. Arrington, 1966:131; Burdick, 1939; Johnson, 1974:9; May, 1989:268, 274; McGinnis, 1971:742; USBA, 1959:66-68.

141. Worster, 1982:12-14.

142. May, 1989:284-285.

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144. Abbott, et al, 1994:183; May, 1989:216.

145. McElvain, 1993:148.

146. Markoff, 1980:325, 337; Shwader, 1987:16-17.

147. Fulton; Markoff, 1980:342; May, 278-279; Shwader, 1987:16-17.

148. Fulton; Markoff, 1980:372-373; Shwayder, 1987:46.

149. Fulton; Markoff, 1980:378; Shwayder, 1987:58.

150. Waters, 1915:236.

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