THE SUGAR BEET INDUSTRY OF THE ARKANSAS VALLEY OF COLORADO

By

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Bachelor of Arts

Oklahoma Agricultural and Mechanical College

Stillwater, Oklahoma

1951

Submitted to the Faculty of the Graduate School of
the Oklahoma Agricultural and Mechanical College
in Partial Fulfillment of the Requirements
for the Degree of
MASTER OF SCIENCE
1954

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PREFACE

The writer first became acquainted with the sugar beet while preparing a research paper on sources of foods. He was amazed at the wide distribution of the industry in the United States and the percentage of sugar the industry supplies to this country's market.

A more detailed study revealed that, in certain areas in the United States, sugar beet production has been on the decline for a number of years. This study of a specific area was therefore undertaken in an effort to discover the cause or causes for this decrease. In order to more completely understand the problems, the writer describes the methods employed in this specific area in growing, in marketing, and in processing the sugar beet.

The area selected for study was the Arkansas Valley of southeastern Colorado. The Valley was chosen because of its compactness and because it is typical of the areas experiencing a decline in beet production.

The principal source for the material in this thesis was from a fifteen-day field study to the Arkansas Valley in 1953. Areas studied were located around Lamar, Las Animas, La Junta, Swink, and Rocky Ford. During this trip farmers, bankers, business men, publishers, local historians, government officials, members of the clergy, labor contractors, and officials of the sugar beet companies were interviewed. Other source material included sugar beet company publications, state and Federal government publications, books, magazines, and newspapers.

The writer wishes to extend his gratitude for valuable information concerning the sugar beet industry to those interviewed, especially to Mr. Fred Kennedy, Field Agent, Mr. Hoarce E. Knapp, Plant Manager, and Doctor Andrew R. Downie, Company Pathologist, all of the American Crystal Sugar Company, Rocky Ford, Colorado; to Mr. Kenneth Bischoff, Chief Agriculturist and Mr. E. O. Preston, Plant Manager, Holly Sugar Company, Swink, Colorado; and to Mr. George Hogan, Plant Manager, National Sugar Company, Sugar City, Colorado.

Particular thanks are due Professor George S. Corfield who ably assisted the writer during the early formative stages of this study, to Doctor Edward E. Keso, Head of the Geography Department, for his untiring aid in the final arrangement of the thesis, to Professor Ralph E. Birchard for his valuable suggestions in analyzing the problems of the study, and to Doctor Robert C. Fite for his aid and encouragement during the completion of this thesis.

T. P. D.

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION.	1
	The Sugar Beet	1
	Early Commercial Sugar Beet Development in Europe. .	3
	Introduction of the Sugar Beet into the United States	3
	Adaptation of the Sugar Beet to the Arkansas Valley.	4
II.	GEOGRAPHICAL DESCRIPTION OF THE ARKANSAS VALLEY	11
	Definition of the Area	11
	Population and Land Use.	11
	Climate.	14
	Topography	25
	Soils.	30
III.	SUGAR BEET CULTURE IN THE ARKANSAS VALLEY	34
	Preparing the Seedbed.	34
	Planting	44
	Cultivating.	45
	Harvesting	48
	Farm Labor Problems.	52
IV.	PROCESSING AND MARKETING OF THE SUGAR BEET IN THE VALLEY.	57
	Processing Procedure	57
	By-Products.	61
	Sugar Payments to the Growers.	63
	Adjusted Payment	64
	Refinery Labor Practices	66
V.	SUMMARY AND CONCLUSIONS	68
	Summary.	68
	Conclusions.	73
BIBLIOGRAPHY		76

LIST OF TABLES

Table		Page
I.	Population	12
II.	Percentage of Land Use	13
III.	Leading Crops by Acreages	13
IV.	Farm Animals	14
V.	Average Monthly Precipitation	17
VI.	Monthly Temperatures	20
VII.	Frost-Free Period	23
VIII.	Fertilizer-Combinations	38

LIST OF ILLUSTRATIONS

Figure		Page
1.	Arkansas Valley of Colorado Showing Irrigable Area	5
2.	(a) Hand Thinning of Sugar Beets	49
	(b) Mechanical Thinning of Sugar Beets	49

CHAPTER I

INTRODUCTION

The Sugar Beet

In a period of eighty years, the sugar beet industry in the United States has grown from one plant in California to eighty refineries located in twenty-two states. Approximately 80,000 farmers supply these refineries with a yearly average of 925,000 acres of beets. The commercial sugar produced from these beets equals thirty-seven million 100-pound bags, an amount which supplies 27 per cent of the United States market.[1] This thesis is the result of an intensive study of the problems peculiar to one sugar beet area in the United States in an effort to determine the forces affecting sugar beet production of that area.

The sugar beet is an off-spring of the mangel, a root forage crop which originated in the Mediterranean area. In the early part of the 16th century the mangel was introduced to the more temperate climates of northern Italy and central Germany, where it changed from an annual to a biennial crop.[2] Thus, in the more temperate climate the mangel stores sugar in its root during the first year and uses the stored sugar to produce seed the following season.[3]

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[1] "How to Grow Sugar Beets," Through The Leaves (November-December, 1950, and January-February, 1951), p. 14.

[2] T. B. Hutcheson, T. K. Wolfe, and M. S. Kipps, The Production of Field Crops (New York, 1948), p. 338.

[3] Farmers and Manufacturers Beet Sugar Association, The Story of Beet Sugar from the Seed to the Sack (Saginaw, 1945), p. 9.

In 1747, Andreas Marggraf, a Prussian chemist, discovered that the mangel contained sugar which possessed identical chemical and physical properties with that of sugar obtained from sugar cane. This discovery led to further experimentations which resulted in the increased sugar content of the root and the breeding of a plant somewhat different from the original mangel. The new plant became known as the sugar beet.[4]

The sugar beet is an enlarged silver-white taproot which extends downward to a depth of two to six feet and gradually diminishes in diameter until it becomes threadlike in size. The first six inches of the root are almost free of side roots, but below this point an extensive and elaborate system of lateral roots and rootlets develop and extend horizontally a distance of two to three feet. The foliage of the sugar beet has a rich, brilliant green color and grows to a height of about fourteen inches. Each leaf has prominent veins and a long petiole which broadens at the base to form the foundation of a large, roughly triangularly shaped leaf.

Through the process of photosynthesis, which occurs in the chloroplast of the leaf cells, carbon from the air and hydrogen and oxygen from the soil are combined to form sucrose or sugar. In the early part of the growing season this sucrose is utilized by the plant in its own development, but as plant growth wanes an increasing proportion of the sucrose is stored in the enlarged taproot just beneath the surface of the soil. Consequently, the enlarged taproot is the source of commercial beat sugar.[5]

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[4]*Ibid.*, pp. 1-3.

[5]*Ibid.*, p. 9.

Early Commercial Sugar Beet Development in Europe

The commercial beet sugar industry had its inception in 1811. In that year Napoleon began his program of sugar beet production aimed at making France independent of foreign cane sugar. Soon other European nations began to follow Napoleon's example and the production and processing of the sugar beet began to spread throughout the continent.[6]

Introduction of the Sugar Beet into the United States

In 1838 the commercial production of the sugar beet was first attempted in the United States, at Northampton, Massachusetts, but it proved unsuccessful.[7] Other attempts in Michigan, Utah, California, Wisconsin, Illinois, Maine, and Delaware also ended in failure. Finally in 1870, the first successful refinery was established at Alvarado, California, thus marking the inception of the beet sugar industry in the United States.[8]

The year 1870 also marks the beginning of sugar beet production in Colorado, with beets being grown in the Platte River bottoms near Denver. However, the necessary capital could not be interested in the construction of a sugar beet processing plant until 1899, when the first refinery was completed at Grand Junction, in western Colorado.[9]

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[6] Ibid., pp. 1-3.

[7] United States Beet Sugar Association, The Silver Wedge: the Sugar Beet in the United States (Washington, D. C., 1936), p. 9.

[8] Production and Marketing Administration, United States Department of Agriculture, Beet Sugar Factories of the United States (Washington, D. C., 1950), p. 1.

[9] R. H. Tucker and T. G. Stewart, Sugar-Beet Growing in Colorado, Colorado State College, Extension Bulletin 363-A (Fort Collins, 1941), p. 3.

Adaptation of the Sugar Beet to the Arkansas Valley

The sugar beet was introduced into the Arkansas Valley of Colorado in the 1890's by George W. Swink. Swink brought the first seeds from Germany and after settling near Rocky Ford he encouraged his neighboring farmers to plant and experiment with the sugar beet. These early experimentations proved successful and the popularity of the beet began to spread. Thus the early beet production gave every indication that the Valley contains suitable soil materials and climatic conditions, with the addition of irrigation water, for the growing of sugar beets. These findings opened the way for a great new industry in the Valley.[10]

In 1900, the American Beet Sugar Company, organized the preceding spring, erected the first beet sugar refinery in eastern Colorado at Rocky Ford (Figure I). Behind the location of this refinery lies a civic promotion scheme exemplified today in many community programs. The merchants and citizens of Rocky Ford guaranteed the American Beet Sugar Company a certain acreage of sugar beets for a period of ten years. To satisfy the needed acreage, many town merchants, business people and plain citizens either bought or leased land for sugar beets, and in some cases one party would pay another to grow his quota of beets.[11]

With this acreage guarantee, the American Beet Sugar Company moved into Rocky Ford and purchased 6,000 acres of sub-marginal land along the north bank of the Arkansas River. This land, mainly alkaline or in need of drainage, contained, at the time of the purchase, a cover of sage brush and wild grass along with some alfalfa and row crops.

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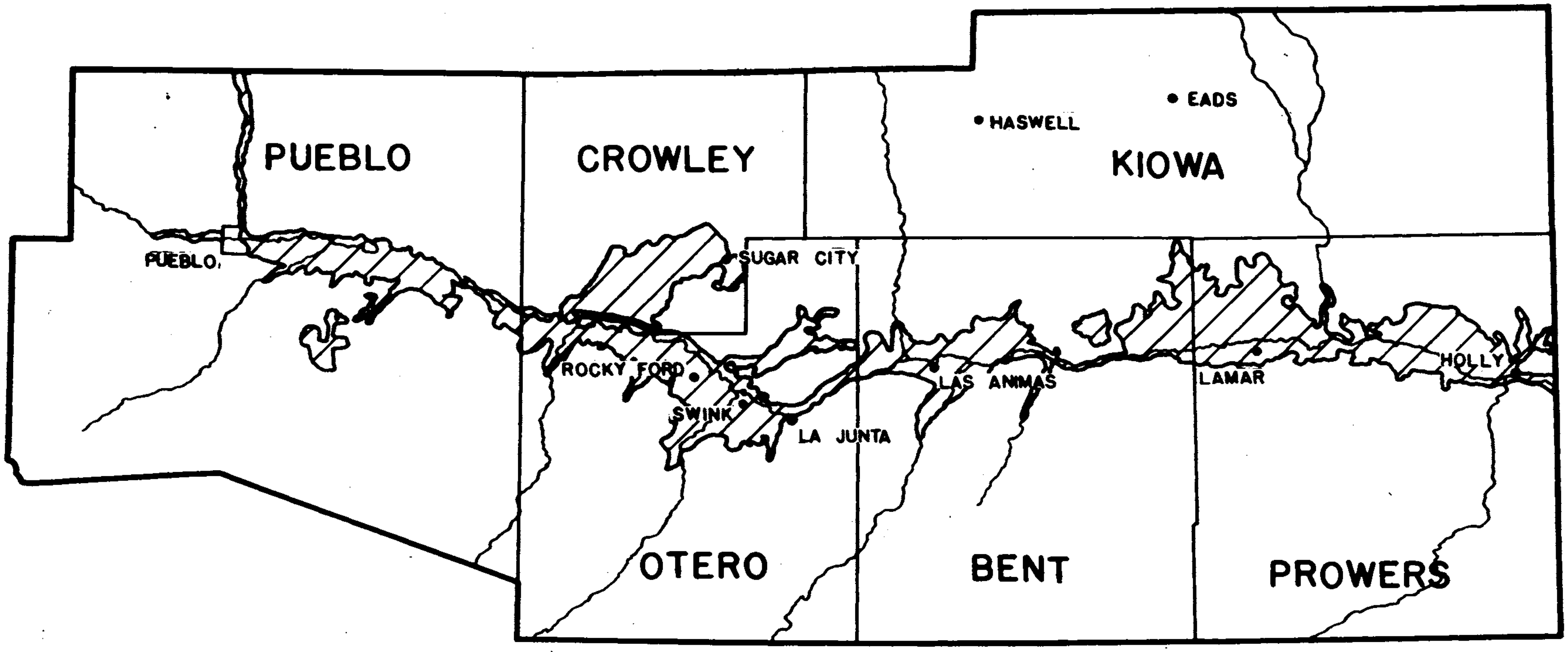
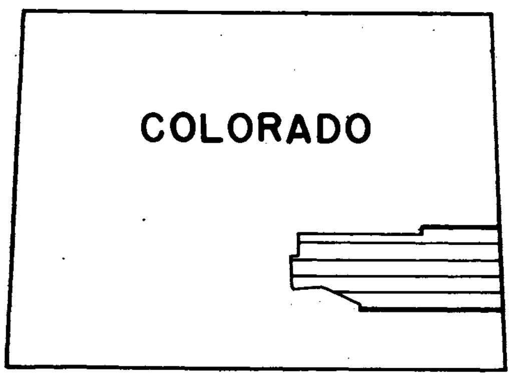
[10]C. W. Hurd, "Agriculture—Sugar Beets and Alfalfa—Brot Railroads and Growth to Valley," Pueblo Star-Journal, Second Section (August 8, 1948), p. 1.

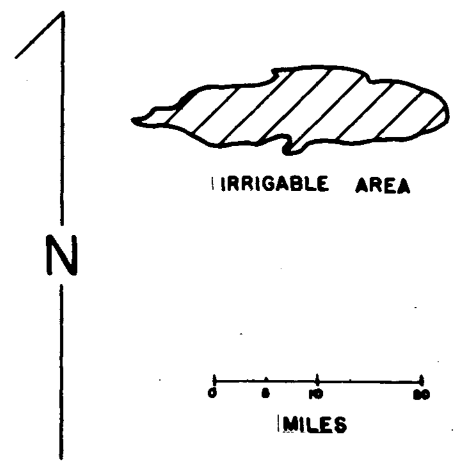
[11]H. B. Mendenhall, personal interview, January, 1953.





ARKANSAS VALLEY OF COLORADO

FIGURE I



While this land has been used to some extent for experimental work and for growing sugar beets, the main reason for its purchase was to assure the refinery ample water priority, from the Rocky Ford canal, for the processing of the beets. This plant could originally process 800 tons of beets in twenty-four hours, but since its inception, its capacity has gradually been increased to 2,500 tons per day. In addition to its basic refining process, the plant possesses a Steffen House, for the processing of refuse molasses, and a pulp dryer.[12]

The year 1899 also marks the founding of the National Beet Sugar Company at Sugar City. The company began to take form in the latter part of the nineteenth century when a group of eastern investors, interested in western irrigated land, bought 12,000 acres in what is now the southern part of Crowley County. At first they were not sure how they could best use the land. Finally the local popularity of the sugar beet won them over, and in 1900 they established a refinery at Sugar City to process the beets produced on the corporation's land.

To aid in operating the refinery and tilling the land, the corporation imported from Germany the necessary industrial and agricultural technicians along with a sufficient supply of German migrant laborers. This system ended in 1906, with the company dividing and selling the land to individual farmers, but still maintaining sufficient water rights for refinery operations. Today, the company owns only a 160-acre experimental farm along with a refinery whose capacity has been increased from an original 500 tons to 1,200 tons per day.[13]

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[12] D. L. Joehnck, personal interview, January, 1953.

[13] George E. Hogan, personal interview, January, 1953.

The next development in the beet sugar industry came in 1905, when the Holly Sugar Company established a refinery at Holly, Colorado. This company, formed by the Equitable Life Assurance Company, acquired land holdings which amounted to 670,000 acres, of which some 4,000 to 5,000 acres were under an irrigation ditch.[14] As in the case of the two earlier refineries, the irrigation water provided the refinery with its operational water supply, in addition to irrigating fields of alfalfa, sugar beets and cantaloupes.[15] This factory at Holly, lasted until 1915, when the lack of a beet supply forced the company to close the refinery and the equipment was moved to Sheridan, Wyoming.[16]

In 1905, the American Beet Sugar Company expanded its operations into the eastern part of the Arkansas Valley, with the establishment of a refinery at Lamar, Colorado. Once again civic pride and pressure exerted its influence on the beet growers and on the American Beet Sugar Company for the establishment and support of a local refinery. The company first acquired a crop acreage guarantee from local growers and then purchased between 6,500 to 7,000 acres of land for its irrigation water rights. With the assurance of a supply of raw materials and water for the refinery, the company moved in the German-made equipment from their then defunct plant at Norfolk, Nebraska.[17] Besides introducing European equipment at Lamar, the company also employed the European method of tenant farming. This method makes use of a farm manager and of groups of farm workers, who

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[14]D. L. Joehnck thought there were 13,000 acres under an irrigation ditch.

[15]R. J. McGrath, personal interview, January, 1953.

[16]Production and Marketing Administration, United States Department of Agriculture, op. cit., p. 6.

[17]D. L. Joehnck and I. W. Reed, personal interviews, January, 1953.

raise beets for the factory and then feed the tops to livestock and return the manure to the fields. This system was soon discontinued and the refinery eventually closed in 1927. The company still maintains some 3,000 acres of its original land for experimental purposes.[18]

This latest refinery gave the Valley a total of four beet sugar factories, one each at Sugar City and Rocky Ford, near the center of the Valley, and at Holly and Lamar, in the eastern section of the Valley. The refineries, along with their surrounding beet areas, which lay in the center of the Valley existed under older-higher priority irrigation canals. The general rule of water apportionment was on a first come greatest share basis. Consequently, the newer canals in the eastern section of the Valley drew water from lower priority ditches than those to the west and during dry periods their water demands often exceeded the supply of available water. This problem existed quite realistically for the Holly Sugar Company at Holly. It made it difficult for them to procure raw materials near at hand, so they brought in beets from the north and west, a distance in some instances of nearly eighty miles. Operations of this type proved to be both expensive and time consuming, so Holly began searching for a more central location.

In 1906, the opportunity presented itself when the Columbia Land and Cattle Company wanted to dispose of 800 acres of ranch land near Swink, Colorado, due to the low price of cattle. The American Beet Sugar Company turned down first chance to buy the land since it lay only five miles from their Rocky Ford refinery. However, the Holly Company very eagerly purchased the land and erected a refinery which they hoped would help carry their marginal plant at Holly. In order to supplement the irrigation

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[18]Earle Garvin, personal interview, January, 1953.

water shares for 800 acres, the Holly Sugar Company drilled wells adjacent to the Swink refinery. Since then they have disposed of most of this land but have maintained water rights from the Catlin Canal.[19] The refinery not only operates today, but its capacity has been increased from 1,200 tons to 2,000 tons per day and its operation has been improved by the addition of a Steffen House.[20]

With these two rival companies operating only five miles apart, competition became keen. The principal and most concentrated source of beets outside the immediate factory environs existed in the Holbrook area in the vicinity of the present town of Cheraw. The beet growers in the Holbrook area had been begging the American Beet Sugar Company for a railroad with which to transport their beets to Rocky Ford but had been put off with promises for the future. However when Holly began operation of their plant at Swink, they also began construction of a railroad from Swink to Cheraw to Holly. With the advent of this construction program the American Beet Sugar Company immediately bought-up a half section right-of-way and began construction of their long promised railroad from Rocky Ford to Cheraw. In the meantime, the Sante Fe Railroad which owned the mainline south of the river became concerned lest the Missouri-Pacific buy out these railroads, so Sante Fe stepped in and purchased both operations in their entirety. The Sante Fe Railroad then discarded the Rocky Ford to Cheraw line, but completed the railroad known as the Arkansas Valley Branch of the Sante Fe from Swink through Cheraw to Holly, with connections south into Las Animas and Lamar.

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[19] D. L. Joehnck and I. W. Reed, personal interviews, January, 1953.

[20] Production and Marketing Administration, United States Department of Agriculture, op. cit., p. 7.

The same year that Sante Fe took over the Arkansas Valley Branch Railroad (1907) the American Beet Sugar Company erected a beet sugar refinery at Las Animas. The company was more or less forced to construct this plant in order to maintain control of the beet acreage in the immediate area.[21] However, the existing beet acreage did not suffice in supporting the plants 700-ton capacity, so in 1920, after functioning nine years out of fourteen, it ceased operation. Slowly, piece by piece the company dismantled the equipment until they completed the operation in 1942.[22]

The era from 1900 to 1907 saw an intense expansion of both beet acreage and processing facilities in the Valley. During this period the beet sugar industry existed on an earning basis which easily attracted capital and interested farmers. The local populace fell into the sugar beet mania and every large community clamored for their own refinery. This resulted in an over expansion in regards to processing facilities and when sugar beet acreage failed to expand proportionately, particularly in the eastern part of the Valley, the factories in the less productive areas ceased to operate. Today the Arkansas Valley which once had six operating refineries does not produce enough sugar beets to keep the three remaining factories operating at their optimum.[23]

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[21] D. L. Joehnck and I. W. Reed, personal interviews, January, 1953.

[22] Ibid., and Production and Marketing Administration, United States Department of Agriculture, op. cit., p. 8.

[23] George E. Hogan, Hoarce Knapp, and Kenneth Bischoff, personal interviews, January, 1953.

CHAPTER II

GEOGRAPHICAL DESCRIPTION OF THE ARKANSAS VALLEY

Definition of the Area

The area included within the Arkansas River Valley of Colorado varies according to the definition and delineation of the boundary. Since natural boundaries are sometimes ill-defined or else tend to vary, the writer has selected the political boundary including the six counties of Pueblo, Otero, Crowley, Bent, Kiowa, and Prowers.

The Arkansas Valley, located in the southeastern part of Colorado, lies between $37^{\circ}40'$ and $38^{\circ}40'$N latitude and $102^{\circ}0'$ and $105^{\circ}0'$W longitude. Lying along the eastward flowing Arkansas River, which bisects it into almost equal north-south halves, the Valley extends over 150 miles from east to west, a distance three times greater than its north-south width.

Population and Land Use

The six counties in the Valley have a total area of 9,442 square miles and a population of 147,000, which gives the Valley a population density of 15.57 persons per square mile. The heaviest concentration of population lies in Pueblo County which, with 37.3 persons per square mile, contains 61 per cent of the total Valley population. Otero County, with 17 per cent of the Valley's population, ranks second in population density with 20.0 people per square mile, while others follow with Prowers, 9.1;

Crowley, 6.4; Bent, 5.7; and Kiowa, 1.7[1]

A breakdown of the population figures shows that of the 147,000 people in the Valley, 65 per cent, or 95,000, are classed as urban and 35 per cent, or 52,000, are rated as rural. Of the 52,000 rural people, about 20,000, or 38 per cent, live on farms. Table I lists a more complete breakdown of the population for each county:

TABLE I

POPULATION*
(1950)

County	Urban	Rural Population Non-Farm	Rural Population Rural Farm	Rural Population Total	Total
Pueblo	73,247	12,069	4,872	16,941	90,188
Otero	11,799	8,184	5,292	13,476	25,275
Prowers	6,829	4,203	3,804	8,007	14,836
Bent	3,223	2,987	2,565	5,552	8,775
Crowley	(none)	3,016	2,206	5,222	5,222
Kiowa	(none)	1,603	1,400	3,003	3,003
	95,098	32,062	20,139	52,201	147,299

* U. S. Census of Population (1950), U. S. Department of Commerce, Bureau of Census (Colorado) and Rand-McNally Commercial Atlas and Marketing Guide, 82nd Edition (New York, 1951), pp. 84-91.

The total land acreage in this area approximates 6,020,000 acres, which gives a forty-one acre per capita holding. With 83 per cent of this land-area in farmland, it breaks down into the following general uses: 17 per cent in cropland; 72 per cent in pastures; and 11 per cent used for other purposes; i.e., farmland not cropped or pastured, farm house lots and roads, and farm wastelands. These percentages have been compiled on a county basis and are listed in Table II.

[1]Rand-McNally Commercial Atlas and Marketing Guide, 82nd Edition (New York, 1951), pp. 84-91.

TABLE II

PERCENTAGE OF LAND USE*

County	Farmland			Irrigated
	Cropped	Pastured	Other Uses	Farmland
Pueblo	8.0	87.0	5.0	4.2
Otero	9.0	88.0	3.0	9.7
Crowley	14.0	74.5	11.5	9.8
Bent	11.0	84.0	5.0	6.9
Prowers	31.0	48.0	21.0	9.5
Kiowa	27.0	51.0	22.0	0.002

* U. S. Department of Commerce, Preliminary 1950 Census of Agriculture, Farms, Farm Characteristics, Farm Products, Bureau of Census (Colorado).

It might be of interest to note that over one-third, 320,000 acres, of the total cropland of 850,000 acres receives irrigation. However, many pastures receive irrigation water, hence, in Table II, Otero county has more land irrigated than cropped.

Below is a list of cropland usage according to leading crops:

TABLE III

LEADING CROPS BY ACREAGES*

Crop	County					
	Pueblo	Otero	Crowley	Bent	Prowers	Kiowa
Wheat (winter)	20,174	1,880	9,592	27,669	154,278	132,445
Sorghum	2,768	1,132	7,879	23,019	80,234	74,385
Cut Hay	16,248	24,012	13,093	24,135	28,021	898
Corn	11,167	16,584	11,621	12,083	16,464	2,121
Barley	8,024	9,027	4,879	7,633	13,656	5,780
Annual Legumes	17,200	2,348	3,776	538	264	9
Alfalfa Seed	638	3,843	1,615	6,231	6,945	358
Vegetables (sale)	5,073	6,272	2,000	988	1,121	(A)
Sugar Beets	4,681	4,446	3,358	979	2,788	0
Oats	1,696	1,980	741	655	2,238	80
Sudan Grass Seed	35	10	85	12	42	4,595
Broomcorn	0	0	100	276	3,638	650
Small Grains	517	117	150	306	320	1,796
Wheat (spring)	612	241	236	200	1,090	290
Sweet Clover Seed	9	43	91	194	284	33
Rye	33	31	15	82	365	95
Tree-Vine Crops	42	136	20	6	6	1

* Preliminary 1950 Census of Agriculture (Colorado).
(A) Composed of small, widely scattered acreages.

As 72 per cent of the farmland lies in pasture, and as the residue from sugar beets forms a significant part of seasonal feeding for cattle, sheep and to a lesser extent hogs, the writer has enumerated the livestock population below:

TABLE IV

FARM ANIMALS*

	County					
General Types	Pueblo	Otero	Crowley	Bent	Prowers	Kiowa
Horses-Mules	2,941	1,559	819	1,535	2,027	1,004
Cattle-Calves	43,763	36,144	18,720	32,332	35,518	23,132
Hogs-Pigs	6,237	12,759	5,803	7,773	11,812	1,960
Sheep-Lambs	29,245	22,293	3,563	31,377	44,316	2,600
Poultry	64,316	56,781	27,781	45,547	73,661	26,165

* Preliminary 1950 Census of Agriculture (Colorado).

Climate

The Arkansas Valley of Colorado lies within a climatic zone which Blair classifies as middle-latitude steppe.[2] This middle-latitude steppe occupies a transitional, or intermediate, position between a desert and a humid climate. Because of the greater precipitation than in the desert, the steppe tends to be better suited for human settlement and in turn the middle-latitude steppe possesses a smaller population than the more humid climate to the east.[3] Precipitation plays a more important part than temperature in determining the boundary which separates the steppe from the humid climates to the east.[4]

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[2] T. A. Blair, Climatology: General and Regional (New York, 1942), p. 184.

[3] G. T. Trewartha, An Introduction to Weather and Climate (New York, 1943), pp. 380-381.

[4] R. DeC. Ward, The Climates of the United States (New York, 1925), pp. 432-433.

The general climatic features of this steppe area include a light yearly rainfall; a large daily range in temperature; a high day temperature in summer; a few protracted cold spells in winter; a large amount of sunshine; a moderately high wind movement; and a low relative humidity.[5]

Precipitation: In the more interior and continental locations summer usually becomes the period of maximum precipitation. This relates to the higher temperatures, the greater specific humidity, and the inblowing system of monsoonal winds in the summer. In winter the low temperatures and the anticyclonic pressure condition serves to discourage any great amount of condensation.[6]

The rainfall of the steppe area increases from west to east but varies little from north to south. Within the immediate shadow of the Rockies, the rainfall averages from ten to fifteen inches per year, while eastward, to approximately the 100th meridian, the yearly precipitation amounts to fifteen to twenty inches.[7]

The precipitation in the Arkansas Valley follows this general east-to-west trend of decreasing precipitation. In the east, Lamar receives 15.40 inches yearly, while Pueblo in the west receives 11.67 inches. The Valley as a whole receives a yearly average of 13.4 inches.

An important feature of the Valley's rainfall regime is the proportionately large amount that falls during the growing season. Of the total precipitation, 10.27 inches fall during the warm season, the months of April to September inclusive. Nevertheless, this area is not immune to the occasional summer dry spell which may last for several weeks.

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[5]Ibid., p. 433.

[6]Trewartha, op. cit., p. 377.

[7]Blair, op. cit., p. 187.

Of seven stations studied, all experience a slight yearly double-maximum in the months of May and July.[8] The May moisture comes from slow, steady rains which occur along the warm front of moving cyclones. Their influence lessens in June, and with the summer heat of July, thermal convection becomes more evident and most of the summer rains occur in the form of thunder showers. These thunder showers fade away as the winter season approaches, and once again cyclonic precipitation becomes dominant over the Valley. This cyclonic precipitation often comes in the form of rain as the warm front passes and then changes to snow when the cold front arrives.

The Valley occasionally receives a small amount of orographic precipitation in winter. When a low pressure area forms west of the mountains and a winter high exists over the Missouri and upper Mississippi valleys, winds move easterly up slope across the mountains and bring moisture to eastern Colorado.[9] This winter moisture, nevertheless, is not plentiful. In all of the reporting stations, January ranks as the driest month, with a Valley average of .27 inches.

According to the isohyet map of Colorado, the dry spot of the Valley exists in the northern half of Pueblo County and extends into the west-southwest part of Crowley County. South of this low moisture center the precipitation increases rapidly as the fourteen-and sixteen-inch isohyets are crossed within a short span of less than fifty miles. The fourteen- and sixteen-inch isohyets continue eastward across central and southern Otero County and into Bent County. In Bent County, the fourteen-inch isohyet curves northward just west of Lamar and passes east of Eads as it

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[8] U. S. Department of Commerce, Climatological Data: Colorado, Vol. LVII, No. 13 (Washington, 1952), pp. 174-175.

[9] Blair, *op. cit.*, pp. 188-189.

leaves Kiowa County and the valley. Meanwhile, the sixteen-inch isohyet crosses southern Prowers County and swings northeast into Kansas only to reappear in the extreme northeastern tip of Kiowa County.[10]

The general monthly average precipitation for the Valley stations are listed below:

TABLE V

AVERAGE MONTHLY PRECIPITATION*
(In inches)

	Stations						
Months	Eads	Haswell	Lamar	Las Animas	La Junta	Rocky Ford	Pueblo
Jan	.26	.22	.31	.25	.25	.29	.31
Feb	.40	.28	.52	.40	.46	.31	.47
Mar	.67	.50	.83	.62	.74	.62	.69
Apr	1.35	1.15	1.63	1.48	1.57	1.49	1.31
May	2.39	2.39	2.27	2.04	1.99	2.01	1.60
June	2.07	1.93	2.12	1.53	2.06	1.37	1.36
July	2.36	2.21	2.47	2.04	2.25	2.27	1.94
Aug	1.79	1.74	1.96	1.62	2.21	1.58	1.82
Sept	1.13	.98	1.21	.91	.63	.84	.75
Oct	1.08	.94	.99	.76	.88	.85	.66
Nov	.44	.65	.51	.40	.65	.46	.36
Dec	.28	.27	.58	.46	.58	.41	.50
Total	14.22	13.26	15.40	12.51	14.27	12.50	11.67

* Climatological Data: Colorado (1952), pp. 174-175.

One cannot deny that this rainfall regime of the Arkansas Valley greatly influences the acreage of sugar beets. Its main influence however lies in limiting the area of distribution. The sugar beet needs water. In fact, in the course of the growing season, an average-size sugar beet requires fifteen gallons of water for its growing process. This water, most of which moves up through the plant and out into the air, makes up

[10] U. S. Department of Agriculture, Yearbook of Agriculture, Climate and Men (Washington, 1941), p. 807.

about eighty-five per cent of the total content of the whole beet plant at harvest time.[11]

Water is the life-blood of all plants, and the sugar beet uses it in two ways: first, the sugar beet needs water simply to satisfy its thirst; and second, the water either dissolves soil foods or else contributes to their bacterial or chemical changes which then makes it possible for the plant to assimilate them.

The sugar beet needs this moisture throughout its entire growing season, and the lack of water at any time, will cause the leaves to wilt and will slow down the growth process. Since the Valley's summer rainfall is undependable, the only means of assuring a sufficient water supply lies in irrigation. In order to supplement the Valley's twelve to fifteen inches of moisture, it is necessary to add between twenty and thirty inches of irrigation water per crop season. The time and method of applying this additional moisture must be determined by the grower.

In general, however, the sugar beet uses irrigation water at a relatively low rate during May and June, months of greatest rainfall, but the amount it needs increases during July, August, and September, months of lower precipitation and higher evaporation.[12]

Temperature: Temperatures in this middle-latitude steppe region range from almost subtropical on the southern border to cold continental in the north. The main difference in temperatures, within the general area, occurs in the colder months, with high temperatures in summer being characteristic of the entire region. This perhaps is best shown by comparing the annual temperature ranges and the July temperatures for a few

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[11] "How to Grow Sugar Beets," Through The Leaves (November-December, 1950, and January-February, 1951), p. 105.

[12] Ibid., pp. 104-114.

select stations. Amarillo, Texas, to the south, is characterized by a July temperature average of 76°F. and an annual range of 41°F.; Bismarck, North Dakota, to the north, experiences an average July temperature of 69°F. and a yearly range of 61°F. The Arkansas Valley has a July average of 76°F. and a per annum temperature range of 47°F.[13]

While the temperature in the steppe region shows a latitudinal variation, the temperature in the Valley reflects local influence and decreases from east to west. In the east, Lamar experiences a yearly average temperature of 54.4°F., and Pueblo in the west has an annual average of 50.8°F. The greatest difference in these two stations is noticed by averaging the six warm-season months for each station. This average temperature gives Lamar a reading of 69.4°F. and Pueblo a reading of 64.7°F., which makes a difference of 4.7°F. A similar comparison for the cold-season averages for the two stations shows a difference of 2.8°F., with Pueblo having the lower temperature. These figures show that while the yearly temperature range varies less in the western part of the Valley, the east experiences a higher yearly temperature.

In the Valley as a unit, the yearly temperature averages 52.3°F., with the cold-season having an average of 38.4°F. and the warm-season averaging 66.7°F. The warmest month in the Valley is July with a monthly average of 76.3°F., and January, besides being the driest month, also ranks as the coldest with an average of 29.2°F.[14]

The Valley, typical of continental areas, experiences a wide range of temperature extremes. Maximum temperatures in summer reach as high as 114°F. and in winter as low as -32°F. While no definite trends in either

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[13]Blair, op. cit., pp. 184-185.

[14]Climatological Data: Colorado (1952), op. cit., p. 173.

extremes of temperature appear, there seems to exist a tendency for greater temperature extremes to occur in the east-central part of the Valley, around Las Animas and Lamar. Table VI lists the average monthly temperatures for five Valley stations, in addition to the Valley averages:

TABLE VI

MONTHLY TEMPERATURES*

	Stations(A)					
Months	Eads	Lamar	Las Animas	Rocky Ford	Pueblo	Total
Jan	28.7	30.7	28.5	29.4	28.7	29.2
Feb	33.5	35.0	33.2	33.6	32.1	33.5
Mar	41.4	43.5	42.2	42.0	40.8	41.9
Apr	49.8	53.5	52.2	51.7	49.4	51.3
May	60.1	63.1	61.8	60.9	58.9	60.7
June	70.6	73.3	71.9	70.6	68.6	71.0
July	76.2	78.5	77.0	75.5	74.2	76.3
Aug	74.6	77.2	74.8	73.9	72.7	74.6
Sept	66.6	68.8	66.8	65.8	64.6	66.5
Oct	53.8	55.7	54.0	53.5	51.2	53.6
Nov	39.8	41.6	40.3	39.8	38.3	39.9
Dec	29.6	31.4	30.2	30.3	30.1	30.3
Average	52.1	54.4	52.7	52.2	50.8	52.3

* Climatological Data: Colorado (1952), p. 173.
(A) Temperatures listed in degrees fahrenheit.

The role that temperature plays in the production of sugar beets is important, although sugar beets will grow in any area of the United States. However, beets grown only in those regions of the United States which possess an optimum environment will produce a quality and quantity of sucrose suitable for commercial production.[15] This zone includes most areas in which the summer temperature averages about 70°F. In addition, the area that lies within this zone possesses a daily summer maximum which

[15] E. W. Brandes and G. H. Coons, "Climatic Relations of Sugar-cane and Sugar-beet," Yearbook of Agriculture (Washington, 1941), pp. 43 and 431-432.

rarely exceeds 95°F., and a night temperature which is comparatively cool. Another criterion of an optimum sugar-producing area is found in the temperature progression of the early spring and fall months. An area rates as ideal if its spring temperature rises above 35°F. from February 16 to April 1 and above 45°F. from March 16 to May 1; in the fall season, the temperature needs to fall below 45°F. between October 16 and November 16 and below 35°F. from November 16 to December 1.[16]

These temperature requirements, while allowing some fluctuation, are based on years of study and research and greatly influence the distribution of sugar beets. A summer season temperature in excess of the 70°F. apparently causes growth to flag,[17] while on the other hand, a summer temperature that falls too low tends to cut short the growing season.[18]

The spring temperature requirement needs consideration because the sugar beet seed germinates slowly at temperatures only a few degrees above freezing. Hence, to assure emergence rather than rotting in the soil, the sugar beet seed requires an air temperature of at least 45° to 48°F. At the emergence stage, as the bent hypocotyl pulls the seed leaves above the ground, the sugar beet becomes most sensitive to cold; i.e., temperature of about 27°F. or below. However, once above ground and somewhat conditioned, the plant becomes very hardy to cold temperatures.[19]

The fall temperatures play an equally important role in sucrose production to those in spring. While the cool fall days and frosty nights

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[16] Esther S. Anderson, The Sugar Beet Industry of Nebraska (Lincoln, 1935), pp. 38-40.

[17] Brandes and Coons, op. cit., p. 433.

[18] Oswald Schreiner and B. E. Brown, "Soil Nitrogen," Yearbook of Agriculture (Washington, D. C., 1938), p. 771.

[19] Brandes and Coons, op. cit., pp. 432-433.

check vegetative growth, the sunny weather with its photosynthetic activity continues and instead of adding to its vegetative growth, the sugar beet produces and stores sucrose in its root. If left unharvested, the plant remains dormant during the colder period, and with the advent of warm weather, it utilizes the stored sugar to blossom forth with its seed crop.[20]

Frost-free Period: The frost-free period in the steppe region varies from 200 days in west Texas to ninety days in southern Canada. The frost-free period in the Valley, however, closely follows an east-west line of 160 days, and this line, much like the river, tends to bisect the region horizontally. To the north and west of the 160 day line, the frost-free period tends to decrease as the elevation increases, with the 140 day line closely paralleling the contour lines of the Black Forest region, northeast of Colorado Springs. To the south of the 160 day line and particularly towards the southeast the frost-free period lengthens until it reaches 180 days in the extreme southeast corner of Colorado.[21]

Besides varying slightly within the Valley, the frost-free period fluctuates from year to year. However, in forty years of weather recording, the growing season has remained within a 130- to 220-day limit.[22]

Table VII lists the average dates for the last killing frost in spring, the first killing frost in fall and the average number of days in the frost-free period

Since the sugar beet produces and stores commercial quantities of sugar within a period of 130 to 200 days, the Valley, with its average growing season of 160 days, fits well within this program. The sugar

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[20] Ibid., p. 43.

[21] U. S. Department of Agriculture, Yearbook of Agriculture. Climate and Man, op. cit., p. 807.

[22] Ibid., pp. 802-803.

TABLE VII

FROST-FREE PERIOD*

Stations	Frost Dates(A) Spring	Fall	Growing Season
Holly	April 27	October 11	167
Eads	May 7	October 9	155
Lamar	April 26	October 10	167
Las Animas	April 29	October 9	163
Rocky Ford	April 28	October 9	163
Pueblo	April 23	October 14	174

* U. S. Department of Agriculture, Yearbook of Agriculture. Climate and Man, p. 807.
(A) Records vary from twenty to forty years (average thirty-six).

beet needs this time in order to attain its vegetative growth and produce and store its sucrose. More specific details on the growing season have already been covered in the section on temperatures.

Sunshine: The steppe area with its relatively dry atmosphere, low rainfall and high elevation receives a great amount of intense solar radiation. Although this solar radiation is more direct and intense during the summer months, these months contain fewer sunny days than those in winter, with April experiencing the fewest sunny days of any month, and September receiving the most. This September maximum, when accompanied by above average solar radiation in August, October, and November, provides the sugar beet with ideal conditions for sugar production. As stated earlier in the section on temperature, cool fall temperatures and large amounts of solar energy cause the sugar beet to cease vegetative growth and to produce and store sucrose in quantities suitable for profitable handling.[23]

[23] Climatological Data: Colorado (1947), p. 104.

Wind: In summer, low pressure systems develop over the interior of the continent, and the winds over the Great Plains prevail from the south and southeast. In winter the process reverses itself and a continental high pressure area breeds winds from the north or northwest.[24] The yearly winds in the valley, however, prevail from the northeast around Las Animas and from the west-northwest at Pueblo, with an average velocity of 7.5 miles per hour.[25]

Unfortunately, the three months of April, May, and June rank among the windiest in the Valley, with an average of nearly nine miles per hour. These spring winds work a great hardship on the tender young beet plants, and often cause severe damage to the plants where the fields are smooth and sealed over as a result of rain. Since man's control of surface winds remains negligible, the only means to combat this difficulty lie in keeping the field surface roughed up by cultivation.[26]

Humidity: The humidity of the steppe country is relatively low. This low humidity makes for a high rate of evaporation and in turn decreases the precipitation effectiveness. This precipitation effectiveness, however, increases in the north where lower temperatures, than in the south, decrease the rate of evaporation. Also, the precipitation as well as the humidity increases towards the eastern margin of the steppe area.[27] The Valley shows the eastward increase in precipitation and humidity, with Pueblo experiencing an average humidity of 52 per cent.[28]

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[24]Blair, op. cit., p. 188.

[25]Climatological Data: Colorado (1947), p. 104 and statement by Ray Cook, personal interview, January, 1953.

[26]"How to Grow Sugar Beets," op. cit., p. 76.

[27]Ward, op. cit., pp. 274-275.

[28]Climatological Data: Colorado (1947), p. 104.

The important controls exerted by humidity consist of the amount of precipitation and the rate of evaporation. Because the sugar beets in the Valley do not rely solely upon natural rainfall and as long as evaporation can be countered by an increased application of irrigation water, the effects of humidity on the beet have to a certain extent been nullified by man.

Topography

The Arkansas Valley of Colorado lies in a physiographic region which Atwood classifies as the Great Plains Province. This province, throughout most of its extent, borders the Central Plains, or Lowlands, to the east and the Rocky Mountains to the west. Its east-west distance fluctuates irregularly between 150 to 400 miles, and from north to south it covers about 4,600 miles, extending from the Arctic Coastal Plain on the north to the Gulf Coastal Plain on the south. For thousands of square miles this province seems so monotonously flat that it resembles the bottom of an ancient sea. Observation of the drainage will prove, however, that the surface of the Great Plains declines gently eastward from an elevation of about 5,500 feet at the eastern base of the Rocky Mountains to about 1,500 feet at the western margin of the Central Lowlands.[29] This gives the province an average eastward slope of about ten feet per mile.

While its western margin joins the Rocky Mountains in a definite boundary, the eastern limit of the Great Plains lacks a well defined border. In southern Canada and the Dakotas, an eastward facing escarpment marks its eastern limit, but this fades out in eastern Nebraska. The

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[29] W. W. Atwood, The Physiographic Provinces of North America (Boston, 1940), pp. 253-254.

boundary then reappears in north-central Kansas as a belt of hills, which disappears in central Kansas, in the vicinity of the Arkansas River, only to reappear again in southern Kansas in the form of a ruggedly disected escarpment. This escarpment then veers southwest through Oklahoma and into Texas where it continues south to its terminus.[30]

Beneath the surface of this Great Plains Province rest layers of sandstone, limestone, shale, lignite and conglomerates. Many of these accumulated in the marine waters that swept north from the Gulf of Mexico to the Arctic Ocean, while others have formed in inland seas, where the waters were brackish. Aside from a few local flexures, these layers have not been subjected to folding, but have been broadly uplifted and depressed successively, so that today they lie in a nearly horizontal position. The only exception to this condition exists where these sedimentary layers lie steeply tilted at the base of the mountains.

On top of these sedimentary layers have been placed a Tertiary mantle of alternating layers of gravel, sand and loam, which were washed down from the mountains and deposited in river beds, on flood plains and in ancient lakes by the rivers of that era.[31] The period of sedimentation ended with an uplift of the present Rocky Mountains to the west. This movement increased the gradient of the Tertiary mantle causing the streams which traverse the area to cut broad parallel valleys and ridges into the previously smooth slope. The second stage in the topographic development of the area came to an end when the streams lost their carrying power. The following period was one of deposition in which the eroded valleys were

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[30] Nevin M. Fenneman, <u>Physiography of Western United States</u>, (New York, 1931), pp. 3-4.

[31] N. H. Darton, U. S. Geological Survey, <u>Professional Paper</u> 32 (1904), pp. 21-110.

filled and the intervening ridges were covered over, once again leaving the area with a smooth upper surface. In the final stage, which exists today, virtually the same streams have returned to their earlier destructive habits, and erosion has in a large part carried away the high level plains of stream construction.[32]

Today, what is left of this fluviatile plain, or High Plains, extends from southern South Dakota to near the Rio Grande River, while its east-west extent varies greatly because of severe erosion. To the east of the present Tertiary mantle lies a sub-division of the Great Plains known as the Plains Border. This is an area from which the Tertiary mantle has to a large extent been eroded and which now lies dissected but not reduced to the low relief which characterizes the Central Lowlands. This belt contains a hilly topography formed by the headward erosion of the more humid streams of the eastern Great Plains. To the west of the remaining Tertiary mantle, or present High Plains, lies the Piedmont sub-division of the Great Plains. The Piedmont has likewise lost much of its Tertiary cover and all of its original flatness, but for a different reason. This area exists under a drier climate than does the High Plains, and the native bunch grass which grows here affords poor protection against erosion as compared with the closely matted sod of the High Plains. Also, there existed a steeper gradient near the base of the mountains.[33]

The Piedmonts exist most extensively in the Pecos River valley of eastern New Mexico and in the adjoining drainage area of the South Platte

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[32]Willard D. Johnson, "The High Plains and their Utilization," 21st. Annual Report, U. S. Geological Survey, Part IV (1900), p. 629.

[33]Nevin M. Fenneman, "Physiographic Divisions of the United States," Annals of the American Associations of Geographers, XVIII, No. 4 (1928), pp. 320-321.

and the Arkansas rivers in northeastern and south-central Colorado respectively. A smaller area also lies astride the North Platte River where it crosses the Wyoming-Nebraska state line.[34]

Across the Piedmont of south-central Colorado flows the Arkansas River, which with its tributaries bears the responsibility for many of the Valley's present physiographic features. From the western Pueblo County line to the Kansas border, the Arkansas River, which covers a direct areal distance of 161 miles, varies in elevation from 4,950 to 3,350 feet. Throughout the greater part of this distance the tributaries of the Arkansas flow to it in a southeastward and a northward direction. The easternmost of these tributaries delimit the eastern margin of the Piedmont and the western boundary of the High Plains. Along the north bank of the Arkansas River, the Big Sandy Creek, which flows into the Arkansas River thirteen miles west of the Kansas line, marks the general limit of the Piedmont in this area. To the south of the river, the Two Butte Creek, which flows into the Arkansas River some five miles west of the Kansas border, designates the boundary to the south. This general north-south drainage pattern of the Piedmont area lies in great contrast to the eastward flowing streams of the High Plains. The Arkansas Valley, consequently, lies almost entirely in the piedmont subdivision of the Great Plains.

Taken as a whole, this section presents an old erosion surface, broadly rolling but locally scarped. Such topography might be expected to result, under an arid climatic regime, from a considerable degradation of rocks which are on the whole weak but not uniformly so, and which contain a few strong formations. In general the slope of the present surface closely follows that of the main stream, being on the average of 5,000

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[34]Fenneman, _op. cit._, pp. 19, 30, and 47.

feet or more at the foot of the mountains and decreasing to an average of a little under 4,000 feet at the Colorado-Kansas line.

A better understanding of the topography of the area may be had by examining the nature of the underlying rock formations. These formations all dip steeply eastward at the foot of the mountains, only to rise again farther to the east, creating a structural basin near the mountains. However, south of Pueblo a strong fold, extending to the southeast, brings to the surface many of the younger formations, which to the north lie over a mile beneath the surface. One of these rock formations is the Dakota sandstone which lies exposed over an extensive area south of the Arkansas River. On the northern side of this fold, in the immediate valley of the Arkansas, the Niobrara limestone comes to the surface. This formation appears at the surface in low ridges or lines of limestone hills, or in cuestas with heavily dissected scarps rising as high as 400 to 500 feet.

In addition to the sandstone to the south of the Arkansas and the limestone in the river valley, the area also contains a great deal of shale. The shale formation is directly responsible for much of the rolling topography north of the Arkansas River. This topography in many areas has been greatly modified by the presence of a younger layer of limestone which has resulted in the formation of scarps and conical-shape hills. Within the area there also remains fragments of the Tertiary mantle which not only fill many streambeds with sand and form a line of dunes along the river east of La Junta, but form an extensive dune area to the northeast of Pueblo.[35]

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[35] *Ibid.*, pp. 25-34.

South of the river, the various exposed layers of sedimentary rocks have formed the base through which the streams of the area have incised relatively deep canyons. The Dakota sandstone forms the dominant rock strata throughout most of the region, with remnants of limestone formations forming high table lands.

Through the heart of this general region the Arkansas River flows eastward to the Colorado-Kansas border. The river has carved for itself a generally shallow valley, marked by a flat alluvial plain varying from one to ten miles in width. This valley, bordered by terraces, lies between 100 and 300 feet below the general upland. Wind and water erosion has tended to remove much of the loam from the older terraces, but the lower terraces, still loam covered, form the irrigated lands of the Arkansas Valley.[36]

The relationship between the topography of the area and the growth of sugar beets is the same as its relationship with most any other intensive irrigated agricultural product. In this area of low rainfall, irrigation is essential to successful agriculture, hence the ability to prepare land for the reception of irrigation water marks the principal effect of topography on sugar beet culture.

Soils

Soil is the end product of the complex relationship between such factors as climate, vegetation, topography and parent material. The soils and soil-forming materials of the Arkansas Valley fall within a soil province

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[36] Hoarce B. Patton, "Underground Water Possibilities for Stock and Domestic Purpose in the La Junta Area, Colorado," Colorado Geological Survey, Bulletin 27, Part I (Boulder, 1924), pp. 1-57.

which Marbut describes as the Great Plains soil region. The eastern boundary of this region, which begins at the Canadian border just east of the North Dakota-Minnesota state line, passes near Sioux Falls, South Dakota; Lincoln, Nebraska; Hutchinson, Kansas; El Reno, Oklahoma; Brownwood, San Antonio, and Corpus Christi, Texas. The western margin of the Great Plains soil region fronts on the foothills of the Lewis Range in northern Montana, the Bighorn Mountains in Wyoming, and the Front Range in Colorado, while in central New Mexico the boundary makes a loop to the west and then follows the Pecos River to its terminus with the Rio Grande in Texas.

The soils in this region are pedocals. They have developed in a region of light rainfall and under a vegetative cover of grasses. This has resulted in the formation of a soil group which possesses a combination of dark surfaced soils and a sub-strata accumulation of salt, usually lime carbonate.[37]

The quality of the surface color varies within the region according to rainfall and temperature. An increase in the amount of rainfall normally produces more vegetation which results in a greater amount of organic matter and a darker colored surfaced soil. Consequently, the surface soil color grows progressively darker within the region from west to east. Temperature, on the other hand, affects the soil color by influencing the rate of oxidation of organic matter. In the more southern areas of the Great Plains region, higher temperatures increase the rate of oxidation, hence producing a lighter colored surface soil. The soils, therefore, tend also to become progressively darker from south to north.[38]

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[37] C. F. Marbut, "Soils of the Great Plains," Annals of the Association of American Geographers XIII, No. 2 (June, 1923), pp. 41-66.

[38] L. A. Wolfanger, The Major Soil Divisions of the United States (New York, 1930), p. 78.

Another characteristic of the region, in addition to the dark surface color, is the horizon of salt accumulation. This salt layer occurs predominantly in regions where the rainfall is too light to leach the salts from the soil. Consequently, the salt horizon lies near the surface in the western extent of the Great Plains region and gradually becomes deeper in the soil until it is completely leached away in the soil province which lies to the east of the Great Plains. The salt horizon serves as the basis for delineating the eastern margin of the Great Plains region, while the change from brown-colored range land soils to the desert soils of the far west marks the western margin of this soil region.[39]

In the western section of the Great Plains soil group lies the Brown soil sub-division which contains the heart of the sugar beet area of the Arkansas Valley. The soils in this sub-division on the whole possess a light brown surface color, the lightest of all the Great Plains, and a shallow zone of salt accumulation.[40] While this description applies to the typical soil of the Arkansas Valley, it does not necessarily reflect the many variations found in the local soil types. Many of the soil types within the brown soil sub-division bear little relationship to sugar beet culture, since within the sub-division of southeastern Colorado only a small percentage of land can ever be planted to sugar beets.

This sugar beet land lies in the irrigated areas of the Arkansas Valley. Of a total of 6,020,000 acres in this six-county area, only 320,000 acres receive irrigation water.[41] These lands, which lie in the

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[39]Marbut, op. cit., pp. 41-66.

[40]Wolfanger, op. cit., p. 30.

[41]U. S. Bureau of the Census, Census of Agriculture: Colorado (Washington, 1950).

valley bottoms and on the river terraces of the Arkansas River, are classed as alluvial soils.[42] Of the alluvial soils, clays, clay loams, and silt clay loams stand out as being the principal producers of sugar beets, although other soil types are also used for beet production.[43] The importance of soil in sugar beet production lies not so much in its physical properties but more so in its chemical properties. Mr. Kenneth Bischoff states that sugar beets are grown in almost all soil types in the irrigated areas of the Arkansas Valley, with the primary soil need being high fertility.[44]

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[42] L. A. Brown, D. S. Romine, R. T. Burdick, and Alvin Kezer, Land Types in Eastern Colorado, Bulletin 486 (Fort Collins, 1944), p. 27.

[43] A. T. Sweet and Wayne Inman, Soil Survey of the Arkansas Valley Area: Colorado, U. S. Department of Agriculture, No. 24 (Washington, 1926), 58p.

[44] Kenneth Bischoff, personal interview, January, 1953.

CHAPTER III

SUGAR BEET CULTURE IN THE ARKANSAS VALLEY

Preparing the Seedbed

Crop Rotation: The maintenance of soil fertility is a cultural aspect of soil use and has become one of the primary concerns of man. Through a system of planned agriculture, along with the application of barnyard manure, green manure, and commercial fertilizers, man has devised the basis for the preservation of soil fertility.

In the Arkansas Valley, successful irrigated agriculture contains some system of crop planning. Planning becomes essential because it makes better use of irrigation water and levels off the peak demand on both the water and labor supply for various crops. Also, planned crop rotation lessens trouble from diseases and pests, since as a rule certain diseases or pests attack only specific crops. Therefore, with each crop being subject to diseases or pests peculiar to itself, these diseases or pests tend to decrease in a particular field or area with the rotation of that crop.

In mechanized farming, the weed constitutes one of the most serious problems. This is particularly true in irrigated sections where canal and drainage ditches readily carry seeds from farm to farm in both irrigation and waste water. The periodic clean cultivation of row crops in a rotation system in time tends to remove most weeds from the field. Another advantage of crop rotation concerns itself with crop risks such as hail, flood, wind or drouth. While these risks may prove disastrous to one crop, they seldom prove so to all crops in a planned crop system. Consequently, diversification minimizes crop risks.[1]

The above statements list some of the advantages of crop rotation in the Arkansas Valley. Below is listed a basic program of crop rotation as advocated by agricultural specialists, field agents and county farm agents, all of whom play an integral part in the sugar beet culture of the Valley. A good successful farming program in irrigated areas of the West includes alfalfa, grains, sugar beets and livestock. Alfalfa exists as the crop around which the rotation program functions. This crop normally remains in the rotated field from two to five years and is followed by a grain, either large or small, but usually corn. Following one year of corn comes the sugar beet, which normally grows for only one year. After sugar beets the farmer can work in one of many specialty crops, such as onions, potatoes, cantaloupes, watermelons, cucumbers, tomatoes, or beans. This fundamental plan completes the primary rotation program.[2]

These exist, however, room for variation as the individual farmer so desires. The length of rotation may be varied from three to seven or more years. An extended program of this length may include two consecutive crops of sugar beets, or else the beets may be interrupted by a field of beans, grains, or potatoes. Frequently, however, the farmer will foresake this soil-saving system to play the market and grow a good market crop year after year.

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[1]"How to Grow Sugar Beets," <u>Through The Leaves</u> (November-December, 1950, and January-February, 1951), pp. 42-43.

[2]Fred Kennedy, George Zonich, Kenneth Bischoff, Herbert Creie, and Ronald Brady, personal interviews, January, 1953.

A program of this type, today, normally excludes the sugar beet, which does not fit in with crop speculation. The beet exists as a stable, dependable income crop year after year and is not known as a big money crop. Another reason many farmers do not raise sugar beets is the prevalent belief that the beet depletes the soil of its plant nutrients. In reality, the only elements removed in the sucrose, or commercial sugar, are carbon, hydrogen, and oxygen, which come from water and air. The soil nutrients consumed by the beet plant remain in the pulp and tops, and when the farmer returns these by-products to the soil, either directly as green manure or indirectly as animal manure, the soil fertility is maintained almost intact.[3]

Fertilization: The maintenance of soil fertility solely through the application of green manure and barnyard manure is an ideal situation which does not exist even in a sound system of crop rotation. In too many cases the greater part of the plant is removed for commercial purposes, thus denying the field of its share of green manure or barnyard manure. To make up for this depletion of plant nutrients, commercial fertilizers must be added to the soil.

Of the inorganic materials, or commercial fertilizers, needed by the soil, two stand out as being of primary importance in the Arkansas Valley: nitrogen and phosphorus. Of these two inorganic materials, phosphorus normally receives more attention in the growth of sugar beets than does nitrogen. According to Dr. Downie, an excess of nitrogen tends to decrease sugar content and to increase the amount of nitrate impurities in the beet, particularly when applied late in the growing season.[4]

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[3]Kenneth Bischoff, personal interview, January, 1953.

[4]A. R. Downie, personal interview, January, 1953.

The proper time of application varies according to the structure of the soil, the type of fertilizer being applied and the preceding crop. In the case of heavy soils, they should be fertilized and worked in the fall, while, according to Kenneth Bischoff, the lighter soils, with their inherent tendency to blow, should be fertilized and worked in the spring.

The time variation in relationship to the application of fertilizer concerns itself primarily with the solubility of the two elements. When the grower applies phosphorus to the soil, particularly to the alkaline soils of the western beet growing areas, it undergoes a change called fixation. This means that the phosphorus combines with certain other substances in the soil, usually iron and alumina, in such a manner as to render it insoluble in water. The insoluble phosphate, however, can be made available for plant use by the slow decay of organic matter. As the organic matter decays it creates an acidic condition which slowly releases the insoluble inorganic elements. This operation, being slow, requires time. Hence, phosphate fertilizers can be more readily available to the following crop if applied in the fall of the year.

On the other hand, nitrogen, which tends to be completely soluble, readily becomes available for crop use. Therefore, it can be successfully applied to a field of growing beets. The solubility of nitrogen, however, not only makes it easy to apply, since it can be placed on or in the top soil, but also makes it susceptible to some loss by leaching, which is a liability. In some areas the growers take advantage of its solubility by applying nitrogen to a depth of two or three inches at the time of the first cultivation.[5] Fred Kennedy also advocates adding nitrogen, either in

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[5]"How to Grow Sugar Beets," <u>Through The Leaves</u>, op. cit., pp. 23 and 28-31.

late summer or early fall, to the preceding crop. He claims that the residue from any crop can be better converted into a usable form if the grower adds nitrogen in the fall, just prior to plowing or discing the land.[6]

The effects of the preceding crop as to the time of application and the proportion of the elements used normally shows slight variance. Dr. Downie has suggested several fertilizer-combinations, as listed in Table VIII, for use in this area according to the preceding crop:

TABLE VIII

FERTILIZER-COMBINATIONS(3)

Combination(1) (Percentage)	Principal Use(2)
1. 10 - 18 - 5	General use.
2. 10 - 20 - 0	Follows corn, with about sixty pounds per acre of nitrogen as a side dressing in the spring after thinning.
3. 6 - 24 - 6	Follows vine crops.
4. 6 - 30 - 0	Can be used either in #2 or #3.
5. 0 - 43 - 0	Follows alfalfa.

(1) These combinations are listed by percentages of nitrogen, phosphorus, and potassium and in that order.
(2) These fertilizers are added to the fields prior to plowing or discing following the harvest or growing season. The amount added normally ranges between 250 to 500 pounds per acre.
(3) Statement by A. R. Downie, personal interview, January, 1953.

The above combinations indicate the need for a high percentage of plant nutrients in the Valley. This is particularly true for phosphorus which fluctuates from eighteen units in combination number one, to forty-three units in the last combination.

[6]Fred Kennedy, personal interview, January, 1953.

Barnyard manure, which contains 1,720 pounds of water, twelve pounds of nitrogen, and three pounds of phosphoric acid per ton, serves as another source of inorganic matter. This amount may seem insignificant at first, but the addition of eight to ten tons of manure per acre provides around 110 pounds of nitrogen and thirty pounds of phosphoric acid for each acre. This addition of inorganic matter becomes significant when one realizes that an above-average production of eighteen tons of sugar beets per acre removes about fifty pounds of nitrogen and fifteen pounds of phosphoric acid per season.[7] Other sterling features of manure lie in its ability to add humus, to improve the structure, and to increase the water-holding capacity of the soil. While eight to ten tons of manure per acre normally will suffice, Mr. Frank Milenski places the desirable amount anywhere from thirteen to forty tons per acre if it can be obtained. This particular farmer raised twenty-seven tons of sugar beets per acre in 1952, which rates as one of the top production records in Otero county. However, all sugar beet growers are not as fortunate as Frank Milenski in the procurement of barnyard manure. The Valley farmer of today has come to specialize in field crops at the expense of livestock, with many farmers even failing to keep milk cows. During the past year, many small farmers ventured into the stock feeding business only to lose money with the decline in the price of beef. However, the large-scale stock feeders still operate, but their supply of manure falls short of the Valley's requirements.

Seedbed Preparation: The first step in seedbed preparation concerns itself with the breaking up of the preceding crop residue. This process varies slightly as to the crop to be worked. Small grains, wheat, oats, and barley, are usually disced immediately after harvest in order to allow

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[7]"How to Grow Sugar Beets," Through The Leaves, op. cit., pp. 32-33.

any fallen seeds to germinate. In some cases water will be run onto the field to assure good germination. Corn is handled in a similar manner, only in some instances about sixty pounds of nitrogen will be added per acre in order to speed up the decay process of the large corn stalks. Also, some farmers will "sell" the residue from grain crops by allowing stock feeders to graze their fields with livestock, principally beef cattle and sheep.[8] While an operation of this type removes some plant nutrients from the field, it provides many farmers with a source of immediate revenue. It also provides the stock feeder with a winter feed which is becoming an expensive item in drouth-strickened southeastern Colorado.[9]

The only other crop which provides some difficulty in the removal of its residue from the field is alfalfa. While some farmers will allow alfalfa to remain in a field for as long a period as fifteen years they eventually must replace it with another crop. This is done in two ways: (1) by plowing under rather than harvesting the last cutting, and (2) by crowning the alfalfa, that is plowing to depth of only about three inches, following the last cutting and then harrowing the field and letting the sun dry-out the alfalfa for about two weeks.

All of the above work is preliminary to the fall seedbed preparation. In November or December, most farmers add manure and fertilizer to the field and plow it to depth in excess of ten inches. This may be followed by light harrowing or light rolling if the field is excessively cloddy. A partially cloddy field is desirable, however, since it retards excessive blowing. If moisture conditions are low and water is available, the better farmers may ditch and irrigate their fields as late as Christmas.[10] The

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[8] Fred Kennedy, personal interview, January, 1953.

[9] Oklahoma City Times (June 23, 1953), p. 19.

[10] Fred Kennedy, personal interview, January, 1953.

main exception to fall plowing exists in areas where the fields, being sandy, tend to blow excessively. In such cases, the farmer works his fields in the spring as soon as the ground thaws and becomes sufficiently dry. If the farmer has sufficient time he should, for best results, follow the same procedure as in fall preparation. However, in cases where the soil has drifted, it should be leveled prior to plowing.[11]

The field now awaits the final spring operation to condition it for the beet seed. But in the meantime, the big sugar interests are determining, indirectly at least, just how many acres of beets the individual grower will plant. In the fall of the year, usually around the last of November or the first of December, the Secretary of Agriculture calls a meeting of representatives of the growers, the processors, and the large consumers of sugar. From these sources he gathers plans, suggestions, needs and opinions which he studies and which aid him in declaring the country's sugar consumption for the coming year. This total consumption figure is then divided among the various sources of sugar; i.e., the domestic beet producer, 25 to 27 per cent, the domestic cane producer, 6 per cent, and the insular cane producer, 67 to 69 per cent.

The domestic beet growers take their quota and, according to previous yearly production records, apportion the allotment to the various beet growing districts. The district refinery manager takes his share of the processed beet sugar allotment and apportions certain acreages to the growers of his district according to the individual grower's history.[12] These alloted acreages are then given to field agents who serve different territories within the district. It is the field agent's job to sign

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[11] "How to Grow Sugar Beets," Through The Leaves, op. cit., p. 56.

[12] H. E. Knapp, personal interview, January, 1953.

acreage contracts equal to his territorial allotment. He usually begins by signing contracts with the last year's growers and if any allotment remains he then tries to induce other farmers to contract beets. During periods of crop competition, sugar beet production sags and there is no need for a ceiling on an individual farmer's contract acreage. The contract used by the field men contains terms which were previously drawn up at a joint meeting of a committee from the Beet Growers Association and representatives of the beet sugar corporations.[13] The contract primarily affords the grower with a guaranteed market for his beets and the company with a source of raw material.

After the farmer has contracted his beet acreage he makes the final preparations of the seedbed for its reception of the beet seeds. The first work in spring for a field that has been fall plowed is the discing which is followed by a leveling operation. This should leave a one to one and a quarter inch mulch in the field. If nature has been kind and the cultural work performed satisfactorily, the seedbed will be firm, even in structure, and be level.[14] Now the farmer is ready for his supply of sugar beet seeds.

The seeds are sold by the company to the growers, with payment being deducted from the grower's first crop payment in the fall. The seeds handled by the companies in the Valley are especially bred and treated for tolerance to the most prevalent disease in the area. The seeds are raised mainly in New Mexico, Arizona, California, Oregon, and Washington and are shipped to the Valley as whole seeds. The seeds come from these states because certain areas produce better seed varieties. The most dominant

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[13]Kenneth Bischoff, personal interview, January, 1953.

[14]Fred Kennedy, personal interview, January, 1953.

variety used in the Valley last year was bred for leaf spot resistance. The leaf spot, a fungus growth, can live in or on the soil and can be splashed by rain drops or blown by the wind onto the leaf of the beet plant. Once on the leaf, the fungus spores of the disease kill the leaf stomata so that only a brown spot remains on the leaf. Another occasionally harmful disease is the curly top, for which a certain amount of tolerance can be bred into the beet seed. This disease affords the Valley growers the most trouble during extremely dry weather. During drouth periods the Russian thistle and other dry-land vegetation dry-up forcing the leaf hopper to migrate to the irrigated beet fields, which they infest with the virus curly top disease. At the present time, a combination curly top-leaf spot breed of beet is in the experimental stage, with research men continually cross-breeding for improved quality and quantity.

When the whole-hybrid seed arrives in the Valley, it is processed or decorticated by a revolving emery disk that fractures the multi-cell seed segments into single cells. This process is necessary because at the time of germination, the whole seed contains two or more embryos, each of which can produce a beet seedling. So by reducing the seed to a single seed embryo, the job of thinning the field of its surplus seedlings is greatly simplified. Following the decorticating process, the seed is coated with an organic mineral known as phygon. Phygon decreases the possibility of the damping-off seedling disease, which, caused by a mold in the soil, brings on the rotting of the seed, the seedling, or the stem of the young plant.[15]

[15] A. R. Downie, personal interview, January, 1953.

Planting

A great deal of variation exists in regards to the proper time in which to plant the beet seed, with the determining factors being the individual farmer and the condition of his seed bed. The most satisfactory period lies between April 1 to 30, but seeds may be planted anywhere between the last of March and the first of June. The important thing to remember is that with all other factors being equal the longer growing season will produce the larger crop. Consequently, the plantings in late May and early June are usually the result of delays by unseasonally wet field conditions or else the farmer is replanting a crop hurt by a hard late freeze.[16]

In the days before the advent of the segmented seed, a farmer would plant anywhere from fifteen to twenty pounds of whole seed to each acre. Today, with the use of the segmented seed and the single seed planter, excellent results are attained by planting only six to eight pounds of segmented seed per acre. The farmer uses either a four or six row planter which sets the seeds at a depth of one-half to one inch in twenty to twenty-two inch rows.[17]

The seed planter has an added attachment which furrows out irrigation ditches between every or every other row, depending on the individual farmer. Immediately following the planting, the beets are irrigated-up with the application of about two acre-inches of water. As soon as the field is dry enough to be worked a light harrow or a finger weeder is pulled across the rows in order to stir the surface soil and to kill the

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[16] A. R. Downie and Fred Kennedy, personal interviews, January, 1953.

[17] A. R. Downie, personal interview, January, 1953.

small weeds.[18] The beet seedlings will emerge about two weeks after the planting of the seed and under normal conditions of 85 to 95 per cent germination, there will be eight to twelve seedlings for every linear foot of planted row.[19]

Cultivating

The first operation in cultivating the beets occurs some two to three weeks following the emergence of the seedlings. By this time the beets normally have developed from four to six true leaves and need to be blocked and thinned. The purpose of blocking and thinning is to remove the excess beets so that the growing plants will be from eight to twelve inches apart. This distance allows each sugar beet a sufficient area from which to draw its moisture and plant nutrients. At the time of emergence there will be from eight to twelve seedlings for each foot of row.

The blocking operation simply makes a rough swath at designated intervals along the row, thus removing large clumps of excess seedlings. In the case of an all-hand blocking and thinning operation, the workers use a short-handled hoe to block the row, while they thin around the selected beet by pulling the adjacent seedlings with their free hand (Figure IIa). This method is slow but it completes the work in one operation. The two other blocking methods are both mechanical. The older process employs a regular cultivator which the grower equips with special knives and then pulls across the rows to block the field. This work needs to be followed in a few days by thinning with a long-handled hoe. The second mechanical method is a relatively new process which works down the row. The machine

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[18] Fred Kennedy, personal interview, January, 1953.

[19] Kenneth Kischoff, personal interview, January, 1953.

contains revolving wheels whose L-shaped knives rotate perpendicularly to the rows and quite accurately remove a predetermined number of seedlings per row. This system requires two trips over the same field in addition to a final hoeing operation. The purpose of the first trip is to remove one-half of the beet seedlings by employing an eight-knife wheel (Figure IIb). The second trip is normally completed with a sixteen-knife wheel and removes a sufficient number of seedlings for a good stand. The length of the cutting edge varies as to the stand of seedlings.

The first cultivation of the field occurs about five days after either the hand blocking and thinning operation, the blocking with the cross-row cultivator, or the first operation of the down-the-row blocker. In the first cultivation the inter-row area is cultivated to within an inch of the seedlings, thus approaching nearer the beets than all subsequent cultivations. In the early stages of the plant's development frequent cultivating is necessary for the following reasons: (1) it keeps down the weeds which would otherwise deprive the beets of needed moisture and plant nutrients, (2) it maintains a surface mulch which conserves near surface moisture for the shallow-rooted seedlings, and (3) it aids in maintaining a rough surface area which decreases the possibility of damage from blowing sand.

Following the first cultivation, the farmer that blocked his field by the cross-row method uses the long-handled hoe to finish the thinning, while the down-the-row blocked field is blocked once again. Next comes the second cultivation which is followed by the hoe thinning of the down-the-row blocked field.

The thinning operation is normally completed within four to six weeks after the beets have been planted, which in the Valley is around the latter part of May. Regardless of the type of blocking and thinning employed, the first cultivation following the completed thinning is the deepest and comes as soon as possible after the thinning. The number of times per season a field is cultivated depends solely upon local conditions of the weather, but usually four or five will suffice. The main object is to keep down the weeds and maintain a loose surface.

Irrigation also tends to be a flexible factor, which depends on conditions of the weather. Most farmers watch the beet leaves for signs of severe wilting, and when a field of beets fail to recover at night from noonday wilting they need to be irrigated. A normal irrigation usually requires two acre-inches of water or an amount which does not cover the beet crown.[20] Frequent-light irrigations prove more advantageous than infrequent-heavy irrigations, because the beet obtains approximately 65 per cent of its water from the top foot of soil and another 20 per cent from the second foot.[21]

As a rule, the intra-row area will become weedy again towards the end of June or the first of July, and it may be necessary to give the field another hoeing. Also around the first of July the beet leaves normally have toughed, thus doing away with all other cultivations, but still leaving the possibility of a later hoeing if the weeds become prominent. The only work remaining to be done before harvest consists of an occasional irrigation, with the last one coming about ten days to two weeks prior to the harvest.

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[20] A. R. Downie and Fred Kennedy, personal interviews, January, 1953.

[21] H. E. Knapp, "Controlled Irrigation," Crystal-ized Facts About Sugar Beets, Vol. II, No. 3 (July, 1948), p. 11.

Harvesting

During the months of August and September, the company's field agents pay particularly close attention to the contracted fields in their respective territories. Within this period they must supply the refinery with estimates of beet tonnage to be harvested. In September, a sample is taken from each field and examined at the refinery to determine more accurately the amount of recoverable sugar per ton of beets and the length of the coming campaign, or the number of days the factory will operate. Finally around the last of September or the first of October, the company gives the order to begin the harvest. All growers will not begin at one and the same time, because in order to keep from causing an overflow of beets the company will stagger the time of harvest for the various growers. Other factors such as wet fields, frozen ground, and lack of labor will tend to spread the length of the harvest throughout the Valley. This period normally runs from the first of October until Thanksgiving.[22]

As in the case of blocking and thinning, the harvesting of the beets may be carried out by either semi-manual or mechanical means. The semi-manual method employs a beet lifter which severs the beet from its long tap root and loosens it in the ground. The field worker follows this operation with his long-bladed, hooked knife and hooks the beet from the ground and then severs the crown with the cutting blade. The topped beets are placed in windrows to await the mechanical loader which loads the beets for transportation to the beet dump.

The mechanical methods, which simply replace man with a machine, are of two basic types: (1) tops the beet while still in the ground, and (2) digs the beet before topping. Of the three primary types of machines

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[22] A. R. Downie and Fred Kennedy, personal interviews, January, 1953.

A. HAND THINNING

B. MECHANICAL THINNING

FIGURE II

employed in the Valley, the ones most widely used top the beets in the ground. These harvesters have feelers which control the position of the cutting knives according to the height of the beet crown. After the beets have been topped they are either pulled or spiked from the ground and carried through a separating operation which discards the field trash. The harvesters will then either convey the beets to a separate truck, to a connected wagon, or back into the field in windrows. The machines that first dig and then top the beets follow a similar procedure.[23]

Conveyor belts or loaders transfer the beets into specially built side-hinged dump trucks for transportation. If the harvested field lies within a short distance of one of the refineries the truck will carry the beets directly to the factory grounds. Otherwise, the beets will be unloaded at one of the nearby temporary railroad dumps. Regardless of where the grower dumps his beets, he must go through the same procedure. First the company weighs the farmer's truck and its content. Then as the piler tips the truck's bed spilling the load into a hopper, a company worker catches a random twenty-five to thirty pound sample of beets which he tags and ships to the refinery. With a sample from each load, the plant chemist determines the average sugar content of the beets for the individual load and the actual weight of usable beets per sample, which varies according to the quality of the topping. These factors determine the payment the farmer will eventually receive for his beets.

In the meantime, the beets are elevated by a conveyor belt from the hopper onto a screening device which removes and returns most of the dirt and field trash to the farmer's dumped truck. The truck is then reweighed to determine the net weight of the beets. The cleaned beets are carried

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[23] H. E. Knapp, personal interview and "How to Grow Sugar Beets," <u>Through the Leaves</u>, op. cit., pp. 122-24.

on a conveyor which dumps them in large temporary piles on the ground. These piles usually average forty to fifty feet in width and vary in length as to their needs. The beets in the temporary piles which lie out side of the factory grounds are loaded into drop-bottom gondola cars, with the aid of a drag-line, and shipped to the refinery. At the refinery, these gondola cars are run up an elevated track which lies over a flume. When the bottoms of the gondolas are opened, the beets fall through the railroad ties and braces into the flumes in which they are carried into the factory.[24]

The factory yard also contains a more permanent type of beet storage dump in which the beets may remain for a period up to three or four months without too great a loss from shrinkage or spoilage. This dump contains lengthwise flumes in which the beets are transported into the refinery. To keep the beets from falling into the flumes during storage periods, metal sheets, which can be easily removed in small sections, cover the flumes. Besides carrying water, these flumes can be used as forced air ducts for cooling the beet pile. This is important, since the beets give off heat which if not controlled will cause severe shrinkage and spoilage. Temperature may harm the beets in another way through freezing, but as long as the beets do not thaw out little harm will be done.[25] However, with last year's campaigns in the Valley not running more than forty-five days, storage was not too great a problem in 1952.[26]

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[24]Fred Kennedy, personal interview, January, 1953.

[25]A. R. Downie, personal interview, January, 1953, and J. O. Gaskill, "Wilting of Sugar Beet Roots After Harvest Causes Excessive Storage Losses," Crystal-ized Facts About Sugar Beets, Vol. III, No. 4 (October, 1949), p. 15.

[26]H. E. Knapp, Kenneth Bischoff, and G. E. Hogan, personal interviews, January, 1953.

Farm Labor Problems

The sugar beet, an intensive agricultural commodity, requires a large amount of labor to produce and harvest a commercial crop. Immigrants from Europe furnished the needed labor supply during the 19th century and this source was supplemented with Mexican nationals for the first two decades of the 20th century. Immigration laws, however, closed this source of labor after World War I, but the beet sugar companies continued their policy of recruiting and paying Spanish-Americans for beet field work. This policy ended around 1925, when the Beet Growers Association decided the individual grower could more satisfactorily handle the labor problem. Since that time labor has been supplied mainly through the efforts of private contractors, beet sugar company recruiters, and state employment officials who fill the growers' requests for labor. This labor supply comes primarily from the local areas within the Valley and from Texas and New Mexico.[27]

The labor needed to work and harvest the beets is seasonal and normally the work can be completed in a period of ninety days. This ninety-day period divides into a fifty-day period from May 20 to July 10 for thinning and a forty-day period from October 1 to November 10 for harvesting.[28] Both operations need to be completed as near the optimum time as possible, hence they require a large amount of reliable and timely labor.

In order to aid their contracted growers in satisfactorily completing the thinning and harvesting operations, the beet sugar companies maintain

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[27] Fred Kennedy, personal interview, January, 1953.

[28] Report of Governor's Survey Committee on Migrant Labor: Colorado (Denver, 1951), Exhibit I, pp. 2-9.

recruiting agencies in the southwestern states. When the company's field agent signs the individual grower to an acreage-contract he also determines whether or not the grower wants the company to recruit his labor. If the grower needs the company's assistance, the field agent provides the company's recruiter with a list of the farmer's crops that will require hand labor; the number of workers the farmer will need; a description of the available housing; the location of the farm; and a desired date of arrival. In the case where the companies recruit the labor, they will in addition pay the migrants' transportation to the Valley.

In many instances, however, the farmer will not have sufficient work to occupy the laborers between thinning and harvesting. In such cases, the laborers will be referred to the state employment agency for interim work. If the state employment agency cannot find sufficient work for the laborer until harvest time, he may desert the grower and join the crew of a private contractor. Also, the private contractor will often times entice company-recruited laborers away from the sugar beet growers, thus robbing them of their recruited harvest labor.[29] The private contractor may then contract with the grower for the harvest at a price in excess of the government minimum. This situation has created a great deal of bitterness among the growers and has caused some of them to decrease the acreage of high-labor crops.[30] Nevertheless, many farmers in the Valley still do business with the private contractor, since he does complete the job. Also the private labor contractor normally provides the workers in his employment with more working hours per season. He contracts field work in all

[29] Fred Kennedy, personal interview, January, 1953.

[30] J. B. Adams, personal interview, January, 1953.

crops within his area of the Valley and the more work he contracts the greater is his income.[31]

This contracting method has evidently proven successful since the state employment office at La Junta has employed a similar program. The state agency recruits the workers and divides them into crews, each of which works under a supervisor. These crews are dispatched to the various farms where the farmer has registered a need for outside labor.[32]

However, since the beginning of World War II the local source of labor has become more undependable because of competing industry in the Valley. Workers who were exposed to lucrative war-time jobs seem reluctant to perform the low-paying, tedious hand work which accompanies beet work.[33]

This war-generated situation has intensified research in the field of mechanical harvesting and thinning. The mechanization of both operations has long been a dream of men in the beet sugar industry, but it has only been since World War II that economical-mechanically sound machines have been developed. In the pre-war era mechanical operations were all but unknown in the beet fields. During the war years mechanical beet culture was experimented with on a limited scale and has resulted in a rapid post-war expansion in mechanization. Mechanical harvesting in the Valley has increased from a 1945 figure of less than ten per cent to a 1952 figure in excess of seventy per cent. Mechanical thinning has been slower to develop, but, nevertheless, about fifty per cent of the Valley's acreage was spring mechanized in 1952. The beet sugar company officials are very enthusiastic and optimistic with the present degree of mechanization and

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[31] Dave Nava, personal interview, January, 1953.

[32] A. M. Gorton, personal interview, January, 1953.

[33] Fred Kennedy, personal interview, January, 1953.

some sources predict the complete mechanization of the sugar beet industry in the foreseeable future.[34]

There are several reasons in addition to the labor shortage for the rapid adoption of mechanical thinners and harvesters: (1) the work can be done more economically by mechanical means than by hand labor, (2) the mechanical methods require less time, (3) the mechanical methods require less labor, and (4) the difference in the quality of work performed by the two methods is so slight as to be insignificant.

The mechanical method of beet work has proven to be superior to the hand method in both controlled experiments and normal farm use. The principal drawback to the wide adoption of the mechanical thinner and the mechanical harvesters is the initial cost. Many farmers will hesitate to invest $500 to $600 in a thinner and $3,000 in a harvester. An outlay of this amount would be economically unsound for a small acreage. However, the beet sugar companies have devised a plan by which they will rent the thinners to the farmer. At the time the grower signs his beet acreage contract with the company he may sign up for a thinner at the rate of fifty cents per acre. The companies also rent special beet drills, but, although they will aid a farmer in financing a harvester they do not rent them.[35]

The mechanization of the sugar beet culture has opened the way for custom farming in the industry. It seems quite evident that soon mechanized crews will be making the rounds of the Valley contracting for the thinning and harvesting of the beets. Thus the quality of labor in the sugar beet field is becoming more technical as the mechanic replaces the man with the

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[34] Arkansas Valley Journal (December 18, 1952), p. 1.

[35] Fred Kennedy, personal interview, January, 1953.

hoe.[36] However, the present system of mechanization does not completely exclude the hoe from the field. Rather it greatly decreases the amount of hand work necessary and increases the number of acres that each worker can handle. This means that the individual hand laborer makes more money in working a beet field that has been thinned by mechanical means. It also means that fewer workers will be required in the beet fields for thinning while the mechanical harvester entirely excludes hand labor.[37]

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[36]Milton Booth, personal interview, January, 1953.

[37]M. C. Sullivan, "Beet Labor Performance in 1951," Crystal-ized Facts About Sugar Beets, Vol. VI, No. 1 (January, 1952), pp. 17-19.

CHAPTER IV

PROCESSING AND MARKETING OF THE SUGAR BEET IN THE VALLEY

Processing Procedure

Mechanical improvements have also been achieved in the refining phase of the beet sugar industry. In the latter part of the 19th century it required from six to eight factory labor hours to produce 100 pounds of sugar. Today in the most modern plants the factory labor requirements have been reduced to less than thirty minutes per 100 pounds. The improvement has been brought about by the increased capacity of the refineries through greater mechanization and by the improved quality of the beets both in sugar content and purity.[1]

The raw materials used in the refining process consist of limerock, coke, and sugar beets. The limerock supply comes from Glennwood Springs, Colorado and is used on a basis of 8.5 per cent of the beet tonnage processed. Coke on the other hand comes from eastern United States and is consumed on the basis of 9.75 per cent of the limerock tonnage. Other materials used in the refinery consist of chemicals, chiefly soda ash, caustic soda, and muratic acid, as well as bunker oil or natural gas, which fires the furnace and provides the main source of mechanical power.[2]

Mechanization in the processing phase begins in the storage pile from which the beets are carried into the factory in flumes of rapidly moving

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[1] H. E. Zitkowski, "New Developments in Beet Processing," Crystal-ized Facts About Sugar Beets, Vol. VI, No. 3 (July, 1952), pp. 7-8.

[2] E. O. Preston, personal interview, January, 1953.

warm water. In transit a large part of adhering soil, rocks, part of leaves, and other trash are removed mechanically. On entering the mill the beets are washed in a tank, with large rotating paddles and carried on an elevator to the top floor.

The beets now tumble into the scales where their weight is automatically recorded, and fall into revolving knives, where they are cut into long strips, like "shoe-string" potatoes. The slices are known as cossettes, one of the many French words used in the industry. Factory workers call them "chips."

The cosettes are next carried by high-speed belts to the diffusion battery, which consists of a number of large cylindrical tanks. As the cossettes pour into the tops of the cells the battery crew, known as "noodle punchers" in factory slang, push down the cossettes with tridents. Hot water moves from cell to cell, extracting sugar from the cossettes. It is customary to bring fresh water into contact with the nearly exhausted cossettes and, conversely, to bring the freshest cossettes into contact with the richest juice. Two products result from this process: (1) diffusion juice, known as raw juice, and (2) exhausted cossettes, called beet pulp. The pulp goes to the wet pulp silo where it is stored for cattle feed.

Juice purification is the next stage. Raw juice from the battery goes to "first carbonation," where milk of lime, a suspension of slaked lime in water, is added. The lime is prepared by burning limerock and coke in the limekiln. The burning releases carbon dioxide gas, which is also used in the process. As the raw juice comes from the battery it contains certain soluble and suspended matter other than sugar. Lime coagulates and renders insoluble part of the non-sugars. Carbon dioxide is bubbled through the mixture, rendering the lime insoluble. The juice containing sugar in solution is now separated by filtration from insoluble lime and non-sugars. The result is "first press juice" and "lime cake," the latter which can be used as a soil amendment.

In "second carbonation" the "first press juice" is again treated with carbon dioxide gas and once more filtered to remove the remaining lime. After the second filtration, the product known as "second press juice" is treated with sulphur dioxide gas in order to adjust it to proper alkalinity.

The thin juice produced in the preceding steps contains ten to twelve per cent of sugar, and must be concentrated before the sugar can be crystallized. This is done in multiple-effect evaporators. In each of the five evaporators air pressure is successively reduced, so that the liquid boils at lower temperatures. Thus steam used in the first evaporator heats the second, the second heats the third, the third heats the fourth, and so on. The juice discharged from the evaporators contains fifty-five per cent sugar and is called "evaporator thick juice."

The thick juice is also treated with sulphur gas for final adjustment of alkalinity. Sulphuring is followed by a very careful filtration to obtain a clear sparkling liquor known as "blowup thick juice."

The filtered thick juice goes to the vacuum pans, large containers in which the liquid is boiled under reduced pressure to such a concentration that sugar begins to crystallize. Boiling is continued until the crystals reach the desired size and the mass in the pan becomes a thick mixture of crystals and syrup, known as "white massecuite." Sugar may be boiled to small or large crystals, for the size of crystal is without significance in determining the quality of sugar.

In the next step, high speed centrifugal machines separate the sugar crystals from the mother liquor. The sugar clings to a metal screen, or basket, whirling at a speed equal to more than two miles a minute. The syrup flies through the screen and the brown mass turns white as the machine spins. Meanwhile a jet of hot water plays on the basket, removing the last traces of the syrup. Wet sugar from the centrifugals passes to the granulators, where it is dried in a current of warm air, then screened, and sent to the warehouse, to be sacked and stored, ready for shipment.[3] This sugar is normally shipped to parts of Colorado, Kansas, Oklahoma, Texas, and New Mexico. The product of a bumper crop, however, will find an expanding market to the east, in some years even reaching Chicago. The companies employ their own trucks for local shipments of around 200 miles, but common carriers, both truck and railroad, cover the remaining area.[4]

In the meantime the company has drawn off two kinds of syrups from the centrifugal machine for re-working: (1) mother liquor or "high green," the first to be expelled, and (2) a syrup known as "high wash." The high wash, a liquor of high purity, is filtered and returned to the white vacuum pan near the end of the boiling period. High green is boiled again and a second crop of crystals is produced, known as "high raw sugar." The mother liquor from this operation, known as "high raw machine syrup," is boiled once more and after the resulting massecuite is treated in a crystallizer for several hours, it is centrifuged and a third crop of crystals is produced. This product is known as "low raw sugar." Both high and low raw sugars, being unmarketable, are remelted and returned to the main process. In the re-processing stage they pass through certain purification steps and are sent to the white pan as part of the blow-up thick juice and finally recovered as granulated sugar.

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[3] The Silver Wedge: The Sugar Beet in the United States (Washington, D. C., 1936), pp. 52-54.

[4] H. E. Knapp and E. O. Preston, personal interviews, January, 1953.

The mother liquor obtained from the centrifugal machines after the third boiling is known as molasses, and is so low in purity that no more sugar can be profitably extracted by crystallization. The molasses, therefore, is sent to factories equipped with the Steffen process.[5] Of the three refineries in the Valley, only Holly's refinery at Swink and American Crystal's plant at Rocky Ford have equipment for the Steffen process. National's refinery at Sugar City ships its molasses to Holly's refinery.[6]

The Steffen process adds finely ground quicklime to a cold molasses solution. The sugar forms an insoluble compound with the lime, known as calcium saccharate. This is separated by filtration, thoroughly washed, and returned to the process, where it is mixed with incoming diffusion juice. The lime in the saccharate serves the same purpose in clarifying the diffusion juice as does the milk of lime.

After a factory using the Steffen process has reworked its molasses a number of times, there is an accumulation of certain non-sugars which renders further working uneconomical. This molasses, known as final discard molasses, joins with beet tops and beet pulp to form the three by-products of the sugar beet.[7]

By-Products

The discard molasses is handled as a by-product by the American Crystal Sugar Company and the Holly Sugar Company. Holly utilizes its

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[5] The Silver Wedge: The Sugar Beet in the United States, op. cit., p. 54.

[6] A. R. Downie, personal interview, January, 1953.

[7] The Silver Wedge: The Sugar Beet in the United States, op. cit., pp. 54-56.

supply of molasses in feed lots where it is mixed with alfalfa and other feeds. American Crystal on the other hand sells its supply to a feed company, to livestock feeders, and to yeast companies, where its fermentation properties are used in the production of baker's yeast and citric acid.

All three refineries handle wet pulp, which is a succulent, highly palatable, carbohydrate concentrate with a ninety per cent moisture content. The refineries return the wet pulp to the growers on a fifty-fifty basis. The farmer is entitled to an amount of wet pulp equal to one-half of the amount recovered from the sugar beets he sold the refinery. Most of the growers who claim their share of the pulp live in the vicinity of the refinery, since they must bear the shipping cost. Nevertheless, the pulp is so highly regarded as a livestock feed that some growers freight the wet pulp distances up to one hundred miles. The sugar companies dispose of their share of the wet pulp by either selling it to livestock feeders or feeding it in their own feeding pens.

Although American Crystal possesses pulp drying equipment, it has not been used in nine years. Thus no dry pulp is processed in the Valley. However, in order to accommodate its growers, American Crystal ships in a mixture of dry pulp and molasses from its refinery at Grand Island, Nebraska.

The remaining by-product, the beet top, belongs entirely to the grower. The beet top, a low fibre, high protein feed, may be fed alone but gives best results when used as a supplement with grain and hay. It is the most palatable feed produced on the farm and contains a rich supply of carotene, protein and other essential food factors. The beet top may be left in the field for pasturage, but there is a smaller loss of nutrients if the beet top is placed in a silo soon after harvest. Farm use of the beet wastes is highly desirable, not only to add to the meat supply but also to return mineral elements to the soil and increase the farmer's income.[8]

Sugar Payments to the Growers

November 15 marks the day on which the companies mail out the first payment checks to the beet growers for beets delivered during October, with payment for November deliveries being made on December 15. The farmer is paid on the basis of the number of pounds of sugar he produces. This is figured on each truck load of beets the farmer delivers. The company takes a sample of each weighed-load of beets and delivers it in a marked container to the refinery's laboratory. In the laboratory, the beets are weighed, washed, dried, trimed of any excessive crown and weighed again. By comparing these two weighings the company determines the approximate true-beet weight of each farmer's truck load. The chemist then pulverizes the beets and treats them with acid in order to determine their percentage of sugar. This information is sent to the grower, the local field agent, and the company's front office. The company takes the true-beet weight of each load and multiplies it by the sugar percentage of the corresponding sample, thereby determining the amount of sugar recoverable per load. This figure forms the basis for individual payments.

The growers, however, do not receive an amount equal to the value of their beets in the first payment. Since the beet sugar company sells its product throughout most of the year, it is necessary to consider the

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[8] A. R. Downie, Ray Gilbert, and E. O. Preston, personal interviews, January, 1953; "How to Grow Sugar Beets," Through The Leaves (November-December, 1950, and January-February, 1951), pp. 140-144; and H. S. Owens, C. L. Rasmussen, and W. D. Maclay, "Production and Utilization of Sugar Beets," Economic Botany, Vol. 5, No. 4 (October-December, 1951), p. 363.

possibility of price fluctuation. Therefore, the first payment is based on last season's price and the market prospects for the coming season. Usually this figure falls below the eventual payment, since it is easier to give an additional payment than to take money away. These periodic market-influenced payments may be made until October of the following year.[9]

In addition to the company's payments, the growers receive an adjusted payment from the government as authorized by the Sugar Act of 1937. This payment comes from a fund accumulated by an excise tax on all domestic and foreign sugar consumed in the United States.[10]

Adjusted Payment

The Sugar Act of 1937 is designed primarily to protect the domestic sugar beet and sugar cane producers of the United States and its possessions and territories, thus assuring the country of a minimum supply of sugar regardless of international conditions. The Sugar Act achieves this goal in two ways: (1) by an established production quota for all areas supplying the consumer market in the United States, and (2) by imposing an excise tax on all domestic and foreign sugar consumed in this country.

The Sugar Act imposes a market quota on domestic and foreign producers. The quota allots about 27 per cent of the market to the domestic beet producers, about 6 per cent to the domestic cane producers, and the remainder to the various insular producers; i.e., Hawaii, Puerto Rico, Virgin Islands, Philippines, and Cuba.[11]

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[9] Fred Kennedy, personal interview, January, 1953.

[10] Sugar Beets and the Sugar Act (Washington, D. C., 1939), p. 2.

[11] Kenneth Bischoff, personal interview, January, 1953.

The Act also provides for an excise tax of 50 cents per 100 pounds of raw sugar, 96 per cent pure, and 53.5 cents per 100 pounds of refined sugar, 99.99 per cent pure.[12] Under the quota provisions, a small percentage of refined and liquid sugar is allowed to enter the United States each year. However, the majority of the sugar enters this country in the form of raw sugar, or sugar of 96 per cent purity. This raw sugar is further processed at United States refineries located on the Atlantic, Pacific, and Gulf coasts to produce the various types of refined cane sugar.[13]

The revenue received from the excise tax on the processors and the import duty on Cuban sugar is combined to form the source of payments to the domestic beet and cane producers. The 1951 amount derived from the tax and duty totaled $83,660,289, of which $67,806,529 went to domestic beet and cane growers, while the remaining $15,853,760 was kept by the government. The areas whose growers benefit by these adjusted or conditional payments are beet and cane growers in continental United States, and cane growers in Hawaii, Puerto Rico, and the Virgin Islands.[14]

In order to qualify for the conditional payment, the individual grower must not employ child labor, he must pay at least the minimum wage established for the workers, he must make efforts to preserve and improve soil fertility, and if also a processor, he must pay a fair price for the beets or cane purchased from other producers.

The conditional payment in addition to increasing the amount of revenue received by the grower also serves as a form of limited crop

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[12] A. R. Downie, personal interview, January, 1953, and _Sugar Beets and the Sugar Act_, _op. cit._, p. 2.

[13] C. W. Briggs, "Sugar Price Trends," _Crystal-ized Facts about Sugar Beets_, Vol. VI, No. 3 (July, 1952), p. 12.

[14] H. E. Knapp, personal interview, January, 1953.

insurance for which the grower pays no premiums. If drought, flood, storm, freeze, disease, or insects cause widespread damage and reduce yields below 80 per cent of normal, the grower receives a conditional payment based on 80 per cent of his normal production. If similar conditions force farmers to abandon completely some or all of their beet acreage, payments are made on a third of the normal yield of the abandoned acreage. The normal yield is the average yield for the last seven consecutive years. The normal yield belongs to the farm and not to the farmer, so when the farm is sold the sugar beet production record is included in the sale.[15]

Refinery Labor Practices

Many of the smaller growers receive additional income from the sugar companies by working in the refineries during the campaign. The companies also employ housewives, part-time workers, seasonal agricultural workers, and some business men from the local area. The three refineries in the Valley use around 1,000 workers during the processing period as compared to less than 200 for the remaining ten or eleven months. The greatest increase in employment is in the factory operations where the processing period requires an addition of some 650 to 700 semi-skilled workers. The field work requires an additional 130 workers to handle the beets, while the office force needs remain about the same.

The campaign, or processing period, usually begins one week after the start of harvest operations and continues for a period of one to two months. The 1952 campaign for the three Valley refineries average around thirty-eight days with "Holly" registering a thirty-day period and "National" a forty-five-day period.

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[15] Sugar Beet and the Sugar Act, op. cit., p. 4.

During the inter-campaign period the main working force is employed in the factory. It consists of skilled workmen who maintain the equipment, and a crew of semi-skilled workmen who clean the equipment and ship the sugar. This group works on a twelve-month basis, and, like the beet sugar refineries, they are a permanent factor in the life of the Arkansas Valley.[16]

[16] H. E. Knapp, George Hogan, and E. O. Preston, personal interviews, January, 1953, and Arkansas Valley Journal (October 9, 1952), p. 1.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The sugar beet, in the more primitive form of the mangel, spread from the southern coast of the Mediterranean to central Europe in the 16th century. The cooler climate changed the sugar beet into a biennial crop, a factor which led to its commercialization in France in 1811.

The sugar beet was introduced to the northeastern area of the United States in 1838, and after experiencing numerous failures, successful commercial production was achieved in 1870 at Alvarado, California. In the year 1870, the sugar beet was introduced to the Platte River bottom near Denver, but the first refinery in Colorado was not established until 1899, at Grand Junction.

George W. Swink planted the first sugar beets in the Arkansas Valley of southeastern Colorado in the 1890's. The first Valley refineries were operated as early as 1900 at Rocky Ford and Sugar City. By 1907, other refineries had been completed at Swink, Las Animas, Lamar, and Holly, bringing the Valley total to six.

However, because of a shortage of sugar beets in the eastern part of the Valley, the refineries at Las Animas, Lamar, and Holly became an economic liability and were closed by the 1920's. The beet shortage in the eastern half of the Valley was caused primarily by the uncertain supply of irrigation water afforded the farmers. When the three eastern refineries were closed, many beet growers in the area substituted other crops for the sugar beet. This was the beginning of a fairly steady decline in sugar beet acreage, which was aided by an unstable sugar price and mounting labor difficulties.

The six southeastern Colorado counties of Pueblo, Otero, Crowley, Bent, Prowers, and Kiowa, have been designated as comprising the Arkansas Valley of Colorado. The combined area of 9,442 square miles has provided the population of 147,000 people with a marketable surplus of such crops as wheat, sorghum, hay, sugar, onions, melons, broomcorn, and various types of seed.

The area lies within a middle-latitude steppe climate which includes a light yearly rainfall; a large daily range in temperature; a high day temperature in summer; a few protracted cold spells in winter; a large amount of sunshine; a moderately high wind movement; and a low relative humidity.

The rainfall, which comes in the Valley during the early part of the growing season in May, June, and July, is low and variable with an average of 13.5 inches. However, the 320,000 acres of irrigated terrace and bottom land produces bountiful crops by making use of the heavier mountain precipitation which falls within the watershed of the Arkansas River.

With an annual temperature range of 47° F., the area enjoys a growing season of 160 days which is favorable for a wide variety of crops. The spring and fall temperature progressions are ideal for the sugar beet as is the high diurnal range in temperature, which results from the high-altitude atmospheric conditions and the large amount of sunshine.

The degree of influence of topography on the sugar beet is determined by the ability of the land to properly handle the gravity flow of irrigation water. The importance of soil type in the growth of sugar beets is negligible, although in the Valley more beets are grown on clays, clay loams, and silt clay loams. However, fertility, which can be regulated through cultural practices, is the determining factor in successful production.

Crop rotation on irrigated lands is vital to successful agriculture. The sugar beet has proven to be a crop well suited to crop rotation, irrigated agriculture, and a well balanced farm program.

Soil fertility is vital not only to successful sugar beet production but to the production of most crops. Contrary to the opinions of some farmers in the Valley, the sugar beet, if handled properly, will not draw excessively on the nutrients of the soil. The proper use of crop residue, livestock manure, and commercial fertilizers aid in maintaining soil fertility.

In preparing the seed bed, a deep-fall-plowed, even-textured seed bed results in proper pore space and moisture conditions, thus making more plant nutrients available for the successful germination of the special breeds of segmented seeds. This preparation and planting can be handled by the individual farmer without the use of migrant labor.

The majority of the beets in the Valley are planted during April. Six to eight pounds of seed per acre are recommended when set one inch apart at a depth of three-fourths to one inch in twenty to twenty-two inch rows. The seeds are immediately irrigated and the seedlings should emerge in two weeks. When the beet seedlings have reached the four to six true-leaf stage, or about three weeks after emergence, they are ready to be thinned to ten to twelve seedlings per one hundred feet of row. In the past this task has been handled entirely by slow hand labor. This source of labor, which is recruited from Texas and New Mexico, has become difficult to acquire and so undependable that many farmers have ceased to grow sugar beets. However, a new mechanical down-the-row thinner has proven so successful that it has emancipated the sugar beet from its previous position of dependence on large amounts of seasonal labor. Today, a mechanically thinned field usually needs only one quick hoeing which requires off-the-farm assistance.

The farmer will handle the remaining work by himself with the possible exception of the harvest. During the period from the latter part of May until the time when the beet leaves touch across the rows in the first part of July, the farmer will cultivate his field from four to five times. He will also run water on the field whenever the beet leaves wilt excessively. Irrigation is the only work which proceeds through the summer, with the last run of water coming about two weeks prior to the harvest, or the middle of September.

The harvesting of the beets, like thinning, once required large amounts of additional labor. However, since World War II, various types of machines have reduced harvest to a one to three man operation. The labor problem, consequently, has seemingly been remedied to the satisfaction of the majority of the growers.

The sugar beet has become a highly mechanized crop. A crop which is planted and cultivated by the individual farmer, with the thinning and harvesting being handled either by the farm family or by a mechanized custom-job crew.

The farmer hauls his harvested beets either to the refinery's beet dump or one of the many temporary railroad dumps that dot the countryside. The company takes a test sample from each weighed truck load in order to determine the amount of sugar the beets contain.

At the refinery dump, the beets enter a warm-water flume which transports them into the refinery. The beets are washed, dried, weighed, sliced into long-thin slices called cossettes, and dumped into the diffusion battery where running hot water removes the sugar from the cossettes leaving what is known as beet pulp. The syrup is next purified to remove the non-sugars, and concentrated to 55 per cent sugar in the evaporator. This concentrated syrup is run into the vacuum pans where it is crystalized. These crystals are placed in a centrifuge machine which separates the crystals from the residue molasses. While the molasses is being reprocessed in order to remove more sugar, the crystals are dried in the granulator and sacked for commercial sale. Most of the Valley's sugar goes to Colorado, Kansas, New Mexico, Texas, Oklahoma, and a few points farther east.

The three by-products of the sugar beet, beet tops, beet pulp, and molasses, serve as excellent feed for livestock. Molasses is also used in baker's yeast and citric acid.

The grower benefits from the by-products as well as receiving payment from the sugar company and the Federal Government. The company pays the grower for the pounds of commercial sugar his beets produce, and the government pays the grower on the basis of his normal sugar production averaged for the last seven years. The government acquires this money through a processor's excise tax levied on all sugar consumed in the United States as well as a duty on foreign imports. The government payment goes to both beet and cane producers in the United States, Hawaii, Puerto Rico, and Virgin Islands. To qualify for this payment the growers must not employ child labor, they must employ soil conservation measures, they must pay labor a minimum wage, and if they also process sugar, they must pay the growers a fair price for their beets or cane.

The labor employed by the refineries in the Valley consist mainly of local people such as small farmers, housewives, agricultural workers, business men, and part-time workers. The refinery operates 24 hours a day for a period of one to one and one-half months, thus affording additional employment to the citizens of the Valley. The sugar beet refineries have definitely become part of the local community.

Conclusions

The sugar beet of today, with a sugar content of fifteen to twenty per cent, is an efficient plant. It has been bred to suit many environmental idiosyncracies of different areas, both climatic and biotic.

With the addition of irrigation water, the sugar beet has proven to be well adapted to the natural environment of the Arkansas Valley. However, the cultural environment has not been as receptive. The beet, which in 1920 had a Valley acreage well in excess of thirty-thousand acres, has declined to less than one-half of this total. Nevertheless, during this period the population of the United States has increased by forty per cent, thus enlarging the market for sugar.

This decline has resulted from three main causes (1) an unstable sugar market, (2) an undependable supply of irrigation water, and (3) labor difficulties. The Sugar Act of 1937, through its system of quotas and conditional payments, has stabilized the price of sugar at a level generally acceptable to the consumer and to the grower. The food index shows that in recent times the price of sugar has increased less than all other major commodities except fats and oils. Consequently, the price of sugar to the consumer as regulated by the Sugar Act is far from being exorbitant.

The Sugar Act also makes it profitable for the farmer in sugar beet areas to produce beets, by providing restrictions on foreign imports. This procedure is not new in American history, because America has consistently maintained protective tariffs as a means of developing a nearly self-sufficient economy. Therefore, the Sugar Act has a place in the American economic scene.

The present Act has been in force for sixteen years, with only minor alterations. It appears, therefore, that the Sugar Act is justified and the present regulations are adequate to accomplish the purposes for which it was intended.

The water problem in the Valley is still acute. Since World War II, the U. S. Corps of Engineers has completed the John Martin Dam, which is to provide irrigation water to the eastern half of the Valley. By impounding excess water during the season of low demand, the reservoir will be able to supply approximately 300,000 acre-feet of irrigation water annually and promises to materially aid the critical water problem.

At the present time, the people of the Valley are working on a proposed project for diverting water from the Gunnison River area across the continental divide into the Arkansas River. A similar project has been operating in northern Colorado for a number of years, thus providing the Platte River Valley with additional irrigation water. With the present Federal Administration following a budget-balancing program, the future of the water diversion project is most uncertain, but more water should mean more beets.

The labor problem appears more favorable today than does the water situation. Mechanization has come to the sugar beet fields to stay. Machine thinners and harvesters have proven more economical, more efficient, and much faster than the hand labor method. The machines are ideal for the beet grower who has in excess of twenty acres of beets. Small growers can rent thinners or combine their resources and buy thinning and harvesting machines. In the near future the beet fields will undoubtedly be thinned and harvested by professional crews similar to those that combine the nation's wheat. Weather permitting, a thinner or harvester can be operated 24 hours a day. Thus, accomplishing these operations nearer the optimum time.

The only operation under a mechanized program requiring hand labor is the weed hoeing. This work is made easier and can be performed at a faster rate in a machine-thinned field. Consequently, many hand workers refuse to work in fields that are hand thinned. This hoeing operation can be handled in machine-thinned fields by the same workers who work in onions, hay, tomatoes, melons, and other crops. Mechanization has tended to level off and stabilize the Valley's labor demands.

A program of assuring the growers a dependable type of labor has been worked out by the State Employment Office in La Junta. This office recruits and screens the workers and supervises their labor. Beet hoeing can be accomplished by fewer workers than thinning, consequently, the labor needs will be filled in the future largely from the local labor supply.

The sugar beet will remain an important crop in the Valley. The sugar companies have large investments in the area and the refineries are too important to the economy of the Valley to be closed. Once the down-stream irrigation facilities begin to function, in conjunction with mechanization, and with combined government support and protection, the sugar beet industry of the Arkansas Valley should experience a renaissance.

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