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# Fifty Years Experience on the Belle Fourche Irrigation Project

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50 YEARS EXPERIENCE ON THE

# BELLE FOURCHE IRRIGATION

PROJECT

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# 50 Years Experience on the BELLE FOURCHE IRRIGATION PROJECT

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## Introduction

Interest in irrigation farming for South Dakota has been stimulated by the prospect of large scale irrigation development in the James River Valley.

To more fully understand the implications involved in this type of water resource development, farmers, businessmen, and other citizens are expressing a desire to learn about irrigation projects. In their quest for information they have turned to examining experience on existing irrigation projects. Fortunately the Belle Fourche Irrigation District, located in western South Dakota, is available for their consideration.

### Purpose of the Study

The purpose of this research is to determine the lessons learned from the experience of irrigation farmers on the Belle Fourche Irrigation Project, Newell, South Dakota. Authorized by the Secretary of the Interior May 10, 1904, this project is one of the oldest Federal reclamation irrigation enterprises in the United States. Consequently, the experience of South Dakota farmers with this project should prove valuable to persons contemplating further irrigation development within the State.

### Procedure

The Belle Fourche Irrigation Project is to some extent still being influenced by decisions and events occurring during its planning and development stages. Therefore, the experience gained and the present state of affairs on the project cannot be well understood without considering the conditions and events that shaped the course of its development. Thus, the first portion of this study concerns conditions on the project as it evolved through six rather distinct periods or stages in its first 50 years.

Conditions on the project during the six periods show that a number of far-reaching changes have been

[1]Assistant Rural Sociologist; Rural Sociologist; and Graduate Student, Agricultural Economics Dept., respectively. (Note: Dr. Kumlien conceived of this study and was working on it at the time of his death in 1953. After his death, Mr. Riley continued the research and prepared the manuscript for publication.) Acknowledgment is made to Denton Morison, Student Research Assistant, who contributed valuable assistance in the preparation of the manuscript.

taking place. To understand the nature and extent of certain basic changes, a consideration of trends in settlement, crops, and livestock is given in the second portion of the study.

A knowledge of important events, conditions, and problems experienced on the project, together with an understanding of certain basic changes, provides a background for the last portion of the study. In this section, experiences gained on the project that have broad implications for irrigation development are discussed in terms of the situations in which they have arisen.

### Sources of Data

The Belle Fourche Project annual histories are the primary source of data for this study. These reports are compiled at the project headquarters after the close of the irrigation season and are available for each year the project has been in operation. In addition to records on the operation and maintenance of the project's diversion, storage, and distribution system, these annual reports also include data on settlement, crops, and livestock. This latter information is collected by the ditch-riders each fall when the project's annual crop and livestock inventory is taken.

There are two main limitations of the annual inventory data. First, the ditch-riders are not trained in the technique of collecting such information. Though they have generally done a good job, the lack of special training for this work has undoubtedly resulted in some inaccuracies in reporting.

Secondly, concepts used by the Bureau of Reclamation such as "farm," "tenant," and "owner" have sometimes been poorly defined, particularly in the past, so that it is difficult to know the exact nature of the information included under the terms.

Also, changes in the definition of terms and method of reporting information, although a necessary part of the process of keeping up-to-date, make comparisons with information collected and reported under "old" definitions difficult.

In addition to the annual project histories, a number of published and unpublished reports and studies have been used as sources of data.

### Description of the Project Area

The Belle Fourche Irrigation Project is located immediately north of the Black Hills in western South Dakota (figure 1). It covers the valley of the winding Belle Fourche River for about 30 miles below the city of Belle Fourche.

The project area, about 12 miles wide on the average, consists of the valley of the main stream, the narrow valleys of tributary streams, the high river terraces, and the rolling foothills forming the local watersheds. Nearly all of the project area lies within Butte County; the remainder, a few square miles of the southeastern part, falls within the boundaries of Meade County.

The climate is typical of northwestern South Dakota. The summer season, semiarid, is characterized by hot, windy days and cool nights. Winter is characterized by cold dry atmosphere combined with

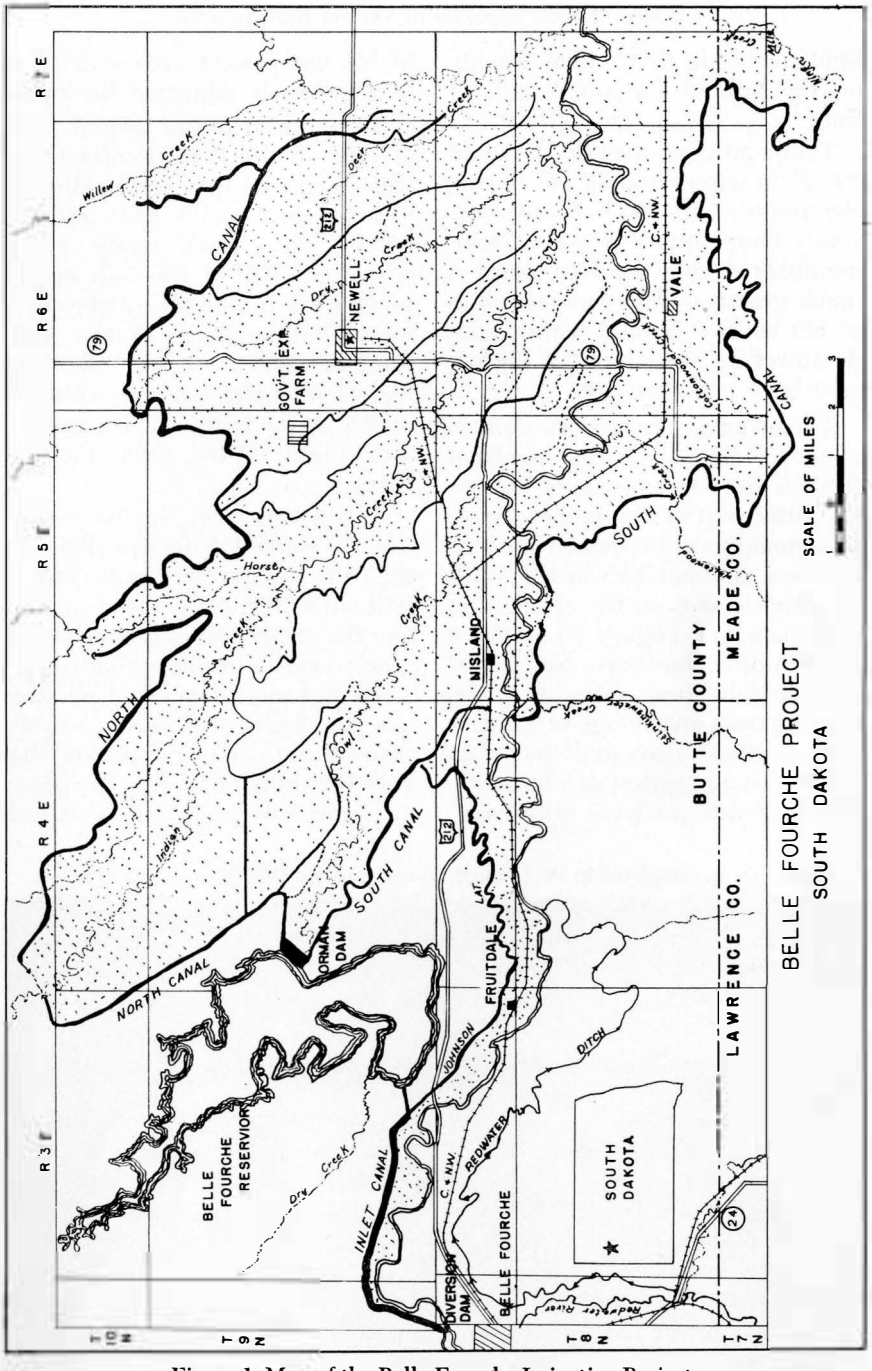



**Figure 1. Map of the Belle Fourche Irrigation Project.**

light snow falls that seldom remain on the ground for any length of time.

Temperatures average around 19° F. in winter and 73° F. during the summer with 46° F. the average yearly temperature. However, temperatures during the year cover a much greater range. Summer days as hot as 110° F. and winter temperatures as low as 38° F. below zero have been recorded.

The average growing season is about 130 days; the period free from frosts is from the middle of May to the latter part of September. Average annual precipitation for the project area is about 15.5 inches, most of which occurs in the spring and early summer (figure 2). Annual precipitation, however, has varied considerably from year to year, ranging from an average of 9 inches in the 5 driest years to 25 inches in the 5 years of greatest precipitation. Severe hailstorms have occasionally hit the project area and often have seriously damaged the crops.

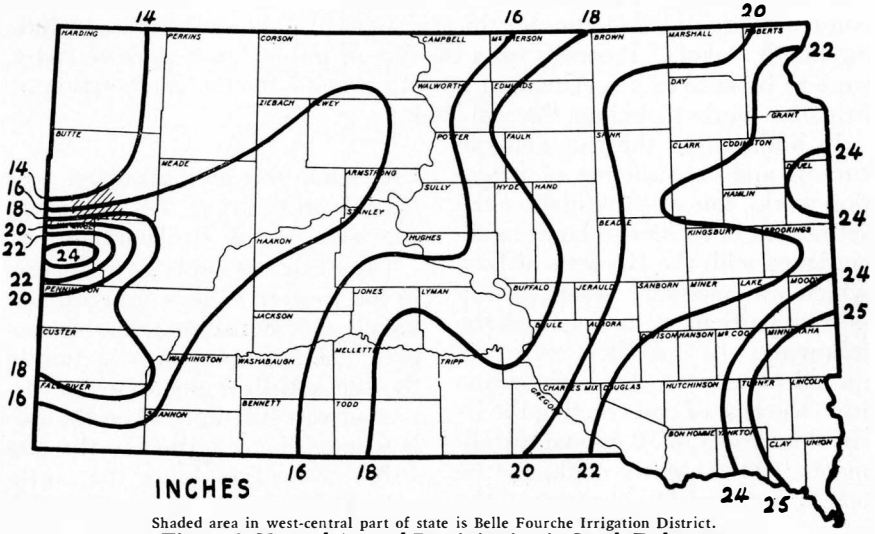
Although there are several types of soils on the Belle Fourche Project, in general they can be divided into the heavy clay soils and the lighter loam and sandy types. About one-half of the soils on the project are of the heavy clay type found largely north of the Belle Fourche River (figure 3). The lighter textured soils are confined mostly to the bottom lands and the area south of the Belle Fourche River.

The lighter soils on the project can be worked with less difficulty than the heavier clay soils. This is particularly true in a wet season. On the lighter soils crops can be planted earlier in the spring, and in a wet fall sugar beets and potatoes can be harvested more readily. Some persons believe, however, that with the proper handling the heavy clay soils will produce fully as well

**Orman Dam, completed in 1911, which stores water for the Belle Fourche Project.**

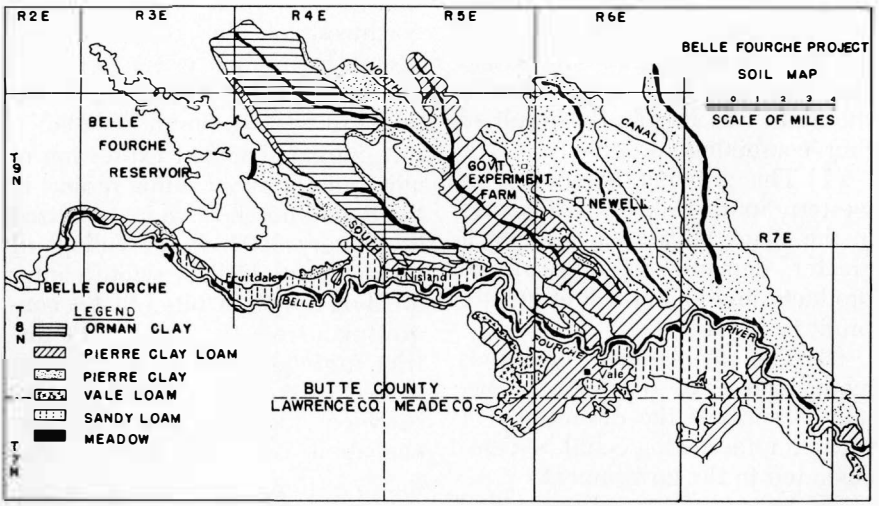
as the lighter loam soils and will continue to do so for a longer period of time.

Topography of the project area is varied. The land varies from rather large, smooth plains to rather steep breaks. Generally speaking, the land north of the Belle Fourche River has a more rolling topography than that south of the river, although there are sections of hilly terrain scattered throughout.




Shaded area in west-central part of state is Belle Fourche Irrigation District.

**Figure 2. Normal Annual Precipitation in South Dakota**




(Source: Adapted from Strahorn and Mann, *Soil Survey of Bellefourche Area, South Dakota.*)

**Figure 3. Soils Map, Belle Fourche Project.**

# Construction, Settlement, and Development

## Preconstruction

**Authorization.** Federal legislation that established a legal framework for constructing government sponsored irrigation projects such as the Belle Fourche came about with the passage of the Reclamation Act of 1902. Under this act the Federal government was given the authority to construct irrigation facilities for the arid areas of 16 western states, including South Dakota.[2] Proceeds from the sale of public lands in these states were to be used as a reclamation fund to provide for the construction of irrigation works to reclaim the arid land.

In addition to the examination, survey, and construction of irrigation works, the act provided for the settlement of reclaimed lands in accordance with the Homestead Law which was modified in certain important particulars, among them the following: (1) settlers were required to repay to the reclamation fund the cost of constructing the irrigation works in 10 annual installments, (2) the entry could not be commuted, and (3) the area of the entry was limited to not less than 40 or more than 160 acres.

**Motivation.** Interest in western South Dakota as a possible location for the forthcoming Federal irrigation enterprise to be established in the State was largely the result of four combining forces:

(1) The growing population of western South Dakota, particularly in the Black Hills area, brought a greater demand for agricultural products, and an outlook of greater profit to farmers.

(2) The availability of funds made large scale irrigation financially possible if the desirability of such an undertaking could be demonstrated to the government.

(3) Large tracts of unsettled public lands in western South Dakota made this area attractive and feasible in terms of the homestead provision of the Reclamation Act.

(4) Early attempts at irrigation in the western valleys of South Dakota had demonstrated relative success. The beginning of irrigation in the Black Hills region dates to various private attempts when the valleys were being settled in the late 1870's. For example, in the northern Black Hills area, Spearfish Creek was utilized for some irrigation in Spearfish Valley, and the Redwater Canal which "heads" northwest of the community of Spearfish supplied water to one of the largest early irrigation enterprises in western South Dakota.

**Agitation.** The first expression of agitation for an irrigation project in the Belle Fourche area materialized in January 1903. P. P. Vallery of Snoma, South Dakota, wrote a letter to Eben Martin, United States congressman from the Black Hills district, urging him to use his influence to see that Butte County receive early consideration under the Reclamation Act. Mr. Vallery also

[2]The Act of February 25, 1905 extended the Reclamation Act to a portion of the state of Texas, and the Act of June 12, 1906 extended the Reclamation Act to the entire state of Texas.

wrote the chief clerk of the Geological Survey requesting a reconnaissance of the Belle Fourche area for possible dam and reservoir sites.[3]

A reply to this letter by the chief clerk assuring Vallery that such a reconnaissance would be made the following summer was published in a Belle Fourche newspaper along with an enthusiastic article on irrigation possibilities in Butte County.[4] These comments created public interest in the enterprise.

**Initiation.** As a result of requests made by citizens of the Belle Fourche area, the Department of Interior sent Raymond F. Walter, Reclamation Service engineer, to South Dakota in June 1903. During the summer of 1903, Walter's reconnaissance party made surveys of streams in western South Dakota having their source in or near the Black Hills to determine the most feasible site for an irrigation project.

A number of possible sites were found, but the one promising the most immediate returns was the valley of the Belle Fourche River east of the city of Belle Fourche. Walter found that irrigable lands were located on both sides of the Belle Fourche River, the north side lands being mostly public and available for settlement, while those on the south side were nearly all in private ownership. His report states that although little stream flow data existed (river-flow records were for a single year, 1903) irrigation by reservoir storage would be practicable.[5]

As a result, preliminary plans and estimates were completed during the winter of 1903-04, and on April 29, 1904, a Board of Reclamation Engineers recommended that plans and specifications be prepared for construction at an early date. On May 10, 1904, the project was approved by the Secretary of the Interior, and $2,100,000 was set aside from the reclamation fund for the construction of the Belle Fourche Irrigation Project.[6]

## Construction

On April 24, 1905, the contract to build the diversion dam was let to a St. Louis firm. Later that year, Orman and Crook Construction Company was awarded the contract for the storage reservior.

Construction began on May 18, 1905, when ground was broken for the diversion dam of the Inlet Canal. Plans called for a diversion dam to be located on the Belle Fourche River 1½ miles below Belle Fourche from which water would be transported by means of a 6½-mile Inlet Canal to a reservoir on Owl and Dry Creeks formed by the Orman Dam (figure 1). This earthen dam, contemplated as one of the largest of its kind in the United States, was to be capable of retaining about 246,000 acre feet[7] of water with a reservoir surface of 9,000 acres. It was thought that about 90,000 acres of land would be irrigated by the main branches of the distributing system, the North and South Canals.

[3]R. Y. Chapman, "History of the Belle Fourche Irrigation Project," p. 10.

[4]Chapman, *Loc. Cit.*

[5]U.S. Department of Interior, Bureau of Reclamation, *Reclamation Project Data,* p.17.

[6]U.S. Department of Interior, Reclamation Service, *Ninth Annual Report of the Reclamation Service,* p. 254.

[7]An acre-foot of water is 1 acre of water 1 foot deep.

The water used for irrigating about 60,000 acres of chiefly heavy clay soils north of the Belle Fourche River and east of Owl Creek was to be supplied by the North Canal. This canal was designed to be 45 miles long and have a water capacity of 650 second-feet as it left the reservoir.

The South Canal, on the other hand, would supply irrigation water to about 35,000 acres of mainly loam and sandy loam land, part of which was located west of Owl Creek, the remainder south of the Belle Fourche River. The South Canal was designed to be about 44 miles long with an initial water capacity of 350 second-feet. Even though the carrying capacity of these canals, as related to the areas served by them, appears to be about the same, it is generally conceded that the water requirement for the soil types found under the South Canal (loam and sandy loam) is greater than for those found under the North Canal (heavy clay). In addition, transmission losses are greater on the South Canal.

Plans also provided for another branch of the distributing system known as the Johnson Lateral (figure 1). The Johnson Lateral was designed to take water directly from the Inlet Canal and supply water to about 3,000 acres of land north of the Belle Fourche River from a point 1 mile west of the reservoir to 3 or 4 miles east of Orman Dam.

With the completion of work on the Diversion Dam and Inlet Canal in September 1907, limited irrigation was started the next year. Since no water could be stored in the uncompleted reservoir, water was furnished to the Johnson Lateral under the Inlet Canal and to the South Canal through the temporary Dry Creek Canal.

By May 1910, the Belle Fourche Reservoir was sufficiently completed to be partially used for storage, and the diversion works, Inlet Canal, reservoir, the first section of the North Canal, and the entire South Canal were operated from May to October.

Orman Dam was completed in 1911, and with the addition of the second section of the North Canal in June 1912, the basic construction features of the project were essentially complete.

## Settlement

**Publicity.** A brief review of the publicity given the project in an effort to stimulate interest and promote settlement is basic to an understanding of the problems of the settlers. Prior to the delivery of water, many of the citizens and officials favoring the irrigation development created a feeling of great optimism regarding its forthcoming success.

It was pointed out that here was an area with abundant sunshine and rich soil, which if provided with sufficient water, would produce good crops and make hundreds of farms available to settlers and their families.

This enthusiasm, for the most part uncritically given and received by the supporters of the project, is exemplified by a statement appearing in the *Belle Fourche Bee* on February 28, 1907, which summa-

rized the irrigation outlook in the following terms:

> A government irrigation expert, whose name we are not pivileged to divulge, stated that he was familiar with every irrigation project in the United States, whether public or private, and that he had visited and studied the irrigated areas of the old world, including those of Asia and along the Nile, as well as such as exists in Mexico and South America, but of all of them he considered the Belle Fourche Project the most promising.

**Few Facts.** Such optimism, however, was not founded on actual facts derived from adequate surveys. Early surveys lacked thoroughness. Records of stream flow data were available only for a short period, and soil reports failed to emphasize the caution that would be necessary to make the Pierre and Orman clay soils productive.

It was not until after the construction was well under way and the first public notice opening lands for settlement was issued that the first adequate soil survey of the area was published on December 8, 1908. This survey was the result of field work done by A. T. Strahorn and C. W. Mann in 1907.[8]

Although it was known previous to this survey that about half the soils were of the heavy clay type, and that considerable skill and care would be needed to make these soils produce under irrigation, the dangers involved were often minimized when put before the public eye. Illustrating some of the optimism expressed regarding the dangers inherent in irrigating heavy clay soils, the *Belle Fourche Bee* on February 28, 1907, stated:

> A government expert on soils and cultivation assures us that under irrigation gumbo can be handled by keeping it in a certain condition as regards moisture; that the government has demonstrated this fact by experiment. All concede that gumbo is the richest and strongest soil when it can be handled, being extremely rich in plant food, and with water at command at all times and cultural problems settled as it will be, the farmers on the gumbo may find themselves fortunate as compared with those on the lighter and more friable soils.

Reports such as this only hinted at the difficulty to be expected when water was put on the gumbo lands. Further misconception, growing out of a lack of information, was generated by failure to emphasize other potential dangers involved in irrigating these soils.

In 1908 Strahorn and Mann pointed out that alkali is generally present in the soils of the area north of the Belle Fourche River. Under conditions of dry farming, the report continued, this alkali would be of no particular danger, but with the application of irrigation water there was a great danger that water soaking down into the lower soil would cause an upward movement of harmful salts.

It was not until the later units were opened for settlement, however, that farmers felt the impact of problems inherent in irrigating the heavy soils. The first farmers on the Belle Fourche Project were, for the most part, private land holders within the area who converted their farms to irrigation units with the coming of the project. Their farms

[8] A. T. Strahorn and C. W. Mann, *Soil Survey of Bellefourche Area, South Dakota.*

were nearly all comprised of the lighter soils of the first two units opened.[9]

**Speculation.** As a result of the success of these farmers and because of a limited knowledge of the difficulties to be expected with the irrigation of heavy clay soils, many persons thought land values would quickly rise, allowing the owner a good measure of profit. This expectation caused a considerable amount of land speculation when the later units on the heavy clay soils were opened for settlement.[10]

In many instances speculators and home-seekers, without a knowledge of the area, and some without even a background in farming, occupied homesteads on the heavy clay soils. About half of these homesteads were taken up by non-farmers, such as clerks, school teachers, lawyers, and businessmen. Many of these homesteaders had no capital other than the filing fee, and often they went into debt for the necessary outlay, thinking it could easily be repaid from the ensuing profits of irrigation farming.[11]

The experience of these early settlers largely validated the cautious conclusions of the Strahorn and Mann report. With a limited knowledge of water requirements and methods of application, the settlers had to work out their own methods. The heavy clay soils were found to require more skill in handling than the inexperienced settlers possessed. In some instances more water was used than was necessary which resulted in leaching and erosion of the soil and seepage of the land which caused alkali damage.

Higher construction charges on the heavy clay land combined with the poor results from this land to make the situation more disheartening. The speculating settler soon learned that possession of irrigated land was not the guarantee of prosperity and that irrigated land was worth only what it could be made to produce.

Moreover, this speculation took place during the formation of the inflationary bubble of World War I. When this bubble burst in the early 1920's the forces of exaggerated speculation and unexpected deflation seriously undermined the confidence in the project expressed earlier.

## Inflation

The increasingly higher prices paid to farmers for agricultural products during World War I, along with an unceasing demand for these products, tended to create an inflationary period. This inflationary period continued even beyond the end of World War I, and it was not until 1920 that rising land prices, increased settlement, and high prices paid to farmers for commodities fell off, leaving project farmers in the grips of a deflation.

[9]A comparison of figures 3 and 4 will make it apparent that the more difficult to handle soils (Pierre and Orman clay) comprise only a small part of the first and second units opened, constitute a greater amount of the third unit opened, and are by far the most prevalent soil types found in the last two units opened for settlement.

[10]Construction charges on the heavy clay soil units were higher than on the units composed of the lighter soils. Public notices opening lands for settlement on the project appeared as follows: first unit 1907—11,294 acres ($30/acre); second unit, 1910—34,787 acres ($30/acre); third unit, 1912—18,222 acres ($40/acre); fourth unit, 1915—12,826 acrse ($40/acre); and fifth unit, 1917—4,712 acres ($45/acre).

[11]Raymond Lund, "Belle Fourche Irrigation Project, 1903-46; Anlysis No. 2," p. 2.

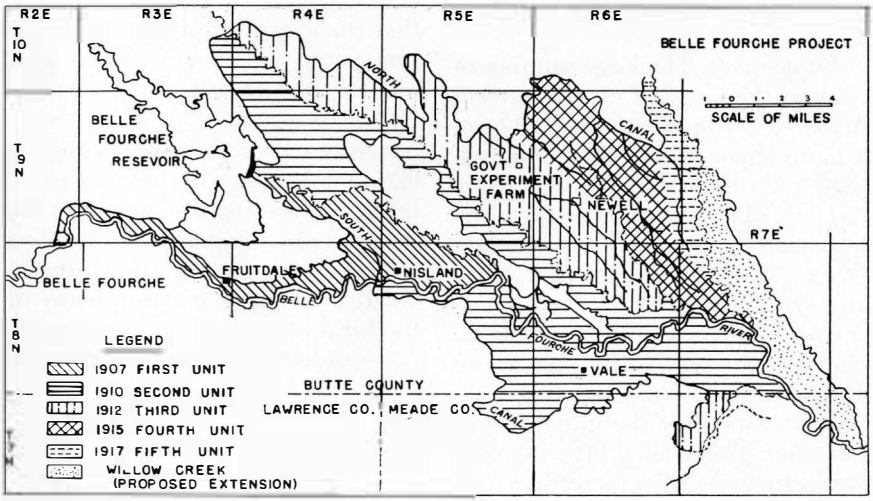
**Crop Prices.** Changes in crop prices paid farmers from 1915 to 1919 illustrate the spiraling and inflationary trend within this period. In 1919 project farmers were receiving at least twice as much for each of the major crops they raised as compared with 1915 receipts. Alfalfa prices, for instance, soared from $4.50 per ton in 1915 to $20 at the peak of the inflation in 1919 (table A-1). Corn, which sold for only 50 cents a bushel in 1915, brought farmers $1.50 a bushel in 1919. Wheat prices increased from 80 cents a bushel in 1915 to $2.20 in 1919. Oats, which brought 40 cents in 1915 was bringing project farmers 80 cents a bushel in 1919.

Total crop value on the project during this period increased from $462,050 in 1915 to $1,962,683 in 1919 (table A-2). This tremendous gain of 325 percent in total crop value from 1915 to 1919 was made possible by an increase of only 31 percent in the total area cropped and by a gain of 29 percent in the irrigated acreage.

**Farm Organization.** The period 1915-19 witnessed several important changes in farm organization on the project. Most important among these changes was a shift from major emphasis on cash crop production to greater concern with cattle, hog, and sheep raising. Sheep numbers for instance, increased from 26,210 in 1915 to 75,398 in 1919 (table 7). In 1919 there were 19,837 hogs as compared with 14,-798 in 1915 and 1,790 in 1912.

Cattle numbers also increased during the 1915-19 period. Increases in livestock production during this period were reflected in changing crop production patterns on the project. Forage requirements for feeding more livestock resulted in expanded acreages planted in alfal-

**Figure 4. Date and location of units opened for settlement.**



fa and a decline in the number of acres devoted to corn and oat production.

**Renewed Interest.** Because of inflationary conditions farmers were prospering during this period. Consequently, persons interested in the rapid expansion of their capital exhibited a renewed interest in the Belle Fourche Irrigation Project from 1915 to 1919. For instance, in 1919 at the peak of this period of inflation, more project land changed hands through voluntary transfers than in any year before or since. Over one-fifth of the settled land changed hands at prices as high as $125 an acre in 1919.[12]

Population of the irrigated farms increased from 1,877 in 1915 to 2,597 in 1919 or an increase of 38 percent over a 4-year period. The number of irrigable farms likewise increased during this period. In 1919 there were 1,000 irrigable units as compared with 653 in 1915. Moreover, most of the new farm units settled during this period were operated by owners rather than tenants.

**Repayment.** The large number of farmers who settled on the project in the 1915-19 period benefited from a more lenient repayment contract. Under the terms of the Extension Act of 1914, settlers were required to pay only a 5 percent construction charge downpayment upon entry (about $2 an acre).

The balance of the construction charge debt was to be paid in 15 annual installments, the first payable 5 years after the initial downpayment. This placed little immediate financial burden on settlers during this period and was undoubtedly one of the major factors to encourage land speculation, since speculation was possible for anyone with means enough to pay the filing fee and the construction charge downpayment.[13]

From 1915 to 1919 the construction charges were fairly well paid. This along with inflationary prices paid to farmers for their products, gave the project a period of apparent prosperity.

### Deflation

Varying degrees of deflationary pressure were felt from 1920 through 1937 on the project. Deflationary pressures were first felt in 1920 when the high prices paid to farmers for their products suddenly collapsed. Project crop values averaging $34.65 an acre in 1919 had dropped by 1920 to $13.90 an acre, a much greater decline than could be accounted for by the slightly lower yields. By 1921, the lower farm prices were followed by rapidly falling land values, making it clear that the apparent prosperity of the preceding period was inflationary, and that the project, along with the Nation, had entered a deflation.

**Settlers.** With the onset of the deflation in 1920 one of the main problems confronting the project was that of obtaining enough settlers to operate the farm units. Throughout the period of inflation many of the farm units had been bought by non-resident owners chiefly for pur-

[12]L. W. Wallin, "Land Transfers on the Belle Fourche and Lower Yellowstone Irrigation Projects from Settlement to 1945," p. 11.

[13]Filing fee for 160 acres was $14. Prior to this time, settlers were required to pay off the total construction cost for an irrigated unit in 10 annual installments.

poses of speculation. Others were held by "part-time" farmers who lived in town and operated the irrigated unit as a spare-time occupation. As a consequence, a large number of farm units were without buildings, or if buildings were present, the state of their repair was poor.

At the beginning of the deflation in 1920, large numbers of "part-time" farmers, speculators, and nonresident owners, many of whom were heavily mortgaged, were in serious financial arrears. Consequently, many unimproved farm units became available for settlement as these individuals tried to sell their land and thereby free themselves from an unprofitable investment.

Economic conditions, however, did not encourage new settlers to buy irrigable farms. Deflationary conditions made it almost impossible to obtain satisfactory credit to buy farms and live on the project. In addition to this, the prospect of living on farms that were still undeveloped, lacking houses and other improvements, helped to discourage resettlement during this period of low farm prices. For the most part, therefore, buyers, as well as renters for these farms were difficult to find. Both owners and tenants left in large numbers, the owners renting their units or contracting with the remaining farmers for their management. In some cases the difficulty of finding tenants was so great that owners rented their farms for terms that barely covered the taxes and water charges they were required to pay. Other owners, finding it impossible to secure renters or managers for their units, were forced to let them stand idle.

**Problems.** Scattered settlement, such as was created by the loss of settlers from the project at this time, may impose social and economic problems different from and often more serious than those experienced through the loss of population in dry-farming regions. For example, even though a number of the irrigated farms are not operated, the canal mileage cannot be reduced and the burdens of maintaining and paying the cost of constructing the entire irrigation system fall upon a reduced number of farmers resulting in an increased cost to each. Thus, as farmers left in large numbers from 1920 to 1926, the impact of problems such as these was felt with increasing severity (figure 5 and table 1).

Concurrent with population losses during the 1920-26 period were pronounced changes in the tenure pattern. In 1920, 68 percent of the farm units were operated by their owners and the remainder (32 percent) were rented or leased (table 1). As owners and tenants left the project this picture was nearly reversed. Thus, by 1926 there were 136 (14 percent) idle farms and only 32 percent of the farm units were operated by their owners as compared to 54 percent rented or leased.

**Prices.** The intensity of the deflationary conditions prevailing on the project in the early twenties is well illustrated by crop prices paid to farmers at that time. Alfalfa prices received by farmers from 1920 to

1926 averaged only $6.28 a ton as compared to $11.70 on the average during the inflation from 1915 to 1919. Corn, which averaged $1.24 a bushel from 1915 to 1919 fell to almost half that level (69 cents) from 1920 to 1926. Wheat, oats, and barley prices similarly underwent drastic declines from 1920 to 1926 as compared to the high price level of the inflationary period 1915-19.

Total crop value and crop value to the acre also underwent significant declines as the deflation hit the project in the early and middle twenties. Total crop value from 1915 to 1919 averaged $1,085,886. Deflationary conditions reduced this figure to an average of only $701,408 from 1920 to 1926. While part of this reduction was due to a decline in acres farmed as farmers

Figure 5. Trend in population on irrigated farms.

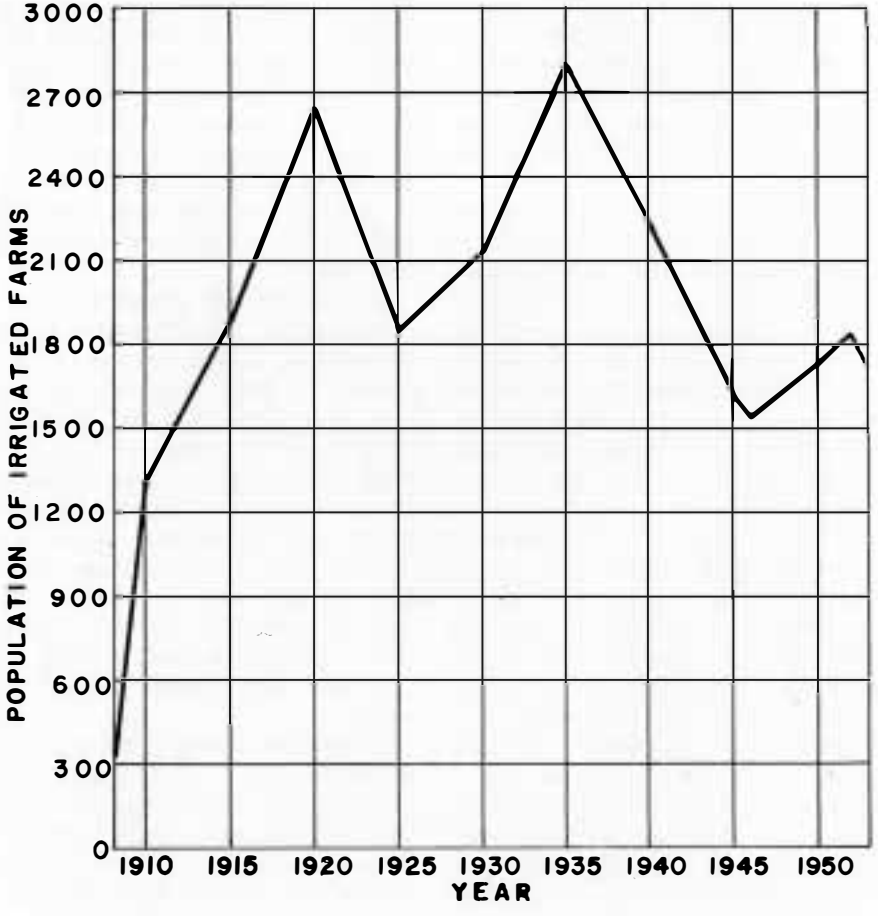


**Table 1. Settlement Trends, Belle Fourche Project, 1908-53***

| Year | Total Number Irrigated Farms | Farms Operated by Owner | Farms Operated by Tenant | Owners on Farms | Tenants on Farms | Farms Idle | Total Population Irrigated Farms |
|---|---|---|---|---|---|---|---|
| 1908 | 62 | ----† | ----† | ----† | ----† | ----† | 340 |
| 1909 | 77 | ----† | ----† | ----† | ----† | ----† | 490 |
| 1910 | 312 | ----† | ----† | ----† | ----† | ----† | 1300 |
| 1911 | 350 | ----† | ----† | ----† | ----† | ----† | 1450 |
| 1912 | 537 | 405 | 206 | ----† | ----† | ----† | 1352 |
| 1913 | 637 | 456 | 181 | ----† | ----† | ----† | 1575 |
| 1914 | 615 | 401 | 214 | ----† | ----† | ----† | 1724 |
| 1915 | 653 | 430 | 223 | ----† | ----† | ----† | 1877 |
| 1916 | 744 | 495 | 249 | ----† | ----† | ----† | 2067 |
| 1917 | 813 | 553 | 260 | ----† | ----† | ----† | 2150 |
| 1918 | 906 | 590 | 316 | ----† | ----† | ----† | 2424 |
| 1919 | 1000 | 668 | 332 | ----† | ----† | ----† | 2597 |
| 1920 | 1024 | 692 | 332 | ----† | ----† | ----† | 2650 |
| 1921 | 953‡ | ----† | ----† | 418 | 165 | ----† | 2510 |
| 1922 | 953‡ | ----† | ----† | 371 | 169 | 86 | 2213 |
| 1923 | 953‡ | ----† | ----† | 320 | 182 | 75 | 2035 |
| 1924 | 965‡ | ----† | ----† | 276 | 178 | 97 | 2020 |
| 1925 | 965‡ | 371 | 475 | 256 | 178 | 119 | 1850 |
| 1926 | 965 | 310 | 519 | 242 | 207 | 136 | 1913 |
| 1927 | 969 | 327 | 530 | 245 | 251 | 112 | 1851 |
| 1928 | 980 | 331 | 521 | 250 | 259 | 128 | 2165 |
| 1929 | 975 | 340 | 555 | 240 | 264 | 80 | 2180 |
| 1930 | 975 | 331 | 532 | 235 | 263 | 112 | 2106 |
| 1931 | 975 | 283 | 532 | 215 | 257 | 160 | 2180 |
| 1932 | 975 | 284 | 565 | 222 | 281 | 126 | 2350 |
| 1933 | 975 | 271 | 543 | 214 | 280 | 125 | 2579 |
| 1934 | 975 | 290 | 558 | 241 | 296 | 127 | 2609 |
| 1935 | 901§ | 293 | 429 | 254 | 295 | 128 | 2807 |
| 1936 | 900 | 340 | 394 | 240 | 263 | 166 | 2675 |
| 1937 | 900 | 298 | 460 | 232 | 263 | 142 | 2190 |
| 1938 | 900 | 289 | 466 | 221 | 247 | 145 | 2250 |
| 1939 | 900 | 270 | 406 | 229 | 239 | 173 | 2119 |
| 1940 | 900 | 269 | 430 | 213 | 262 | 166 | 2237 |
| 1941 | 900 | 287 | 410 | 234 | 246 | 160 | 2176 |
| 1942 | 900 | 313 | 409 | 238 | 231 | 178 | 2092 |
| 1943 | 900 | 296 | 447 | 236 | 208 | 157 | 2007 |
| 1944 | 900 | 336 | 449 | 242 | 186 | 115 | 1895 |
| 1945 | 900 | 387 | 377 | 228 | 154 | 136 | 1616 |
| 1946 | 900 | 411 | 380 | 248 | 142 | 109 | 1540 |
| 1947 | 900 | 463 | 404 | 261 | 143 | 33 | 1612 |
| 1948 | 900 | 556 | 320 | 273 | 125 | 24 | 1635 |
| 1949 | 423‖ | 260 | 163 | 260 | 122 | 0 | 1605 |
| 1950 | 410 | 321 | 89 | ----† | ----† | ----† | 1709 |
| 1951 | 410 | 333 | 77 | ----† | ----† | ----† | 1768 |
| 1952 | 400# | 294 | 106 | ----† | ----† | ----† | 1847 |
| 1953 | 404# | 319 | 85 | ----† | ----† | ----† | 1713 |

*Sources: "Belle Fourche Project, Annual Project Histories:" 1910-53. *Annual Reports of the Reclamation Service*, 1908-31. *Economic Survey of Certain Federal and Private Irrigation Projects*, 1930.

†Data not available this year.

‡Adjustment in number due to exclusion of certain lands by Adjustment Act of 1926.

§75 units dropped from statistics because they were thought too small to be called farms.

‖Change in system of reporting farms. Number of actual farms rather than farm units now reported.

#These figures exclude 3-acre or less residence type units. 25 such units are excluded from the total number of irrigated farms in 1952, and 31 in 1953.

left, the reality of the deflation is made clear by comparing crop values to the acre for the periods of inflation and deflation. From 1915 to 1919 the average crop value to the acre amounted to $21.02. Deflationary pressures in the early twenties cut this value to only $13.26 an acre from 1920 to 1926.

**Temporary Improvement.** A new repayment contract negotiated in 1927, together with the construction of a sugar refinery, marks the beginning of a short period during which the project lifted itself from the deflation and its problems.

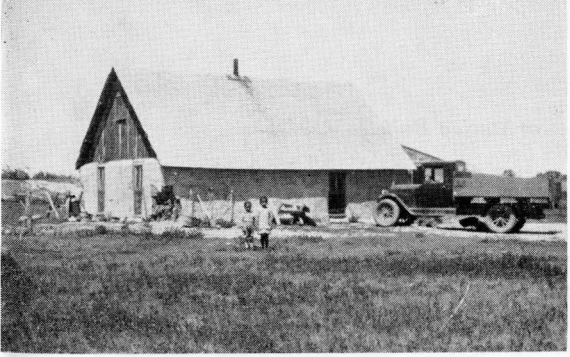
The new repayment contract relieved the farmers from any construction charge obligations in 1926, 1927, and 1928, and in addition to this, extended the total repayment period to 40 years instead of the existing 20 years. The contract of 1927 also provided a loan for financing a drainage system to alleviate damage resulting from alkali and water logging on about 10,000 acres of land. Construction of the drainage system commenced in 1928, and by 1934 more than 200 miles of deep, open drains were completed at a cost of about $740,000.

**Sugar Refinery.** Sugar beets were first raised on the project in 1913 but did not assume major importance until 1927 with the construction of the refinery. In 1927 sugar beets became the major cash crop as 13 percent of the irrigable cropland went into beet production. Thus, the establishment of the Utah and Idaho Sugar Refinery at Belle Fourche fulfilled the desires of many groups and individuals seeking to establish a local industry and stimulated concerted efforts to attract new settlers to the project.

**Resettlement.** The Bureau of Reclamation, the Belle Fourche Commercial Club, the Chicago and Northwestern Railroad Company, and the sugar factory all gave special attention to resettlement of the project through an extensive advertising program in 1927 and 1928. The result was that some of the unoccupied farm units became resettled, mostly by tenants. Although such increases in the population of irrigated farms as occurred at this time were not of sufficient magnitude to bring settlement up to the pre-deflation level, favorable effects were felt.

**Report.** But the forces of deflation were not spent. From 1931 through 1937 the effects of the nation-wide depression interacted with a number of local factors to bring renewed difficulties. The nature and intensity of these difficulties as they appeared to the project farmers is vividly brought out by a report of the Belle Fourche Irrigation District. The report was made to members of a Reclamation Repayment Commission that met on the project in December 1937.

The report, after presenting information concerning the district's ability to meet operation, maintenance, and construction payments made a plea for leniency on the part of the Bureau of Reclamation in the collection of the current district debt. The plea was made on the basis of the following: (1) water shortages in 1931, 1934, 1935, 1936, and 1937 had caused significant decline in production during this per-



(Left) Home of an early settler located in the heavy clay section of the project.
(Right) Present day farm home on the project near Vale, South Dakota.

iod of low level farm prices; (2) because the demand for project land was practically nonexistent, land prices were falling rapidly; (3) credits for land, livestock, and crops were nearly impossible to obtain; and (4) growing numbers of tax debt and mortgage foreclosures made it clear that farmers found difficulty in meeting the most basic expenditures, not to mention construction charge payments.

In short, the report concluded, unfavorable conditions necessitating the deferment of construction charge payments from 1932 through 1936 had not abated, and the need for continued leniency was apparent.

In addition to the report concerning the plight of the settlers from about 1930 to 1937, it is worthwhile to consider certain other data which shed light on the condition of the project at that time.

**Population.** It will be seen by examining table 1 that the irregular population growth, which started in 1927 with the introduction of sugar beets, continued until 1935. Specifically, from 1930 to 1935, in the midst of the depression, the project gained 701 people, or a population increase of 34 percent in 5 years. Such population growth during a period of depression may possibly be accounted for by the feeling of some depression migrants that the chances for economic rehabilitation were better on the project than elsewhere. Actual farming experiences evidently did not, however, provide the tenants migrating onto the project in this period with as much depression relief as they sought.

As the depression moved through its climax, conditions on the project, when compared to conditions in other areas, no longer made it appear to the newly acquired settlers to be the refuge it had been earlier. Settlers left from 1935 to 1937 at an even faster rate than they had come during the 1930-35 period. The project's all-time high population in 1935 of 2,807 dwindled to 2,190 by 1937.

It is difficult to determine the extent to which the movement off the project during these years was due to unfavorable conditions that had developed, such as water shortage, or due to the attraction of other areas created by a slight improvement in conditions there. In individual cases it seems likely one or the other or both of these factors may have provided the reason for leaving the project.

## Reconstruction

The period 1938-48 on the Belle Fourche Project was characterized by a slowly but steadily increasing degree of prosperity. Following closely upon the gradual easing of deflationary pressures and severe water shortages in the late thirties, the years 1942-48 brought production gains in a period of strong demand and favorable World War II prices for farm commodities. As a result, the water users were able to rise from the staggering blow of the depression and make considerable progress toward economic stability and the further development of a prosperous project. For discussion purposes the period from 1938 to 1948 has been divided into three sections: the prewar years (1938-41), the war years (1942-45), and the postwar years (1946-48). Following separate discussions of these subperiods, a summary treatment of the entire period 1938-48 will be presented.

**Prewar Years.** Although the pressures of the depression were abating by 1938, it was not until 1941 that conditions on the project noticeably improved. Water supplies, which were extremely short for several years during the depression, continued to be somewhat inadequate from 1938 through 1940. In addition to this, improvement in crop prices was insignificant until 1941, and crop production was cut during 1938 to 1940 by a heavy infestation of grasshoppers. Nevertheless, as a result of Federal crop bonuses and a definite increase in the water supply and crop prices in 1941, 1938-41 can be viewed as a period during which there was a slight but encouraging movement away from the depression condition which existed from 1931 to 1937.

Crop prices paid to project farmers from 1938 to 1941, as compared to 1931 to 1937 were lower on the average for every crop except beets. However, beet prices and production were sufficiently high to allow average total crop value and average value per acre gains for the years from 1938 to 1941. Net increases in average crop value in these years were probably not as great as the gross figures indicate. The increase was due primarily to sugar beets, which cost more to produce than most other crops.

The average yearly crop value to the acre from 1931 to 1937 was $18.33. From 1938 to 1941 this figure increased to $22.77. Similar differences appear in a comparison of average yearly total crop values for the two periods. The average yearly total crop value from 1931 to 1937 in the depression was $829,685. This figure advanced to $1,003,990 from 1938 to 1941, a gain of 21 percent.[14]

Although relatively small financial gains from 1938 to 1941 are illustrated by a comparison of this period with the depression years, one feature of this period can be pointed out as a substantial contribution to the project. This was the presence of Federal aid in the form of Civilian Conservation Corps (CCC) labor, equipment, and funds. From

[14]It should be noted that crop value records for 1937 to 1941 omit crop acreage and values for land cultivated but not irrigated. To obtain figures comparable with the rest of the years, crop values for the acreage cultivated but not irrigated have been estimated for these years and added to the total crop value of irrigated land.

1938 to 1941 CCC forces assigned to the project replaced numerous wooden irrigation structures with concrete, thereby allowing the distributing system to function more efficiently. Material restrictions, labor shortages, and higher costs during World War II made it a considerable advantage to have this work done in the 1938-41 period.

**War Years.** Signs of economic recovery from 1942 to 1945 continued to become apparent but at about the same gradual rate as during 1938 to 1941. As a result, conditions on the project during the World War II period (1942-45) reflected only a small part of the general war time prosperity prevalent in agricultural communities at that time.

Several factors were involved in the failure of the project to parallel other farm areas in World War II prosperity. Long distance livestock hauling by truck declined on account of the war situation and tended to discourage feeding operations. High wages in west coast defense industries attracted workers and greatly reduced the number of persons available for farm labor. This was particularly true regarding labor for sugar beet thinning and topping. The availability of German war prisoners and some Mexicans for hand labor did not solve the problem. In addition, production gains from 1942 to 1945 fell below expectations as a result of heavy grasshopper and insect infestations and considerable hail destruction.

While the average yearly production of alfalfa, barley, wheat, and oats increased somewhat over the 1938-41 averages, declines were witnessed in corn and beet production. Nevertheless, exceptionally favorable prices from 1942 to 1945 along with small increases in the over-all production picture allowed the farmers to make average total crop value and average crop value per acre gains over the 1938-41 period of 19 percent and 15 percent, respectively.

**Postwar Years.** Substantial financial gains, however, were apparent only after World War II. Important crop value increases from 1946 to 1948 were possible through production advances and a continued price rise on farm commodities. With the fall of Japan in August, 1945, farm commodity prices continued to rise and the yearly total crop value averaged $2,137,733 from 1946 to 1948. This figure represents a gain of $1,191,857 from 1942 to 1945. In addition, high livestock prices and increased feeding operations from 1946 to 1948 further improved the economic position of project farmers in the postwar years.

Changes in crop production took place from 1946 to 1948. Severe grasshopper attacks on young alfalfa resulted in smaller acreages of this crop in 1948, and alfalfa production, accordingly, declined sharply. Similarly, in 1948, sugar beet acreages were at an all time low (since the construction of the sugar factory in 1927) as a result of continuing labor shortages for beet thinning and topping. High sugar beet yields, however, resulted in production increases for this crop during 1946 to 1948. The over-all crop production level continued to

increase because of substantial gains in barley, oats, wheat, and corn production.

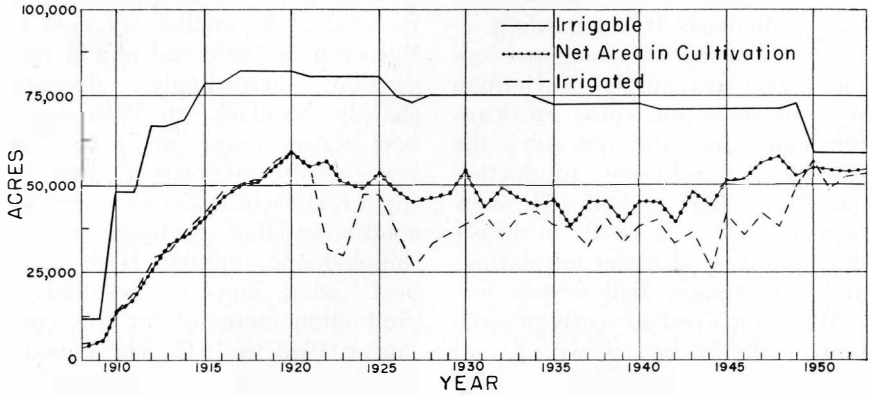
Livestock numbers generally increased in the postwar period. An exception to this pattern was a noticeable decline in the number of sheep on the project as the result of parasite infestation and labor costs. Despite such handicaps, however, favorable prices and production in other livestock and feeding operations made this activity a major source of income in the postwar years.

**1938-48 Period.** Viewing the period 1938-48 as a whole, a number of interesting and significant changes on the project are revealed. Crop production increased considerably, and shifts in emphasis were apparent in the crop production pattern. Alfalfa and beet production fell off sharply from 1938 to 1948, while barley, oats, wheat, and corn production increased. In livestock, slight over-all production advances were made despite declining sheep numbers. Along with production advances in crop and livestock enterprises, increasingly favorable prices made 1938-48 a period of growing financial stability for project farmers.

During this period there was a growing tendency on the part of project farmers to dry-farm considerable portions of their irrigable acreage (figure 6). From 1938 to 1948 an average of nearly 30 percent of the net area in cultivation was dry-farmed. With the decrease in alfalfa acreage due to grasshopper infestations, and declining sugar beet production as the result of labor shortages, farmers no longer found their highest returns in alfalfa and beets.

Favorable prices for small grains in the 1938-48 period caused project farmers to turn to crops such as wheat, oats, and barley. Since these crops were adaptable to dry-farming conditions, they found it convenient to use this method and thereby avoid the extra labor in-

**Figure 6. Irrigable acreage, net area in cultivation, and irrigated acreage, Belle Fourche Project 1908-53.**



volved in irrigating these crops. Such dry-farming was possible because of increased precipitation for several years of the 1938-48 period. Thus, the shift to barley, wheat, and oats during this period was largely a reflection of the increased acreage dry-farmed.

Growing prosperity from 1938 to 1948 is indicated by the decrease in the number of idle farms from 145 in 1938 to 24 in 1948. Tenancy also decreased during this period. In 1938, 38 percent of the project farms were operated by their owners, while in 1948, 63 percent of the farms were owner operated.

As indicated by improvements such as new buildings and land leveling on project farms in the 1938-48 period, the financial condition of the farmers improved substantially during these years. Particularly in the postwar years from 1946 to 1948 was prosperity apparent in the form of new farm equipment including tractors, trucks, and cars. That such a degree of prosperity was long in coming to the project is made clear by the fact that it was not until 1946 that the total crop value surpassed the 1919 level.[15]

### Progress in Recent Years

The improving conditions noticeable on the project during the 1938-48 period were soon reinforced by a number of programs that brought further improvement, thus making the years from 1949 to 1953 a period of continued progress.

**New Contract.** A new contract between the Belle Fourche Irrigation District and the Bureau of Reclamation in 1949 was outstanding because of its far reaching implications. Generally regarded as an improvement over former contracts, the sigificant features of the contract of 1949 are as follows:

(1) Greater power of self-government for the district. The district now hires and pays its own project manager and employees and is in charge of the operation and mainteance of the project. In addition, the district now has the right to modify land classifications and to provide for the correction of proved injustices to water users.

(2) A new land reclassification completed in 1948 eliminates 13,605 acres from the assessment roll. Charge-offs for construction and drainage previously assessed these and other lands resulted in a substantially reduced district indebtedness to the Federal government. Construction charges on assessable lands were adjusted to a more equitable basis, and total district construction charges fixed at $38,700 annually.[16]

(3) The United States agrees to loan the district up to $400,000 to be spent for rehabilitation and betterment of the district's irrigation works.

(4) Project farmers are released from the old joint liability feature of district repayment policy. Joint

[15]This statement, of course, makes no attempt to take into account differences in operating expenses for the two periods. It is entirely possible that operating costs were higher in 1946 than in 1919, and thus the actual economic position of farmers on the project may have been lower in 1946 than it was in 1919.

[16]Annual construction charges per irrigable acre for 1952 were as follows: class 1 land, $1.85; class 2 land, $1.55; class 3 land, $0.65; and, class 4 land, $0.15. Total water charges per irrigable acre, including operation and maintenance and construction for 1952 were as follows: class 1 land, $3.40; class 2 land, $3.10; class 3 land, $2.20; and class 4 land, $1.70.

liability was intended to give security to the government's investment, but it caused many creditors to be very cautious in making loans, since every farmer could be legally held liable for construction charge delinquencies of other project farmers.[17]

Under the contract of 1949, it is possible for the district to take land in payment of construction charges just as the county can take land when taxes are delinquent. Hence, it is no longer possible for individual farmers to be burdened by the construction delinquencies of other farmers, and for this reason credit is more readily available.

**Agencies for Technical Aid.** Favorable features of the 1949 contract hastened and encouraged further development and acceptance of improved irrigation practices. An increase in the number and activities of agents and agencies on the project helped farmers solve their irrigation problems and contributed to the advancements from 1949 to 1953.

***Newell Field Station.*** The oldest technical agency on the project is the Newell Irrigation and Dry Land Field Station at Newell, South Dakota. It was established in 1907 to provide farms with research information on crops of local importance raised under dryland and irrigation agriculture. Irrigation research was started in 1912. In 1926 the South Dakota State College Agricultural Experiment Station became actively identified with the livestock research at this station; since the early 1930's this type of research has been supported by State appropriations.

In the spring of 1950 the Newell Irrigation and Dry Land Field Station initiated a new research and education program. At that time the crop research program was changed to more adequately meet the needs of all project farmers by locating experimental plots on portions of several privately owned farms representing major soil types in the project area.

Prior to this change, most of the research work had been limited to the heavy clay soils characteristic of the Newell Field Station. During the time the new program has been in effect, project farmers have exhibited a definite increase in interest and acceptance of Experiment Station recommendations. The new program has also substantially aided in advancing the trend toward better irrigation farming.

New projects on livestock have also been added to the research program. Experimental work in animal husbandry has been keeping pace with current interest in irrigated pastures. Since 1950, research has been focused on determining the place of livestock in an irrigation economy by measuring beef and lamb production on irrigated grass-legume pastures.

[17]Between 1927 and 1949 the district in levying assessments to meet yearly charges due to government increased the assessments due from each farmer by an amount called the "deficiency percentage." This assessment had as its purpose meeting district deficits resulting from delinquencies of certain landowners not meeting their individual assessments. Any sums paid by a landowner to meet his deficiency percentage assessments were not considered as part of his payment upon the construction charge applicable to his land. Charges on lands not meeting assessments became the liability of paying lands, and the amount that could be added in the form of deficiency percentage assessments against the land was limited only by the total charges against all district land. Project farmers were, in effect, joined together in the same relationship as business partners—every farmer was liable without limit for the other's failure to pay construction charge assessments.

***Sugar Company.*** The Utah and Idaho Sugar Company farm represents another attempt to promote better irrigation farming among project farmers. In 1948 this company bought 320 acres of land in the Arpan Flat area and started a demonstration farm to see what could be done with the heavy soil in that area. The farm was rundown, weedy, and had a record of low production. Experiments in new rotations, addition of organic matter, fertilizer, and different irrigation methods have made this farm a model unit.

In addition to the demonstration farm program, the sugar company tests soil from project farms to help farmers build soil fertility. It also provides beet raisers with technical assistance, machinery and labor to help in planting, thinning, and harvesting the crop. Besides increased sugar beet production on the project, efforts of the company are also reflected in better irrigation methods among beet farmers and in increased acceptance of labor-saving machinery such as mechanical beet thinners.

***Irrigation Specialist.*** An area irrigation specialist assisted with specialized irrigation farming problems on the project during 1950, 1951, and part of 1952. This man, employed jointly by the Bureau of Reclamation and the South Dakota Extension Service, was specifically assigned to assist individual farmers with their irrigation problems. He also contributed a number of articles on irrigation farming to local newspapers and participated in organizing group meetings on irrigation problems.

***Soil Conservation Service.*** Land leveling under the Production and

**Cucumbers for pickles were an important supplemental cash crop on the project in the early 1930's.**

Marketing Administration is supervised by the Soil Conservation Service. Consequently, the expansion of the Soil Conservation District in 1951[18] to include the entire project marks the adoption of another measure designed to aid project farmers in improving irrigation practices. This has resulted in better planning, surveying, leveling, and farm ditch layouts than when farmers did most of the work without assistance.

The various new agencies and programs working on the project in recent years to assist in solving the problems of irrigation farming have resulted in a growing interest in improved irrigation methods. The increasing use of plastic tubes to prevent ditch erosion, sprinkler systems to irrigate and germinate sugar beets, and border systems of irrigation to conserve water and save labor reflect the services of these agencies.

Because of financial considerations, however, project farmers have often had to accept such things as land leveling, border irrigation, and siphon hoses more in principle than in actual practice. Nevertheless, improved irrigation practices are being adopted. This, along with the acceptance of such practices as an ideal to strive toward, marks a significant and progressive change in the attitude of project farmers.

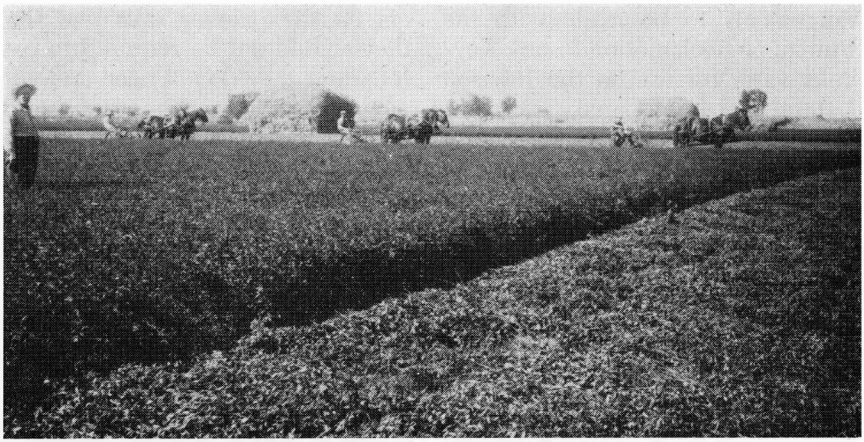
**Improved Water Service.** Attempts to improve the district's water supply and distribution system supplement the educational efforts of technical agencies. As mentioned previously, the provisions of the 1949 contract included a loan (by the Federal government) of $400,000 for rehabilitation and betterment of the irrigation works. With these funds the district has undertaken a comprehensive program aimed at improving water service to project farmers.

Among the results of the rehabilitation and betterment program are numerous structural improvements. Some of these are new outlet control works on the North and South Canals and the installation of devices to facilitate operation and maintenance work, such as two-way radio units for project vehicles.

An enlarged weed and willow control program for the district's water distribution system is another instance of an attempt to improve water service to project farmers. Moist soil conditions in and along the banks of canals, laterals, and ditches support heavy growths of weeds and trees, especially willows. These growths, besides obstructing water passage through the distribution system and contributing to seepage through the ditch banks, drop large quantities of seeds into the irrigation water which eventually results in weed growth in the farmers' fields.

In addition to the use of weed and willow sprays to alleviate this condition, the district began cooperative spraying work in 1951 with the Butte County Weed Board aimed at eradicating leafy spurge and Russian knapweed on project lands. The Butte County Weed Board also carries out a separate program of weed control using district equipment to spray noxious

[18]Prior to 1951 project land falling within the boundaries of the Soil Conservation District included largely the land irrigated by the South Canal.



**Cutting irrigated alfalfa on the G. W. Morsman farm in 1930.**

weeds along county roads, railroad rights-of-way, and on farms badly infested with perennial peppergrass.

Experimental asphalt and bentonite canal-lining programs conducted in the 1949-53 period represents still another program to improve water service to project farmers. Porous sections of canals and laterals give rise to seepage which results in loss of valuable irrigation water and in many instances the "waterlogging" of nearby fields.

Canal lining experiments are designed to find the most economical and effective method of sealing irrigation ditches against such seepage. Tests using asphalt membrane and bentonite linings reveal that both types of lining are very helpful in retarding seepage, but durability and effectiveness tests extended over a period of time will be necessary to determine which lining process will best serve the project's needs. Bentonite, a local product, is considerably lower in cost which presently makes it the more economical.

**Supplemental Water.** A significant step toward improving district water supply occurred in the 1949-53 period with the construction of the Keyhole Reservoir[19] on the upper reaches of the Belle Fourche River near Moorcroft, Wyoming. The Keyhole unit, authorized by the Flood Control Act of 1944, is designed to provide flood control, municipal water supply, pollution abatement, silt control, fish and wildlife conservation, and recreation in addition to providing supplemental water for the Belle Fourche Irrigation Project.

Initial funds for construction of the Keyhole Unit were appropriated in 1948. Work was started in 1950 and by July 29, 1952 it was about completed, allowing temporary ar-

[19]Keyhole Reservoir was built by the Bureau of Reclamation as a unit of the comprehensive Missouri River Basin Project. Keyhole Dam is 168 feet in height, 3,420 feet long (approximately ⅔ mile) and provides storage of 130,000 acre feet of water for irrigation, 140,000 acre feet for flood control, and 70,000 acre feet for sediment storage. The reservoir lies 146 miles up-stream from the diversion dam at Belle Fourche.

rangements to be made with the Bureau of Reclamation to buy Keyhole water for use on the Johnson Lateral and Inlet Canal.

Lands along the Johnson Lateral and Inlet Canal depend directly on the flow of the Belle Fourche River for their water supply and have continually suffered from water shortages in dry seasons. It is expected that the Keyhole Unit will provide additional irrigation water for the whole project in years of water shortage, as well as providing a more stable water supply for lands irrigated from the Inlet Canal and Johnson Lateral.

Considerable controversy has surrounded the execution of a permanent contract for the purchase of Keyhole water for use on the project. Through annual water service contracts with the Bureau of Reclamation, water stored in Keyhole Reservoir has been received for use on the Johnson Lateral, Inlet Canal, and other lands pending agreement on a permanent contract.

In an election in October 1952, water users rejected a contract that called for an average charge of about 40 cents per acre for Keyhole water.[20] Most of the land owners and farmers on the project are in favor of the additional water supply the Keyhole Reservoir will provide, but many feel it is not worth the 40 cents (average) an acre they have been asked to pay.

One reason for this is that farmers on the heavy soil do not usually need more than their water allotment, while those on the lighter soils use all their allotment and need more. Consequently, the farmers on the heavier soils feel that they should not be required to pay for water they do not need and will not receive. On the other hand, farmers on the lighter soils do not feel that supplemental water will be of enough value to them to warrant paying all the costs of such water.[21]

Any contract the district water users agree upon will undoubtedly reflect an attempt to compensate for such differences in the need and ability to pay for Keyhole water.

**Crop Value and Production.** The growing trend toward favorable crop prices and high production, apparent on the project from 1946 to 1948, continued from 1949 through 1952, allowing slight gains in the average total and per acre crop values for these more recent years. However, because of large reductions in 1953 crop values, a comparison of the years from 1946 to 1948 with the period 1949-53 shows a decline in the average total crop value and the average crop value per acre. Thus, whether crop values in the current period show a decline or a gain over the immediately preceding years is dependent upon the inclusion or exclusion of 1953 crop values.[22]

[20]Under the proposed contract the cost would have run approximately 25 cents an acre a year for class 4 land to 70 cents an acre for class 1 land. At that time the charges for Keyhole water would have made the total charges (construction, operation, and maintenance plus Keyhole charges) for class 4 land $1.75 an acre and for class 1 land $3.90 an acre. This contract was rejected by a vote of 235 to 179.

[21]D. M. Tucker, "An Economic History of the Belle Fourche Irrigation Project," Chap. V.

[22]From 1946 to 1948, the average total crop value was $2,137,733 and the average crop value per acre was $38.52. The average from 1949 through 1952 advanced slightly to stand at $2,203,655 and $41.05. Crop damage and price declines in 1953 reduced the average total and per acre crop value from 1949 to 1953 to $2,032,283 and $37.82.

The significance of the year 1953 for the period is that hail, wind, frost, and rust damage, together with a general decline in farm commodity prices, resulted in a total crop value reduction that year of nearly a million dollars. Crop values for all of the six major crops grown (beets, wheat, corn, alfalfa, oats, and barley) declined in 1953 when compared to their average value from 1949 to 1952.

The largest portion of the decrease in crop value occurring in 1953 is accounted for by price and production declines in alfalfa and sugar beets. Alfalfa prices, which averaged $20 a ton from 1949 to 1952 dropped to $10 a ton in 1953. These price drops, along with production losses, resulted in a $484,630 reduction in the value of the alfalfa crop from 1952 to 1953. Sugar beet prices and production likewise fell sharply from 1952 to 1953, resulting in a decrease of $274,936 in the value of that crop.

The major change in the crop production pattern in the 1949-53 period consisted of increases in the acreage of alfalfa and sugar beets. Alfalfa, which constituted only 13 percent of the net area in cultivation in 1948, advanced to 37 percent by 1953, and was by far the leading crop.

Sugar beet acreage reached an all-time low in 1948 when only 2,781 acres were planted, and it constituted only about 5 percent of the net area in cultivation. By 1953 sugar beet acreage had increased to 3,714 acres and included over 9 percent of the cultivated acreage. It is of interest to note that alfalfa and sugar beets, the only major crops to have their acreage increased in 1953, were, unfortunately, the crops experiencing the greatest price declines that year.

**Livestock.** Until 1951 livestock production patterns on the project followed trends that began in the early 1940's. Parasitic infestations and labor shortages at lambing time in 1949 and 1950 brought further declines in sheep numbers, and the less stringent labor requirements for beef production combined with a strong market to encourage continued increases in beef cattle.

From 1951 through 1953, however, better control over sheep parasites, along with abating labor shortages, resulted in significant increases in sheep numbers. Beef cattle numbers on the project increased greatly from 1950 to 1951, but declining prices after 1951 halted this increase and resulted in slight declines.[23]

Total dairy cattle numbers declined in the 1949-53 period because of the changeover to the production of high-quality milk (partly as a result of the demand created by Ellsworth Air Force Base near Rapid City). Costs of meeting sanitation requirements tended to eliminate the smaller herds with the lower producing cows. However, from 1950 to 1953 the number of grade A milk producers increased. Hog numbers fell off sharply from 1949 through 1953 and stood at an all-time low in 1953 with only 733 hogs reported.

[23]The method of reporting livestock numbers was changed in 1951. It has been necessary to reclassify data from 1951-53 to make comparisons with the other years possible.

**Population and Living Conditions.** The period 1949-53 revealed a more lively interest in the purchase of project farms. The elimination of "joint liability" under the contract of 1949 had the effect of stimulating renewed interest in project farms. In addition, land prices on the Belle Fourche Project were comparatively lower than on other irrigation projects. This served to attract a number of out-of-state irrigation farmers.[24] The result was an increase in the proportion of owner-operated farms in the 1949-53 period.

From 1946 to 1948 an average of only 56 percent of project farms were operated by their owners. However, increased land sales to former tenants and new settlers in the 1949-53 period boosted this average to 75 percent.

Growing interest in project farms, in addition to increasing the number of owner-operated farms on the project, affected farm population in the 1949-53 period. After having suffered heavy population losses during the war years (1942-45), renewed interest in project farms brought small but fairly steady increases in the population of irrigated farms after 1946. These increases continued from 1949 through 1952.

Throughout the 1949-53 period, growing interest was shown in farmstead and land improvement on the project. This interest was due, in part, to the increase in the number of farms operated by owners. Moreover, several years of higher income gave project farmers the financial means to buy material, services, and equipment necessary to manage their farms efficiently and furnish their homes with labor-saving devices.

This is reflected in the results of a sample survey of 45 project farms in August 1953. The survey showed that 95 percent of the farms had rural electrification and, largely as a result of this, 58 percent of the farms had running water, 98 percent had power washing machines, ad all were using mechanical refrigerators and radios.

In addition, the survey revealed that 71 percent of the farms had telephones, 91 percent had autos (other than trucks), and 73 percent received daily newspapers. Assuming that the sample in the survey reported is representative of project farms as a whole, the high proportion[25] of modern conveniences indicated points strongly to the conclusion that during the 1949-53 period project families enjoyed better living conditions than at any other time in the history of the project.

[24] "Belle Fourche Project, Annual Project History," 1951, p. 40.

[25] Sample data from the 1950 U.S. Agricultural Census reveals the proportion of modern conveniences on 66,452 South Dakota farms as follows: mechanical refrigeration 64 percent, telephones 55 percent, electricity 69 percent, running water 33 percent, radios 95 percent. A comparison of these percentages with those revealed on the project in 1953 survey would appear to justify the statement that "a high proportion of modern conveniences" are found on project farms.

# Main Trends in the Project Area

## Trends in Settlement

**Number of Farms.** The plan for the original settlement of the project called for each homestead farm unit to contain 40 to 80 acres irrigable land and a maximum dry and irrigable combination of 160 acres. Project land already in private ownership was limited to 160 irrigable acres held by one individual. This plan called for over 1,000 irrigated farm units.

The number of irrigable farm units has changed considerably throughout the history of the project (table 1). From 1921 to 1949 fluctuations in the number of irrigated farm units occurred primarily because of the inclusion or exclusion of certain farm units due to land reclassification. The new definition of a "farm" introduced in 1949 resulted in a drastic reduction in the number of irrigated farms since different farm units operated by one individual were no longer recorded as separate farms. In 1949 the number of irrigable farms was 423, and since that time there has been little change in number.

**Farm Ownership.**[26] The authors of the Federal Reclamation Act believed it desirable to have all the farm units on an irrigation project operated by owners. This ideal has never been realized on the Belle Fourche Project, although it is closer to it today than ever before. During the early years of the project this ideal was not being approximated even in the prosperous years of the inflation period. In 1919, for instance, 67 percent of the farm units were operated by their owners while 33 percent were rented or leased (table 1).

Six years later, even this proportion of owner-operated units had declined significantly. In 1925, only 39 percent were operated by their owners as compared to 54 percent rented or leased, while 14 percent were idle. From 1925 through 1944 tenant-operated farms consistently outnumbered owner-operated farms and the proportion of owner-operated units fell to an all-time low of 29 percent in 1933.

Since 1944, owner-operated farms have outnumbered tenant-operated farms. The largest proportion of project farms operated by their owners or managers occurred in 1951 when 81 percent were in this category, and only 19 percent were rented or leased. Only minor changes in this pattern have occurred since that date, and in 1953 over 78 percent of all farms were operated by their owners.

**Farm Population.** The trend in the population of irrigated farms on the project is characterized by five phases which reflect the influence of changing social and economic conditions on settlement. The first phase (the opening of the project to settlement) is characterized by the rapid growth of population on irrigated farms from 340 in 1908 to 2,650 in 1920 (table 1 and figure 5). Deflationary pressures contributed

[26] Because of limitations of the data, farm ownership here will be concerned only with the ownership of operated farms.

to the second phase—5 years of steady population decline starting in 1921. By 1925 the population had dropped to 1,850, a loss of 800 since 1920.

Organized attempts to encourage resettlement, the influx of sugar beet farmers due to the construction of the sugar factory, and drought on dryland farms all contributed to a new period of population increase from 1926 to 1935. The last year of this phase, 1935, showed the largest farm population in the history of the project—2,807 inhabitants.

However, this all-time high population dwindled rapidly to only 2,190 by 1937. Water shortages and several years of low farm prices during the depression had ushered in a fourth phase, one of population decline. This decline in population continued, with minor exceptions through 1941, and was accelerated with our entry into World War II. As a consequence, the lowest ebb in the population of irrigated farms since 1912 occurred in 1946 when the population was 1,540.

Shortly after the end of the war a renewed interest in project farms brought small but fairly continuous increases in population. This fifth phase was still in force in 1952 when the population was 1,847, an increase of 300 over 1946. Though the population for 1953 shows a drop of 134 since 1952, it is doubtful that this loss is symptomatic of a large population decline.

**Population Density.** Although the project consists of only about one-eleventh of the total land area of Butte County, its farm population at 10-year intervals from 1920 to 1950 constituted, on the average, over one-half of the farm population of the county (table 2). The project had its greatest concentration of population on irrigated farms in 1920 with 13.3 persons to the square mile, whereas the greatest density for the remainder of the county's farm population occurred in 1930 with 1.3 persons.

In 1950 the farm population density of the project area was 8.5 persons. Union County, the most densely settled farming area in the State in 1950, had 11.9 persons to the square mile, and the farm population of Brookings County had the same density as the project area. On the other hand, the remainder of Butte County had a farm population density of only .5 persons to the square mile in 1950.

**Table 2. Butte County, Project Area, and Butte County Less the Project Area, Rural-Farm Population and Population Density, 1920-50***

| Unit | Area in Square Miles | Rural-Farm Population | | | | Population Density† | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1920 | 1930 | 1940 | 1950 | 1920 | 1930 | 1940 | 1950 |
| Butte County | 2,266 | 4,453‡ | 4,894‡ | 4,050 | 2,820 | 2.0 | 2.2 | 1.8 | 1.2 |
| Project Area§ | 200‡ | 2,650 | 2,106 | 2,237 | 1,709 | 13.3 | 10.5 | 11.7 | 8.5 |
| County less Project | 2,066‡ | 1,803‡ | 2,788‡ | 1,813 | 1,111 | .9 | 1.3 | .9 | .5 |

*Sources: County Data, *U.S. Census of Population, South Dakota,* 1920, 1930, 1940, and 1950; Project data, "Belle Fourche Project, Annual Project Histories," 1920, 1930, 1940, and 1950.
†Persons per square mile.
‡Estimated.
§Population on irrigated farms only.

Establishment of an irrigation project with intensive farming in a sparsely settled region is usually expected to increase the population of that area. Many social benefits are believed to result from this increased concentration of population.

The extent to which the greater population density of the project area is due to irrigation is difficult to determine. The population density of the river valley now encompassed by the project would probably have been somewhat greater than that of the surrounding rangeland even if irrigation had not been introduced. It seems unlikely, however, that the area would have achieved a population density anywhere near its present one without irrigation.

**Communities.** The towns and villages within the project area are Newell, Nisland, Vale, and Fruitdale. Although Belle Fourche is located just outside the project's western boundary it is the county seat of Butte County and serves as an important trade center for project families.

In 1920 the U. S. Census showed the total population of project communities as 2,243, excluding Vale.[27] At this time Fruitdale had a population of 40, Nisland 173, Newell 414, and Belle Fourche 1,616. All four of these communities increased in population during the following decade and in 1930 had a total population of 2,879. The number of business establishments, as reported by Dun and Bradstreet, for these communities in 1930 ranged from 5 at Fruitdale to 78 at Belle Fourche (table 3).

In spite of the depression during the thirties the project communities, with the exception of Fruitdale, continued to grow. Thus, in 1940 their total population was 3,480, 21 percent over 1930. The number of business establishments increased from 1930 to 1940 in all of the communities except Fruitdale. Total increase of the four communities was 51 percent.

From 1940 to 1950 Fruitdale continued to decline in population, whereas Belle Fourche increased 40 percent, and the communities of Newell and Nisland increased 12 and 2 percent respectively. The number of business establishments in project communities increased less on the whole than during the previous 10 years.

[27] It is necessary to omit Vale from this discussion of project communities as population figures are given only for Vale township.

**Table 3. Total Population and Number of Business Establishments for the Communities in the Project Area for 1930, 1940, and 1950***

| Towns | Population | | | | Number of Business Establishments | | |
|---|---|---|---|---|---|---|---|
| | 1920 | 1930 | 1940 | 1950 | 1930 | 1940 | 1950 |
| Fruitdale | 40 | 113 | 89 | 70 | 5 | 5 | 5 |
| Nisland | 173 | 187 | 212 | 216 | 12 | 18 | 11 |
| Newell | 414 | 547 | 683 | 784 | 38 | 51 | 49 |
| Belle Fourche | 1616 | 2032 | 2496 | 3540 | 78 | 127 | 151 |
| **Total** | **2243** | **2879** | **3480** | **4610** | **133** | **201** | **216** |

*Sources: Population data, *U. S. Census of Population, South Dakota*, 1920, 1930, 1940, and 1950. Number of business establishments, Dun and Bradstreet, *Reference Books*, 1930, 1940, and 1950.

The fact that the project communities have, in general, shown a rather marked growth, particularly since 1930, raises the question of the influence of irrigation development on these communities. A comparison of the growth of each project community with other communities of a similar size in the State in 1930 reveals,[28] for the period from 1930 to 1950, the following points:

(1) Only one project community, Fruitdale, showed a population loss for the total period (table 3); however, non-project communities the size of Fruitdale, Nisland, and Newell had on the average, population losses for the period (table A-3).

(2) Three project communities, Nisland, Newell, and Belle Fourche had steady population gains throughout the period, while only one group of nonproject communities, those the size of Belle Fourche, had a steady population increase.

(3) Total population gain for project communities from 1930 to 1950 was 60 percent, whereas the average population increase for nonproject communities during the same period was 16.5 percent (table A-4).

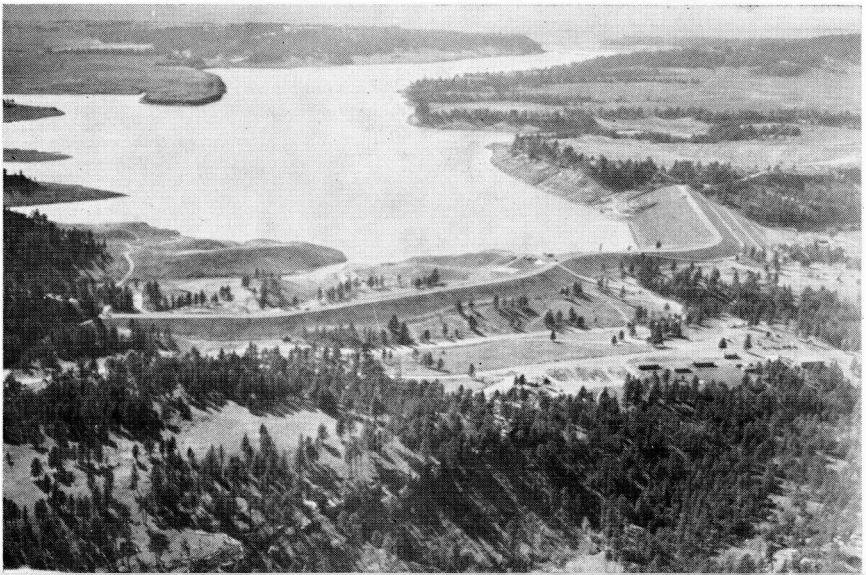
(4) Belle Fourche and Newell showed a considerable increase in the number of business establishments for the period as a whole, while nonproject communities the size of Belle Fourche and Newell gained less than the two project communities.

(5) Total increase in the number of businss establishments for all the project communities for the period was 62 percent, while the increase for nonproject communities averaged 20 percent.

It is difficult to determine the extent to which the greater increase in the population and the number of business establishments of the project communities over the nonproject communities can be attributed to irrigation development. There are at least two main reasons for this statement.

[28]Findings based on study by John Thompson, "Changes in the Population and Number of Business Establishments of the Communities in the Belle Fourche Irrigation Project Area, 1920-1950." Unpublished seminar report on file in the Department of Rural Sociology, South Dakota State College, 1954.

**Keyhole Reservoir near Moorcroft, Wyoming. Completed in 1952, this reservoir furnishes supplemental irrigation water for the project.**



(1) A large portion of the total growth of the project communities is contributed by the outstanding increase in population and number of business establishments of one community, Belle Fourche. However, in addition to benefiting from the irrigation project, the growth of Belle Fourche has also been influenced by the fact that it is a county seat and by the development of a number of local industries, livestock markets, tourist trade, and a trade area much larger than that of the project area. Consequently, without a careful analysis of the contribution of each of these factors to the growth of Belle Fourche, it would be difficult to estimate the influence of the irrigation project on the development of this community.

(2) Many of the nonproject communities used for comparison are older than the project communities and have probably gone through their phase of rapid growth. They were, thus, in the phase in which their populations were leveling off. The impact of social and economic changes experienced from 1930 to 1950 would be expected to be different for these older communities as compared to the younger, more rapidly growing project communities.

### Trends in Principal Crops

Although the principal crops raised on the project today are, with the exception of sugar beets, essentially the same as those raised in 1912, a number of significant changes have taken place as to the relative importance of each crop (figure 7). During the early years of the project, cropping followed about the same pattern common to the adjoining dry-farmed lands.

Crops consisted mainly of grains raised for cash market and for sale to dryland stockmen. Alfalfa soon came to the front as an important irrigated crop because of the ready sale to ranchers, but when supply outstripped this demand, and it was found that the long distance shipments of hay were unprofitable, project livestock holdings increased rapidly. As indicated in table 4, 60 percent of the cultivated area was given to producing wheat and oats in 1912, while only 14 percent was in alfalfa. By 1922, however, alfalfa was up to 51 percent of the acreage in crops, small grains down to 21 percent, and corn was coming in as a principal crop with over 7,000 acres that year.

Sugar beets had been raised on the project in small quantities ever since 1912, but because of the long distance to markets, the sugar beet industry was not firmly established until 1927 when the Utah and Idaho Sugar Company refinery was built at Belle Fourche. The 6,000 acres of beets planted that year made up 13 percent of the acreage in cultivation and moved beets to the status of a principal crop. The acreage devoted to this crop varied from a high of 8,473 acres in 1929 to a low of 2,781 acres in 1948 (table A-1). This decline in beet acreage started in the 1930's, probably due to the shortage of water. During the years of World War II, labor shortage and the high grain prices caused a further decline in beet acreage.

**Alfalfa.** In the 1930's alfalfa production suffered from heavy grasshoppers infestations that lasted for nearly 15 years. This made it difficult to start new alfalfa, and the proportion of the project's acreage in this crop dropped to a record low of 14 percent (7,734 acres) in 1948. New chemicals for grasshopper control were used extensively in

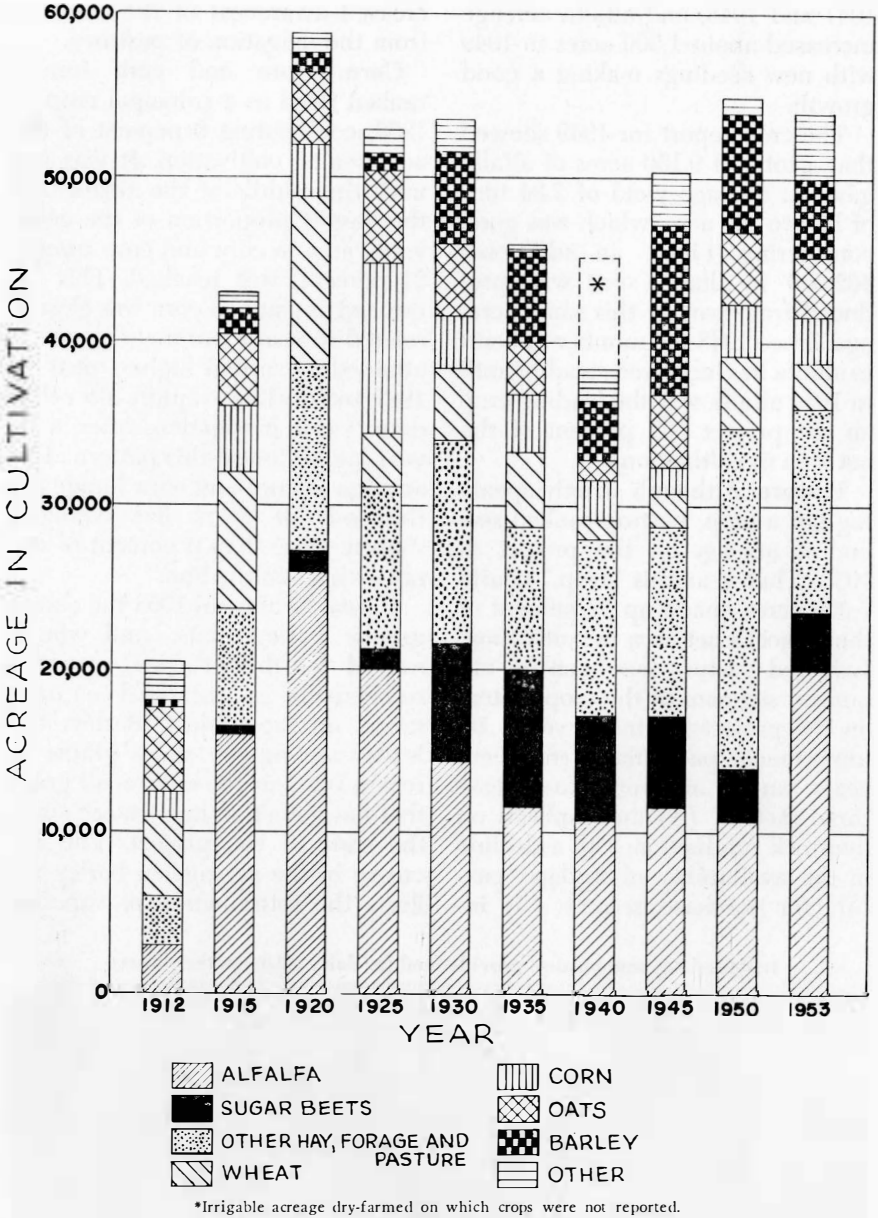
**Table 4. Acreage of Principal Crops as Percentage of Net Area in Cultivation, Belle Fourche Project, 1912-53***

| Year | Alfalfa Hay | Sugar Beets | Corn & Corn Forage | Native Hay Pasture | Native Hay Other Hay | Barley | Oats | Wheat | Other† Crops | Total Percent |
|---|---|---|---|---|---|---|---|---|---|---|
| 1912 | 14 | 0 | 7 | 1 | 11 | 1 | 20 | 40 | 6 | 100 |
| 1913 | 23 | 0 | 8 | 1 | 8 | 2 | 16 | 40 | 2 | 100 |
| 1914 | 27 | 0 | 14 | 10 | 6 | 4 | 17 | 21 | 1 | 100 |
| 1915 | 38 | 0 | 15 | 8 | 6 | 4 | 10 | 18 | 1 | 100 |
| 1916 | 38 | 0 | 11 | 13 | 5 | 6 | 9 | 16 | 2 | 100 |
| 1917 | 39 | 4 | 8 | 12 | 9 | 5 | 10 | 10 | 3 | 100 |
| 1918 | 39 | 2 | 6 | 17 | 6 | 3 | 8 | 18 | 1 | 100 |
| 1919 | 44 | 2 | 5 | 12 | 6 | 2 | 7 | 19 | 3 | 100 |
| 1920 | 44 | 2 | 6 | 14 | 5 | 3 | 8 | 16 | 2 | 100 |
| 1921 | 47 | 2 | 11 | 13 | 2 | 3 | 10 | 10 | 2 | 100 |
| 1922 | 51 | 1 | 13 | 9 | 4 | 2 | 9 | 10 | 1 | 100 |
| 1923 | 53 | 1 | 18 | 12 | 1 | 2 | 9 | 3 | 1 | 100 |
| 1924 | 44 | 3 | 20 | 20 | 2 | 1 | 6 | 1 | 3 | 100 |
| 1925 | 39 | 2 | 21 | 15 | 3 | 2 | 10 | 5 | 3 | 100 |
| 1926 | 42 | 5 | 17 | 8 | 2 | 3 | 11 | 11 | 1 | 100 |
| 1927 | 42 | 13 | 12 | 5 | 5 | 4 | 6 | 11 | 2 | 100 |
| 1928 | 36 | 15 | 12 | 6 | 3 | 7 | 8 | 11 | 2 | 100 |
| 1929 | 34 | 18 | 8 | 8 | 4 | 10 | 9 | 5 | 4 | 100 |
| 1930 | 27 | 13 | 9 | 10 | 3 | 11 | 9 | 6 | 12 | 100 |
| 1931 | 27 | 13 | 14 | 15 | 4 | 11 | 5 | 3 | 8 | 100 |
| 1932 | 25 | 11 | 19 | 5 | 6 | 13 | 9 | 6 | 6 | 100 |
| 1933 | 27 | 18 | 11 | 11 | 11 | 10 | 5 | 5 | 2 | 100 |
| 1934 | 25 | 18 | 14 | 11 | 9 | 9 | 6 | 5 | 3 | 100 |
| 1935 | 26 | 18 | 10 | 6 | 10 | 12 | 8 | 10 | 0 | 100 |
| 1936 | 34 | 11 | 7 | 14 | 8 | 13 | 5 | 7 | 1 | 100 |
| 1937 | 39 | 10 | 15 | 7 | 7 | 8 | 4 | 6 | 4 | 100 |
| 1938‡ | 28 | 16 | 11 | 11 | 9 | 11 | 3 | 7 | 4 | 100 |
| 1939‡ | 26 | 15 | 14 | 12 | 14 | 9 | 3 | 3 | 4 | 100 |
| 1940‡ | 27 | 14 | 16 | 11 | 12 | 10 | 4 | 3 | 3 | 100 |
| 1941‡ | 35 | 14 | 15 | 10 | 5 | 10 | 6 | 3 | 2 | 100 |
| 1942 | 40 | 14 | 9 | 7 | 4 | 15 | 5 | 4 | 2 | 100 |
| 1943 | 34 | 7 | 7 | 12 | 5 | 21 | 6 | 3 | 5 | 100 |
| 1944 | 32 | 9 | 8 | 7 | 11 | 19 | 8 | 4 | 2 | 100 |
| 1945 | 23 | 11 | 5 | 14 | 10 | 20 | 9 | 4 | 4 | 100 |
| 1946 | 19 | 10 | 6 | 7 | 8 | 23 | 9 | 9 | 9 | 100 |
| 1947 | 15 | 8 | 8 | 21 | 8 | 20 | 8 | 9 | 3 | 100 |
| 1948 | 14 | 5 | 11 | 20 | 7 | 19 | 7 | 13 | 4 | 100 |
| 1949 | 17 | 6 | 14 | 14 | 8 | 15 | 7 | 14 | 5 | 100 |
| 1950 | 20 | 7 | 8 | 25 | 7 | 13 | 8 | 8 | 4 | 100 |
| 1951 | 27 | 5 | 11 | 13 | 7 | 12 | 8 | 13 | 4 | 100 |
| 1952 | 34 | 5 | 12 | 13 | 8 | 10 | 7 | 8 | 3 | 100 |
| 1953 | 37 | 7 | 9 | 13 | 7 | 8 | 7 | 6 | 6 | 100 |

*The data in this table are taken from the following sources: for the year 1912, *Twelfth Annual Report of the Reclamation Service,* 1912—1913; 1912 through 1932, *Agricultural Investigations at the Belle Fourche (S. Dak.) Field Station;* and 1933 through 1953, *Annual Projects Histories* 1933-1953.

†"Other crops" include small acreages in such crops as: flax, rye, millet, cane, cucumbers, potatoes, dry beans.

‡Crop records from 1938-41 do not include dry crops raised on irrigable land. Prior to 1938 and after 1941 crops raised on irrigable land dry-farmed have been included in calculating percentages.




*Irrigable acreage dry-farmed on which crops were not reported.

**Figure 7. Acreages of principal crops, Belle Fourche Project 1912-53.**

1947 and 1948, and alfalfa acreage increased about 1,500 acres in 1949 with new seedings making a good growth.

The crop report for 1949 showed that a total of 9,150 acres of alfalfa gave an average yield of 2.34 tons of hay to the acre, which was good considering that an additional $62,000 in alfalfa seed was produced from part of this same acreage. Since 1948 the number of acres in alfalfa has increased steadily until in 1953 alfalfa was the leading crop on the project (37 percent of the net area in cultivation).

**Pasture.** Although strictly speaking not a crop, pasture ranked second in acreage on the project in 1953. That year this "crop," nearly 7,000 acres, made up 13 percent of the project's net area in cultivation. Irrigated pasture has been an important segment of the crop system on the project for many years. Its importance, particularly in recent years, can be attributed to at least three factors: (1) an emphasis on livestock production; (2) a decline in the availability of dryland pasture for purchase or rent; (3) increased awareness of the benefiits from the irrigation of pastures.

**Corn.** Corn and corn forage ranked third as a principal crop in 1953, constituting 9 percent of the net area in cultivation. It was not until the middle of the 1920's that the largest proportion of the cultivated area in corn and corn forage, 21 percent, was reached. This increased average in corn was closely related to swine production, which attained its second highest peak in 1923 and declined rapidly after that date. Corn production, after a 2-year lag, followed this pattern. The acreage in corn and corn forage for the last 10 years has averaged slightly more than 9 percent of the net area in cultivation.

**Cereal Grains.** In 1953 the cereal grains, barley, oats, and wheat, ranked fourth, fifth, and seventh, respectively, as principal crops raised on the project. Barley, the leader among the small grains in recent years, is the only small grain that has gained in importance since the start of the project. The increase in the acreage in barley reflects the introduction of superior

**Irrigated hay and pasture provide feed for dairy cattle on the project.**

varieties and the increased use of feed grains to finish livestock for market. The largest proportion of irrigated land in barley, 23 percent, occurred in 1946. Although the acreage in barley in 1953 amounted to only 8 percent of the net area in cultivation, it has, on the average, constituted 16 percent for the last 10 years.

Wheat and oats have declined in importance since the beginning of the project when they were the leaders among the principal crops. In 1912, for example, 40 percent of the net area in cultivation was in wheat and 20 percent was in oats. By 1920, the area in wheat was only 16 percent of the total and oats 8 percent. By 1930 the acreage in wheat had declined so that it made up only 6 percent of the net area in cultivation, while oats was 9 percent. During the last 10 years, wheat has averaged 9 percent and oats 8 percent of the net area in cultivation; however, in 1953, wheat was 6 percent and oats 7 percent of the cultivated area.

**Sugar Beets.** Sugar beets ranked sixth in acreage in 1953. The smallest acreage in sugar beets since the construction of the sugar refinery was in 1948 when only 2,781 acres were planted in this crop, and it constituted only about 5 percent of the net area in cultivation. At this time the sugar beet production on the project was so small that officials of the sugar company became alarmed and could foresee the closing of the factory at Belle Fourche if this trend continued.

Acreage in this crop increased some in 1949 and again in 1950; however, most of this increase was lost in 1951 and 1952 when smaller acreages were planted. This reduction in acreage is explained by low yields in 1950, shortage of labor, and the slow transition to labor-saving machinery. The impact of the reduction of sugar beet acreage in 1951 and 1952 was not as great as it had been earlier. The Mirage Flats Irrigation Project in Nebraska was now producing about 3,500 acres of beets and shipping them to the Belle Fourche factory. By 1953 sugar beet acreage on the Belle Fourche Project had increased back to 3,714 acres and included slightly less than 7 percent of the irrigated acreage. Increased acceptance of labor-saving machinery such as mechanical beet thinners helps to explain this renewed interest in sugar beets.

**Other Crops.** Each year a small portion of the total irrigated acreage of project land is devoted to the production of vegetables, fruits, and other truck garden crops (table 5). These items, in addition to miscellaneous crops of small acreage such as flax and rye, are included in the general category "other crops."

Although the acreages in fruits, vegetables, and commercial beans have been small compared to the principal crops, they have been of some importance as supplemental cash crops. Cucumbers for pickles, for example, were first grown as a commercial crop in 1925, and returned an average of $102 per acre during the first 4 years of production. However, in more recent years, high labor costs together with the limited market have great-

Table 5. Irrigated Acreage in Selected Miscellaneous Crops, Belle Fourche Project, 1947-53*

| Year | Beans | Potatoes | Cucumbers | Gardens | Apples |
|---|---|---|---|---|---|
| 1947 | 143 | 100 | 83 | 99 | 9 |
| 1948 | 947 | 103 | 68 | 146 | 24 |
| 1949 | 886 | 59 | 78 | 104 | 16 |
| 1950 | 277 | 86 | ---† | 80 | 11 |
| 1951 | 245 | 52 | ---† | 61 | ---† |
| 1952 | 137 | 35 | ---† | 86 | ---† |
| 1953 | 103 | 28 | ---† | 19 | ---† |

*Data from "Belle Fourche Project, Annual Project Histories," 1947-53.
†None reported.

ly reduced the importance of cucumbers a supplemental cash crop.

**Yields.** Yield data on crops raised only under irrigation are difficult to obtain. This difficulty is due in part to the fact that crop yields for the project are reported for the "total area cropped" or "net area in cultivation" which in any given year may include yields from crops raised under irrigable land dry-farmed as well as under irrigated conditions. For example, in 1922, 1923, and 1927 only about 60 percent of the total area cropped on the project was irrigated (figure 6). In addition, production varies from year to year under both irrigation and dry farming practices and is affected by the amount and time of precipitation, the nature of the growing season, and other agricultural hazards. Also, yields on similar soils under identical growing conditions vary greatly with the farming methods employed by the individual settlers.

Comparisons of yields may be misleading unless qualified and explained. This is particularly true of the Belle Fourche Project, where average yields may include production from lands that were later excluded or suspended as unfit for irrigation, lands that were in the process of being developed, and lands that were obviously farmed in a poor and inefficient manner.

Average yields for 10-year periods are given for the principal crops grown on the project (table 6). In addition to the project data, yields obtained under experimental conditions for both dry and irrigated types of farming are given for the 10-year periods that these data are available.[29] These results are from the Newell Irrigation and Dry Land Field Station and were obtained on one-fourth to one-half acre plots of Pierre clay soil under scientific farming methods that included crop rotations and, in some cases, fertilization.

While experiments are not always designed to obtain the highest yields, the general results are no doubt in excess of what could be expected under ordinary farming conditions, and in that sense generally tend to approximate the ideal rather than the production that could be expected of the average farmer. As the Experiment Station results cover both irrigation and dryland farming conditions for three 10-year periods, 1912-21, 1922-31, and 1932-41, the results un-

[29]After 1941 the irrigated experimental plots were changed so that comparable data on irrigated plots are not available for the period 1942-51.

der each experimental method are more or less comparable. However, strict comparisons between project yields and experimental yields should be avoided because of the difference in soils, farming methods, and objectives.

Data from the Newell Irrigation and Dry Land Field Station indicate, on the average, higher yields under irrigation. For the 30-year period that both irrigation and dryland experimental data are available, 1912 to 1941, the crop showing the greatest response in yield to irrigation was alfalfa. Response of corn to irrigation was second to alfalfa, and oats was third. Yields of both wheat and barley were the least responsive to the effects of irrigation.

Thus, under ordinary irrigation practices, assuming that good standards of cultivation would be employed, it appears resonable to expect a considerable increase in return on such crops as alfalfa, corn, and oats. It should be remembered, however, that because of the cost of water and higher labor requirements, crops produced by irrigation cost more per acre than those produced by dry-farming. Thus, the difference in yields and gross crop values realized do not necessarily represent a net increase in profit to the farmer.

## Trends in Livestock

Livestock has always been an important source of income for the Belle Fourche water users. Even before the project was developed, this area, with its abundant native grass pasture, was utilized for grazing beef cattle and sheep. Under irrigation, cattle and sheep feeding operations were developed, and hogs and dairy cattle were added to the existing livestock industries. Of all livestock raised, sheep appear to be the best suited to the interests of the project farmers.

Today, farmers on the project feel they need livestock as an essential part of their irrigation farming operations. They realize that to be successful, irrigation farmers in that

**Table 6. Mean Yields for 10-Year Periods of Principal Crops Grown on the Belle Fourche Irrigation Project and on the Newell Irrigation and Dry Land Field Station***

| | Total Period (1912 to 1941) | | | 1912-21 | | | 1922-31 | | | 1932-41 | | | 1942-51† | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Project Area | Newell Irrig. | Newell Dry Land | Project Area | Newell Irrig. | Newell Dry Land | Project Area | Newell Irrig. | Newell Dry Land | Project Area | Newell Irrig. | Newell Dry Land | Project Area | Newell Dry Land |
| Oats (bu.) | 28.7 | 58.5 | 34.2 | 27.0 | 63.8 | 33.5 | 31.0 | 60.6 | 48.3 | 28.1 | 51.1 | 20.8 | 32.2 | 46.3 |
| Corn (bu.) | 21.1 | 38.8 | 17.6 | 18.6 | 42.2 | 20.5 | 23.0 | 42.2 | 25.5 | 21.6 | 31.4 | 6.7 | 23.5 | 12.2 |
| Barley (bu.) | 24.9 | 27.7 | 25.1 | 23.5 | 24.9 | 23.6 | 26.4 | 31.6 | 33.1 | 24.8‡ | 26.7‡ | 20.8‡ | 27.7 | 28.8 |
| Sugar Beets (tons) | 10.1 | 8.7 | — | 8.9§ | 9.7‖ | — | 11.5 | 10.9 | — | 9.9 | 8.7 | — | 9.6 | — |
| Alfalfa (tons) | 1.8 | 2.7 | 0.9 | 2.0 | 3.0‖ | 1.0 | 1.6 | 3.0 | 1.2 | 1.7 | 2.6 | 0.4 | 1.8 | 1.1 |
| Wheat (bu.)# | 15.3 | 17.9 | 16.0 | 12.4 | 21.2 | 15.3 | 18.2 | 17.5 | 23.2 | 15.3 | 15.0 | 9.5 | 16.8 | 23.5 |

*Sources: Data on Newell Field Station dryland yields, 1912-31, Technical Bulletin No. 454, U. S. Department of Agriculture, October, 1934; Newell Field Station dryland yields, 1932-51, and data on Newell Field Station irrigation yields, Newell Field Station; data on Belle Fourche Irrigation Project yields, Bureau of Reclamation.

†After 1941 the irrigated experimental plots were changed so that no comparable data on irrigated plots are available for the period 1942-51.

‡Data for 1940 not included. (Average for 9 yrs.)

§No data for 1912 (Average for 9 yrs.)

‖No data for 1919 (Average for 9 yrs.)

#For project area, both winter and spring wheat, although winter wheat constitutes only a small proportion of total production. For dry and irrigated Field Station yields, spring wheat only.

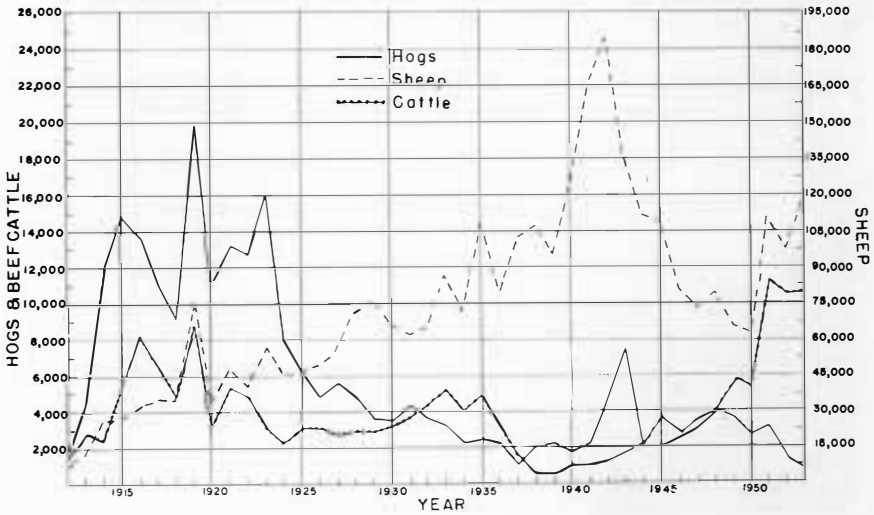
area cannot afford to "just haul their crops to market." Instead, they must, whenever possible, feed their crops to livestock. They have discovered that this procedure not only provides a greater financial return for their crops but, in addition, furnishes manure which is very essential to the intensive farming practiced under irrigation.

**Two Trends.** A consideration of cattle, hog, and sheep numbers on the Belle Fourche Project from 1912 to 1953 (table 7) reveals at least two rather outstanding trends. The first trend may be thought of as a very gradual, although at times markedly fluctuating, movement toward increased livestock production (figure 8). This trend is difficult to demonstrate because of the fluctuation in livestock numbers between years and the fact that general increases or decreases involve different kinds of livestock. However, a rough indication as to the nature of this trend can be given by obtaining the number of cattle, hogs, and sheep for an early 10-year period and a more recent 10-year period, converting these averages into animal units,[30] and comparing the total number of animal units for the average year of the early period with a corresponding figure for the more recent period.

The years 1919-28 are selected for the early period because it is the first 10 years occurring after the project was fairly well settled. The yearly average numbers of livestock for this period are: Sheep, 52,284;

[30]An animal unit is a device for measuring different kinds of livestock on a basis common to all; in this case, it is average feed requirements. As used here, one head of cattle, six head of sheep, or five head of hogs, is the equivalent of one animal unit. See United States Department of Interior, Bureau of Reclamation, *Columbia Basin Joint Investigations; Problem 2, Types of Farming*, pp. 304-305.

**Figure 8. Livestock numbers, Belle Fouche Project 1912-53.**



hogs, 10,258; and all cattle (dairy and beef), 7,759.

Yearly average number of livestock for the 10 most recent years, 1944-53, are: sheep, 91,905; hogs, 2,829; and all cattle (dairy and beef), 9,273. Converting the yearly average figures for each period into animal units, the total yearly average number of animal units for the

**Table 7. Livestock Numbers, Belle Fourche Project, 1912-53***

| Year | Horses & Mules | Range & Feeder Cattle | Total† Beef Cattle | Range & Feeder Sheep | Total Sheep‡ | Hogs | Dairy Cattle§ |
|---|---|---|---|---|---|---|---|
| 1912 | 2135 | ‖ | 1480# | ‖ | 8264 | 1790 | ‖ |
| 1913 | 2579 | ‖ | 2785# | ‖ | 12872 | 4636 | ‖ |
| 1914 | 2907 | ‖ | 2514 | ‖ | 25740 | 11988 | 1578 |
| 1915 | 3200 | ‖ | 5524 | ‖ | 26210 | 14798 | 2200 |
| 1916 | 3600 | ‖ | 8178 | ‖ | 32152 | 13631 | 2870 |
| 1917 | 3822 | ‖ | 6616 | ‖ | 36459 | 10946 | 2912 |
| 1918 | 3974 | ‖ | 4801 | ‖ | 35607 | 9007 | 3330 |
| 1919 | 4318 | ‖ | 8806 | ‖ | 75398 | 19837 | 2421 |
| 1920 | 3708 | ‖ | 3751 | ‖ | 34781 | 11037 | 2969 |
| 1921 | 3890 | ‖ | 5390 | ‖ | 48510 | 13260 | 3870 |
| 1922 | 3414 | ‖ | 4907 | ‖ | 40028 | 12792 | 3778 |
| 1923 | 3036 | ‖ | 3507 | ‖ | 55233 | 16064 | 4138 |
| 1924 | 3099 | ‖ | 2415 | ‖ | 45350 | 7979 | 4509 |
| 1925 | 2736 | ‖ | 3277 | ‖ | 46461 | 6141 | 3714 |
| 1926 | 2506 | ‖ | 3245 | ‖ | 51727 | 4919 | 3063 |
| 1927 | 2795 | ‖ | 2903 | ‖ | 55052 | 5675 | 3846 |
| 1928 | 2650 | ‖ | 3095 | ‖ | 70325 | 4873 | 3990 |
| 1929 | 2615 | ‖ | 2980 | ‖ | 76469 | 3880 | 4035 |
| 1930 | 2454 | ‖ | 3378 | ‖ | 67101 | 3610 | 3952 |
| 1931 | 2199 | ‖ | 3788 | ‖ | 64926 | 4417 | 3684 |
| 1932 | 2081 | ‖ | 4237 | ‖ | 69291 | 3708 | 3796 |
| 1933 | 2173 | ‖ | 5394 | ‖ | 86783 | 3395 | 4445 |
| 1934 | 2227 | ‖ | 4136 | 44595 | 68920 | 2470 | 3536 |
| 1935 | 2222 | ‖ | 5005 | 68587 | 106152 | 2518 | 3315 |
| 1936 | 2160 | 244 | 2901 | 46618 | 82922 | 2491 | 3476 |
| 1937 | 1918 | 182 | 1640 | 61463 | 102972 | 1714 | 3629 |
| 1938 | 1846 | 45 | 820 | 67589 | 106153 | 2114 | 3481 |
| 1939 | 1710 | 97 | 825 | 61139 | 99005 | 2275 | 3336 |
| 1940 | 1626 | 32 | 1027 | 80680 | 125960 | 1835 | 3249 |
| 1941 | 1544 | 112 | 1187 | 59909 | 164534 | 2114 | 3400 |
| 1942 | 1533 | 279 | 1348 | 72994 | 186266 | 4618 | 4029 |
| 1943 | 1395 | 55 | 1887 | 78499 | 135285 | 7637 | 4221 |
| 1944 | 1227 | 238 | 2120 | 76329 | 119484 | 2114 | 4186 |
| 1945 | 1101 | 1138 | 3608 | 57407 | 108724 | 2101 | 3324 |
| 1946 | 741 | 923 | 2941 | 55785 | 82395 | 2563 | 3650 |
| 1947 | 702 | 487 | 3770 | 56263 | 73793 | 3049 | 2900 |
| 1948 | 653 | 1154 | 3913 | 53615 | 78107 | 4044 | 3227 |
| 1949 | 575 | 856 | 5714 | 37549 | 65965 | 3859 | 2516 |
| 1950 | 450 | 880 | 5599 | 26877 | 64867 | 2881 | 2500 |
| 1951** | ‖ | 3475 | 11188 | 36048 | 109467 | 3041 | 1659†† |
| 1952** | ‖ | 1837 | 10426 | 35893 | 97706 | 1208 | 1417†† |
| 1953** | ‖ | 3032 | 10497 | 53101 | 118241 | 733 | 1636†† |

*Source: "Belle Fourche Project, Annual Project Histories," 1912-53.
†Includes range and feeder cattle.
‡Includes range and feeder sheep.
§Includes dairy calves and sires.
‖No report.
#Includes dairy cattle.
**Classificaiton changed for reporting livestock. 1951 figures for beef cattle reclassified to make data comparable.
††Dairy cows only.

early period is 18,525 a year and for the most recent period a yearly average of 25,156 animal units.[31]

**Sheep and Hogs.** Within the broad trend of increasing livestock production, an even more distinct trend is apparent. This trend is the increase in the number of sheep and a decrease in the number of hogs on the project, a shift from hog to sheep production. Using the periods considered previously, the yearly average number of hogs on the project was 10,258 and sheep 52,259 for 1919 to 1928. On the other hand, for the most recent 10-year period, 1944-53, the yearly average number of hogs was 2,829 and the number of sheep, 91,905.

The shift from hog to sheep production on the project was of sufficient magnitude to evoke the interest of research personnel in the State. A study was undertaken by the Agricultural Experiment Station at South Dakota State College in 1939 to attempt to determine the comparative advantages of certain classes of livestock in the irrigated area of Butte County.[32]

This area had formerly produced large numbers of feeder and serum pigs but by 1939 had almost gone out of the hog business, while at the same time the buyers of such pigs appeared to be in the market and premium prices were still being paid for a quality product. In addition, studies made at the Newell Irrigation and Dry Land Field Station, indicated that pigs could be grown very economically on the irrigated alfalfa pastures.

**Livestock Enterprises.** Thirty farmers on the project whose operations were considered representative of the irrigated area were interviewed as to their livestock operations. When these 30 operators were asked which livestock enterprises fitted best into their business, they replied as follows: 17 for sheep raising and/or feeding; 8 for sheep and cattle; and 1 each for sheep feeding and stock dealing; sheep, cattle, and hogs; hog raising; cattle raising; and cattle feeding. In other words, 90 percent of the operators favored sheep as the enterprise, or as one of their enterprises, while only 7 percent mentioned hog raising. Furthermore, when asked if they planned to change their livestock organization in the near future only four indicated plans for a change, and these four intended to add sheep to their business.

A change had come about and the operators were not only satisfied with it but expected to carry it further. When asked directly why they had ceased to raise hogs, they individually mentioned one or more of the followings reasons:

1. Hogs require relatively large quantities of concentrate feeds which are difficult to grow under western conditions and expensive to buy.
2. Local hog prices have not been favorable for several years, and the earlier demand for serum pigs has vanished.
3. Hog raising requires 6 months or so to realize an investment.
4. Hog raising requires considerable labor and requires it during the crop-

[31]This comparison excludes any consideration of horses and mules. If they were included in the comparison, the difference between the two periods would be reduced substantially.

[32]Max Myers, "A Study of the Comparative Advantage of Sheep and Hog Production in the Irrigated Area of Butte County, South Dakota," unpublished study, Experiment Station, South Dakota State College, Brookings, South Dakota, 1939.

ping season in conflict with irrigation and haying.
5. Hog raising requires special equipment and fencing which they cannot afford.
6. Cholera and other infections cause too much loss.[33]

Their reasons for undertaking sheep raising were in most cases the reverse of that for hogs:

1. Sheep utilize a higher proportion of roughages and crop residues which are more plentiful in this area, and require little grain.
2. In the opinion of these operators at least, lamb prices have been better than pork prices and there is wool in addition.
3. One realizes quicker returns from investment in sheep. Both wool and lambs are sold. If one feeds lambs, he gets a 90 day turnover.
4. Sheep require less labor, can be put on the range in summer so as not to interfere with cropping, while lambs can be fed out in the slack season.
5. Sheep require less special equipment.
6. Sheep diseases and infections are not so bothersome.[34]

In view of these factors, Myers feels that the operators were justified in increasing sheep numbers because the sheep enterprise fits well the needs of the area. On the other hand, Myers points out, "when one discounts the reasons which are more prejudicial than factual, it is more difficult to understand the great decrease in hog numbers, for it would seem that the hog enterprise could well complement the sheep business without seriously conflicting."[35]

[33]Ibid. p. 12.
[34]Ibid. p. 13.
[35]Ibid. p. 15.

## Experience Gained on the Project

Many problems have been encountered by farmers and officials in 50 years of experience with the Belle Fourche Irrigation Project. Some of these problems are undoubtedly due to inadequate planning surveys in the period prior to construction; others have arisen out of situations apparently unforeseeable in the light of knowledge existing at the time of project planning; all are problems which, whether solved or remaining, have resulted in many valuable lessons learned.

Reclassification of project lands, provision for supplemental water storage, a more integrated crop and livestock program, and the adjustments of repayment policy are only a few of the beneficial changes resulting from lessons learned through 50 years of experience on the project.

Additional lessons of broader meaning and application have also resulted from the half-century of experience with the project. The Bureau of Reclamation has learned many lessons from the construction and operation of early projects such as the Belle Fourche and has put this knowledge to use on old and new projects alike. Errors in planning, administering, and operating the Belle Fourche and other early projects have been recognized to the extent that greater wisdom has been exercised in establishing subsequent reclamation projects. Problems and attempted solutions have led to the accumulation of knowledge, and increased knowledge about irrigation has led to improved irrigation practices.

Valuable lessons with broad implications derived from experience with the Belle Fourche Project have not been obtained without cost. Although providing knowledge applicable to subsequent irrigation projects, some of the early errors committed on the Belle Fourche have exacted their price by retarding the progress of the project itself.

Discovery of the need for adequate subsoil drainage was not a situation immediately resolved with the construction of a drainage system in 1928, for example. Damage from seepage and alkali had taken place in the meantime and the removal of these conditions was slow and costly.

An objective evaluation of the Belle Fourche Project must consider that the project is to some extent still being handicapped by mistakes made during its planning and development stages. Therefore, because of the continued influence of some of the earlier problems, it is impossible to expect that there should be a perfect relationship between existing irrigation knowledge and irrigation success in the case of the Belle Fourche Project.

On the other hand, the errors which in some cases have held back project development over a long period are helping provide the lessons which speed more recent projects to development and success. The extent to which conditions al-

low the lessons learned to be effectively applied is the important question.

**The Need For Research and Adequate Planning Prior to Construction.** Experience on the Belle Fourche Irrigation Project has shown that prior to the development of an irrigation enterprise it is essential to have adequate data on all factors which enter into the design or may affect the operation and maintenance of the project.

The two factors most basic to the design of an irrigation project are suitable land and water. It is only after adequate information is available on the quantity and quality of water and land to be used for irrigation that it is possible to determine the type of storage and canal system needed. The information out of which good plans are formulated is provided only by thoroughgoing surveys and research carefully conducted. Such essential information was not present when the Belle Fourche Project was designed and constructed.

Initially contemplated and publicized to include about 100,000 irrigable acres, the project as of 1954 served approximately 57,400 irrigable acres. Part of this difference between the expected and the present size of the project is due to a lack in understanding the importance of determining the suitablility of soils for irrigation prior to starting construction.

Actually, the kind of research needed before designing the project, such as the Strahorn and Mann basic soils survey, was not completed until after the project was under construction. Consequently, included in the area to be irrigated were large blocks of land consisting of steep hillsides, coulees, shaly soil, and gravelly areas, all of which today would be excluded.

The other major factor that contributes to the difference between the expected and actual size of the project has been a shortage in anticipated water supplies. River flow records on which reservoir water supplies were planned were available for but a single year, 1903. Such short-term records failed to reflect periods of low runoff like those occurring in the 1930's. Consequently, sufficient carryover was not provided to assure ample supply in dry years.

The project has paid a heavy price in learning that the soil and water data used in developing project plans were not based on careful surveys and research. The planning and construction of a storage and distributing system for the project involved the expenditure of several million dollars.

To such initial expenditures have been added the subsequent costs incurred in operating these systems and in changing them to fit needs not revealed in the information available at the time they were planned. Moreover, these changes and improvements have been slow in coming, and disappointments resulting from soil difficulties and water shortages have been a factor in causing farmers to leave the project. This places the entire cost and maintenance burden on the reduced number of settlers during periods when there were idle farm units.

Thus, inadequacies in land and water information have contributed to past problems such as repayment and scattered settlement. The cumbersome pace of changes and improvements attempting to solve these problems is but a reflection of the far-reaching implications of basic survey data.

**Irrigating Project Soils.** Experience in developing the Belle Fourche Project has shown that irrigation is a much more involved process than the mere application of water to land. Different soil types have been found to require different amounts of water and different methods of application. Experience has shown the need for skill and caution in irrigating project lands and the fundamental importance of adequate subsoil drainage. In addition, lessons have also been learned regarding the importance of land leveling and the desirability of periodic land classification.

Although the Pierre clay, Orman clay, and Pierre clay loam soils are distinct and separate soil types, they have certain common characteristics. In general, management of these soils under irrigation has proved a difficult task. These soils which comprise about half the project, tend to become sticky when wet and must dry a longer time than the lighter soils before they can be worked satisfactorily.

When the heavy clay soils are dry, water penetrates rapidly to a depth of about 2 feet because of the cracked condition on the surface. After this layer becomes wet it swells, becoming nearly impervious; additional water penetrates very slowly, and the depth of root penetration is less than on more pervious soils. Thus, it has been learned that small amounts of water are essential for successful irrigation of the heavy clay soils.

The light soils[36] of the project also present certain management problems. These soils, in general, have a coarser, sandier texture than the heavy clay soils and are capable of infiltrating larger quanities of water without becoming sticky and impervious. They dry out faster than the heavy clay and hence require frequent, large water applications.

The greatest difficulty occurs when the water infiltration of the lighter soils is so high that the large amounts of water necessary to irrigate an entire field are not always available. This is true for two reasons.

(1) In passing through the area where the lighter soils are located, the South Canal (and its laterals) loses considerable quantities of water through seepage into the sandy soils.[37]

(2) The carrying capacity of the South Canal is no larger in relation to the area it serves than the North Canal, despite the larger water requirements of the lighter soils served by the South Canal.

As a result of these factors, water shortages have occurred more often and have been more severe along the South Canal.

A major lesson learned on the project has been the importance of

[36]Particularly Vale fine sandy loam and Vale gravelly sandy loam. See figure 3 (soil map).

[37]Recent experiments with canal linings in the South Canal have as one of their purposes the relief of this situation by reducing water losses through seepage.

the relationship between water application, soil type, and drainage. Early settlers attempting to work out their own methods often failed to exercise caution in water application and a common result was over-irrigation. Since some of the heaviest clay soil is found where the land is extremely flat, surface drainage did not remove the surplus water resulting from such over-irrigation.

Over-irrigation of these fields eventually resulted in the seepage of water to the impervious subsoils, creating an upward movement of the harmful alkaline salts underlying much of the heavy clay soil.

When the lighter soils were over-irrigated, large quanities of water percolated through the porous subsoils and raised the water table, causing waterlogged areas in which crops suffered from excess moisture. In addition, the lighter soils in some areas became waterlogged as a result of seepage from canals and ditches.

By 1928 with about 10,000 acres affected by seepage, waterlogging, and the accompanying damages of alkali, a comprehensive system of deep artificial drains was necessary to reclaim affected areas and protect other tracts from becoming damaged.

Another lesson learned on the project is the importance of accurate timing in the application of irrigation water. Because of the hand labor involved in getting water on the crops some farmers are hesitant about using irrigation water if there is any possibility that rain will supply the moisture requirements. This "looking toward the sky" instead of "opening the gate" is sometimes carried to the point where poor timing is effected in the application of irrigation water.

In addition, accurate timing in applying irrigation water is often difficult to achieve because of the interference of hot, drying winds. When the application of irrigation water is poorly timed, the effect is often little better than no water at all. Farmers may attempt to make up for their delay by applying large amounts of water to their crops. This often results in over-irrigation.

The lessons learned regarding water application and drainage techniques on the project might well have been more easily acquired had land leveling been practiced prior to early attempts at irrigation. At the outset of the project many of the settlers possessed relatively few and simple tools, and specialized

**Plastic siphon tubes are used to get water from ditches onto the fields.**

power equipment was then unknown. Little was done to prepare the land for irrigation; and consequently, the amount of labor was increased and the water was not used efficiently. Experience has shown that water application, soil handling, and drainage are all facilitated by land leveling.

Other aspects of land management which have been found of fundamental importance to obtaining and maintaining high production under the more intensive practices of irrigation farming are as follows: (1) adequate fertilizer programs, (2) well planned rotations, (3) use of crop varieties developed for irrigation, (4) increased plant population per acre over dryland areas, and (5) raising such crops as alfalfa, pasture, and corn to a larger extent than small grains.[38]

Had the lessons regarding water application, drainage, and land leveling been known to project planners and early settlers, it is conceivable that fewer problems would have been encountered in irrigating project soils. But such knowledge would not have appreciably decreased the problems encountered in irrigating the large blocks of land consisting of steep hillsides, coulees, shaly soil, and gravelly areas included in the original irrigable area of the project.

Experience in irrigating and paying construction charges on these lands has only demonstrated their unsuitableness for irrigation farming and, consequently, the need for their exclusion from the irrigable (assessed) acreage of the project. However, major soil reclassification providing for the suspension of such areas and others made temporarily non-productive because of seepage and alkali have been made only twice in the history of the project. Consequently, lands that were not suitable for irrigation have been assessed construction charges until a major soil classification released them or changed their classification to a lower assessment rate. From such experience has been learned the desirability of basic soil surveys and periodic, thorough land classification.

**Experience With Water Supply.** Inadequate information in the planning stage of the project failed to give an accurate picture of the water supply available for irrigation. Cycles of low runoff in the Belle Fourche River were not revealed by the river flow records for the single year, 1903. In addition, the amount of water initially expected to be lost through seepage and evaporation in the storage and distributing system (25 percent) was underestimated.[39] Experience has shown that such losses have amounted to about 50 percent of the stored water.[40]

***Water Shortages.*** Whatever the specific shortcomings in the original

[38] Alfalfa, pasture, and corn are better adapted to irrigation farming since they utilize the full growing season and benefit from supplemental water during the drier late summer season. Small grains are better adapted to dryland farming since they grow and mature during the normal rainy season of spring and early summer and are harvested before the drier late summer season.

[39] U.S. Reclamation Service, Fourth Annual Report, 1905, p. 313.

[40] "Report on the Suitability of the Belle Fourche Project of the U.S. Bureau of Reclamation as a Site for Rehabilitation Farms" (to the South Dakota Rehabilitation Farm Corporation), unpublished report, on file Department of Agricultural Economics, South Dakota State College, Brookings, 1934, p. 5.

water supply information, water shortages have occurred on the project. Severe and recurrent water shortages have, for the most part, been limited to lands along the Johnson Lateral and Inlet Canal which depend directly on the flow of the Belle Fourche River for their supply, but occasional shortages have been felt by the entire project.

The first project-wide water shortage was in 1911. In general, supplies were sufficient from 1912 to 1930, but shortages in 1931, 1934, 1935, 1936, 1938, and 1939 created an awareness of the problems of water supply. Although supplies were, in general, plentiful from 1942 through 1953, the shortages in the previous decade and persistence of Johnson Lateral and Inlet Canal shortages made it apparent that additional irrigation water was necessary.

Moreover, the results of a 1939 silt survey of the Belle Fourche Reservoir indicated that after 31 years of operation siltation had reduced the reservoir storage capacity by 13 percent (203,000 to 177,500 acre feet). Although this siltation rate is low, the storage capacity is being further reduced each year. As an attempt to alleviate both the problems of water supply and siltation, Keyhole Reservoir[41] has been constructed.

***Other Water Shortages.*** Project farmers served by the North and South Canals have learned that temporary water shortages may occur on individual farmsteads even though an ample supply exists in the reservoir.

This problem is found to be much more common along the South Canal, particularly at the lower end. The South Canal can deliver no more water than the North Canal in relation to the area it serves and is incapable of providing enough water to supply additional needs during the peak demand period of about 20 days during the summer, due to (1) the higher water requirements of the sandy pervious soil, (2) large seepage losses as the canal and laterals pass through sandy and gravelly areas, and (3) generally higher water requirements of the crops grown under the South Canal. Thus, water deliveries must frequently be staggered on the South Canal. Because of the delays involved in this procedure some farmers experience temporary shortages in periods of high general demand.

The most acute individual water shortages in the areas served by the Belle Fourche Reservoir occur at the lower end of the South Canal. Ditch-riders and water-masters have tried almost every means available to increase water service to this area, but even though the South Canal runs "bank full at the reservoir" there are frequent shortages during the peaks of the irrigation season.

Water shortages have had far-reaching, adverse effects. Losses in crop production due to water shortages in the thirties occurred at a time when farm income was reduced by the economic depression. Because of the irrigation farmer's overhead due to construction and operation costs, even greater burdens were placed on him.

[41] Cf. section, "Progress in Recent Years," pp. 38-40.

***Financial Implication.*** Difficult financial problems imposed upon farmers by such conditions were, therefore, an important factor in causing many farmers to grow dissatisfied and leave the project. Moreover, the problems associated with water shortages have been instrumental in attaching a stigma to the project which has retarded resettlement even in years of ample water supply, high production, and favorable prices.

***Domestic Water Supply.*** Domestic water supply on the project is also somewhat of a problem. To obtain water of satisfactory quality from shallow wells is often difficult, and the depth of artesian wells is usually great. Farmers on the project have solved the problem in a number of ways. In most cases farm and home supplies are provided by a large cistern. This cistern may be filled by running water from the irrigation canal through some sort of filter, by hauling ice from a convenient pond during the winter, by collecting rain water, or by hauling it from a nearby artesian well.

Livestock water, in some cases, is supplied by stock dams which are largely dependent upon irrigation water for their supplies. Municipal water supply for Newell, likewise is obtained from filtered irrigation water. Regardless of the method, however, it remains a fact that obtaining adequate water supply for home and farm use represents additional work and expense for many project farmers.

**Experience With Repayment.** In order that a clearer understanding may be gained of the lessons learned in repaying construction costs, it is necessary that the reader be acquainted with the repayment record of the project. The following is a simplified account of the complex and involved financial transactions with the Bureau of Reclamation pertaining to the repayment of the project's construction costs.

***Costs.*** The original estimate made in 1904 of the cost of constructing the storage and canal system was $2,100,000 based on an estimated 60,000 irrigable acres. This estimate was soon revised because it was found that land south of the Belle Fourche River could be included in the project and the cost was then placed at $2,565,000 for about 90,000 irrigable acres. However, this cost for primary construction had to be revised upward nearly $1,000,000 because of preparing additional lands for service and higher prices for material and labor due to World War I, and other unforeseen construction items. The total primary construction cost reported in 1952 is $3,531,575.18 (table 8).

In addition to this figure, a supplemental construction cost of $1,106,660.89 has been added to the construction debt. The principal item was the construction of a drainage system for the project in 1928 and a project rehabilitation and betterment program (allowed under the terms of the 1949 contract) estimated at $650,000.

These items bring the total construction obligation to $5,288,236.07. Additional debts owed the government because of a moratorium on operation and maintenance costs ($570,194.90) during depression

years, and postponed penalty and interest debts ($106,382.63) are indicated in table 8.

Costs of $250,000 in excess of contract on rehabilitation and betterment funds have been credited to the project. Deductions, which include payment for lands withdrawn from irrigable acreage such as the Willow Creek Extension, total $1,393,630.47. Thus, the total construction rehabilitation and betterment debt ($5,288,236.07) plus the monies funded through moratoria, minus $250,000 credit on rehabilitation and the total deductions leave a net obligation of $4,321,183.13 (table 8).

***Credits.*** On the credit side of the ledger, payments by water-users on construction charges through December 31, 1948 total $1,079,853.65. Accruals from miscellaneous receipts and rentals are $22,908.52. In addition to other credits amounting to $106,727.97, payments of the water-users on construction since 1948 under the 1949 contract amount of $133,736.74.

The total of all accruals and credits to June 30, 1952 was $1,343,226.88. The total accruals subtracted from total obligation leaves an unaccrued balance, as of June 30, 1952, of $2,977,956.25 yet to be paid by the Belle Fourch Irrigation District. Payout of this balance, which commenced in the fiscal year of 1951, is scheduled for completion in about 77 years through the payment by the irrigation district of $38,700 annually.

***Factors in Repayment.*** The lessons learned from experience with the repayment of the construction costs of the irrigation works on the Belle Fourche Project can be best understood by considering some of

**Table 8. Summary of Construction Costs, Deductions, and Accruals of the Belle Fourche Project, 1904-52***

| | | |
|---|---|---|
| Primary construction cost | $3,531,575.18 | |
| Supplemental construction cost | 1,106,660.89 | |
| Rehabilitation and betterment | 650,000.00 | |
| Total | | $5,288,236.07 |
| Operation and maintenance funded | | 570,194.90 |
| Interest and penalties funded | | 106,382.63 |
| Less: Rehabilitation and betterment costs in excess of contract | | 250,000.00 |
| Deductions: | | |
| Contributed funds | 5,324.86 | |
| Chargeoff (Act of May 25, 1926) | 379,031.58 | |
| Chargeoff, Willow Creek Extension | 273,667.90 | |
| Chargeoff, land classification December 27, 1948: | | |
| Primary construction charges 13,604.7 acres at $43.90 | 597,246.33 | |
| Share of drainage costs 13,604.7 acres at $10.17 | 138,359.80 | |
| Total deductions | | 1,393,630.47 |
| Total obligation | | 4,321,183.13 |
| Accruals: | | |
| Miscellaneous receipts and rentals | 22,908.52 | |
| Collection accruals through December 31, 1948 | 1,079,853.65 | |
| Other credits | 106,727.97 | |
| Accruals under ammendatory contract | 133,736.74 | |
| | | $1,343,226.88 |
| Unaccrued balance, June 30, 1952 | | 2,977,956.25 |

*Source: Bureau of Reclamation, *Repayment Histories and Payout Schedules,* 1952, pp. 16-17.

the factors that have contributed to repayment problems. In general, these factors have made repayment more difficult by reducing the ability of the water-users to pay or by adding to the construction debt. Outstanding among these factors are the following:

(1) ***Reduced irrigable acreage.*** Although the construction and consequently the cost of the project was based on about 90,000 irrigable acres, the irrigable acreage has had to be reduced, and the largest acreage ever irrigated has not exceeded 60,000 acres. Thus, less than two-thirds of the project has been carrying the burden of repayment. This situation was, to a large extent, corrected in the 1949 contract.

(2) ***Unrealistic repayment periods.*** The first contract provided a period of 10 years to repay construction costs. This repayment period did not take into account the economic assets of the settlers or the cost of converting raw land into farms. The repayment period was extended to 20 years and later to 40 years, indicating the need to adjust repayments to conditions of the project. The 1949 contract, although setting a figure of $38,700 annually for repayment by the district, gives the option of a variable formula.

(3) ***Delayed land reclassification.*** There have been only two major land reclassifications on the project. As experience with the land of the project increased, it was found that certain acreages originally considered irrigable were not suitable for irrigation and should not be assessed construction charges. However, only a major land reclassification provided the proper basis for the suspension of such lands. Consequently, lands that were not suitable for irrigation were assessed construction charges until a major classification released them, or changed their classification to a lower assessment rate. A major land reclassification correcting some of these inequalities provided the basis for the terms of the 1949 contract.

(4) ***Joint-liability.*** The concept of "joint-liability" under which the water-users were held legally responsible for the failure of other project water-users to pay their construction charges served to create a pessimistic attitude toward the payment of construction charges, and also affected their collateral for credit. This type of joint-liability was removed by the 1949 contract.

(5) ***Inequality of construction charges.*** The first two units that were opened for irrigation were comprised primarily of the lighter soils and were assessed a construction charge of $30 an acre. The remaining three units were composed of larger proportions of the heavy more difficult to handle gumbo soils and carried a construction charge of $40 an acre.

(6) ***Unplanned construction costs.*** Preliminary estimate of construction for the completed project was $2,565,000. This is the cost upon which the early public notices were based. By the time of the 1923 contract, the estimated construction cost had increased about $1,000,000. This increase was due to additional surveys, increased material and labor costs due to World War I, and

other unforeseen costs. The construction of a drainage system and the rehabilitation and betterment program has added about $1,500,000 to the construction debt.

**Size of Farm Unit.** The Reclamation Act of 1902 limited homestead farms within Federal reclamation projects to not less than 40 nor more than 160 irrigable acres. In addition, the act prohibited each private landowner within a reclamation project from receiving water for more than 160 irrigable acres. Such limitations had as their purpose the making of a large number of homes available for farm families, and preventing large landholders from monopolizing the benefits of Federal irrigation.

***Homesteads.*** In keeping with the limits set by the Reclamation Act, Bureau of Reclamation policy for the Belle Fourche Project called for each homestead farm unit to contain 40 to 80 acres of irrigable land, with a maximum of 106 acres of dry and irrigable project land in combination. Land already in private ownership on the project was limited to a maximum of 160 irrigable acres held by one individual.

A total of 580 public land homesteads were entered on the project, having an average irrigable area of 59 acres based on the reclassification of 1926. Of these farms, 496 (85 percent) were on the heavy clay soil.[42]

***Private Ownership.*** On the other hand, the bulk of the farms in pri-

[42]Speech by F. C. Youngblutt, "Belle Fourche Project, Resume of Economic Ills and Proposed Remedies," copy on file, Bureau of Reclamation, Missouri Oahe District Office, Huron, South Dakota, p. 4.

**Leveling land on a project farm. Project farmers consider land leveling of fundamental importance for successful irrigation.**

vate ownership were larger by virtue of their higher limitation (160 acres) and were located mainly on the lighter soils of the project. Thus, it appears that the size of the units on the project showed little relation to the type of soil in the unit. This, together with inexperienced settlers and shortcomings in financial and technical assistance, facilitated the development of wide differences in production on project farms. In many instances, project homesteaders learned that their farms were too small to provide their families with an adequate level of living.

***Increased Size.*** Because acreage limitations considered created many units too small to support a family, the regulation limiting private landholdings[43] to 160 acres has come to be interpreted to mean that the husband and the wife can each hold title to 160 acres or 320 acres together. The extent to which changes in the conception of the size of farm unit needed on the project has allowed a large number of farms to have an increased irrigable acreage is indicated by table 9.

In 1950, farms with less than a total of 80 irrigable and nonirrigable acres comprised only 27 percent of all project farms and contained only 8 percent of the project's irrigable area. These farms had an average of only 41 irrigable acres to the farm. On the other hand, farms with a total of 160 acres and over constituted 40 percent of all project farms and included 67 percent of the project's irrigable area. These farms averaged 222 irrigable acres to the farm.

Thus, experience has brought about a reinterpretation of the number of irrigable acres needed for a family farm on the project. This reinterpretation has resulted in an increased number of farms considerably larger than the 80 irrigable acres originally regarded as the maximum necessary for the support of a homesteader's family.

***Off-Project Lands.*** In addition to the fact that the irrigable acreage of many project farms has increased, the utilization of large tracts of off-project dryland range and pasture in conjunction with the irrigated farm units have become a common feature of farm organization. For example, a study in 1945 of a sample of 73 project farms showed that nearly one-third of the 73 farmers were operating an average of about 1,300 acres of off-project dry-

[43]Homestead holdings on the project have, of course, been "proved-up," and such holdings are now private.

**Table 9. Number of Farms and Acres Irrigable, by Size of Farm, Belle Fourche Project, 1950***

| Size of Farms (acres) | Number of Farms | | Acres Irrigable† | | |
|---|---|---|---|---|---|
| | Number | Percent | Number of Acres | Percent of Project Irrigable Acres | Average Acres Per Farm |
| 0-79 | 110 | 27 | 4465 | 8 | 41 |
| 80-159 | 138 | 33 | 13813 | 25 | 100 |
| 160 and over | 166 | 40 | 36814 | 67 | 222 |
| Total | 414 | 100 | 55092 | 100 | 133 |

*Data from 1950 Legal Descriptions of Project lands (based on 1948 land classifications); Belle Fourche Irrigation District Office, Newell, S. Dak.
†Paying acreage. Includes land classes 1, 2, 3, and 4A.

land range and pasture in addition to their project lands.[44]

A more recent indication of the tendency to utilize the surrounding dryland range is revealed by the fact that project farmers operated a total of 217,000 acres of grazing land in 1951.[45] This trend is, in part, due to the interest in livestock production.

**The Need for Settler Selection.** Those desiring to settle on the original project homesteads were not required to meet specified standards of character, industry, capital, or farm experience. As a result, many of the persons taking up project homesteads did not have the qualifications that are today considered necessary, and a considerable number were interested in acquiring an irrigated farm only for speculative purposes. Often the homesteaders had no capital other than the filing fee[46] and went into debt for necessary farm improvements, thinking it could easily be repaid from the ensuing profits of irrigation farming.

About one-half of the 580 public land homesteads entered on the project were taken up by nonfarmer elements such as clerks, school teachers, lawyers, and businessmen. As these inexperienced settlers attempted to work out their own irrigation methods, difficulties resulting from unskillful land management and water application plagued the project. A frequent result of this situation was that the discouraged settlers left the project. Their unoccupied units either stood idle or were rented, creating the problems inherent in scattered settlement, tenancy, and absentee ownership.

***Occupations of Settlers.*** An indication of the type of settler and the later settlement situation on the project homesteads is furnished by data available on 100 unoccupied irrigated farms in Newell township in 1928. This township is somewhat typical of the settlement situation on the heavier soil where the majority of the homestead units on the project are found. It comprises parts of the third, fourth, and fifth units opened for settlement in 1912, 1915, and 1917, respectively. Of the 210 farms in Newell township in 1928, 107 were unoccupied. The latter figure includes seven State school land farms which are omitted from consideration.

A summary of the occupations of the original entrymen of 100 farms in Newell township which were unoccupied in 1928 is as follows:[47]

| | |
|---|---|
| 32 Farmers | 1 Lumberman |
| 12 Lady Homesteaders | 1 Cleaner & Dyer |
| | 1 Clothing Salesman |
| 7 U. S. Employees | 1 Stenographer |
| 5 Laborers | 1 Carpenter |
| 4 Mechanics | 1 Electrician |
| 3 Miners | 1 Drayman |
| 3 Clerks | 1 Undertaker |
| 2 Preachers | 1 Surveyer |
| 2 Ranchers | 1 Jeweler |
| 2 Students | 1 Painter |
| 2 Teachers | 1 Barber |
| 2 Garagemen | 1 Plumber |
| 2 R. R. Employees | 1 Civil Engineer |
| 2 Blacksmiths | 1 Stock Buyer |
| 2 Attorneys | 1 Merchant |
| 1 Retired Lady | 1 Contractor |

[44]John Muehlbeier, *et. al.*, "Class and Size of Farm, Tenure and Income," p. 14.

[45]"Belle Fourche Project, Annual Project History," 1951.

[46]The filing fee for 160 acres was $14.

[47]Committee on Irrigation and Reclamation, House of Representatives, *Economic Survey of Certain Federal and Private Irrigation Projects*, pp. 74-6.

Only 32 of the original entrymen of these 100 farms were classified as "Farmers." On the other hand, the 68 remaining settlers fall into 32 separate occupational categories, only one of which (ranching—two ranchers) is directly related to farming. This heterogeneous array of backgrounds found among the original homesteaders, unfortunately, is reflected in the status of these farms and their owners in 1928.

Besides being unoccupied, a lack of settlers and poor demand saw a number of these farms renting for considerations below the actual overhead expenses of the owners. Moreover, in 1928 only 34 of these farms were owned by the original entrymen. Of the remaining 66 farms that had changed owners, 31 had been acquired through mortgage foreclosures, 26 through purchases, 6 through inheritances, and 3 through bank failures.

Such experience has shown the importance of protecting both settler and project from failure by selecting for settlement only those persons whose background and resources give them the greatest likelihood of success in irrigation farming. It should be pointed out, however, that even if settler selection had been practiced at the outset of the project, the relatively small number of those desiring to homestead would have made qualified settlers difficult to obtain.

***Settler Qualification.*** Experience with irrigation projects such as the Belle Fourche, together with the availability of a large number of applicants, has permitted the Bureau of Reclamation to set up definite qualifications for settlers on more recently developed irrigation projects. As an illustration of these qualifications, the following is a summary of requirements to homestead irrigated land on the Columbia River Basin Project. Similar requirements, although differing in details, exist for settlement on the recently constructed Angostura Irrigation Project[48] near Hot Springs, South Dakota.

(1) ***Capital requirements.*** Applicants are required to have a minimum of $4,500 of assets in excess of liabilities, with no more than $500 of this amount valued in household goods or $500 in a passenger car.

[48]Settlement and development of this project is under the jurisdiction of the U.S. Soil Conservation Service.

**A mechanical beet thinner. Machinery such as this is reducing the amount of hand labor necessary to grow sugar beets.**

(2)***Farm experience.*** Applicants are required to have had 24 months of farm experience since their 15th birthday. Not more than 1 year of this time can be substituted by college agricultural courses, county extension work, vocational agricultural work, or related experience.

(3) ***Health.*** Applicants must be in physical condition adequate to engage in normal farm work.

(4) ***Character and industry.*** Applicants must be possessed of honesty, temperance, thrift, seriousness of purpose, a record of good moral conduct, and an intent to engage in farming as an occupation.[49]

In addition to these requirements, qualified veterans are usually given preference over nonveterans. Another feature being increasingly adopted as part of settler selection programs is to inform the prospective settler and his family of the problems likely to be encountered in developing an irrigated farm. Furnishing this information to the prospective settlers further promotes the selective process by discouraging some and giving others a background of the necessary guidance for success.

**The Need for Financial Assistance to Settlers.** Early settlers on the project soon learned that the development of an irrigated farm involved much greater cost than they had anticipated. Over and above the expenses for buildings, machinery, seed, and livestock were the previously unknown payments for the operation, maintenance, and construction of the project.

***Lack of Capital.*** Often the entrymen not only lacked the necessary capital to meet such expenses but were unsuited to the trials and hardships of the early irrigator's life. Consequently, after obtaining loans to provide a bare minimum of farm improvements, many of the early settlers became dissatisfied and moved away from the land. Their farms remained essentially undeveloped, lacked building improvements, and rented on terms that barely covered the owner's taxes and water charges. Under such circumstances many owners were forced to allow their holdings to pass into the hands of creditors, or to be taken by the county for taxes.

The unsuccessful efforts of early settlers was undoubtedly one of the factors making it difficult for subsequent settlers to secure adequate credit. Joint liability[50] was another factor which has made credit more difficult for settlers to obtain. While joint liability was intended to give security to the government's investment, it caused many creditors to be cautious in making loans since every project irrigator could be legally held liable for construction charge delinquencies of other farmers in the district. Recently, however, the Contract of 1949 alleviated the credit problems imposed by joint liability by eliminating this feature of project repayment.

***Credit Needs.*** Credit facilities, in general, have provided short-term loans for settlers already established and operating to the extent that they needed livestock loans. How-

[49]Bureau of Reclamation, *Public Notice No.* 13—*Columbia Basin Project*, (Washington: Jan. 29, 1953), p. 2, cited by H. R. Stucky, "Settlement and Repayment Policies on Irrigation Projects," pp. 108-111.

[50]See section on "Progress in Recent Years."

ever, the credit situation on the project, at least until recent years, has been such that little money has been available to settlers for intermediate - term farm - development loans. Credit problems of this nature have unquestionably been instrumental in the past in retarding resettlement of the project.

Settlers on the project have utilized various ways of compensating for the limited financial aid available to develop their farms. For example, new settlers have often leaned heavily on cash crops during their first years of operation. Another method of adapting to the credit situation is a variation of the cash crop technique made possible by sugar company loans.

In an effort to increase beet production on the project, the sugar factory has participated in a program of providing beet raisers with technical assistance, machinery and labor to help in planting, caring for, and harvesting the crop. In turn, the cost of this aid is paid to the factory out of the farmer's return at the end of the season, thereby providing a type of "credit" useful to the new settler.

***Implications.*** The acute credit situation on the project has contributed to the difficulties in repaying project construction charges. Inadequate credit has retarded the development and effective organization of project farms, thereby contributing to repayment deliquencies which in turn have necessitated extensions of the repayment period. Thus, insufficient financial assistance for settlers has been one of the factors causing the Bureau of Reclamation to extend a form of "credit" by refinancing the construction obligation of the project.

Problems of repayment and development encountered on the Belle Fourche and a number of other irrigation projects illustrate the importance of providing settlers with sufficient financial assistance. Unfortunately, even on many recently developed irrigation projects, credit in amounts adequate for the rapid development of the irrigated farms is not, or has not, been available.

***Attempted Solutions.*** One solution to this problem has been to establish somewhat high capital requirements ($3,000–$5,000) as one of the qualifications for settler selection.[51] However, many farmers desiring farms, particularly young men, cannot meet this requirement. Thus, if one of the purposes of Federal land reclamation is to help provide family-size farms, an interesting question arises as to whether the capital requirements for settlement should be so high as to eliminate from selection those perhaps in greatest need of assistance in obtaining a farm. A clear-cut answer to this question would serve as a basis for determining the amount of financial assistance to be provided for settlers.

A plan being tried on a few recently developed projects[52] attempts to compensate for the lack of credit facilities available by a program of predevelopment of the farms. Using this plan the agency in charge of development undertakes

[51] See section on "The Need for Settler Selection."

[52] For example, Buffalo Rapids Project, Division I, Buffalo Rapids, Montana; and Kinsey Project, Kinsey, Montana.

land leveling, field and ditch layout, house and building construction, fencing, and even well drilling prior to the settlement of the project. The cost of these improvements then becomes part of the farm's construction charge obligation and is paid by the settler over a long period of time.

Thus, the energy and resources of the settler can immediately be channeled into crop and livestock production, and the chances of slow project development are greatly reduced. In addition, procedures such as land leveling prior to settlement permit the fitting of the individual farms into a well integrated irrigation and drainage system for the project.

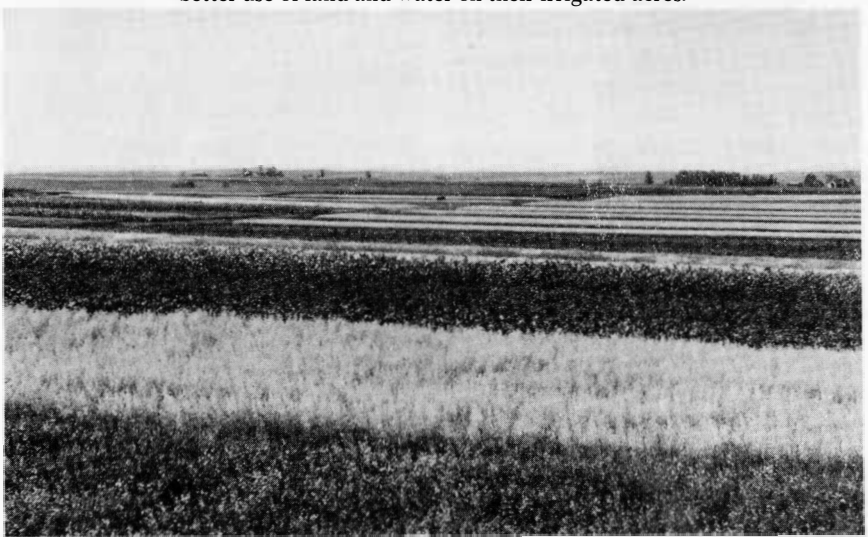
**The Need for Technical Assistance.** Experience on the Belle Fourche Project has demonstrated that farmers on irrigation projects require specific technical information to help organize their soil, crop, livestock, and over-all farm management programs. This is true because of (1) the introduction of new crops requiring specialized methods, (2) the necessity of more intensified agriculture under irrigation, (3) the need to adapt crop and livestock programs to irrigation, and (4) the unique problems of irrigation farming associated with the application of water and the control of waste water and seepage.

***Early Experience.*** What was probably a familiar scene during the early years of irrigation is recalled by Ralph Milberg, whose father was one of the men who worked to have the project started. Referring to the first delivery of water on the Milberg farm, he recalls, "We got the water at the headgate and then we wondered what to do with it."[53]

At the outset of the project the inexperienced settlers found little information available on clearing and leveling the land, laying out farm irrigation systems, and the adoption of profitable, efficient irrigation practices. This has been a factor contributing to (1) farmers failing to develop management knowledge and skills as rapidly as necessary for success, (2) large areas being made temporarily unproductive because

[53] *The Mitchell Daily Republic*, December 26, 1952.

**Crops growing in the experimental plots at the Newell Irrigation and Dry Land Field Station, Newell, S. Dak. Information provided by these trials aid farmers in making better use of land and water on their irrigated acres.**



of improper irrigation and drainage practices, (3) many families losing out after years of hard work, (4) slow project development—repayment defaults, and (5) loss to the public by not getting the best possible production from the project.

As a result, an important lesson learned on the project has been the need for a program of education and guidance for settlers to aid them in handling the technical problems of irrigation farming. Such technical assistance services should, ideally, be made available early in the development of the project. Assistance to the farmer is most effective at the time when the original farm investments are being made and while he is gaining experiences in operating and managing the irrigated farm.

***Increased Assistance.*** Even after the initial settlement of the project, technical assistance services were slow to appear. It has been in recent years, particularly since 1948, that new agencies and expanded programs by existing agencies have been present on the project to assist farmers in solving the problems of irrigation farming. Thus, the new program of the Newell Irrigation and Dry Land Field Station, the services of the county agricultural agents, and the irrigation specialist, the Sugar Company demonstration farm, and the expansion of the Soil Conservation District have made major contributions to a growing interest in improved irrigation methods in recent years. To a considerable extent the adoption of new and improved irrigation methods and techniques reflect the services of such agencies.

Experience on the project also points to the necessity of thorough dissemination of knowledge discovered by research agencies. A criticism of early research work was that it could not be utilized to the maximum degree because it was not adequately made known to project farmers. Thus, it has been learned that technical information will benefit farmers only to the extent that it is known and understood by them.

In addition to the necessity of disseminating technical information, the importance of integrating research and technical assistance into a meaningful program for the farmer has been learned.

Educational agencies in agriculture often reveal a common weakness, the specialized or "single factor" approach. As a result, the farmer on an irrigation project receives a considerable amount of specialized information from various sources which needs to be fitted together.

An example of an agency attempting to correct these situations is the Agricultural Extension Service which, working through its county agents in the dissemination of technical information, is emphasizing the integrated "whole-farm" approach in order to achieve the maximum value from efforts to aid farmers.

# Appendix

**Table A-1. Total Acreage, Yields, and Unit Price for Principal Crops, Belle Fourche Project, 1912-53***

| Year | Sugar Beets | | | Wheat | | | Corn | | | Alfalfa | | | Barley | | | Oats | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres Total | Yield Av. | Price† Unit | Acres Total | Yield Av. | Price Unit | Acres Total | Yield Av. | Price Unit | Acres Total | Yield Av. | Price Unit | Acres Total | Yield Av. | Price Unit | Acres Total | Yield Av. | Price Unit |
| 1912 | ---- | ---- | ---- | 11,083 | 17.6 | 0.70 | 1,830 | 11.8 | 0.50 | 3,906 | 2.1 | 5.00 | 247 | 30.8 | 0.50 | 5,478 | 33.7 | 0.35 |
| 1913 | 8 | 5.9 | 5.00 | 13,096 | 14.9 | 0.60 | 1,859 | 19.1 | 0.80 | 7,388 | 2.1 | 4.50 | 744 | 24.3 | 0.60 | 5,343 | 30.3 | 0.40 |
| 1914 | 37 | 8.0 | 4.00 | 7,885 | 14.0 | 0.90 | 4,415 | 24.0 | 0.70 | 9,745 | 2.1 | 4.50 | 1,448 | 24.0 | 0.70 | 6,392 | 33.0 | 0.40 |
| 1915 | 31 | 10.0 | 4.00 | 7,747 | 17.2 | 0.80 | 4,470 | 14.3 | 0.50 | 16,152 | 2.2 | 4.50 | 1,613 | 29.3 | 0.65 | 4,440 | 37.2 | 0.40 |
| 1916 | 161 | 9.4 | 4.50 | 7,554 | 5.1 | 1.25 | 3,846 | 19.6 | 0.80 | 17,945 | 2.0 | 7.00 | 2,740 | 15.6 | 0.70 | 4,119 | 22.1 | 0.40 |
| 1917 | 1,771 | 5.9 | 6.50 | 5,122 | 13.1 | 1.90 | 2,902 | 15.9 | 2.00 | 19,702 | 1.8 | 15.00 | 2,286 | 24.2 | 1.25 | 4,955 | 21.5 | 0.70 |
| 1918 | 1,087 | 9.8 | 9.00 | 9,563 | 15.7 | 1.90 | 2,068 | 21.2 | 1.40 | 20,467 | 2.1 | 12.00 | 1,636 | 24.9 | 1.00 | 4,331 | 31.7 | 0.70 |
| 1919 | 978 | 10.8 | 10.00 | 10,742 | 11.1 | 2.20 | 2,903 | 21.9 | 1.50 | 24,804 | 2.2 | 20.00 | 1,351 | 33.2 | 1.50 | 3,665 | 21.4 | 0.80 |
| 1920 | 1,103 | 9.3 | 10.50 | 9,851 | 5.1 | 1.75 | 3,272 | 19.1 | 0.75 | 26,035 | 1.9 | 8.00 | 1,695 | 15.2 | 0.45 | 4,864 | 23.0 | 0.45 |
| 1921 | 926 | 11.1 | 5.50 | 5,341 | 10.3 | 0.90 | 5,622 | 19.6 | 0.50 | 25,829 | 1.7 | 5.00 | 1,423 | 13.2 | 0.40 | 5,390 | 16.4 | 0.32 |
| 1922 | 324 | 9.7 | 5.00 | 5,482 | 15.6 | 0.90 | 7,130 | 24.9 | 0.56 | 28,968 | 1.7 | 5.00 | 1.284 | 19.8 | 0.45 | 5,051 | 26.4 | 0.32 |
| 1923 | 565 | 12.6 | 6.50 | 1,379 | 15.6 | 0.96 | 8,826 | 33.1 | 0.60 | 26,768 | 1.5 | 5.96 | 949 | 21.4 | 0.45 | 4,587 | 23.1 | 0.32 |
| 1924 | 1,281 | 7.7 | 8.75 | 689 | 17.0 | 1.25 | 8,638 | 14.8 | 1.00 | 21,824 | 1.4 | 6.50 | 553 | 21.5 | 0.70 | 3,229 | 26.5 | 0.50 |
| 1925 | 1,238 | 16.2 | 8.25 | 2,906 | 23.4 | 1.25 | 10,698 | 27.0 | 0.70 | 20,731 | 1.6 | 6.50 | 1,082 | 33.7 | 0.50 | 5,254 | 41.7 | 0.40 |
| 1926 | 2,184 | 16.2 | 8.25 | 5,071 | 21.8 | 1.15 | 7,612 | 27.1 | 0.70 | 19,945 | 1.7 | 7.00 | 1,507 | 32.1 | 0.50 | 5,198 | 32.4 | 0.32 |
| 1927 | 6,021 | 9.2 | 7.00 | 4,901 | 14.6 | 1.05 | 4.253 | 22.0 | 0.80 | 19,300 | 1.6 | 6.50 | 1,746 | 27.1 | 0.60 | 2,953 | 28.5 | 0.40 |
| 1928 | 6,929 | 12.1 | 7.00 | 5,307 | 22.1 | 0.80 | 4,560 | 19.7 | 0.70 | 16,696 | 1.6 | 8.00 | 3.285 | 32.1 | 0.50 | 3.514 | 43.0 | 0.35 |
| 1929 | 8,472 | 10.5 | 7.00 | 2,180 | 21.6 | 0.90 | 2,634 | 23.8 | 0.75 | 16,500 | 1.7 | 8.00 | 4,756 | 28.9 | 0.50 | 4,437 | 36.1 | 0.38 |
| 1930 | 7,060 | 12.3 | 7.00 | 3,469 | 20.0 | 0.50 | 3,131 | 24.1 | 0.70 | 14,355 | 1.5 | 8.00 | 5,709 | 31.3 | 0.45 | 4,719 | 31.6 | 0.30 |
| 1931 | 5,815 | 8.8 | 5.50 | 1,534 | 11.0 | 0.48 | 2,448 | 13.4 | 0.55 | 12,046 | 1.2 | 10.00 | 4,976 | 16.0 | 0.35 | 2,415 | 20.7 | 0.25 |
| 1932 | 5,490 | 11.2 | 5.40 | 2,768 | 22.5 | 0.27 | 7,158 | 21.5 | 0.25 | 12,177 | 1.5 | 4.25 | 6,625 | 35.4 | 0.12 | 4,200 | 36.3 | 0.12 |
| 1933 | 8,344 | 8.7 | 5.53 | 2,513 | 14.9 | 0.65 | 3,113 | 18.9 | 0.40 | 13,014 | 1.6 | 5.00 | 4,062 | 19.3 | 0.25 | 2,513 | 27.3 | 0.25 |
| 1934 | 8,015 | 7.9 | 6.97 | 2,209 | 17.7 | 0.90 | 2,084 | 17.0 | 0.70 | 10,846 | 1.9 | 12.50 | 4,070 | 23.7 | 0.60 | 2,538 | 28.5 | 0.55 |
| 1935 | 8,268 | 9.8 | 7.16 | 4,527 | 13.4 | 1.00 | 3,118 | 19.6 | 0.60 | 11,771 | 2.0 | 5.50 | 5,716 | 27.5 | 0.40 | 3,490 | 30.3 | 0.32 |
| 1936 | 4,157 | 7.6 | 6.81 | 2,794 | 10.6 | 1.20 | 1,154 | 17.9 | 1.10 | 12,590 | 1.7 | 14.00 | 4,848 | 17.1 | 8.80 | 2.011 | 19.3 | 0.50 |
| 1937‡ | 3,259 | 10.5 | 7.23 | 2,092 | 14.6 | 0.90 | 3,005 | 25.0 | 0.50 | 12,995 | 1.5 | 7.50 | 2,609 | 22.4 | 0.40 | 1,334 | 21.8 | 0.30 |
| 1938‡ | 6,631 | 12.3 | 6.49 | 2,984 | 11.7 | 0.50 | 1,974 | 22.2 | 0.50 | 11,551 | 1.4 | 8.50 | 4,405 | 21.3 | 0.40 | 1,381 | 21.3 | 0.30 |
| 1939‡ | 5,257 | 8.2 | 6.69 | 1,131 | 11.3 | 0.65 | 2,053 | 18.5 | 0.55 | 8,989 | 1.7 | 10.00 | 3,101 | 19.2 | 0.40 | 878 | 24.2 | 0.32 |
| 1940‡ | 5,567 | 11.9 | 7.13 | 1,278 | 14.0 | 0.60 | 3,119 | 25.2 | 0.55 | 10,514 | 2.0 | 7.50 | 3,709 | 23.9 | 0.40 | 1,371 | 27.7 | 0.32 |
| 1941‡ | 5,597 | 10.7 | 8.49 | 1,358 | 21.4 | 0.82 | 6,079 | 30.4 | 0.60 | 14,106 | 1.9 | 5.00 | 4,202 | 36.9 | 0.43 | 2,296 | 44.7 | 0.32 |
| 1942 | 5,564 | 9.9 | 8.41 | 1,653 | 21.6 | 0.90 | 2,690 | 25.0 | 0.60 | 15,774 | 1.9 | 7.00 | 5,888 | 32.7 | 0.48 | 2.108 | 41.9 | 0.32 |
| 1943 | 3,352 | 8.1 | 11.57 | 1,461 | 15.6 | 1.15 | 2 321 | 13.5 | 1.00 | 16,131 | 1.4 | 12.50 | 10,009 | 17.3 | 0.85 | 2,901 | 27.8 | 0.60 |
| 1944 | 4,025 | 7.2 | 12.90 | 1,863 | 13.0 | 1.30 | 2,032 | 23.9 | 1.00 | 14,064 | 1.4 | 11.50 | 8,213 | 25.1 | 0.75 | 3,432 | 33.0 | 0.45 |
| 1945 | 5,439 | 7.8 | 13.56 | 2,095 | 18.6 | 1.35 | 1,695 | 26.9 | 1.10 | 11,856 | 1.3 | 12.00 | 10,384 | 31.1 | 0.83 | 4,782 | 37.5 | 0.46 |
| 1946 | 5,477 | 10.6 | 13.27 | 4,538 | 24.3 | 1.78 | 2,550 | 29.5 | 1.26 | 10,220 | 1.4 | 12.00 | 12,306 | 31.2 | 1.09 | 4,891 | 40.6 | 0.59 |
| 1947 | 4,734 | 9.0 | 14.03 | 5,085 | 22.4 | 2.44 | 3,357 | 28.4 | 1.90 | 8,401 | 1.5 | 14.00 | 11,428 | 29.2 | 1.48 | 4,573 | 33.7 | 0.91 |
| 1948 | 2,781 | 10.8 | 12.34 | 7,384 | 19.7 | 1.91 | 4,264 | 28.9 | 1.35 | 7,734 | 2.0 | 20.00 | 11,111 | 27.9 | 1.05 | 4,137 | 36.2 | 0.62 |
| 1949 | 3,239 | 11.8 | 13.76 | 7,280 | 18.3 | 1.82 | 5,858 | 27.4 | 1.25 | 9,150 | 2.3 | 20.00 | 7,633 | 26.4 | 0.98 | 3,504 | 35.4 | 0.53 |
| 1950 | 3,710 | 9.6 | 14.67 | 4,395 | 16.8 | 1.90 | 3,012 | 25.5 | 1.40 | 10,848 | 2.2 | 20.00 | 7,003 | 21.5 | 1.00 | 4,548 | 27.8 | 0.83 |
| 1951 | 2,884 | 11.5 | 14.22 | 6,770 | 17.3 | 1.90 | 3,514 | 28.2 | 1.68 | 14,624 | 2.1 | 20.00 | 6,756 | 34.8 | 1.00 | 4,474 | 37.7 | 0.80 |
| 1952 | 2,910 | 13.0 | 14.14 | 4,384 | 13.8 | 2.00 | 3,353 | 26.5 | 1.68 | 18.112 | 2.5 | 20.00 | 5,577 | 24.8 | 1.20 | 3,893 | 30.8 | 0.80 |
| 1953 | 3,714 | 7.0 | 10.00 | 3,176 | 12.8 | 1.88 | 2,884 | 26.8 | 1.40 | 20.046 | 2.1 | 10.00 | 4,232 | 21.9 | 0.96 | 3,781 | 26.4 | 0.64 |

*Source: "Belle Fourche Project, Annual Project Histories," 1912-53.

†Value includes initial factory payment, factory bonuses, and Federal payments.

‡Acreages in principal crops do not include crops raised on irrigable land dry-farmed.

**Table A-2. Irrigable, Irrigated, and Cultivated Acreage and Total Gross and Average Per Acre Crop Values, Belle Fourche Project, 1908-53***

| Year | Total Irrigable Acreage† | Acres Irrigated‡ | Net Area in Cultivation (Acres)§ | Total Gross Crop Value‖ | Average Crop Value Per Acre# |
|---|---|---|---|---|---|
| 1908 | 12,000 | 4,025 | 4,025** | $ 62,266** | $15.47** |
| 1909 | 12,000 | 5,163 | 5,613** | 98,227** | 17.50** |
| 1910 | 48,000 | 15,410 | 13,150** | 171,051** | 13.00** |
| 1911 | 48,000 | 19,810 | 18,000** | 161,955** | 9.00** |
| 1912 | 66,000 | 27,897 | 27,803 | 308,602 | 11.09 |
| 1913 | 66,000 | 32,381 | 32,568 | 355,380 | 10.91 |
| 1914 | 69,000 | 37,454†† | 36,709 | 461,188 | 12.56 |
| 1915 | 79,000 | 44,067†† | 43,063 | 462,050 | 10.72 |
| 1916 | 79,000 | 48,468†† | 46,909 | 557,319 | 11.88 |
| 1917 | 83,000 | 50,272†† | 50,026 | 1,171,239 | 23.41 |
| 1918 | 83,000 | 52,445 | 52,445 | 1,276,115 | 24.33 |
| 1919 | 83,000 | 56,638 | 56,255 | 1,962,683 | 34.89 |
| 1920 | 83,000 | 59,848 | 59,850 | 832,200 | 13.90 |
| 1921 | 82,000 | 55,100 | 55,100 | 513,750 | 9.32 |
| 1922 | 82,000 | 31,150 | 56,920 | 585,770 | 10.29 |
| 1923 | 82,000 | 30,552 | 50,290 | 609,470 | 12.12 |
| 1924 | 82,000 | 48,400 | 49,810 | 597,090 | 11.98 |
| 1925 | 82,000 | 48,800 | 53,120 | 891,254 | 16.78 |
| 1926 | 75,000 | 36,250 | 47,730 | 880,320 | 18.44 |
| 1927 | 74,000 | 26,572 | 45,700 | 910,590 | 19.93 |
| 1928 | 75,000 | 35,910 | 46,700 | 1,173,370 | 25.13 |
| 1929 | 75,000 | 36,193 | 47,955 | 1,206,576 | 25.16 |
| 1930 | 75,000 | 38,844 | 53,803 | 1,204,293 | 22.38 |
| 1931 | 75,000 | 42,126 | 44,372 | 685,070 | 15.44 |
| 1932 | 75,000 | 35,000 | 49,129 | 601,121 | 12.24 |
| 1933 | 75,000 | 42,060 | 47,379 | 723,580 | 15.27 |
| 1934 | 75,000 | 42,625 | 43,405 | 1,022,446 | 23.56 |
| 1935 | 73,000 | 39,225 | 46,081 | 1,026,675 | 22.28 |
| 1936 | 73,000 | 37,546 | 37,546 | 978,142 | 26.05 |
| 1937 | 73,000 | 33,050 | 33,050‡‡ | 652,008‡‡ | 19.73‡‡ |
| 1938 | 73,000 | 40,612 | 40,612‡‡ | 901,302‡‡ | 22.19‡‡ |
| 1939 | 73,000 | 34,222 | 34,222‡‡ | 821,222‡‡ | 24.00‡‡ |
| 1940 | 73,000 | 38,649 | 38,649‡‡ | 950,699‡‡ | 24.60‡‡ |
| 1941 | 72,000 | 40,348 | 40,348‡‡ | 1,121,828‡‡ | 27.80‡‡ |
| 1942 | 72,000 | 33,155 | 39,571 | 1,108,556 | 28.01 |
| 1943 | 72,000 | 41,700 | 47,137 | 1,159,951 | 24.61 |
| 1944 | 72,000 | 25,753 | 44,222 | 1,088,975 | 24.63 |
| 1945 | 72,000 | 41,870 | 50,795 | 1,409,945 | 27.77 |
| 1946 | 72,000 | 36,800 | 52,739 | 2,058,530 | 39.03 |
| 1947 | 72,000 | 41,168 | 56,659 | 2,323,132 | 41.00 |
| 1948 | 72,000 | 39,272 | 57,188 | 2,031,537 | 35.52 |
| 1949 | 73,000 | 51,168 | 52,409 | 2,095,481 | 39.98 |
| 1950 | 59,000§§ | 55,472§§ | 54,493 | 1,981,514 | 36.36 |
| 1951 | 59,000 | 49,364 | 54,137 | 2,327,526 | 42.71 |
| 1952 | 59,000 | 52,991 | 53,370 | 2,410,100 | 45.16 |
| 1953 | 59,000 | 53,369 | 54,158 | 1,346,795 | 24.87 |

*Data in this table from 1908-12 based on *Annual Reports of the Reclamation Service,* 1908-12. Data for the years 1913-53 based on *Annual Project Histories,* 1913-53.

†Acreage to which the Bureau could have supplied water. Includes acreage temporarily suspended from paying water charges (class 5 lands). Figures rounded to nearest thousand.

‡Irrigated acres here include all the irrigable lands on farms to which water was delivered.

§Net area in cultivation includes all land from which crops were harvested, as well as pasture land. It may include land on which crops were grown, but which was not irrigated during the crop year. Years 1937-41 exclude acreages of irrigable land dry-farmed.

‖Includes government and commercial benefit and bonus payments.

#Average crop value per acre is computed by dividing the total gross crop value by the net area in cultivation.

**Estimated.

††Includes acreage irrigated but not cropped, such as: young alfalfa, young orchards, and the like.

‡‡Acreages and crop values for the year do not include crops raised on irrigable land dry-farmed.

§§Includes acreage temporarily suspended from the acreage upon which water charges were levied.

**Table A-3. Average Population and Average Number of Business Establishments in 1930, 1940, and 1950 for Selected Communities in South Dakota***

| Population Range of Selected Communities† | Number of Communities in Each Group | Average Population | | | Average Number of Establishments | | |
|---|---|---|---|---|---|---|---|
| | | 1930 | 1940 | 1950 | 1930 | 1940 | 1950 |
| 100-126 (Fruitdale) | 11 | 112.9 | 118.2 | 84.3 | 8.4 | 5.5 | 5.3 |
| 174-200 (Nisland) | 15 | 188.6 | 175.5 | 156.9 | 14.3 | 9.8 | 9.3 |
| 525-569 (Newell) | 13 | 547.1 | 551.0 | 524.7 | 29.6 | 25.2 | 30.7 |
| 1782-2282 (Belle Fourche) | 4 | 2057.2 | 2332.2 | 2619.5 | 84.5 | 94.0 | 118.3 |
| **Total** | | **2905.8** | **3176.9** | **3385.4** | **136.8** | **134.5** | **163.6** |

*South Dakota communities comparable to the populations of Belle Fourche Project communities selected on basis of their 1930 population. Sources: Population data: *U.S. Census of Population, South Dakota,* 1930, 1940, and 1950. Number of business establishments, Dun and Bradstreet, *Reference Books,* 1930, 1940, and 1950.
†See table 3 for 1930 population of Belle Fourche Project communities.

**Table A-4. Percent Change in Total Population and Total Number of Business Establishments for Project Communities and Sample Group of Communities, 1930-40, 1940-50, and 1930-50***

| Group of Communities | Percent Change | | | | | |
|---|---|---|---|---|---|---|
| | Population | | | Number of Establishments | | |
| | 1930-40 | 1940-50 | 1930-50 | 1930-40 | 1940-50 | 1930-50 |
| Belle Fourche Group | 20.9 | 32.5 | 60.1 | 51.1 | 7.5 | 62.4 |
| Sample Group† | 9.3 | 6.6 | 16.5 | −1.7 | 21.6 | 19.6 |

*Sources: Population data: *U.S. Census of Population, South Dakota,* 1930, 1940, and 1950. Number of business establishments, Dun and Bradstreet, *Reference Books,* 1930, 1940, and 1950.
†Sample taken from South Dakota communities not located in the Belle Fourche Area having a population in 1930 which approximated the population of the towns located in the project area for that same year.

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## Summary

Outstanding among the experiences gained on the Belle Fourche Irrigation Project are the following:

**Project Planning.** Experience on the project has shown that, prior to the construction, it is essential to have adequate information on all important factors that may influence the design or affect the operation and maintenance of a project. Good plans are based on thorough surveys and careful research. Much information of this type was not available when the Belle Fourche Project was designed and constructed.

**Irrigating Project Soils.** Experience gained from irrigating project soils reveals that irrigation is a much more involved process than the mere application of water to the land. Farmers have learned the need for skill and caution in irrigating the soil, the fundamental importance of adequate subsoil drainage, and the value of land leveling.

**Water Supply.** Problems associated with the supply of irrigation water re-emphasize the importance of adequate project planning. Fluctuations in the supply of water available for irrigation need to be known prior to construction so that years of short supply may be taken into account. Estimates of the water supply needed should take into consideration loss through evaporation and seepage requirements for different soils and crops.

**Repayment of Construction Costs.** Complete repayment of the project's total construction cost is scheduled to be paid out in about 77 years. The annual amount of repayment by the irrigation district to the Federal government is now $38,700. Factors such as unplanned construction costs and reduced irrigable acreage contribute to an understanding of the project's repayment problems.

**Size of Farm Unit.** Experience on project farms demonstrated the need for larger irrigation farms than was originally considered necessary for the northern semiarid region. This has led to an increase in the number of farms with more than the 80 irrigable acres originally regarded as sufficient to support a homesteader's family.

**Settler Selection.** The importance of settler selection has been learned through encountering settler and settlement problems on the Belle Fourche Project. Newer irrigation projects are selecting for settlers only those persons whose background and resources give the likelihood of success in irrigation farming. Settler selection attempts to protect both settler and project from failure.

**Financial Assistance.** Costs involved in the development of an irrigated farm are often greater than might be expected in some other types of farming. Existing credit facilities are not always able to meet the irrigator's need for credit, particularly intermediate-term loans. Insufficient financial assistance has tended to retard project development.

**Technical Assistance.** Farmers on irrigation projects require special technical information to help organize their farm management programs, including soils, crops, livestock. Organizations such as the Newell Irrigation and Dry Land Field Station, Extension Service, the Soil Conservation Service, and the Utah and Idaho Sugar Company have been of valuable service in furnishing technical aid to the irrigation farmer.