Trends and Anticipated Changes in Water-Use Practices for Irrigation In the Willamette Valley

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Contents

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TRENDS AND ANTICIPATED CHANGES

IN WATER-USE PRACTICES FOR IRRIGATION

IN THE WILLAMETTE VALLEY

Marvin N. Shearer and Arthur S. King

SUMMARY

The rate of irrigation development in the Willamette Valley followed concentrated promotional efforts rather than simply documented evidence that crops responded favorably to irrigation.

Interest in irrigation existed prior to 1900, but adoption was slow until 1930. Rate of development since that time has been rapid for three reasons: (1) Concentrated educational and promotional programs were conducted by many governmental and private institutions; (2) development of quick couplers, dependable sprinklers, and lightweight tubing; and (3) increased economic demands placed upon agricultural land made increased income per acre essential.

Interest in community projects followed a desire for irrigation by farmers not adjacent to existing supplies of water. Land irrigated under group-type enterprises increased 435% from 1949 to 1965, while the number of group enterprises decreased during this same period.

Sufficient precipitation falls in the Willamette Basin to irrigate all of the cultivated land within its boundaries. Existing evidence gives no suggestion that the ultimate area that will be irrigated will be less than the area now cultivated.

Increased use of fertilizer and improved irrigation scheduling programs will tend to increase seasonal water requirements, while improved application practices will tend to reduce them. Existing farmer practices are varied and are not in themselves a good guide for determining water allocations.

The concept of "full season" water for all irrigated land is supported by double-cropping practices, irrigation of fall plantings, and the large acreage of perennial crops irrigated.

INTRODUCTION

The Willamette Valley is located in northwest Oregon, bounded by the Coast Range on the west and the Cascade Range on the east. It extends from Oregon City southward about 140 miles and for purpose of this study includes the Tualatin Basin, located north and west of Oregon City. Counties involved are Washington, Clackamas, Yamhill, Polk, Marion, Linn, Benton, and Lane. Statistics in this report frequently include a part of Lane County which is in the coast drainage, but the acreage involved is small.

Irrigation development in the Willamette Valley is a recent venture. In the mid-nineteenth century, agriculture started as grain farming. It was not until the 1900's that interest developed in irrigation. By 1929 there were only 4,250 acres under irrigation among approximately 1,400,000 acres of cultivated land in the Willamette Valley. By 1959 irrigation water was being applied to about 150,000 acres and nearly all of this irrigation was developed on an individual farm basis with private financing. Factors affecting this dramatic 30-year growth and the changing concept of irrigation from "supplemental" to "basic" in nature is documented in existing publications and reports.

AREA OF STUDY AND OBJECTIVES

This study is specifically concerned with the trends and anticipated changes in water-use practices in the area described. However, waste water disposal techniques now in use, trends in irrigation, and the status of existing irrigation projects affect future developments and water-use patterns. Detailed facts concerning these related subjects are included under separate headings. An effort is made here to identify the development trends and the more obvious factors contributing to them, using as an outline the following four objectives:

1. To review the development of irrigation.

2. To review the trends in water-use practice.

3. To project anticipated changes in water-use practices.

4. To project the effect of the changes in water-use practices on water requirements.

PROCEDURE

1. Numerous published documents on the subject were reviewed.

2. Field interviews were conducted with persons now active in the field, present and past officers of irrigation projects and associations, and water disposal groups in the Willamette Valley.

3. Information thus developed was tabulated and used as a basis for projecting trends and anticipated changes in water-use practices.

REVIEW OF IRRIGATION DEVELOPMENT

Development of irrigation in the Willamette Valley follows a geometric pattern as shown in Figure 1. At the time of the last general census (1959) the rate of growth was still increasing.

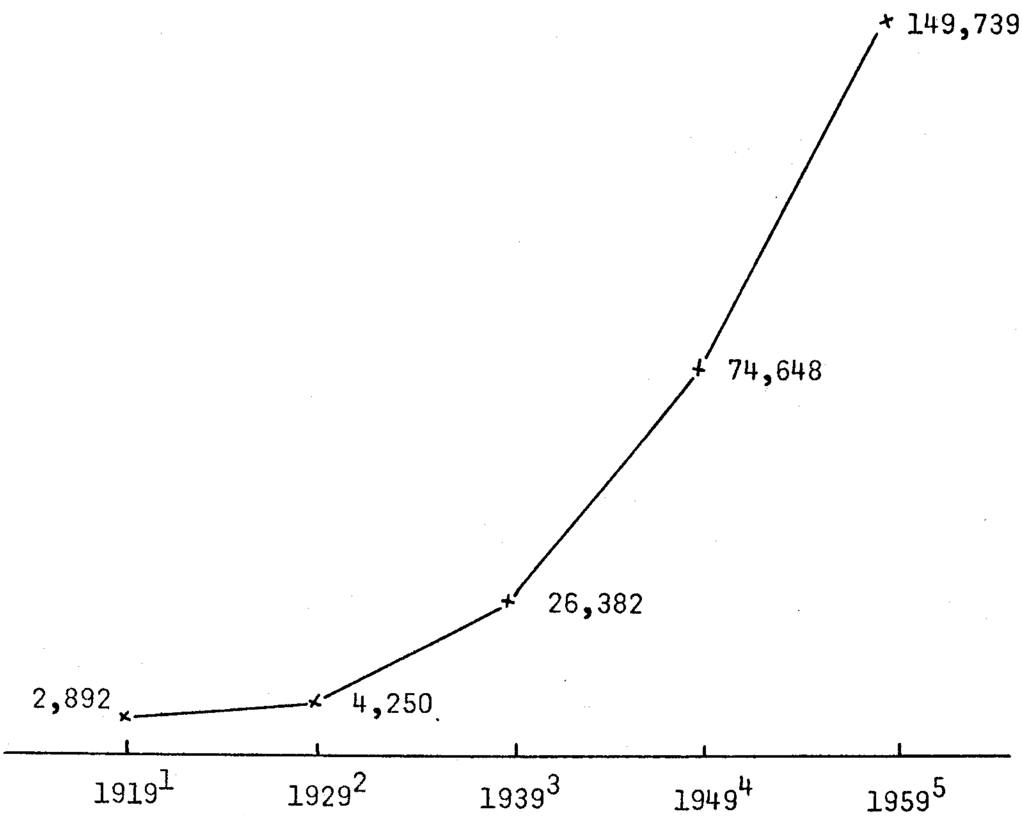

Figure 1. Acres of irrigated land in Willamette Valley farms at 10-year intervals.

[1] U. S. Bureau of the Census, 1930, Census of Irrigation, State Table 8.

[2] Ibid. [3] Ibid, 1950, County Table 2. [4] Ibid.

[5] Calculated from U. S. Bureau of Census, 1959, Census of Agriculture, County Table 1a.

As early as 1906, Oregon Agricultural College, in cooperation with USDA Office of Experiment Stations, initiated research on response of crops to "supplemental" irrigation.[1] By 1911 crops studied included alfalfa, clover, beans, kale, beets, and potatoes. Numerous publications on the response of crops to irrigation were published--principally by Dr. W. L. Powers. An example of the response is given in Table 1.[2]

Table 1. Twenty-five years of supplemental irrigation investigations, all-crop summary, average of all trials[1]

Crop	Period of trial	Yield per acre		Increase
		Dry	Irrigated	
	Years	Tons or bushels		Percent
Alfalfa	1909-32	3.62	5.83	61
Red clover	1908-32	4.17	6.25	50
Alsike	1914-32	1.92	4.01	101
Grass	1915-24	3.33	5.13	54
Potatoes	1907-32	134.00	192.92	43
Beans	1911-32	10.32	15.23	47
Corn	1907-32	6.47	8.93	37
Kale	1911-14	10.61	13.95	31
Beets	1908-14	10.98	15.61	43
Fiber flax	1927-32	1.68	2.36	42

[1]Powers, Twenty-five Years of Supplemental Irrigation, p. 15.

In 1911 a questionnaire was mailed to more than 100 farmers in the Willamette Valley who were said to be practicing irrigation. Over half of them answered; about 30 gave detailed replies, as follows:[3]

Average acres in farms	138
Average acres irrigated	25
Water source streams	15
Water source wells	5

Most farmers used pumping plants. Average total application was 12 1/4 acre-inches per acre for the season.

[1]A. P. Stover, Irrigation Experiment and Investigations in Western Oregon, USDA Office of Experiment Stations Bulletin 226, 1919.

[2]Powers summarizes these results in two publications: Irrigation and Soil-Moisture Investigations in Western Oregon, Oregon Agr. Exp. Sta. Bull. 122, August 1914; and Twenty-five Years of Supplemental Irrigation Investigations in Willamette Valley, Oregon Agr. Sta. Bull. 302, June 1932.

[3]Powers, Irrigation and Soil-Moisture Investigations, p. 88.

Crops grown included truck, meadows, potatoes, hops, berries, wheat, and corn. Transportation facilities were still somewhat limited, so farmers near the larger towns found a ready market for their fresh market produce.

In 1911 irrigation experiments were also conducted at West Stayton in cooperation with the Willamette Valley Irrigated Land Company.[4] This company, the Molalla Irrigation Company, and the Eugene Land and Water Company were the first multiple-farm irrigation projects in the Willamette Valley.

In spite of documented crop response to irrigation, there was little increase in irrigated acreage until the 1930's.

The first published report on duty of water in irrigation studies was prepared by Powers in 1920.[5] It covered results of cooperative work conducted by Oregon State College, the U. S. Office of Irrigation Investigations, and U.S. Bureau of Plant Industry.

From the beginning of irrigation development in the Willamette Valley, wells have been used as a source of water by farmers lacking ready access to surface supplies. Most of the early irrigation wells were hand-dug pits deep enough to reach a gravel strata below the water table. These were successful and adequate only in the recent alluvial deposits. The first large-capacity drilled and cased well was installed by Mr. W. A. Sloper near Independence in 1910.[6] It had a capacity of 600 gallons per minute and was used for irrigating hops.

During the 1920's some interest developed in irrigation of land in the main Valley floor that did not have access to surface water supply. Practically no information was available on the possibility of developing wells in this area with adequate capacity for irrigation. In 1928 the Soils Department, Oregon State College, entered into an agreement with the U. S. Geological Survey to finance jointly a survey of the ground-water possibilities in the Willamette Valley. Field work, under the direction of Arthur M. Piper, was initiated in 1928 and continued through 1930, at which time the project was discontinued to permit the study of ground-water problems in other areas of Oregon. Additional data on ground-water levels as a part of the Willamette Valley study were obtained by the U. S. Corps of Engineers in 1937 and 1938, and a renewal of the cooperative agreement between the Soils Department and the USGS permitted the completion of the report in 1937 and 1938.[7]

4Powers, Irrigation and Soil-Moisture Investigations, p. 93.

5Powers, Duty of Water for Irrigation, Oregon Agr. Exp. Sta. Bull. 161, January 1920.

6Unpublished manuscript, "The Development of Reclamation in Oregon", by W. L. Powers, dated 1957.

7A. M. Piper, Ground-water Resources of the Willamette Valley, Oregon: U. S. Geol. Survey Water Supply Paper 890, 1942.

In 1923 F. E. Price was employed as soils specialist by the Cooperative Extension Service, with part of his time devoted to increasing the amount of irrigation in the Willamette Valley and making more efficient the distribution of water for irrigation.[8]

For the next five years he provided individual pump installation design service to farmers. He established demonstrations with the cooperation of electric power and farm equipment companies. These demonstrations showed yield increases of 30 to 300 percent[9] and vegetable growers were double cropping, but irrigation development still was slow.

Irrigated Ladino clover pasture experiments were initiated in 1927 by the Oregon Agricultural Experiment Station. These were continued through 1938 and proved the profitability of producing irrigated pasture in the Willamette Valley.[10] In 1959 almost one-third of irrigated land was in pasture.[11]

Because of the effect of irrigation on product quality, the Eugene Fruit Growers Association in 1927 refused to contract for snap beans unless they were irrigated.[12]

Growth from 4,250 acres in 1929 to 26,382 acres in 1939 resulted from concentrated and cooperative promotion efforts of many leaders who believed irrigation to be a profitable way of increasing the productive capacity of Willamette Valley agriculture. It is interesting to note this sixfold growth started at a time of overproduction during the depression years. Much of the interest which developed was due to profitable irrigation demonstrations established during this period.

In 1930 Arthur S. King was employed to fill the new position of Extension soils specialist. He organized the first of 10 annual Valley-wide irrigation tours in 1930. Included among the participants of the first tour were such persons as Marshall Dana of the Oregon Journal; W. G. Ide, secretary of the state Chamber of Commerce; Kenneth Miller, agriculturist for SP&S Railroad; Mr. Martindal, manager of Portland Branch, Swift and Company; Ernest Henry, agricultural realtor; and Paul Maris and F.L. Ballard

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8Annual reports of Mr. Price from 1923 and 1927 discuss the cooperative demonstrations established during these years and an evaluation of the problems confronting the early irrigators. These reports are filed in Extension central files at OSU.

9Ibid.

10H. P. Ewalt and J. R. Jones, The Value of Irrigated Pastures for Dairy Cattle, Oregon Agr. Exp. Sta. Bull. 366, September 1939, p. 5.

11Calculated from 1959 Census of Agriculture.

12Price, Annual Report, 1927.

of the Extension Service. One of the most successful tours was held in 1938; 557 persons participated in this two-day event.[13]

In 1931 the Sam Brown demonstration well was constructed at Gervais. It was financed by interested power companies and banks. It was 18 inches in diameter and 155 feet deep, produced 900 gallons per minute, and was used to irrigate 60 acres of berries and small fruit.[14] Today there are several hundred wells in this same area irrigating crops for food processing companies.

Interest also developed in community irrigation projects varying in size up to several hundred acres. A resumé of many of these is found on pages 44 through 69. This interest was sparked by the desire to reach land not adjacent to streams and to provide economically an adequate head of water for surface irrigation.

Surface irrigation methods of applying water were used almost exclusively up to 1931. They required minimum flows of 450 gallons per minute regardless of the acreage included.[15] Small acreages were therefore expensive to irrigate because of high fixed costs of pumping equipment. The solution to the problem was to irrigate more land or to develop a different method of applying water.

Sprinkler irrigation had its start in the Willamette Valley with low pressure perforated pipe, portable light gauge steel, quick couplers, and medium-size rotary sprinklers. Numerous staff persons at Oregon State University and representatives of power companies and of industry can mutually claim credit for development of portable sprinkler irrigation equipment. They all had a part in contributing and testing new ideas and promoting manufacture of successful equipment.

By 1936, two-thirds (78) of the irrigators in the Eugene area were using sprinkler systems, irrigating 500 acres of vegetable crops. Irrigated area in the Valley had now increased to 15,000 acres and irrigation was becoming a recognized practice.[16]

In 1933 the U.S. Army Engineers began making surveys of the Willamette River Watershed for developing a coordinated program of utilization of water resources.[17]

In view of reports and surveys in April 1936, Governor Martin appointed a committee of 42 members, representing all the counties in the Willamette Basin. The purpose of the committee was to study the development of the Basin. Since that date, this committee has been called the Willamette Basin Project Committee.[18]

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[13]Details of these tours and the agriculture leaders active with them can be found in Mr. King's annual reports, located in Extension central files, OSU.

[14]Ibid., 1931. [15]Ibid. [16]Ibid., 1936. [17]Ibid.

[18]Willamette Basin Project Bulletin No. 70, 1956, p. 1.

The Oregon State Planning Board published a comprehensive report in 1936, outlining a coordinated plan for the Valley that was based largely on surveys made by the Army Engineers and other agencies. This plan became known as the "Willamette Valley Project." Later, in 1939, the legislature established a commission having legal powers to represent the state in all matters pertaining to the development of the project.[19]

In 1936 Congress authorized the Secretary of War to make a preliminary examination and survey for flood control on the Willamette River. Funds were secured from the Works Progress Administration and the survey was completed in 1937 and approved by Congress in 1938.[20]

Interest in community projects developed. In 1938 alone, six projects covering an area of 23,000 acres were investigated.[21]

Bonneville Dam was nearing completion. This had two opposing effects. The anticipation of low cost power spurred interest in irrigation among farmers but caused private utility companies, because of rate competition, to reduce the number of their rural servicemen who had been busy advising farmers on irrigation installations as a public relations program. The number of persons employed by industry to sell irrigation equipment increased considerably, however. It is interesting to note that installation of electric pumping plants during this time had made it possible in several instances to construct rural power lines that otherwise could not have been built.[22]

In 1940 the Bureau of Reclamation assigned an engineer to complete surveys on at least three irrigation projects under the Willamette Valley Project.[23]

Reduction in private power rural service personnel continued as the competition from public power agencies was felt. The public agencies did not develop a service which was comparable to that previously rendered by the private utilities.[24]

World War II caused a shortage of irrigation equipment so the number of acres under irrigation increased very slowly. However, lightweight aluminum tubing developed in 1946 from the aluminum war industry and proved to be a boon to the popularity of sprinklers. By 1949, 77% of the irrigation was done by the sprinkler method.[25]

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[19]M. L. Upchurch and E. L. Potter, Irrigation for the Willamette Valley, Oregon Cooperative Extension Bull. 675, September 1946, p. 13.

[20]Willamette Basin Project Bulletin No. 70, 1956, p. 1.

[21]King, Ibid., 1938. [22]Ibid., 1939. [23]Ibid., 1940. [24]Ibid., 1941.

[25]Calculated from 1950 Irrigation Census.

By this time efforts were directed toward improved irrigation practices and better system design. A 1949 study by Becker[26] showed:

No. of farms studied	111
Average acreage in farm	117 (randomly selected farms)
Average acreage irrigated per farm	34
No. of different crops irrigated	40

Only 14 out of 111 systems were adequately designed in all respects.

By 1950 many streams were overappropriated and considerable interest developed in reservoir construction. Irrigation had become an accepted practice as contrasted to a 1914 conclusion that, "Irrigation, to be of much value in the Willamette Valley, must be used only in a supplemental and proper way."[27] The major promotional job for individual developments was over. Future acreage of any magnitude required community efforts or wells for full-season water supplies.

The first contracts for stored water from Fern Ridge Reservoir were signed July 20, 1954, between the Bureau of Reclamation and Ben Forney, A. C. Forney, Chester R. Cook, and Lennie Holderson. These contracts covered 115 acres of land and 239 acre-feet of water. They proposed to dig a canal and pump the water for irrigation.[28]

Although sprinkler irrigation companies continued to be heavily involved in promotion of sprinkler equipment, private utility companies and the University concentrated on programs of improved operation of systems and better irrigation scheduling programs. Momentum had developed and irrigation development continued to ride on it.

The rate of development, however, reflected sociological and economic influences. Higher taxes, insurance, interest, and the "competitive position" tended to increase the rate of development, while a general attitude of resistance to change tended to hold it back. Ultimately, this latter influence will become of minor importance.[29]

In the 1960's a new look was taken at lands once considered nonirrigable. The fact that they were adapted to profitable production of

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[26]M. H. Becker, Sprinkler Irrigation Costs and Practices (Willamette Valley, Oregon, 1950), Oregon Agr. Exp. Sta. Bull. 532, March 1953.

[27]Powers, Irrigation and Soil-Moisture Investigations, p. 198, (emphasis added).

[28]Willamette Basin Project Bulletin No. 68, 1954.

[29]These factors are discussed in detail in a statement submitted by the OSC School of Agriculture at the hearing of the State Water Resources Board on the Upper Willamette at Eugene, Oregon, April 7, 1960.

irrigated pasture was demonstrated as early as 1928.[30] But a five-year research project on the poorly drained Willamette Valley soils, started in 1963, showed that a wide range of crops grown on the soils responded to irrigation if proper soil management practices were followed.[31]

The hill-lands, too, deserve another look as farmers, on their own, are irrigating forage, orchards, berries, and vegetable crops on soils which were not included in the earlier potential irrigable acreage estimates. The Lacomb Project is located almost entirely on these foothill soils.

With the production evidence now available and the adequacy of water supplies assured through storage reservoirs, there appears little evidence to support limiting the ultimate irrigated acreage estimates at less than total acreage of cultivated land. Timeliness is the major question, and that will be answered by the economic development of this area.

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[30] Ewalt and Jones, Ibid., p. 9.

[31] Annual Progress reports on Irrigation Feasibility for Dayton, Amity, Woodburn, Willamette, and Related Soils of the Willamette Valley are on file in the Soils Department, OSU.

Irrigation Tour of Willamette Valley, Oregon

The purpose of the tour was to prove the efficacy and advantages of irrigation in the section.

Official weather records for the Willamette Valley covering the past 35 years indicate an inadequate normal rainfall during the months of May, June, July, and August, to meet the requirements of growing crops.

Research trials conducted by the Oregon Experiment Station show substantial profits for irrigation, and the results are being confirmed in practice on fruit, dairy, and truck farms. The proof was convincing. It was shown that the average return is $2 for every dollar spent for irrigation purposes in the Valley. Interest in the project is general — bankers, merchants, and educators, as well as farmers being represented.

Above: Cars in the "line-up" for the irrigation tour. As many as 45 cars were in the touring caravan at various points. The tour covered seven counties.

Right: A group of the "tourists" studying the construction and manipulation of the irrigation system.

In one county a fruit growers association accepts only string beans for canning grown on irrigated land because of better quality. Figures of vegetable production over a four-year period in the same sections are as follows:

	Irrigated per acre	Non-irrigated per acre
Beets	7.9 tons	3.2 tons
Carrots	36 tons	12.2 tons
Refugee beans	4,289 lbs.	803 lbs.
Kentucky Wonder beans	10,426 lbs.	2,364 lbs.

Clover field, which was seeded in the summer of 1929. Ten acres were prepared and furnished limited pasture that season, but a year later made sufficient growth to support 28 cows from March until July. At this time a seed crop was allowed to mature, and $1,800 worth of seed was harvested from the same ten acres. It is under irrigation.

These clippings tell in part how many agencies and individuals aided in the intense educational program on Willamette Valley irrigation in the 1930's.

WATER TO TURN SOIL INTO GOLD

Irrigationists See New Future for Valley.

TWO-DAY TOUR COMPLETED

Fertility and Productivity Visioned on Every Hand.

EUGENE GREETS VISITORS

Benton and Lane Counties Reveal Many Examples of Intensive Cultivation Methods.

WATER MAGIC SEEN ON TOUR OF VALLEY

Business Men Join Farmers on Irrigation Junket.

STATE COLLEGE SPONSOR

Area Between Cascades and Coast Range Held Destined to Be One of West's Wonders.

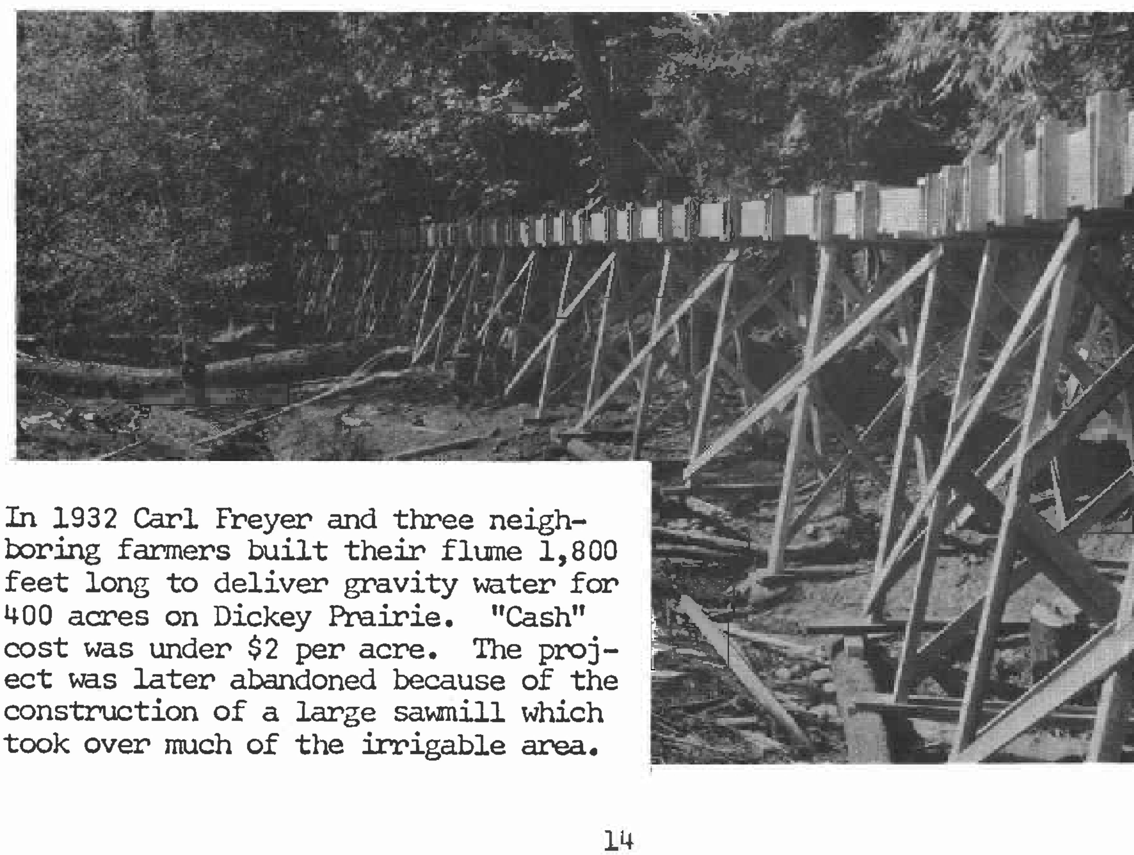
Molalla Gives Farmers Cheap Water System

Oregon Journal
Aug 7, 1932

The 1932 "Willamette Valley Irrigation tour" stopped to visit the farm of A. A. Doubrava, Sheridan. Irrigation equipment on the Doubrava farm was financed by the Yamhill Electric Company, later consolidated with Portland General Electric Company.

On the Doubrava farm eight acres of intensive row crops--vegetables, berries, and cut flowers--were profitably grown using rill irrigation. There was, however, surface runoff and some erosion.

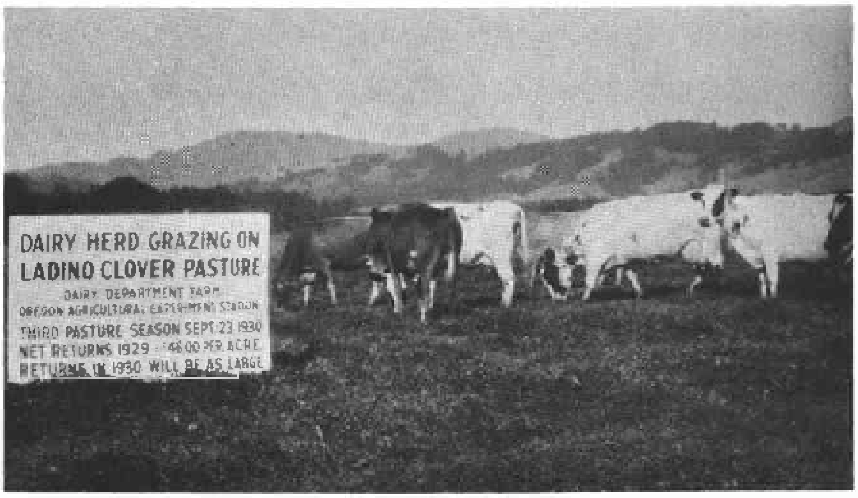
Carl Freyer, Molalla, learned how to build a flume by inspecting this flume under construction in 1932 to deliver water to the Colton project (now the Foothills Association). Farmers who jointly built the Colton project logged their own timber, sawed the lumber, built their own flumes. Cash cost for lumber was $2 per million.



In 1932 Carl Freyer and three neighboring farmers built their flume 1,800 feet long to deliver gravity water for 400 acres on Dickey Prairie. "Cash" cost was under $2 per acre. The project was later abandoned because of the construction of a large sawmill which took over much of the irrigable area.

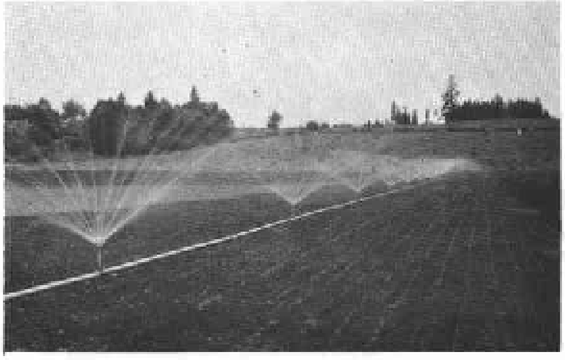
Initiated in 1931, the Mill Creek project delivered water to twelve farms near Sheridan. Three hundred acres were leveled for strip border irrigation in 1932 and seeded to alfalfa and Ladino clover. A reconstructed power canal was utilized for diversion and delivery. The project has been abandoned in favor of direct pumping through sprinkler irrigation systems.

Practically all of the pasture and field crops started in the early 1930's were seeded on land prepared for strip border irrigation. H. P. Ewalt, now OSU Extension Dairy Specialist, is shown above preparing land to expand the OSU dairy pasture in 1931.

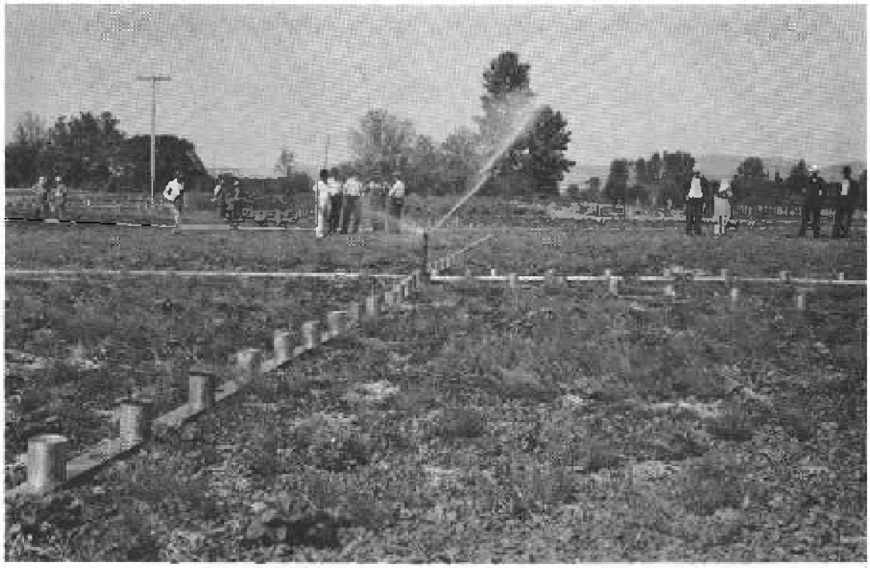


Proof provided by the Experiment Station that irrigated Ladino clover was a widely adapted and profitable pasture for dairy cows and other livestock gave impetus to the early push to expand irrigation.

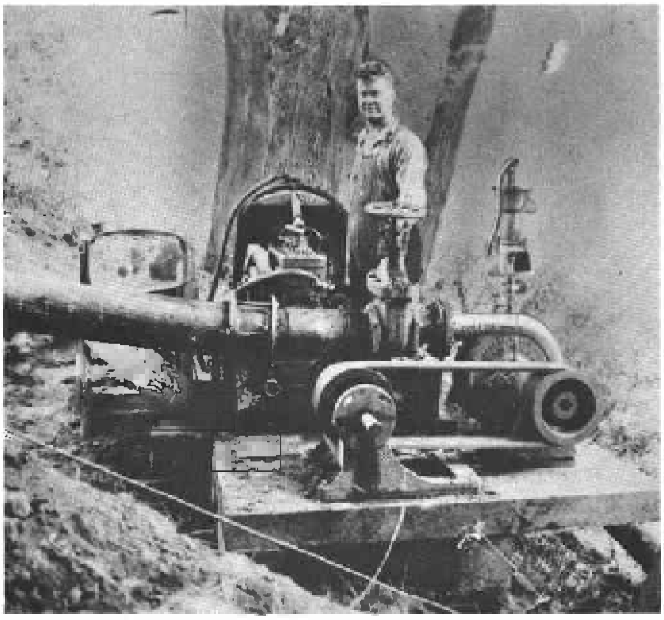
The "Skinner" system of spray irrigation was the efficient forefather of modern sprinkler irrigation. Water was discharged through precisely drilled nozzles inserted in an elevated pipeline. The pipe was turned back and forth by hand or by a hydraulically operated oscillator. Major disadvantages were high installation cost and lack of portability.



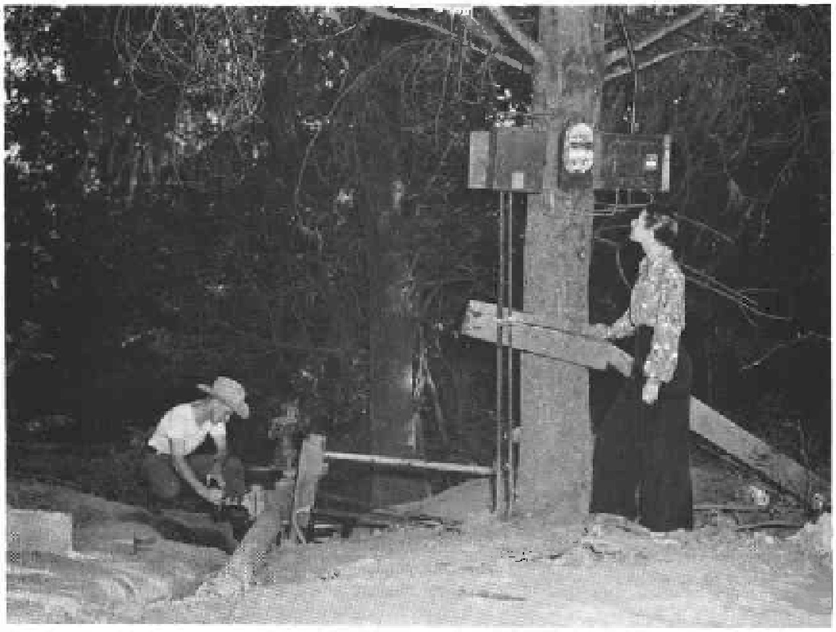
The "Jupe's Pal," manufactured by Doras Young, Wilsonville, was one of many sprinklers developed during the 1930's to meet the demand for a satisfactory portable sprinkler. The Jupe's Pal did not rotate. Water was spread in a square pattern.



Hundreds of tests to determine the rate and efficiency of water application of sprinklers and other equipment were conducted by the Departments of Soils and Agricultural Engineering in the mid-1930's. Test results aided in the development of new equipment and in establishing criteria for the design and operation of sprinkler irrigation systems.



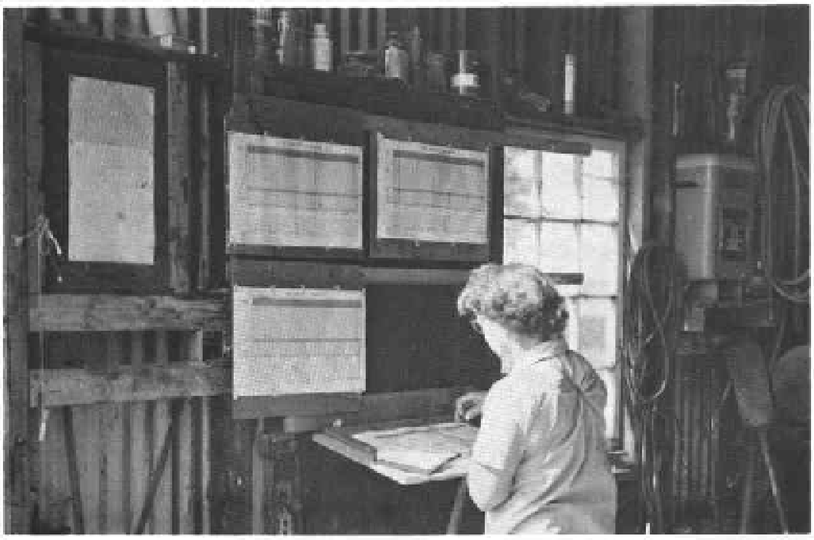
In 1932 much of the Willamette Valley was without adequate electric distribution systems to permit powering pumping plants to supply the heads of water required for surface irrigation. Ed Freudentheall, Hillsboro dairyman, powered his original pumping plant to lift 750 gallons per minute from the Tualatin River with a used car engine. Many other farmers installed similar equipment.



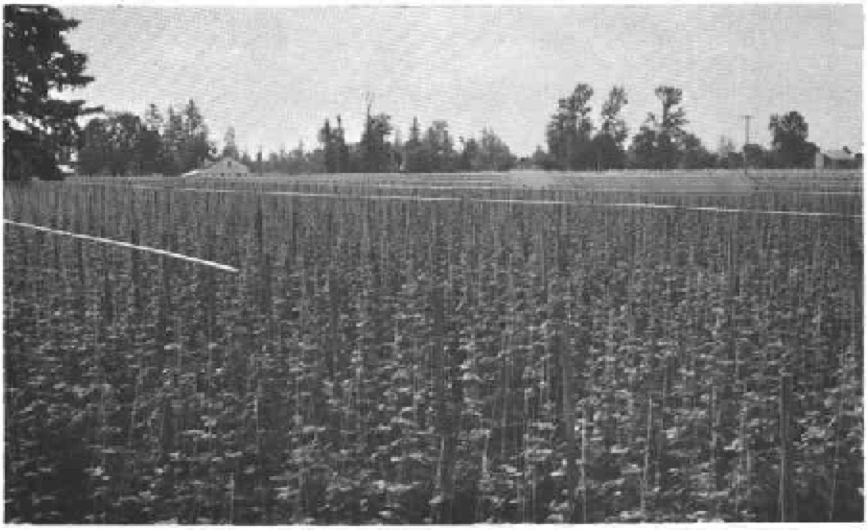
By 1940 three-phase power lines had been extended into most of the areas of concentrated irrigation. Mr. and Mrs. Folmer Bodtker, Junction City, were among hundreds of other farmers to indicate satisfaction with electricity as an economical and dependable source of power.

Before the advent of portable sprinkler equipment, pioneering farmers of Willamette Valley irrigated as best they could. J. G. Medler in 1933 found that it was necessary to pump 10 inches of water to put 3 inches into the subsoil of this Newberg fine sandy loam. Regardless, irrigation brought the moisture-starved walnut orchard into profitable production.

From the beginning, the expansion of irrigation in the Willamette Valley has been handicapped because it has seemingly been uneconomical to irrigate substantially "every acre on every farm" and "every farm" within a project. Beginning in 1963, the Experiment Station reinaugurated research to explore the possibilities of irrigating the poorly drained soil in the Willamette Valley. Much of this work is conducted on the Glenn Jackson farm near Lebanon, in mid-August a green oasis in a desert of brown or blackened rye-grass fields.



Mrs. Ida Rutschman, meter reader for the Dayton Irrigation Improvement Association in 1962, records the day's readings on charts kept in the farmer's workshop. Interest in improved irrigation practices is increasing.



By 1964 about 800 acres of "solid" sprinkler systems were in operation in the Willamette Valley. Two sprinkler manufacturers (R. M. Wade and Moore Rain) developed special quick couplers for small diameter pipe. First developed in 1962, this type of system will replace many now being used on high valued crops requiring good moisture control.

About 95% of the irrigation in the Willamette Valley was done by sprinklers in 1964. In the foreground county agent Hollis Ottaway, farmer Don Davidson, and KOAC-TV program director Bill Smith look over summer squash. Mr. Davidson is president of the North Marion Irrigators.

IRRIGATION TRENDS AND ANTICIPATED CHANGES

Active irrigation development in the Valley is only 30 years old. Predicting irrigation requirements 100 years or more into the future based on 30 years' experience is hazardous to say the least. The physical needs of crops can be described quite accurately; however, other considerations such as "reasonable" irrigation efficiency in light of existing skills and technology, economics of production practices, and competition for available supplies change continually. These are modifying factors, however, used to adjust the "net water requirement" to a "reasonable water requirement."

This section is concerned with identifying existing trends, as they may be useful in determining "reasonable" water requirements under existing and future farming practices and technological skills.

DEVELOPMENT TRENDS

Total Acreage

Estimates on potential irrigable acres in the Willamette Valley vary from 300,000 acres to over 1,500,000 acres. The main reason for such wide variation in estimates lies in the selection of land classes suitable for irrigation. Low estimates include only the better classes of land. Data from "Willamette Valley Land Adaptability," Oregon Agricultural Experiment Station Circular 120, March 1937, indicates the following acreages:

Class I	Class II	Class III	Class IV	Total
243,000	461,000	564,000	276,000	1,544,000

Data from House Document 544, 75th Congress, compiled by U. S. Army Engineers and submitted March 12, 1938, indicate the following acres:

Good irrigability	Fair irrigability	Total
695,000	678,000	1,373,000

Neither of these estimates includes the gently sloping hill-lands bordering the Valley floor and those extruding from the main Valley floor.

A current study on this question is being made by the Oregon State University Soils Department under the direction of Dr. Gerald Simonson. It takes into consideration new research results as they are related to what were considered "problem" soils by early estimators. Until this study is completed, the best estimate for potential irrigation development is "in excess of 1,500,000 acres."

Duty of Water

Early attempts to establish duty of water were concerned primarily with comparing increased production against cost of applying water to the land. In 1932 Powers summarized water requirements for a number of crops (Table 2).

Table 2. Average quantity of water giving maximum net profit per acre[1]

Crop	Years of average	Irrigation (inches)
Alfalfa	16	9.5
Red clover	17	7.9
Grass (mown)	5	11.2
Potatoes	19	4.5
Corn	19	5.5
Beets	8	5.3
Beans	19	3.6

[1]Powers, Twenty-five Years of Supplemental Irrigation, p. 9.

In 1941 Powers suggested a different economic duty of water.[32] He indicated a 12-inch depth would be required for annual crops and 18 to 24 inches for meadow crops measured at the farm field for 40-acre tracts. He also indicated a supply of five gallons of water per minute per acre of irrigable land was found to be adequate for the dry periods when sprinklers were used. These figures were developed on a different basis than the 1932 figures, in that they include the farm losses occurring during transportation of water from the diversion point and the farm application losses.

Calculated seasonal irrigation requirements for specific crops indicate a net requirement of 18.6 inches for Ladino clover pasture in the Willamette Valley.[33] This figure was calculated from average climatological data for longtime periods. Using this figure as a basis for water allocation on an annual basis, however, results in a surplus of water about one-half of the time and a deficit of water the other half. Using data from field trials, however, has its limitations in that it provides accurate information only for the years of record.

[32]Powers, Irrigation Requirement of Arable Oregon Soils, Ore. Agr. Exp. Sta. Bull. 394, June 1941, p. 26.

[33]F. M. Tileston and John W. Wolfe, Irrigation Requirements (Estimates for Oregon), Ore. Agr. Exp. Sta. Bull. 500, July 1951, p. 17

Changes in fertilizer programs, plant species, and irrigation technology have been significant since existing values were determined and as a result they are inadequate for making longtime projections. A revision of Oregon Agricultural Experiment Station Bulletin 500 is now under way by the Oregon State University Agricultural Engineering Department. When completed, it will provide the most up-to-date source of net water requirements estimates available. It will provide not only the longtime average for specific crops but also the chance of occurrence for maximum and minimum values.

Acres Irrigated Per Farm

The average acres irrigated per farm increased 67% from 1929 to 1959. The average size of the irrigated farm increased only 21% during this period. This relationship, shown in Figure 2, is important in that it indicates a trend to irrigate a greater proportion of land within irrigated farms. This trend should result in irrigation of more land within proposed irrigation project boundaries and improve the economic feasibility of such project developments.

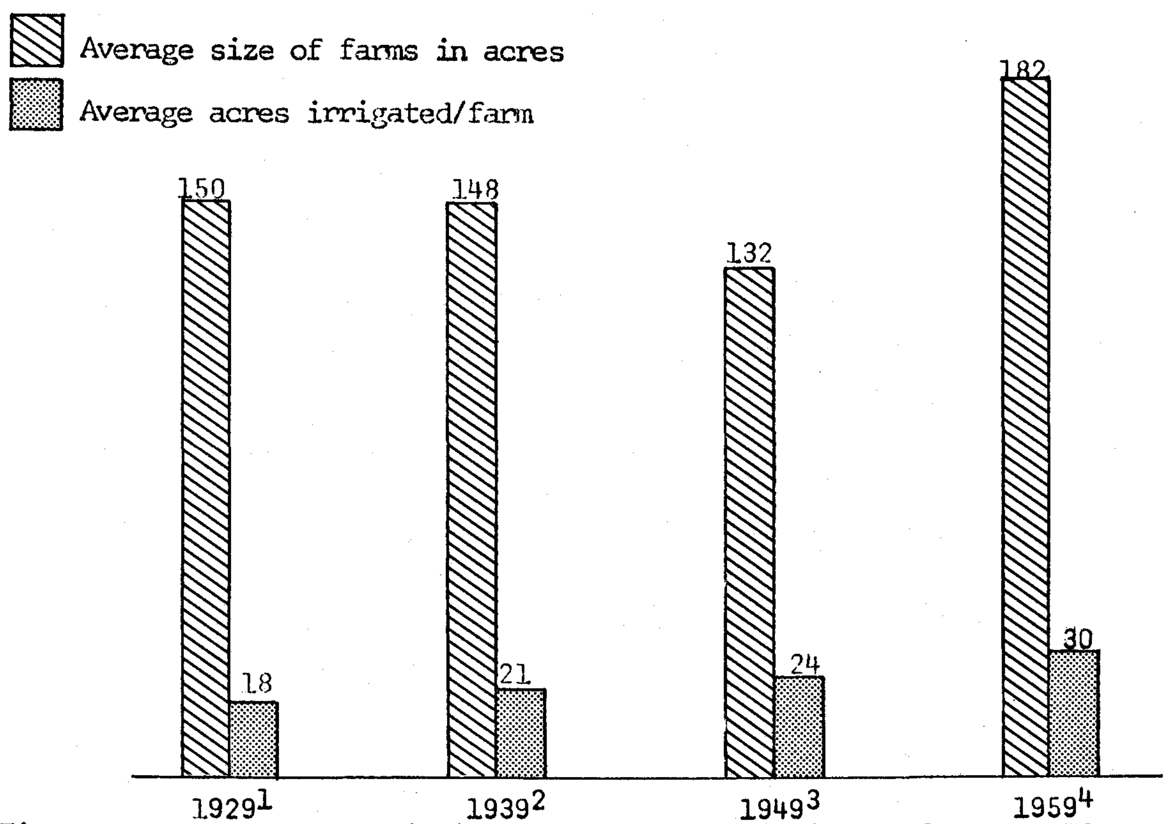


Figure 2. Average acres irrigated and size of irrigated farms at 10-year intervals.

[1]Calculated from 1930 Census of Irrigation. [2]Ibid., 1940.

[3]Ibid., 1950. [4]Calculated from 1959 Census of Agriculture.

Type of Enterprise

Early census figures do not give the acreage served by community enterprises; however, from 1949 to 1965 the percentage of land irrigated from community projects increased 435%. Interest in group-type enterprises existed from the time irrigation first started in the Valley. Detailed descriptions of many of these projects are found on pages 44 through 69 of this report.

Most irrigation in the Willamette Valley has not been developed on a project basis (Figure 3). Future irrigation expansion, however, will lean more heavily to project-type developments because of the problem of developing and transporting adequate water to lands removed from existing sources of water.

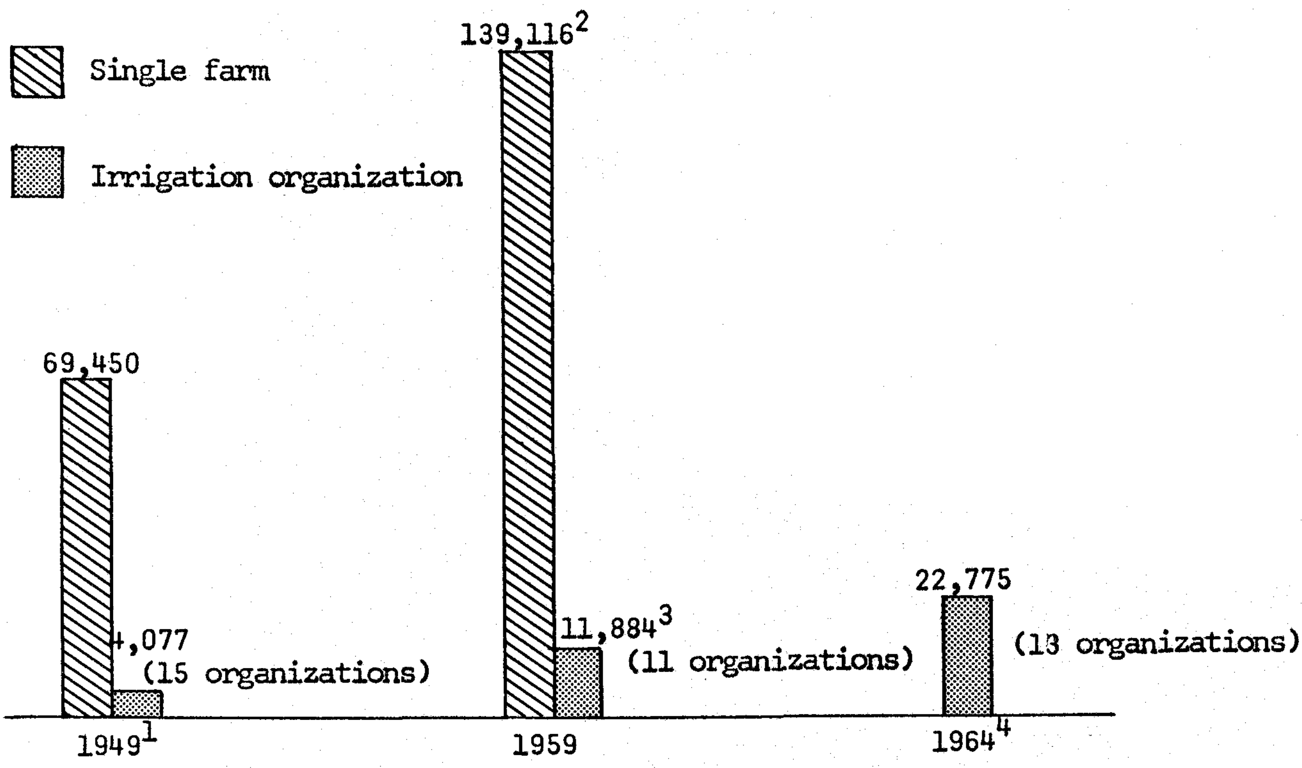


Figure 3. Acres irrigated by type of enterprise.

[1]1950 Census of Irrigation.

[2]Calculated from 1959 Census of Agriculture.

[3]1959 Census of Agriculture.

[4]Field interviews by Bill Averill.

Water Source

The percent of total land irrigated from various water sources has changed considerably from 1950 to 1960, as shown in Figure 4. Seventy-two percent of the land was irrigated from surface sources in 1950, as compared with 58% ten years later.

Early reports indicate that until the early 1930's nearly all water for irrigation was developed from streams. Gravity diversions and small pump installations diverted water to the land for surface irrigation. As stream water became short due to increased demand and as irrigated lands became further removed from streams, the development of ground-water for irrigation increased. As ground-water areas become saturated with wells, a new source of supply will be needed. The most obvious source at present is the large storage reservoirs of the Willamette Basin Project.

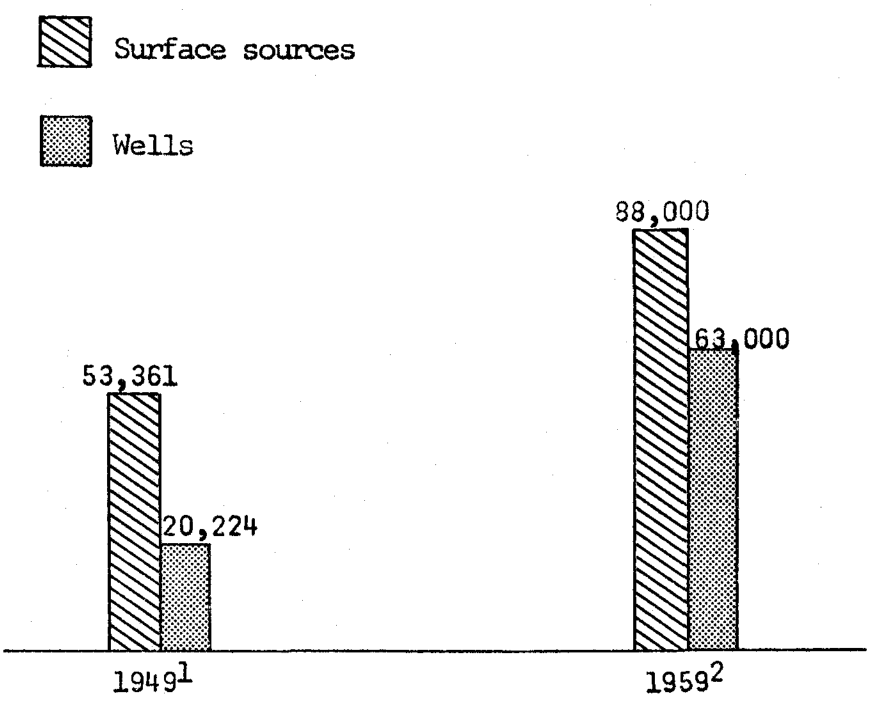


Figure 4. Acres irrigated by water source.

[1] Calculated from 1950 Census of Irrigation.

[2] 1959 Census of Agriculture.

Water from sewage and processing waste is being used more extensively, as shown in Figure 5. Although sewage may not be a major source of water for irrigation in the future, such use can provide the solution to a major problem facing certain types of industrial expansion and water pollution problems. The operation of the seven systems now in use are discussed on pages 36 through 43.

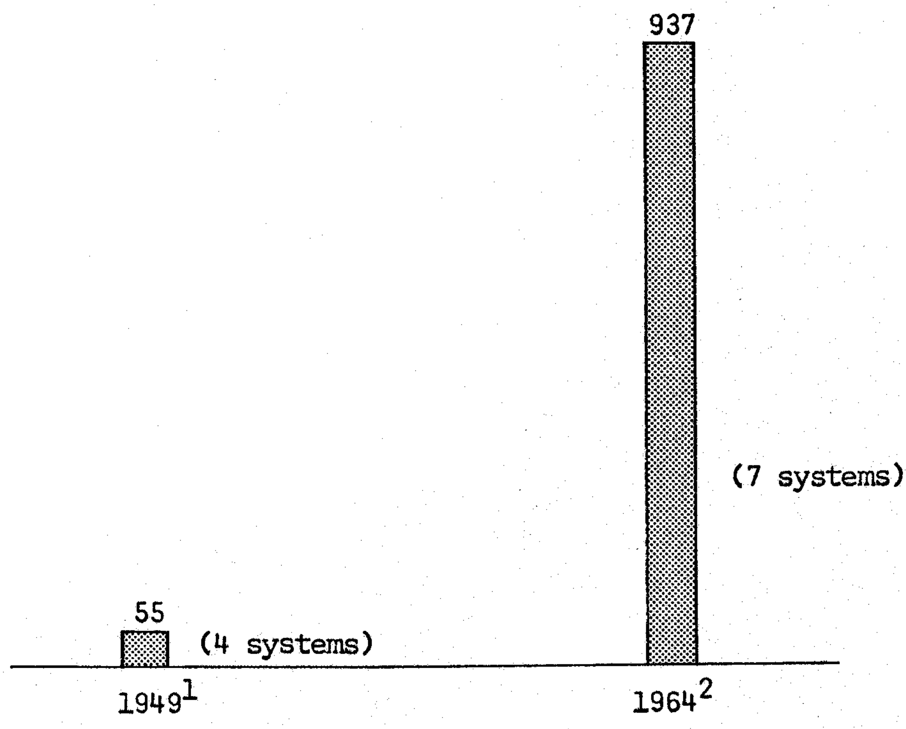


Figure 5. Acres irrigated from sewage or other effluent.

[1]Calculated from 1950 Census of Irrigation.

[2]From field interviews with operators of known installations. See pages 36 through 43.

Crop Response

The irrigation requirement for maximum production of crops varies due to production practices, crop characteristics, and weather patterns. Fertility programs and crop varieties continually change. Under one system of management fertility may be a limiting factor. Once this deficiency is satisfied, however, water may become a limiting factor. An example of this is shown in Figure 6. Maximum yields with 50 pounds of nitrogen required 11.4 inches of water. Maximum yields with 100 pounds of nitrogen required 17.6 inches of water. There was an increase in yield of 3.4 tons per acre when both deficiencies were satisfied. This interrelationship of moisture and fertilizer is true in all crops requiring irrigation, but is particularly important for horticulture crops. Water allocations must be adequate for the highest levels of management.

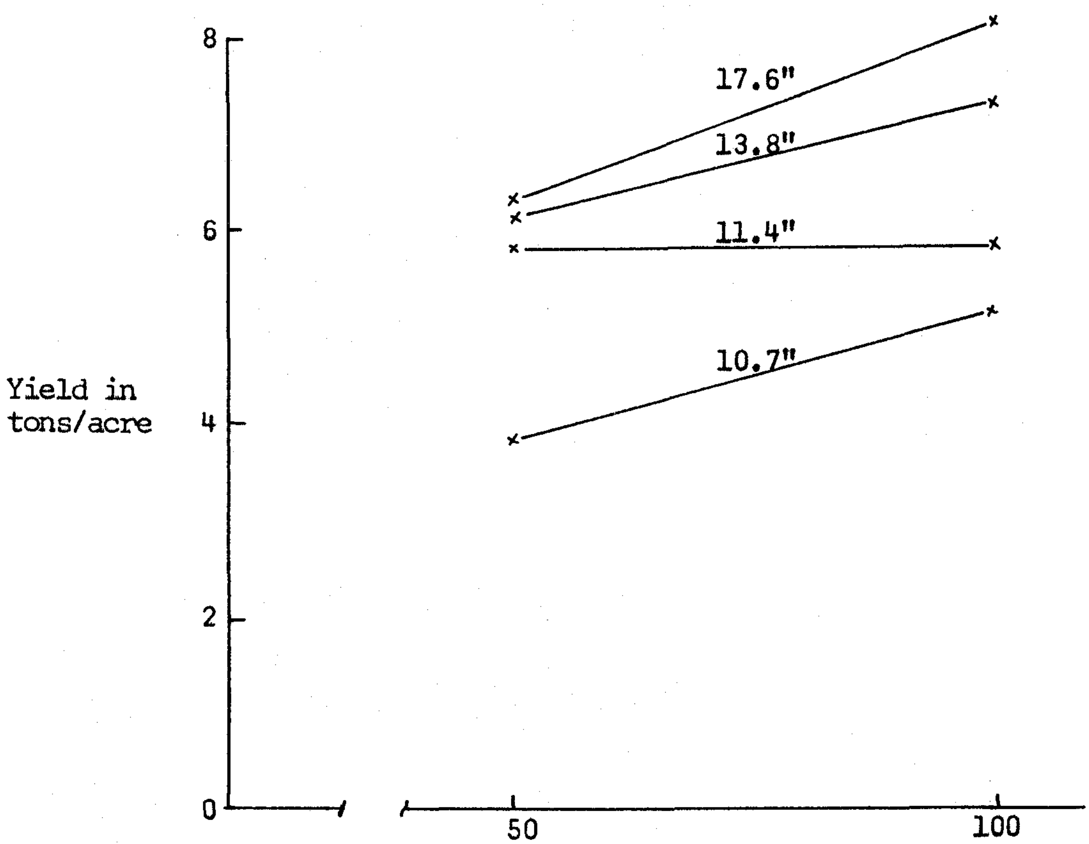


Figure 6. Sweet corn irrigation requirement as affected by fertilizer program.[1]

[1]D. D. Evans, et al., Growth and Yield of Sweet Corn, Ore. Agr. Exp. Sta. Tech. Bull. 53, September 1960, p. 20.

Method of Irrigation

The switch from surface irrigation systems to sprinklers in the Willamette Valley has been almost complete, although some farmers still favor surface irrigation. The record shown in Figure 7 indicates not only that the percentage of land irrigated by sprinklers increased from 77% to 94% in a 10-year period, but also that the acres of surface irrigation decreased about 37% at the same time. This trend is likely to continue as water becomes more scarce and more expensive to develop.

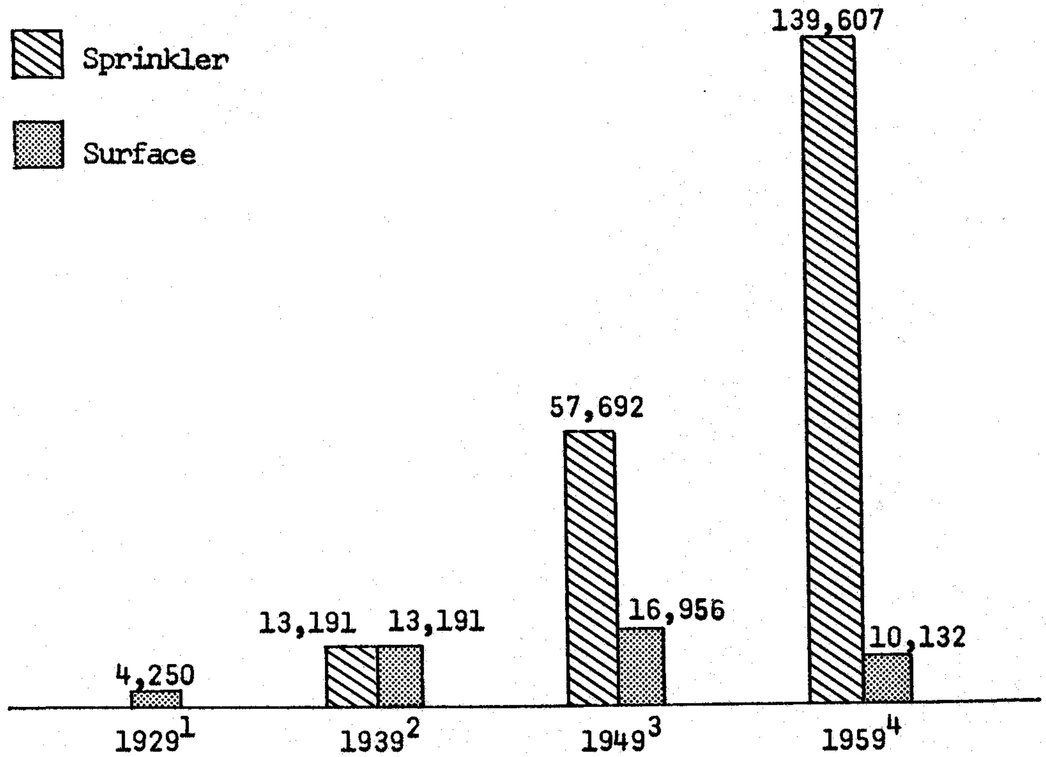


Figure 7. Acres irrigated by method of irrigation.

[1]Sprinkler irrigation acreage was insignificant in 1929. Rotating agricultural sprinklers and perforated pipe had not yet been developed. The few existing overhead systems were of the Skinner type.

[2]Estimated by Art King. Following development of irrigation in the early 1930's farmer acceptance spread rapidly. Powers reported in the 1939 SSA Proceedings that by 1936 two-thirds of the 117 irrigators in the Eugene area were using sprinklers.

[3]Calculated from 1950 Census of Irrigation.

[4]Calculated from 1959 Census of Agriculture.

Farm Application Efficiency

The trend to sprinklers is important from the water requirement standpoint because of the overall efficiency of application which can be achieved through sprinklers by even the inexperienced irrigator. Average irrigation efficiency of existing sprinkler systems will vary from 65% to 75%[34] but may be even less in areas of consistently high winds. Average surface irrigation efficiencies, even on well-planned and prepared surface layouts, rarely average more than 50% efficiency.[35]

This general relationship has proven to be true in Washington's Columbia Basin area, where a three-year study by the Bureau of Reclamation[36] showed an average of 4.19 acre-feet per acre used with surface irrigation systems as opposed to 3.57 acre-feet per acre used with sprinkler irrigation systems.

A more recent study comparing surface and sprinkler irrigation in the Columbia Basin showed farm efficiencies of surface systems to be 43.4% as compared to 64.3% for sprinkler systems. In addition, 95% of the farm land was cultivated under sprinkler systems while only 90% was cultivated under surface systems.[37]

These figures mean that 50% to 70% of the water applied was used by crops grown on the fields; they do not mean the water was lost. Waters which left fields by runoff or deep percolation were reused on other fields or for other purposes.

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[34]This includes both evaporation losses and distribution irregularities. Authorities disagree on procedures for determining application efficiency through sprinklers. A good discussion on the subject is found in Sprinkler Irrigation (2nd ed., Washington, D. C., Darby Printing Co., 1950), pp. 109-115, compiled and edited by Guy O. Woodward.

[35]Numerous studies of existing practices have been made in the Ontario, Hermiston, and central Oregon areas under conditions usually more favorable for surface irrigation than found in the Willamette Valley. Recent results are summarized in: Improving Irrigation in Eastern Oregon, Oregon Agr. Exp. Sta. Bull. 558 (1956); Irrigation Efficiency, Consumptive Use on the North Unit Project, Oregon Agr. Exp. Sta. Misc. Paper 72 (1959); and Improvement of Irrigation Practices in the Umatilla Project, Oregon Agr. Exp. Sta. Spec. Rept. 166 (1963).

[36]U. S. Department of Interior, Bureau of Reclamation, Comparisons of Sprinkler and Surface Irrigation Methods, Irrigation Block 1, Columbia Basin Project, Washington, June 1953.

[37]L. R. Swarner and M. A. Hagood, "Irrigation Trends in the Pacific Northwest," Agricultural Engineering, June 1963, p. 305.

Irrigation Management

Proper irrigation scheduling is a major problem among Willamette Valley irrigators. Improving existing schedules, however, may or may not affect the seasonal demand for waters. Existing farmer practice is not a good criteria for determining water requirements.

A study of 27 farms in the Portland area in 1952 showed a general trend toward overirrigation in the spring and fall and underirrigation in the summer. Only 2 of the 27 farms conducted what could be considered good full-season irrigation programs.[38]

Two surveys on pole beans showed variation in the number of irrigations and the amount of water applied to pole beans. These are tabulated in Tables 3 and 4.

Table 3. Variation in amount of irrigation water applied to pole beans

Year	Number of farms applying						Total farms
	0-5 in.	6-10 in.	11-15 in.	16-20 in.	21-30 in.	31 plus in.	
1946[1]	2	12	8	7	7	9	45
1953-58[2]	3	9	4	2	-	-	18

[1]From unpublished data of M. H. Becker, Extension Farm Management Specialist, OSU, Corvallis. Data for other crops showed this same variation.

[2]Data obtained from cooperative soil-moisture observation programs conducted by Portland General Electric Company, Oregon Cooperative Extension Service, and farmers.

Table 4. Variation in number of irrigations applied to pole beans

Year	Number of farms applying					Total no. of farms
	0-5 irri.	6-10 irri.	11-15 irri.	16-20 irri.	Over 20 irri.	
1946[1]	6	29	4	4	2	45
1953-58[2]	9	10	1	-	-	20

[1]Becker. [2]Cooperative studies.

[38]Study was conducted by Elwood Dull, Special Extension Agent in Soils and Irrigation, 1952.

The latter summary shows considerably more uniformity in irrigation practices than the 1946 report. This change may have been caused by the variation in management abilities of the growers that were studied or it may be the result of an extensive irrigation scheduling education program conducted from 1952 through 1958 by the Oregon Cooperative Extension Service and the Portland General Electric Company.

The Portland General Electric Company also recorded irrigation programs on 56 farms from 1956 to 1958. Crops grown included alfalfa, small fruit, pasture, potatoes, and vegetables. An evaluation of the irrigation programs on these farms shows:

Farms receiving adequate total water		28
rated good scheduling	8	
rated fair scheduling	16	
rated poor scheduling	1	
rated too much per irrigation	3	
Farms receiving inadequate total water		28
rated one irrigation short	17	
rated very poorly scheduled	11	
Total		56

Yields were taken on many of the farms and although they were related to the quality of the irrigation program, they were not related to either the total amount of water applied or the number of irrigations applied during the season.

Farmer Interest in Irrigation Management

Evidence that farmers will strive toward improving the quality of their irrigation programs is shown by their interest in devices which will aid in planning better irrigation programs. Many hundreds of farmers in western Oregon have used soil-moisture measuring equipment for scheduling irrigations. Reading the equipment has been a management problem, however, and many farmers have not continued to use it.

Three soil-moisture measuring associations are in operation in the Willamette Valley for the purpose of providing a reading service. They are:

The North Marion Irrigators, organized in 1959.

The Dayton Irrigation Improvement Association, organized in 1962.

The Washington County Irrigation Improvement Association, organized in 1959.

Cost for this service has generally ranged from $40 to $100 per farm per season, plus the cost of the equipment used. The minimum number of measuring stations was four per farm; the average was eight to ten. Memberships in each of the associations varied from 18 to 25.

In addition to providing a reading service, these organizations have cooperated with the Extension Service in sponsoring meetings dealing with hydraulics of sprinkler systems, crop response to soil-moisture levels, soil-moisture movement and plant relation, and evaluation of irrigation programs.

Pattern of Water Diversion

Although crop requirements may be most important in determining water diversion patterns, many production practices and specific management requirements of crops are just as important. For example, forage is probably better adapted to a minimum continuous-flow diversion than any other type of crop, yet it has one of the highest seasonal requirements. In contrast, small fruits and vegetables have smaller seasonal requirements but are not adapted to continuous-flow diversions because of insect control programs, harvesting inconveniences, and other necessary production practices. Periodic requirements for small fruits and vegetables, therefore, are much higher than for forage.

This problem is not great when water can be freely traded between water users on a rotation or demand schedule as practiced in irrigation districts. As of 1959, however, 94% of the irrigated land in the Willamette Valley was developed on an individual enterprise basis. Rotation between farms is generally awkward and impractical under this type of development pattern.

The "solid set" sprinkler system makes practical very low application rates, improved uniformity of distribution, and maximum flexibility in operation. In spite of investments of four times that of the normal hand-move system, between 700 and 800 acres of "solid set" systems were installed in the Willamette Valley from 1962 - 1964.[39] Most of the systems serve from 5 to 20 acres each.

An industry spokesman estimates that nearly all row crops in the Willamette Valley will be under solid set systems within 10 years. This could change the pattern of demand for water for specific periods considerably, although it would not affect the total season requirement much. To what extent solid sets will affect specific period demands will depend upon how the system is used on the farm, the crops for which it is used, and whether or not special uses such as frost protection are incorporated into the system. Conceivably, periodic demands could reach 80 to 90 gallons per minute per acre. This is a sharp contrast to the 5.6 gallons per minute now allocated in western Oregon.

Cropping Patterns

The types of crops grown affect the amount of water required both for specific periods and for the complete season. With the exception of

[39] Estimated from manufacturers.

irrigated pasture, the acreage of specific crops being irrigated has not been enumerated by the U. S. Census. Figure 8 indicates the growth of irrigated pasture as a percent of the total acres irrigated. These figures indicate that from 1939 to 1959 the percentage of pasture land irrigated to the total land irrigated increased from 19% to 29%. The remainder of the irrigated land was in vegetables, small fruit, orchards, and seed and other field crops. Whether or not pasture acreage increases depends on the growth of the livestock industry in western Oregon. But even if there is no increase in pasture acreage, double cropping by vegetable growers will require full water allocation for the entire season.

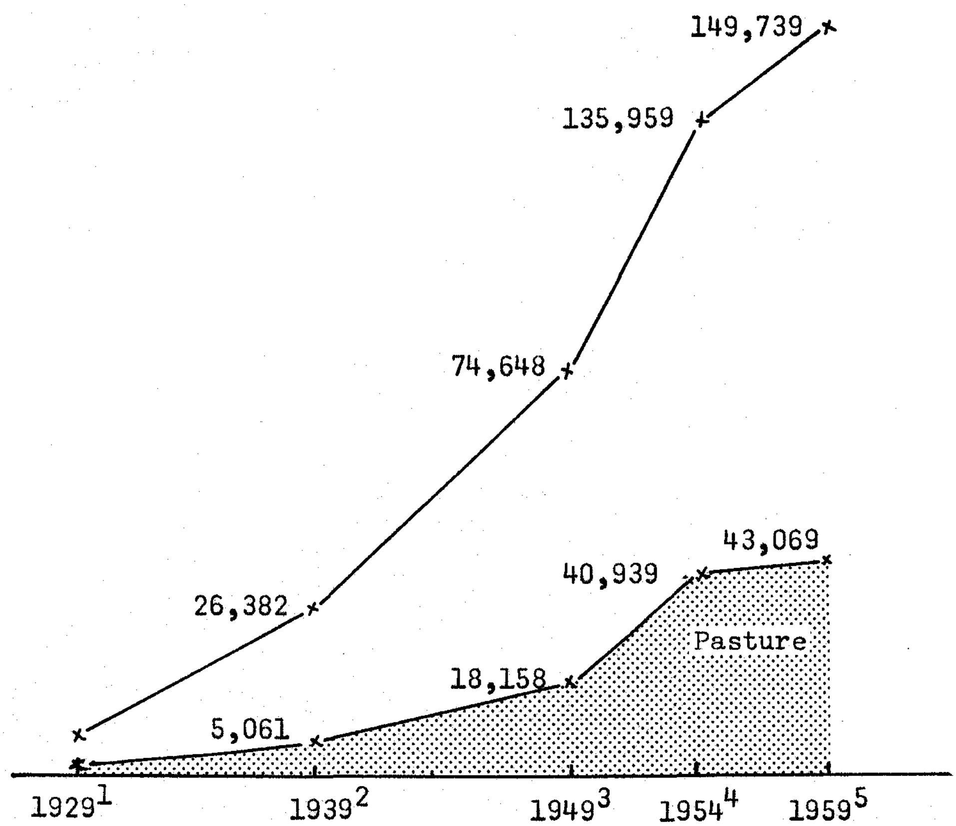

Figure 8. Acres of pasture irrigated compared to total land irrigated.

[1]Calculated from 1940 Census of Agriculture. [2]Ibid.

[3]Ibid., 1950. [4]Ibid., 1954.

[5]Ibid., 1959 (This figure includes some cropland not harvested.)

The amount of water used for only part of a season has been insignificant. In 1950, Irrigation Census data shows 280 acres received water before July 1 only, 63,040 acres received water before and after July 1, and 9,442 acres received water after July 1 only. The average amount of water delivered per acre irrigated for three years is shown in Figure 9. This is the gross amount of water and includes losses on the farm through seepage, evaporation, and uneven distribution through the irrigation system, in addition to water actually used by the crop.

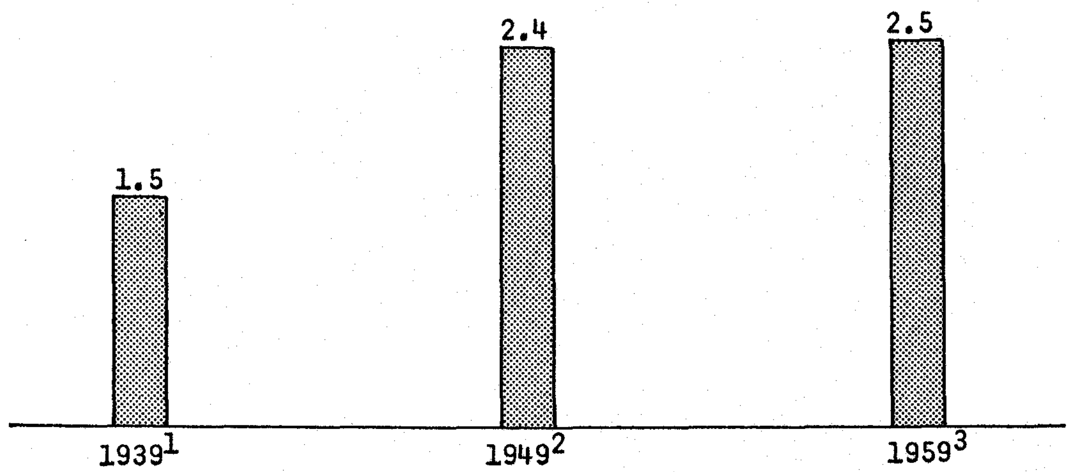

Figure 9. Average acre-feet of water delivered per acre irrigated.

[1]Calculated from 1940 Census of Irrigation.

[2]1950 Census of Irrigation. [3]1959 Census of Agriculture.

Anticipated Needs

Two approaches can be used in predicting ultimate water requirements for irrigation in the Willamette Valley. One is based on the assumption that no land should be placed in the "to be irrigated" class unless there is evidence supporting the conclusion that it will be irrigated. The second approach assumes that all cultivated land will be irrigated unless there is evidence to the contrary.

Evidence available to date suggests no reason why all cultivated land in the Willamette Valley will not eventually be irrigated. Factors encouraging irrigation development support this conclusion. Acceptance of this approach would allow use of the following procedure for estimating water requirements.

1. Assume that all land that is classified as irrigable will eventually be irrigated.

2. Assume a net water requirement for this acreage based on the droughtiest year of record for a full-season, high-use crop such as Ladino clover pasture.

3. Adjust this figure to allow for "reasonable" irrigation efficiency.

4. Readjust this figure only as significant evidence becomes available to justify such action.

Data for points one and two can be obtained from documents now being prepared by the Soils and Agricultural Engineering Departments, Oregon State University. Guides for adjusting the net requirement can be obtained from this document, documents referred to, and future research information. Provision should be made for periodic evaluation and readjustment of acreage and water requirement estimates as new evidence justifies such action.

WASTE WATER DISPOSAL THROUGH IRRIGATION

Irrigation is necessary in the Willamette Valley because of the recurring summer drought. Irrigation diversions deplete the low natural flow of streams, compounding problems of maintaining water quality on those streams carrying waste water from industrial plants or municipalities. The seasonal operation of food processing plants aggravates the problem in some areas. It is therefore logical to consider the possibility of utilizing some substantial share of effluents or waste water for irrigation and thus avoid overloading streams with pollutants, particularly organic materials.

The planned irrigation use of waste water carrying a high percentage of organic material in the Willamette Valley dates back to 1940 when the City of Hillsboro was seeking a means of reducing the biochemical oxygen demand (BOD) content of waste water from food processing plants without damaging additions to the already high BOD level of the summer flow of the Tualatin River.

With the assistance of the Extension Service, a plan was developed to utilize the water for sprinklers. The plan had two objectives. It was assumed that since the waste water carried no harmful salts, it could be beneficially used for irrigation. In addition, it was anticipated that biological activity in the soil would substantially reduce the level of organic material as the water percolated through the soil. The first season's experience indicated that both objectives were substantially achieved.

Realizing that it would be necessary to supply water in excess of consumptive use on the 20 acres originally available for irrigation, the City of Hillsboro installed a tile drainage system to facilitate the percolation and removal of excess water. While the exact levels are not known, the BOD content of the drainage water returned to the Tualatin River was deemed as satisfactory in quality. The untreated material was definitely not satisfactory.

As a result of the early favorable experience, the City of Hillsboro later included the discharge from the sewage treatment plant with the water being used for irrigation. The added volume of waste water used in this manner necessitated the inclusion of additional land in the irrigable area. In 1964, one million gallons per day was applied continuously to 200 acres.

Yields of vegetables were highly satisfactory, but after the first year or two the irrigated area was seeded to grass and clover. This shift was made because of the higher consumptive use of grass and clover; because their deep extensive root systems aided percolation; because of greater tolerance to overirrigation of grass and clover as compared to vegetable crops; and because many crop management problems were eliminated.

In 1950 the Stimson Lumber Company, Hardboard Plant, located on Scoggins Creek in Washington County, faced the problem of disposing of several hundred gallons per minute of water with a high BOD content, during the summer months. Based on the success of the operation at Hillsboro, it was suggested that the water be used for sprinkler irrigation. Arrangements were completed to use the water for the irrigation of pasture on a neighboring dairy farm owned by Knox Brothers. In the early years of operation, pasture production was excellent and the BOD content of a substantial volume of percolating water was at a satisfactory low level as it returned to Scoggins Creek. At the present time, the plant is disposing of 600 gallons per minute through the irrigation system from May to November. Results are usually satisfactory, though high BOD content in the return flow often results if the sprinklers are not moved on a satisfactory schedule.

Research

Research conducted at Oregon State University by R. O. Blosser and E. L. Owens, National Council for Stream Improvement, reveals significant information on the magnitude of the reduction of BOD levels resulting from percolation of pulp-processing effluents through four different Willamette Valley soil types. Effluents were applied to columns of soil supporting a growth of Alta fescue with irrigation rates varying from 5 to 11 inches per week, an excess of two to four times the normal water requirements of Alta fescue. Results were measured in terms of the quality of the recovered percolate, the effect of soil permeability, chemical changes in the soil, and growth of the Alta fescue. The experiments were conducted over a period of nine months or more, the equivalent of two to three years actual use of the effluents in the field.

Results of the work indicated that, with application rates carrying a BOD loading of up to 235 pounds per acre per day, a reduction of 95% in the BOD content of the recovered percolate was accomplished. With this rate of application, the Alta fescue maintained excellent growth and the soil permeability was not impaired. Water with a sodium absorption ratio of up to eight was handled without injuring the growth of the Alta fescue or reducing the soil permeability. There was some deflocculation on one soil with a high clay content, but this was easily corrected with addition of calcium.

Blosser and Owens suggested that, under field conditions, the use of irrigation or "land disposal" pulp mill effluents, when applied at a rate not exceeding 200 pounds per acre per day BOD, results in excess of 95% reduction in the BOD level. This would require a soil that would permit the effluent to percolate through a minimum of 20 inches of soil. They further suggested that effluents with a sodium absorption ratio of eight or less could be handled effectively on permeable soils. With these levels of application, a good stand of Alta fescue could be maintained. The growth of fescue or a similar vigorous crop with an extensive root system is essential to continued operation.

It would be reasonable to assume that this information could be used as a guide for the disposal or use of other industrial or municipal effluents insofar as reduction of BOD levels are concerned.

Under this study, W. S. Averill completed field interviews with the municipalities and industrial companies known to be disposing of part of the effluent or waste water by irrigation. It was the intention of these interviews to gather only general information regarding each operation--the amount of water handled, degree of success, and suggestions as to why or why not the operation was successful. The seven "disposal" projects visited handled a peak volume in total of 8,200,000 gallons per day, about 25 acre-feet per day. This water was applied to 937 acres.

A summation of the interviews suggested that with proper management and an adequate acreage of soil of suitable permeability:

1. A satisfactory reduction in the BOD level can be accomplished during the irrigation and percolation process.

2. Satisfactory forage crops can be grown when irrigated with water carrying high levels of organic material.

3. The use of irrigation and percolation may be less costly than other means of reducing BOD levels.

The interviews further suggest that, with the existing operations, satisfactory effluent disposal was the major objective. There was practically no effort to achieve satisfactory or profitable crop production. There was evidence of damage to stands of grass because of failure to remove matured growth. Overirrigation for limited or extended periods resulted in surface runoff and little significant reduction in BOD levels. In most cases, a limited land area made overirrigation necessary.

The results of limited but significant research and practical field experience with a fairly wide range of effluents, both industrial and municipal, suggest that, with proper management, substantial improvement in water quality can be effected by utilizing the effluents for irrigation, possibly at less cost than other methods of purification. Of greater importance, both research and experience suggest that substantial areas of land could be irrigated profitably with these effluents. Such reuse of water would eliminate part of the competitive demand for summer stream flow, since irrigation would not represent a competitive use with municipal and industrial use. Substantial quantities of water might serve either municipalities or industries and subsequently be used for profitable irrigation. There would be additional benefits in improved water quality.

Research to date and information obtained from the field interviews suggest points worthy of consideration in improving the effectiveness of waste water disposal through irrigation and in profitably utilizing the water for irrigation:

1. The acreage available for disposal should limit the BOD application to 200 pounds per day or less, with a rate of water application less than percolating capacity of the soil.

2. A good cover of grass or clover and grass should be established and maintained. Fertilization should be adequate to support maximum growth.

3. It is preferable to harvest the crop as hay or as silage rather than use as pasture. Livestock interfere with the operation of the sprinkler irrigation equipment, and tramping can seriously reduce the rate of water movement through the soil. Harvesting is necessary to maintain a good stand of cover, and a good cover is necessary to maintain a maximum percolation rate through the soil. Also, a vigorously growing cover substantially reduces the amount of water returned to the drainage system.

If the objective is to obtain maximum returns from irrigation, these points seem important:

1. The acreage available for disposal and irrigation should be double that required primarily for disposal. The extra acreage is necessary to permit disposal to continue without damage to crops during periods when their use of water is low.

2. Regardless of the crop grown, a portion of the acreage should be devoted to clover and grass to provide means for disposal during periods of low use by crops.

3. Access to additional water is desirable to permit supplementing the fixed waste water supply during periods of peak use. The additional water could be helpfully used as a dilutant in case of an unanticipated occurrence of harmful salts or other materials in the waste water.

4. It would seem that the ultimate in waste water disposal and in returns from irrigation could be achieved by handling the disposal in cooperation with a project-type irrigation development. This would permit the adjustment of water supply through controlled additions of supplemental water and in distributing water to locations within a sizable area where cropping needs are the greatest.

5. Additional studies to determine the best methods of managing crops irrigated with various types of effluents are highly desirable.

6. Additional research is desirable (1) to determine the extent of danger from pathogenic organisms in connection with use of municipal effluent and (2) to determine the effective methods of control if there are possible harmful effects.

The following summarizes information obtained by W. S. Averill from field interviews.

UNITED GROWERS, Salem

Date started: 1960.

Source of water: Waste water from processing plant.

Amount of water: No estimate.

Where applied, acres: 100 acres. Part native wood and pasture, part seeded.

How applied: Sprinkler. Connected with sewer in 1965 but will continue to sprinkle some, out of settling pond.

Crops grown: Grass.

Disposal of crop: Wood area pastured. Cultivated area cut for hay.

Comments: Seems to work satisfactorily.

WEYERHAEUSER PLANT, Springfield

Date started: 1959.

Source of water: Waste from processed board plant.

Amount of water: About one million gallons per day.

Where applied, acres: 52 acres.

How applied: Sprinkler. Apply about one-half inch of water per day.

Crops grown: Alta fescue and Canadian clover.

Disposal of crop: Formerly used as pasture, now cut for hay. Stop sprinkling long enough to harvest hay.

Comments: Flood irrigation proved impractical since the hot water killed the grass. Waste goes back into McKenzie River in winter.

STAYTON CANNING COMPANY, Stayton

Date started: 1961.

Source of water: Waste water from processing plant.

Amount of water: 500 to 1,400 gallons per minute, depending on operation.

Where applied, acres: 50 acres. Another 50 acres available.

How applied: Sprinkler.

Crops grown: Grass.

Disposal of crop: All grass cut for hay before plant starts operation, then let grow the rest of season.

Comments: Are working on idea of reusing some water in the plant, thus cutting total volume needed during season.

FOREST FIBER PRODUCTS CO.
Stimson Hardboard Plant, Scoggins Valley, Forest Grove

Date started: 1950.

Source of water: Processing water from hardboard plant.

Amount of water: 600 gallons per minute, 24 hours a day, 6 to 6 1/2 days a week, May to November.

Where applied, acres: 160 acres on Fred Knox dairy farm. Plant sends water to fields under pressure. Water applied to tiled ground got away too fast for satisfactory BOD reduction (probably surface runoff entered tile lines).

How applied: Sprinkler.

Crops grown: Mostly grass and grain, with some corn and other crops.

Disposal of crop: All used for dairy cattle feed.

Comments: Winter water goes into Scoggins Creek. BOD content of waste water is 1,500 to 6,000 parts per million. The reaction is pH 4. In 1965, the plant plans to operate its own sprinkler system on 100 acres of company-owned land.

BIRDS EYE PLANT, Woodburn

Date started: 1963.

Source of water: Waste water from vegetable and berry freezing plant. High BOD water goes through lagoons, then sprinkled.

Amount of water: Three million gallons per day at peak. 1,300,000 gallons daily through lagoons, then to Pudding River.

Where applied, acres: 80-acre tract, irrigated with a solid-set sprinkler system, gets all water it will take. Another 60 acres get surplus water.

How applied: Sprinkler.

Crops grown: Grass.

Disposal of crop: 80 acres chopped and left on field. 60 acres, two miles from plant--first crop given away for cutting.

Comments: Apply mosquito control at end of irrigation. Grass not building up on the 80-acre tract.

CITY OF HILLSBORO

Date started: 1940.

Source of water: Sewage disposal including water from crop processing plants.

Amount of water: One million gallons per day.

Where applied, acres: 200 acres.

How applied: Sprinkler.

Crops grown: Grass. Mostly tall fescue.

Disposal of crop: Pastured some sheep. Burned most of grass. Vegetables grown on the first 20 acres irrigated.

Comments: Apply all water soil will take. Remainder passes through trickling and activated sludge plant. BOD content satisfactory on percolate from irrigated area.

CITY OF FOREST GROVE

Date started: 1953.

Source of water: Discharge from primary sewage treatment plant plus water from two or three processing plants.

Amount of water: One million gallons per day.

Where applied, acres: 195 acres.

How applied: Sprinklers.

Crops grown: Native grass.

Disposal of crop: Largely pastured by cattle and sheep.

Comments: Heavy type soil. Applied more water than soil would absorb. Stopped by state in 1965, BOD level too high.

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IRRIGATION BY ORGANIZATIONS OR PROJECTS

The 1959 U.S. Census of Agriculture defined irrigation organizations as comprising a group of two or more water users, a company, a corporation, a governmental district, or an agency that operates facilities to supply water for the irrigation of farm and ranch lands.

To avoid confusion with the many and varied nonoperating organizations interested in Willamette Valley irrigation, in this study we are using the word project instead of organization in referring to multiple-farm developments.

Prior to 1949, census reports on irrigation by "organizations" did not include the Willamette Valley. The 1949 census reported that 15 organizations supplied water for 4,077 acres. The 1959 census reported that 11 operating irrigation "organizations" provided water for 11,884 acres and that 139,000 acres were irrigated by individual farm enterprises.

Field interviews completed by W. S. Averill as a part of this study and other available information[40] may not accurately reflect either the number of organizations or the acreage irrigated. The discrepancy may be due to the widely scattered and informal nature of irrigation organizations or projects in the Valley. The field interviews indicated there was a decline in the number of projects between 1940 and 1950, with some increase in the number between 1950 and 1960.

Project Development Prior to 1930

A large part of the early irrigation in the Willamette Valley came about because of the initiation of three different projects at about the same time, 1909 to 1910. In 1909, the Molalla Irrigation Company, a group of 22 farmers organized into a nonprofit corporation, constructed a gravity diversion from the Molalla River to irrigate about 800 acres. The project has been in continuous operation since that time, with some increase in acreage.

The other two projects were speculative, built by companies or partnerships with the intent of profiting from the sale of water or the sale of water and land. At that time, speculative irrigation developments were under way throughout the arid West.

A company known as "Benham Investments" constructed a project in 1909 to divert water from the North Santiam River to irrigate 30,000 acres in the West Stayton-Turner-Marion area. It was also intended to dump water into Mill Creek to be used on several thousand acres of land

[40] Annual reports, A. S. King, 1932-1944.

near Salem. The project started the delivery of water in 1910; about 1,000 acres were irrigated in 1911. In the ensuing 50 years the project passed through five different ownerships. There were sporadic increases in acreage; in later years acreage was determined by the demand for vegetable crops for processing. In 1960 the Santiam Water Control District was formed to include the farms that were already served by the project. Financed by a loan from the Farmers Home Administration, the district purchased the interest of the Willamette Valley Water Company. The Santiam Water Control District is now irrigating 12,000 acres and has facilities to irrigate an additional 12,000 acres.

The third project was initiated by the Springfield Irrigation Company in 1909. Water was diverted by gravity from the McKenzie River near Hayden bridge. A canal was constructed to deliver a gravity flow to the peninsula lying between the McKenzie and Willamette rivers north of Springfield. The first water was delivered in 1910. Available records do not indicate the acreage irrigated. There is evidence to indicate that insufficient water was sold to justify adequate maintenance. In 1934, three farmers rebuilt the essential parts of the diversion system to irrigate 300 acres by surface methods. Later, other farmers were included and in 1939 a nonprofit corporation was formed. It was delivering water to 2,300 acres in 1942. Much of the water was pumped from the delivery canal for sprinkler irrigation. Industrial and urban expansion of the Eugene-Springfield area following World War II encroached both on the irrigated land and on the diversion system. At the present time, two of the original three farms involved in the project cooperate and use a portion of the facilities to irrigate 200 acres. They secure water by pumping into the lower portion of the original delivery canal.

During this same period, there was a continued effort to initiate a similar speculative-type project near Canby. There is evidence to indicate that as much as $100,000 was spent for promotion, construction, and for purchasing rights of way. In the late 1920's a pumping plant was installed and water was delivered through a portion of a constructed delivery canal, but little or no land was actually irrigated. In 1938 a sprinkler irrigation project to serve the Canby area was planned by the Bureau of Reclamation, but nothing was ever done because of lack of adequate local interest.

It is significant that these early project proposals included large areas of droughty soils. The Molalla, Stayton, and Springfield areas were made up mainly of soils with gravelly subsoils. Much of the Canby area had a sandy subsoil. Without irrigation, crop production in these areas was severely limited because the subsoil lacked reserve moisture to carry crops through the summer drought.

Presumably, water was applied by surface methods in the Molalla, Stayton, and Springfield projects. Actually, because of the gravelly subsoil and impervious underlying strata, crops were subirrigated.

Project Development During 1930's

The intensive, cooperative educational program during the 1930's developed interest in project-type, as well as individual, farm irrigation enterprises. During this period a number of projects were initiated and constructed in widely separated localities, usually along the tributary streams of the Willamette. Some are still operating; others have been abandoned.

There were more operating projects in the late 1930's than there are today, possibly serving a larger acreage, but about 1940 both the number of projects and the acreage served began to decline. There are reasons for the early development of projects and the subsequent diminishing interest.

In the early 1930's satisfactory portable sprinkler irrigation equipment was not available. Some type of surface application was the only method of water application available for general farm use. Pumping plants and pipelines to deliver the large heads of water, usually a minimum of a cubic foot per second, were expensive. On smaller farms, costly pumping plants with a relatively high power requirement were necessary, even though used only a fraction of the time. "Three-phase" electric power was available only in limited areas, with single installations usually limited to 7 1/2 hp--usually inadequate to power a pumping plant to serve a small farm. In those limited areas where three-phase power was available, the poor load factor made electricity quite expensive. Gasoline or diesel motors were expensive and not well adapted for irrigation use. There were financial advantages in pooling resources through the project approach to achieve delivery of an adequate head of water to the high point of land to be irrigated. This was especially true where it was possible to divert and deliver water by gravity flow. However, some of the early projects installed and operated pumping plants.

Two other factors contributed toward the development of projects during this period. A sizable percentage of farms depended on the production from dairy cows for all or part of their income. This meant that many farms could profitably utilize irrigated pasture, a crop that occupied the greater part of the expanding irrigated area. It was therefore not difficult to find contiguous areas where most farms desired water, a prerequisite to economical project development.

The remaining point of importance was the general economic condition. Because of the general depression, many farmers lacked the cash or credit necessary to purchase and install pumping equipment. On the other hand, labor was plentiful and comparatively cheap. Projects were constructed by cooperating farmers contributing labor in lieu of cash. The cash cost of successful projects seldom exceeded a few dollars per acre. As an example of this cooperative effort, in 1932 a group of farmers at Colton contributed their own labor not only to construct four miles of canals and laterals, but also to log their own timber and operate a sawmill to obtain the lumber for 4,000 feet of flume. The flume for the main diversion had an inside measurement of 2 1/2 feet by 1 1/2 feet.

Most of the projects were initiated, constructed, and operated by informal partnership agreements. Some later changed to nonprofit corporations.

Financing the construction of these projects in the 1930's was largely a matter of each cooperator providing his share of the cash cost as best as he could. It was not unusual for individuals within a project to contribute extra cash and proportionately less labor. For the Muddy Creeks project in Linn and Lane counties, a substantial part of the funds required for the original construction was provided by one farmer, Frank Kropf, Harrisburg. It was many years before the project sold enough water to repay Mr. Kropf in full. Farmers in the Sidney Ditch project in Marion County agreed to pay back taxes and other costs of assuming title to an abandoned power canal, on an installment plan.

Private banks, Farm Security Administration, and other lending agencies aided individual farmers in meeting their share of cash costs in projects. In general, financing was the responsibility of individuals. The concept of organizational responsibility had only limited application.

Probably the first project to assume organizational financial responsibility was the Lacomb Irrigation District; it was organized under the Oregon Irrigation District Law in 1935. On completion of the legal organization, the Lacomb District qualified for a federal grant through the Works Progress Administration amounting to $64,000 of the $85,000 construction cost. The Lacomb District remains as the only operating irrigation district in the Willamette Valley.

Precedent for group-facility loans now available through the Farmers Home Administration may have been established by the Resettlement Administration in 1937. As a part of the resettlement program, large blocks of land were purchased in Yamhill, Polk, and Washington counties. The larger farms were divided into smaller farms of 40 to 50 acres. New farm buildings were constructed and other capital improvements were made to permit the sale of a farm unit ready for operation to qualified clients. Where possible, irrigation systems were installed, including several pumping plants and pipelines to serve two or three farms. The cost of the irrigation installation was included in the contract purchase price established for the individual farm units.

Under the resettlement program five projects were established. One installation served two farms, one included three farms, and one--the Saint Jo project--served seven farms. Water was originally applied by surface methods. An average of 30 acres was irrigated on each farm.

The Saint Jo project, near McMinnville, was the first of any size to install and use pumping plant, pipeline, and distribution systems. A 50-hp pump was installed to deliver water from the Yamhill River to surface irrigate about 300 acres on seven farm units. It is still operating, though modified to include repumping for sprinkler irrigation.

Repayment of construction cost for the Saint Jo project was assured by including a share of the cost in the purchase price of each of the farm units. Operation costs were divided on the basis of proportionate use. In recent years some of the farm units have been consolidated. Two of the original farms pump water directly from the river. The three farmers remaining in the project abandoned the 50-hp pumping plant and shared the cost of a small pump, though they are still using much of the original pipeline. Since there was no clearly established "organizational responsibility" for either capital or operational costs, some interesting problems have developed. For example, who now owns the original pumping plant already bought and paid for?

1940-1950 -- A Period of Project Decline

Interest in project development began to dwindle about 1940, and for the following 10 years few new projects were initiated and several operating projects were abandoned. However, expansion of the irrigated acreage by individual farm development continued at a rapid rate. Several reasons contributed toward decline in project development.

Sprinkler irrigation had largely replaced surface methods. With sprinkler irrigation it was possible to design and install a system to fit an acreage of any size. The large head of water required for surface irrigation was no longer necessary. Pumping plants for sprinkler systems could operate on a full-time basis. With this load factor, electric power costs were quite economical. Sprinkler irrigation required that each farm install a pumping plant and main pipeline. There was little difference in cost between installing the pumping plant on the bank of the stream as compared to a location on the delivery canal. There was little incentive to construct, maintain, or operate diversion and delivery facilities.

Electric power lines were extended, making three-phase power available to most of the Valley and facilitating the installation of individual pumping plants.

Areas where adequate supplies of ground water were available for irrigation were defined and recognized. The technique of well construction was improved. Farmers in areas where ground water was available developed sprinkler irrigation systems using wells as a water source in preference to water delivery by projects.

There was a general decline in dairying. The small dairy farm, 20 cows or less, and the part-time dairy farm disappeared. The number of cows was greatly increased on remaining dairy farms. This shift concentrated the need for additional irrigated pasture on larger farms, often widely separated, and stimulated individual rather than project expansion.

The major expansion of irrigated acreage during this period was devoted to the production of intensive crops--fruits and vegetables for processing, mint and other crops especially adapted to the well drained soils located adjacent to streams or in areas with adequate ground-water supplies. Projects were not needed to provide water.

With the larger farms located on the main Valley floor, farming without irrigation was quite generally profitable during most of this period. The grass-seed industry grew to sizable and profitable proportions. For most of the seed crops, irrigation was not considered necessary. There was little incentive to expand existing projects or initiate new ones to deliver water to major areas of the Valley floor located away from streams or other sources of water.

Another factor contributed to the decline in project development. Several projects initiated in the 1930's included a high percentage of small farms. At the time they were referred to as subsistence farms. During this period there was real incentive to irrigate and intensively manage these small acreages. They produced a substantial part of the family food supply in addition to some cash income. During World War II and the subsequent era of high employment, people from these farms found employment elsewhere. These farms became rural residences and remain as such. There was little incentive to maintain old projects or construct new ones.

One well-established project, Springfield, was absorbed by an expanding residential and industrial area.

The history of project irrigation in the Willamette Valley strongly hints that "people," their attitudes and desires, have as much to do with project success or failure as engineering and economic feasibility. Those projects serving communities where "irrigation farming" became firmly established have continued and expanded. Projects serving communities where the majority of land owners prefer "dry farming" have faltered or failed.

During the 1940's the foregoing factors in varying degrees influenced the status of projects established earlier. The following review indicates some of the reasons why some projects continue successful operation while others were abandoned. Successful projects are:

<u>The Molalla Irrigation Company</u>. Through the half century plus of continued operation, a compact irrigation community has developed. Soils with porous subsoils contributed toward the general reliance on irrigation. Installed facilities were easily adapted to sprinkler irrigation.

<u>Stayton</u>, now <u>Santiam Water Control District</u>. Despite possible fiscal difficulties indicated by a number of different ownerships, the Stayton project contributed to the development of the first large compact irrigation community in the Willamette Valley. The prevalence of droughty Sifton and related soils aggravated the need for irrigation. From the beginning, the area has specialized in row-crop production which has contributed toward the establishment and growth of a nearby food processing plant. The shift to sprinkler irrigation did not disrupt project operation. The irrigation community has expanded well beyond the project boundaries through individual farm development and other projects.

<u>Colton</u>, now operated by <u>Foothills Association</u>. The Colton project, constructed in 1932, began as a result of a consolidated community demand for water. Most of the original farmsteads ranged between 5 and 20 acres. It was recognized that irrigation on the shallow hill soils common to the area would provide a better family living and some additional cash income. Irrigation aided the landowners to withstand the adverse economic pressures

of the 1930's and the area was consolidated as an irrigation community. Although the project is now made up largely of part-time farms or rural residences, it is still maintained to provide water for the homestead, the family garden, and part-time farming.

Lacomb. It was necessary for landowners in the Lacomb area to manifest a community interest in irrigation through the formation of the Lacomb Irrigation District before the construction of the project in 1935. As with the Colton project, a large part of the area was made up of hill soil types. There was a number of small farms, though most of the area was included in ownerships large enough to become commercial farms with the advent of irrigation. There have been changes in crops irrigated, with changing economic conditions, though the 1,550 acres irrigated is still about equally divided between pasture and row crops. Sprinklers have replaced surface methods of irrigation on about half the acreage without hampering project operation. The project is now irrigating within 30 acres of the acres included in the original plan.

Sidney Ditch. The Sidney Ditch has been a successful project since its beginning in 1937, despite the fact that the farms included in the project are not contiguous. This was possible because the project was developed around the rehabilitation of an abandoned power canal which had an established right of way extending for approximately 14 miles. The project began with only six farms in widely separated locations along the canal. Now nearly 60 farmers take water from the canal, though the project area is still not entirely consolidated. Irrigated pasture for dairy cows was a major crop in the beginning; flax was also an important crop. With the decline in dairying, farmers shifted to mint and row crops, but pasture is still important. The project includes a high percentage of large farms, but there was no decline in irrigation interest during the shift from dairying to grass seed, as was the case in some parts of the Valley. The project has become part of the largest irrigation community in the Willamette Valley, extending from Stayton to the junction of the Santiam River with the Willamette.

Muddy Creeks. Muddy Creeks project has some similarity to Sidney Ditch. The original construction involved the rehabilitation of an abandoned diversion canal originally constructed to deliver water to a sawmill located at Coburg. Much of the distribution system utilizes the natural channels of Muddy Creek and Little Muddy. These features make it possible to deliver water to farms at widely separated locations. A distance of 30 miles separates the farms located on the extreme southeast and a farm located on the extreme northwest. In the beginning, the project developed as a consolidated project; pasture for dairy and other livestock was the major crop.

Shortly after the project was started, the rye grass industry began to develop. It was concentrated in the area served by the project. There was a substantial shift from dairying, other livestock, and general farming to grass seed production which did not require irrigation. The project, however, continued a slow expansion since it was able to serve widely scattered farms. Because of a preponderant interest in grass seed, the project area has not consolidated as an irrigation community. In recent years there has been a revived interest in irrigation, stemming from declining grass seed prices and a revived interest in the production of a wide variety of irrigated crops.

The Muddy Creeks project has the greatest potential of any of the existing projects. It is physically feasible to deliver water to an excess of 90,000 acres lying between Coburg and Albany.

Saint Jo. The essential details of the Saint Jo project were described earlier. It is significant that a small irrigation community has developed despite consolidation of farm ownerships and changing economic conditions. The Saint Jo project was the forerunner of similar compact projects initiated in the 1950's.

Drainage Enterprises. At least three drainage enterprises in the Willamette Valley have served as irrigation projects by providing for irrigation to serve multiple ownerships through the installed drainage works. These are the Lake Labish Project, the Woodburn-Hubbard Drainage District in Marion County, and the Gaston area in Washington County. Before 1930, subirrigation was accomplished at Lake Labish and Gaston by controlling the ground-water level. A similar plan was included in parts of the Woodburn-Hubbard Drainage District. In all three areas, drainage ditches now serve as sources of water for sprinkler irrigation in addition to some controlled subirrigation.

Some of the early projects operated over a period of years, but have been abandoned. They are:

Springfield. Initiated as a speculative venture, the Springfield project was constructed, operated for a period of years, and then abandoned, probably because of the lack of sales of water or land. In the early 1930's it was taken over by a small group of farmers and gradually rehabilitated. Other farmers joined in the venture. By the early 1940's the Springfield project had developed into a consolidated irrigation community similar to the Stayton project. There was interdependence between farmers in the project and the large processing plant in Eugene. There was substantial acreage of irrigation pasture devoted to intensive dairy and beef production. As indicated earlier, the area was absorbed by the expanding Eugene-Springfield metropolitan area. It is significant, however, that displaced farmers purchased irrigated farms elsewhere.

Mill Creek - Polk and Yamhill counties. This project was started in 1931. An abandoned canal originally constructed to operate a flour mill at Sheridan was used to divert water by gravity from Mill Creek. The water was delivered to 16 farms. Water was used for surface irrigation. As sprinkler irrigation replaced surface methods, farmers in the project preferred installing a pumping plant to pump water from either Mill Creek or the Yamhill River rather than obtaining water from the diversion canal.

Dickie Prairie - Clackamas County. This project, constructed in 1932, diverted water by gravity from the Molalla River to surface irrigate 400 acres on four different farms. The project was abandoned partly because of the construction of a large sawmill in the area and partially because each of the farms had access to the Molalla River and pumped directly from the river with the advent of sprinkler irrigation.

Cedardale Project - Clackamas County. This project was constructed in 1938. Twelve farms obtained water for surface irrigation from a gravity diversion from Milk Creek. After only a few years of operation, the project was abandoned in favor of sprinkler irrigation and individual pumping plants located directly on the stream.

1950-1960

A revival of interest in project irrigation began about 1950. Contributing factors were: utilization of available surface and ground-water supplies; established water rights had gained established financial recognition; owners of nonirrigated farms began to look on irrigation as a means of achieving increased volume without buying new land; an expanding food processing industry required additional acreage. For these and other reasons, there are indications that major irrigation expansion in the future will be in the form of project development.

Projects initiated during this period are listed below. They followed a different pattern than earlier projects.

Calapooya Irrigation Cooperative. This cooperative was organized in 1950 to solve a problem of competitive water demand. Through the years, individual irrigation diversions from the Calapooya and its tributaries depleted the summer flow of the stream to a point where water power requirements of the Thompson Mills, located east of Shedd, were seriously impaired. It was apparent that the mill held a right prior to any of the irrigation rights and might thus be in a position to demand that any or all of the irrigation diversions be terminated. The irrigators located above the mill formed a corporation and reached an agreement with Thompson Mills whereby the corporation would pay for electric power required to replace the mills' loss in water power caused by the irrigation diversions. As a result of this agreement, water is available to irrigate 1,960 acres; 1,000 acres were irrigated last year. The annual cost is 85 cents per acre. While not involved in the distribution of water, the Calapooya Cooperative serves substantially a similar purpose. The same approach might be used in solving other competitive demands.

The River View Ditch Association. This association was organized and implemented in 1953. This is both a drainage and an irrigation project. The drainage ditch provides a needed drainage outlet to 18 farms. In the summer, water is pumped into the ditch from Thomas Creek to supply water for individual farm pumping plants. The project has a record of 10 years of successful operation; 700 acres are now irrigated, and this could be expanded to 1,200 acres.

Scio Water Improvement Association. This association was organized and started operation in 1958 to provide water to six farms where ground-water supplied from shallow wells had proven inadequate to irrigate the desired acreage. Water is pumped into an open ditch from

Thomas Creek. The ditch is routed through the farms served near the location of the previously constructed wells, making it unnecessary to modify existing pumping plants. The project has continued to operate effectively.

Kingston Project. Located south and east of Stayton, this was organized as a nonprofit corporation in 1959. They installed a pumping plant and pipeline to deliver water to 450 acres under pressure sufficient to operate sprinklers. Each farmer owns his own portable pipe. The project serves 250 acres and could be expanded to 450 acres. Construction costs totaled $33,000 and were financed by the Farmers Home Administration. Power and debt retirement costs total $13.50 per acre per year. Results have been highly satisfactory.

Queener Project. Also located near Stayton in Linn County, this project was initiated in 1960. It is a bit more elaborate than the Kingston project but was financed and organized in the same manner. It is now irrigating 400 acres, with a potential of 744 acres.

Irrigation Districts. It is significant that at about the same time, 1960, the Santiam Water Control District was organized and purchased the interest of the Willamette Valley Water Company in the gravity diversion project serving the West Stayton area. Funds for the purchase and some rehabilitation work were obtained from the Farmers Home Administration. The Santiam Water Control District became the first district organized under the Oregon Water Control District Law to own and operate an irrigation project.

Since 1960, two sizable irrigation districts have been legally organized in the Willamette Valley--the Tualatin and the Monmouth-Dallas. Each was organized to contract with the Bureau of Reclamation for the construction of separate projects. Both await Congressional approval. For both areas the landowners have substantially committed themselves to repay construction costs. This is further conclusive evidence that there will be substantial expansion of irrigation by projects in the Willamette Valley.

Federal Agencies and Project Development

The Corps of Engineers, in planning the overall and multipurpose Willamette Basin project, gave consideration to irrigation project development in the early planning stages preceding construction. Later, about 1938, irrigation planning became the responsibility of the Bureau of Reclamation. As a result of this planning, about 800,000 acre-feet of storage is available in existing reservoirs for future project development.

Since 1938, the Bureau of Reclamation has given some attention to 25 different projects. Some of these studies were made as a part of planning operations carried out in cooperation with the Corps of Engineers, others contemplated the downstream use of water from existing reservoirs, and the remainder included the development of storage.

Projects studied by the Bureau of Reclamation include the Canby, the Carlton, Molalla, Tualatin, Amity, Hopewell, Chehalem, Stayton, Calapooya, Albany, Coburg, East Long Tom, Springfield, Marcola, Eugene, West Long Tom, Clackamas, Cottage Grove, Pleasant Hill, Marys River, Adair, Luckiamute, Scio, Monmouth-Dallas, and Red Prairie.

With only two of these projects, Tualatin and Monmouth-Dallas, have farmers within the project area manifested tangible interest in project construction by forming an irrigation district and indicating a legal willingness to repay construction costs. The lack of this expressed interest in other projects is no reflection on the work of the bureau. Rather, it supports the theme apparent in other phases of this review--the majority of farmers in the Willamette Valley are not quite ready to assume the responsibility of large-scale project development.

The Farmers Home Administration has supported project development, beginning with the construction of the Saint Jo project in 1938. In recent years loans have been made available to the Santiam Water Control District and the Kingston and Queener projects. It would appear that adequate financing is available through FHA to finance the construction of economically feasible and otherwise justified smaller projects.

The Soil Conservation Service has extended valuable technical assistance to existing projects, particularly to the Muddy Creeks, the Santiam Water Control District, the Kingston and Queener projects. Under authorization of Public Law 566 and under the Resource Conservation and Development Program, several project proposals are now under consideration but, as with projects under consideration by the Bureau of Reclamation, a tangible expression of farmer interest has precluded irrigation project implementation.

Observation and Review

This review of operating projects in the Willamette Valley, some with 60 years of experience, justifies these observations:

1. Projects initiated because of the consolidated demand of farmers within the project area have been successful from the beginning.

2. Project development has been handicapped because of lack of desire for the irrigation of consolidated areas. Intermingled non-irrigated land has handicapped construction and operation.

3. Projects proposed by outside public or private agencies without first developing or assuring a preponderant demand on the part of farmers involved have usually been unaccepted or have failed.

4. Projects constructed so as to operate and deliver water to separated farms have usually resulted in development of the consolidated irrigation community over a period of years.

5. Projects have usually been abandoned where farmers have been able to develop their own water supply.

6. To date, inadequacy of financing has not limited project construction. Some projects have had financial problems, many of them self-inflicted, usually because of inadequate annual assessments.

7. The lack, or the delay in the formation, of a legally responsible organization to handle the affairs of the project has created problems with some projects.

8. Established operating projects apparently attract markets. Food processors and distributors of specialty crops tend to concentrate operations in consolidated irrigated areas.

9. It is probable that in the immediate future there will be a substantial increase in the number of small compact pumping projects developed to deliver available storage water to lands lying away from the natural stream.

10. The favorable results of recent research work on the effect of irrigation on poorly drained soils is aiding in developing a new interest in project development by pointing out possibilities for a wider diversity of irrigated crops.

11. The formation of legally organized irrigation districts in Tualatin Valley and the Monmouth-Dallas area, each with a potential of over 20,000 acres of irrigated land, is tangible evidence that large-scale project development will begin in the immediate future.

12. With some modification, existing operating projects in the Valley could deliver water to an additional 120,000 acres.

The following pages summarize information obtained by W. S. Averill and A. S. King from field interviews. Information on completely abandoned projects is not included.

SPRINGFIELD PROJECT, Lane County

Date started: 1909.

Type of organization: Completed 1911 by private company, Eugene-Springfield Land and Water Company. 1,000 to 1,500 acres were irrigated through 1920. Project was abandoned in early 1920's. An informal group of farmers took over and began rehabilitation of the project in 1933. They organized into a nonprofit corporation in 1939.

Acres irrigated: Up to 3,000 acres.

Potential acres for irrigation: Unknown.

Construction costs: Unknown.

Annual operation and maintenance charges: Unknown.

Present status: By 1950 industrial and urban growth in the area had taken over most of the area. The project ceased to function soon after. Two farmers now operate a portion of the facilities.

Successful or not. Why: Not successful because of urbanization.

Crops grown: Originally pasture, all row crops. Two farmers left, dairy pasture and row crops.

Sprinkler or flood: One-half sprinkler, one-half flood. Originally all flood.

Type of delivery: Open ditch to farms.

Comments: Old original ditch and right of way turned over to county. Two farmers at low end of old ditch have put in 4,000 gallon per minute, 14-foot lift pump at river. Fifty feet of pipe puts water in old ditch. One farm flood irrigates pasture, the other irrigates row crops.

Technical assistance: 1933-39 reorganization - Extension Service.

SANTIAM WATER CONTROL DISTRICT, Marion County

West of Stayton
Harry Stewart

Date started: 1909.

Type of organization: Co-op - organized under Oregon Water Control District laws.

Acres irrigated: 12,000 acres.

Potential acres for irrigation: 24,000 acres.

Construction costs: Unknown.

Annual operation and maintenance charges: $26.25 membership. About $3 per acre per year.

Present status: Active.

Successful or not. Why: Successful. Reasonable costs. Soil light, needs water for good crop growth. Water necessary for cannery and frozen food crops.

Crops grown: Small fruits, vegetables, pasture, corn. Most everything.

Sprinkler or flood: Sprinklers 80%; flood 20%. From ditch.

Type of delivery: Open ditch to farms from Santiam River.

Comments: Ownerships--1st - Benham Investments
2nd - ______ Investment Co.
3rd - Willamette Investment Co.
4th - Flax Land Development Co.
5th - Willamette Valley Water Co.
6th - Willamette Valley Water Co. and West Stayton Co-op
7th - Santiam Water Control District

Technical assistance: Originally private engineer. In recent years Soil Conservation Service.

MOLALLA IRRIGATION COMPANY, Clackamas County

East of Liberal
Morris Buxton

Date started: 1909.

Type of organization: Nonprofit corporation.

Acres irrigated: 1,158 acres; 754 acres by members, 404 acres by nonmembers.

Potential acres for irrigation: 10,000 acres with ditch enlargement and adequate water supply.

Construction costs: $5,000 for dam and inlet to ditch.

Annual operation and maintenance charges: 50 cents per acre per year. Nonmembers maintain 1 1/2 miles of ditch cooperatively.

Present status: Very active.

Successful or not. Why: Successful. Cheap water, low operation and maintenance.

Crops grown:	1964 --	30 acres strawberries
		95 acres pole beans
		20 acres broccoli
		1,013 acres pasture

Sprinkler or flood: Originally flood, now sprinkle out of ditch.

Type of delivery: Seven and one-half miles of gravity ditch. Farmers sprinkle out of ditch.

Comments: Twenty-two original members. Five nonmembers. Nonmembers have separate water rights. Six miles of ditch dug by members on strictly cooperative basis, no money changed hands.

Technical assistance: An engineer was hired to lay out ditch and supervise dam construction.

LACOMB IRRIGATION DISTRICT, Linn County

A. A. Ayers, Lacomb

Date started: 1935 WPA project.

Type of organization: Irrigation district.

Acres irrigated: 1,556 acres.

Potential acres for irrigation: 1,589 acres.

Construction costs: $85,000; $64,000 WPA, $21,000 local.

Annual operation and maintenance charges: About $4 per acre per year. Covers all costs, debts, plus operation and maintenance.

Present status: Active.

Successful or not. Why: Successful. Reasonable costs. Need water for pasture and row crops.

Crops grown: Pasture and some row crops. Peppermint started the project.

Sprinkler or flood: Originally flood, now about one-half sprinklers.

Type of delivery: Gravity diversion from Crabtree Creek, open ditch distribution system.

Comments: 1964-65 flood damage at intake, diversion canal, and flumes estimated at $11,000.

Technical assistance: Feasibility, Extension Service. Design and construction, F. C. Dillard and Ralph Cowgill.

FOOTHILLS ASSOCIATION, Clackamas County

Colton

Date started: 1932.

Type of organization: Association, not incorporated.

Acres irrigated: 318 acres. 107 sprinkled.

Potential acres for irrigation: 800 acres.

Construction costs: Built cooperatively. No assessments.

Annual operation and maintenance charges: $2 to $3 per acre per year. Depends on work to be done.

Present status: Active.

Successful or not. Why: Successful. Reasonable cost. Part-time farms need and use water.

Crops grown: Mostly pasture, home gardens, and new berries.

Sprinkler or flood: 107 acres sprinkled, 211 flood.

Type of delivery: Gravity ditch, flood from ditch. Sprinklers have small holding ponds.

Comments: A group of 16 farmers, under the leadership of V. C. Hill, furnished labor to dig ditches, build flumes, and saw their own timber.

Technical assistance: Extension Service.

MUDDY CREEKS IRRIGATION PROJECT, Linn County

Terry McCormack

Date started: 1937.

Type of organization: Nonprofit corporation.

Acres irrigated: 2,000 acres.

Potential acres for irrigation: 90,000 acres; 27,000 acres seriously considered.

Construction costs: $15,000 at intake pump and 2 miles of ditch. No other figures available.

Annual operation and maintenance charges: $15 per acre to join. $3.00 to $3.50 per acre per year to pump from ditches; $4 to flood.

Present status: Active.

Successful or not. Why: Successful. Relatively expensive, but water still pays in increased production and quality of crops.

Crops grown: Some mint on high ground, row crops in river bottom. Pastures, mostly. Almost all crops.

Sprinkler or flood: One-third flood, two-third sprinkler.

Type of delivery: Mostly down natural waterways with ditches across ridges from one to the other.

Comments: Two 15,000 gallon per minute pumps, plus two large Palmer water lifters at intake on McKenzie River near Highway 5. Project goes from intake to within six or eight miles southeast of Corvallis, probably covers 25 miles. Also delivers some water one-half way to southwest Brownsville area.

Technical assistance: Extension Service in the beginning, Soil Conservation Service later.

SIDNEY DITCH, Marion County

North, northeast and northwest of Jefferson
Dave Wied

Date started: 1937.

Type of organization: Nonprofit co-op.

Acres irrigated: 2,983 acres.

Potential acres for irrigation: 4,700 acres; 15,000 acres with canal enlargement.

Construction costs: Cost the co-op $5,000 plus $800 delinquent taxes.

Annual operation and maintenance charges: $20 membership. $1 per acre per year.

Present status: Active.

Successful or not. Why: Successful. Low cost, possible to serve isolated farms.

Crops grown: Row crops and pasture.

Sprinkler or flood: Originally all flood, now all sprinkler.

Type of delivery: Open ditch from Santiam to farms. Excess water goes into Willamette.

Comments: About 60 farmers actively using water. Originally was open ditch to take water to a flour mill on the Willamette River, transportation for the flour.

Technical assistance: Extension Service.

SAINT JO, Yamhill County

Leo Laune, Oral Winters, Stanley Hermans
McMinnville

Date started: 1938.

Type of organization: Joint ownership of pump and pipeline.

Acres irrigated: 150 acres.

Potential acres for irrigation: 200 acres.

Construction costs: $4,000.

Annual operation and maintenance charges: About $5 per acre per year.

Present status: Active.

Successful or not. Why: Successful. Water is needed and intensively used to grow pasture and other feed crops.

Crops grown: Pasture, forage, corn.

Sprinkler or flood: Originally flood, now sprinkler.

Type of delivery: Water is pumped by 20-hp pumping plant, 65 foot lift from Yamhill River and delivered by steel and concrete to individual farm reservoirs. Repumped for sprinklers.

Comments: Project originally installed by Resettlement Administration to irrigate 240 acres on seven farms. Original pumping plant was 50 hp. Later one farmer dropped out in favor of pumping direct from the river. Now three farms are actively in this project, though because of consolidation of farm units essentially the same area is irrigated.

Technical assistance: Resettlement Administration (FHA), Extension Service.

J. R. McLAIN AND JIM THOMPSON, Clackamas County

2 or 2 1/2 miles northwest of Canby

Date started: 1948.

Type of organization: Verbal. Co-op.

Acres irrigated: Ten acres (five acres each).

Potential acres for irrigation: Unknown.

Construction costs: $2,500 for well, pump, plus 300 feet of 2-inch pipe.

Annual operation and maintenance charges: Electric pumping costs.

Present status: Active.

Successful or not. Why: Successful. Cheap; home garden, hobby.

Crops grown: Home vegetable garden and pasture.

Sprinkler or flood: Sprinkler.

Type of delivery: Well--pump and pipe.

Comments: Two retired neighbors wanted water to grow gardens, lawn, pasture. Five acres each. Private plans.

CALAPOOYA IRRIGATION DISTRICT, Linn County

Glen Isom
Brownsville

Date started: 1950.

Type of organization: Incorporated co-op.

Acres irrigated: 1,000 acres.

Potential acres for irrigation: 1,960 acres.

Construction costs: No construction cost. $4,900 spent for legal advice, incorporation, etc.

Annual operation and maintenance charges: 85 cents per acre per year.

Present status: Active.

Successful or not. Why: Successful. Cheap, makes it possible for each farmer to irrigate out of Calapooya and tributaries.

Crops grown: Mostly pasture. Some beans, corn, strawberries, etc.

Sprinkler or flood: Sprinkler.

Type of delivery: Each farmer pumps out of stream. See comments.

Comments: Thompson Mills, east of Shedd, Oregon, has original water right on Calapooya River. These people collect from irrigators to pay Thompson Mills for loss of water. $910 in 1964.

District starts 12 miles above Holly and covers both sides of river to Freeway, probably 30 miles.

RIVER VIEW DITCH ASSOCIATION, Linn County

Herman Zeller
Gilkey Ridge on Thomas Creek

Date started: 1953.

Type of organization: Drainage and irrigation association.

Acres irrigated: 700 acres.

Potential acres for irrigation: 1,200 acres.

Construction costs: Pump and motor, $1,400. $800 for tile across farms not using water. Each farmer paid for ditch across his farm.

Annual operation and maintenance charges: $1.50 to $2.00 per acre per year.

Present status: Active.

Successful or not. Why: Successful. Cheap, grow processing crops.

Crops grown: Processing crops, pasture, sugar beet seed.

Sprinkler or flood: Sprinkler.

Type of delivery: Open ditch. Sprinkle with own systems from ditch. 4 1/2 miles of ditch.

Comments: Eighteen or nineteen farmers involved. 15-hp, 3,500 gallon per minute. Dream started in 1904 by Zeller and Gilkey, wanted to grow crops to take prizes at Scio and State fair.

Technical assistance: Extension Service.

SCIO WATER IMPROVEMENT ASSOCIATION, Linn County

O. D. Westenhouse
Scio

Date started: 1958.

Type of organization: Association, nonprofit.

Acres irrigated: 250 acres.

Potential acres for irrigation: 540 acres.

Construction costs: $5,750 for pump and ditch.

Annual operation and maintenance charges: $35 to $40 per year per farm, regardless of water used. Yearly power about $240.

Present status: Active.

Successful or not. Why: Successful. Cheap, possible to have good pasture. Mostly small farms.

Crops grown: Pasture and hay.

Sprinkler or flood: Sprinkler.

Type of delivery: Open ditch.

Comments: Wells in ditch tend to dry up when ditch is dry for a time. Run water in ditch to fill wells. 3,800 feet of ditch. Six farmers used water in 1964.

QUEENER IRRIGATION PROJECT, Linn County

South and east of Stayton
Delbert Sandner

Date started: 1960.

Type of organization: FHA loan. Nonprofit co-op. Obligation stays with land regardless of subdivisions.

Acres irrigated: 400 acres.

Potential acres for irrigation: 744 acres.

Construction costs: $110,000.

Annual operation and maintenance charges: $18 per acre per year plus metered power cost.

Present status: Active.

Successful or not. Why: Successful. Hill ground; high lift, 165 feet. Delivers water to farms located away from water source.

Crops grown: Pole beans, sweet corn, bush beans, strawberries, pasture. Other row crops.

Sprinkler or flood: Sprinkler.

Type of delivery: 4 1/2 miles of Johns Manville transite pipe. 16 inch down to 6 inch. All under pressure.

Comments: All hill ground, high lift. Pumps 75 and 150 hp, automatically pressure controlled.

Technical assistance: Soil Conservation Service, Pacific Power and Light Company.

KINGSTON, Linn County

South and east of Stayton
Chas. Hecht

Date started: 1959.

Type of organization: Nonprofit corporation. FHA loan.

Acres irrigated: 250 acres.

Potential acres for irrigation: 450 acres.

Construction costs: $33,000.

Annual operation and maintenance charges: 1964, cost $13.50 per acre; average power cost $5.00 per acre. Each farmer keeps track of sprinkler hours and pays on that basis.

Present status: Active.

Successful or not. Why: Successful. Hill ground. Makes it possible to grow processing crops.

Crops grown: Mostly processing vegetables and berries. Alfalfa, pasture.

Sprinkler or flood: Sprinkler.

Type of delivery: Underground pipe under pressure.

Comments: 4,800 feet pipe 12 inches to 6 inches, 168-foot lift. Pipe and pumps only security for loan. Have 30 and 60 hp turbines. Under pressure control. Electrolitic corrosion caused considerable difficulty in the beginning but has been corrected.

Technical assistance: Extension Service, Soil Conservation Service.

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