Station Bulletin 191 July, 1922

Oregon Agricultural College

Experiment Station

Growing Irrigated Crops in Harney Valley

By

OBIL SHATTUCK and DOUGLAS W. RITCHIE

CORVALLIS, OREGON

BOARD OF REGENTS OF THE OREGON AGRICULTURAL COLLEGE AND EXPERIMENT STATION

HON. J. K. WEATHERFORD, President.....Albany
HON. N. R. MOORE, Secretary.....Corvallis
HON. B. F. IRVINE, Treasurer.....Portland
HON. BEN W. OLCOTT, Governor.....Salem
HON. SAM A. KOZER, Secretary of State.....Salem
HON. J. A. CHURCHILL, Superintendent of Public Instruction.....Salem
HON. CHARLES E. SPENCE, Master of State Grange.....Oregon City
HON. C. L. HAWLEY.....Portland
HON. WALTER M. PIERCE.....LaGrande
HON. GEO. M. CORNWALL.....Portland
HON. JEFFERSON MYERS.....Portland
HON. M. S. WOODCOCK.....Corvallis

STATION STAFF

W. J. KERR, D.Sc., LL.D.....President
J. T. JARDINE, B.S.....Director
E. T. REED, B.S., A.B.....Editor

H. P. BARSS, A.B., S.M.....Plant Pathologist
P. M. BRANDT, B.S. in Agri., A.M.....Dairy Husbandman
A. G. BOUQUET, B.S.....Horticulturist (Vegetable Gardening)
G. G. BROWN, B.S.....Horticulturist, Hood River Br. Exp. Station, Hood River
W. S. BROWN, A.B., M.S.....Horticulturist in Charge
D. E. BULLIS, B.S.....Assistant Chemist
LEROY CHILDS, A.B.....Supt. Hood River Branch Exp. Station, Hood River
G. V. COPSON, M.S.....Bacteriologist
H. K. DEAN, B.S.....Supt. Umatilla Branch Exp. Station, Hermiston
*JAMES DRYDEN.....Poultry Husbandman
A. E. ENGBRETSON, B.S.....Supt. John Jacob Astor Br. Exp. Station, Astoria
B. B. FULTON, B.A., M.S.....Associate Entomologist
W. V. HALVERSEN, M.S.....Assistant Bacteriologist
E. M. HARVEY, PH.D.....Horticulturist (Physiology)
G. R. HYSLOP, B.S.....Farm Crop Specialist
W. W. JOHNSTON, B.S.....Assistant in Soils (Irrigation)
J. S. JONES, M.S.....Chemist
R. C. JONES, B.S.....Associate Dairy Husbandman
F. L. KNOWLTON, B.S.....Research Assistant in Poultry Husbandry
F. H. LATHROP, A.B., M.S.....Associate Entomologist
J. C. LEWIS.....Farm Crop Foreman
A. L. LOVETT, B.S.....Entomologist
A. G. LUNN, B.S.....Poultry Husbandman in Charge
F. W. MILLER, M.S., D.V.M.....Assistant Veterinarian
*H. G. MILLER, M.S.....Associate Chemist
G. A. MITCHELL, B.S.....Asst. to Supt. of Sherman County Branch Station
A. E. MURNEEK, M.S.....Assistant Horticulturist (Physiology)
M. B. MCKAY, M.S.....Associate Plant Pathologist
O. M. NELSON, B.S.A.....Associate Animal Husbandman
J. R. NEVIUS, B.S.....Assistant Farm Crop Specialist
A. W. OLIVER, B.S.....Assistant Animal Husbandman
E. L. POTTER, M.S.....Animal Husbandman
W. L. POWERS, M.S.....Chief, Department of Soils
RAY POWERS, B.S.....Jr. Chem., U. S. Dept. of Agr., Coop. Invest. (Hort. Prod.)
*C. K. POWELL, B.S.....Assistant Poultry Husbandman
*J. C. REEDER, B.S.....Assistant Chemist
F. C. REIMER, M.S.....Supt. Southern Oregon Br. Exp. Station, Talent
D. W. RITCHIE, B.S.....Assistant in Soils (Irrigation)
R. H. ROBINSON, M.S.....Associate Chemist
C. C. RUTH, M.S.....Assistant Farm Crop Specialist
C. V. RUZEK, B.S.....Associate in Soils (Fertility)
AGNES RYDER.....Scientific Asst. Seed Lab. U. S. Dept. of Agri. (Seed Analyst)
H. A. SCHOTH, M.S.....U. S. Dept. of Agri. Scientific Asst. in Forage Crops
C. E. SCHUSTER, M.S.....Assistant Horticulturist (Pomology)
H. D. SCUDDER, B.S.....Chief in Farm Management
O. SHATTUCK, M.S.....Supt. Harney County Branch Exp. Station, Burns
B. T. SIMMS, B.S., D.V.M.....Veterinarian
D. E. STEPHENS, B.S.....Supt. Sherman County Br. Exp. Station, Moro
K. S. TAYLOR, B.S.....Assistant in Soils
E. F. TORGERSON, B.S.....Assistant in Soils (Soils Survey)
E. H. WIEGAND, B.S.....Horticulturist (Horticultural Products)
ROBERT WITHYCOMBE, B.S.....Supt. Eastern Oregon Br. Exp. Station, Union
H. M. WOOLMAN, Field Asst., Office of Cereal Investigations, U. S. Dept. of Agri.
C. H. WEBBER, B.S.....Asst. to Supt. of Umatilla Branch Experiment Station
WILLARD W. YATES, B.S.....Assistant Chemist
S. M. ZELLER, PH.D.....Associate Plant Pathologist

*On leave of absence.

SUMMARY

Harney Valley has a vast area of irrigable land that will eventually be irrigated by gravity or pumping.

The irrigation investigations at the Station cover the important factors relating to successful irrigation practice.

The soil type on which the Burns Station is located, is average to poor, as compared with the Valley proper.

The climate of Harney Valley is arid. The precipitation is very light, the evaporation high, and frosts are frequent.

Land should be carefully leveled for irrigation.

The border system of irrigation is one of the best, and is rapidly coming into general use in irrigated sections.

The check system is not recommended for Harney Valley conditions.

The corrugation system is well suited to land sloping in different planes.

The furrow system is well adapted to the irrigation of row crops.

Sub irrigation can be used to advantage on grain and alfalfa where soil conditions permit.

Flooding is a wasteful method of irrigation.

Cleaning and grading all classes of seed, nets the irrigation farmer large returns.

Treating all cereals for smut is essential for good yields.

Federation is the best spring wheat to grow under irrigation.

Turkey Red is the best winter variety, but care must be taken not to over-irrigate this crop, or lodging will result.

Hannchen and Trebi barleys are excellent yielders under irrigation.

Rustless Selection, Swedish Select, and Silvermine are the best oat varieties.

Rye is a dry-land crop and not as good a yielder under irrigation as wheat, barley, or oats.

Grimm alfalfa is the best forage crop for Harney Valley.

Kaiser field peas, when grown for seed, or in combination with oats or wheat, produces excellent yields of hay or silage. It is one of the best legumes to grow in a short rotation.

The clovers are not well adapted to conditions in Harney Valley.

Mammoth Russian sunflowers produce the largest tonnage of silage.

Peas and oats are the best combination crop for Harney Valley.

Early-maturing varieties of potatoes do well in warmer sections.

Sugar beets and mangels do well in some sections but are not as sure as cereal or forage crops.

Field peas in the short rotation and alfalfa in the long rotation have given best returns.

The irrigator must learn from practical experience when the crop needs water. No hard and fast rules can be laid down. Frequent light irrigations are better than heavy ones at long intervals.

Too much water will reduce the yields and injure the soil.

Under the heading "Cost of irrigation by Pumping," the figures represent the pioneer stage. Transportation, cheaper fuel, or adequate power lines would materially reduce the cost per acre.

Growing Irrigated Crops in Harney Valley

By

OBIL SHATTUCK, Superintendent

and

DOUGLAS W. RITCHIE, Assistant in Irrigation

INTRODUCTION

Irrigation is destined to play an important part in the agriculture of Harney Valley. There are approximately thirty thousand acres of irrigable land in the Valley proper. Irrigation investigations have been added to the work of the Burns Station as one of its important projects.

The work of the Station from the time of its establishment in 1911 until the spring of 1916 was confined to dry farming by the summer-fallow method. In 1917 a deep well was drilled and a pumping plant installed to provide water for the irrigation investigations. The work has been carried out with the advice and cooperation of the main Station at Corvallis. This publication reports briefly the progress to date and offers suggestions based upon the results obtained.

Object of the Investigations

The object of these investigations is—

1. To determine whether the cereal, forage, root, and miscellaneous crops can be successfully and profitably produced.

2. To determine by actual application, the amount of water required by each crop for highest economical returns.

3. To determine the best crop rotation for yield, economy, and fertility.

4. To determine the plant food needs of these soils for crop production.

5. To determine the best time, rate, and date of seeding irrigated crops.

6. To secure data on the possibilities of irrigation by pumping.

LOCATION AND SOIL TYPES

The Burns Station is located six miles east of Burns, Oregon, on typical sage-brush land varying from sandy loam to sandy silt or clay loam, the major portion of which is spotted with alkali. The soil is considered average to poor, as compared with the valley proper. Geologically classified, the soils of Harney Valley are lake and stream deposits from sedimentary rocks.

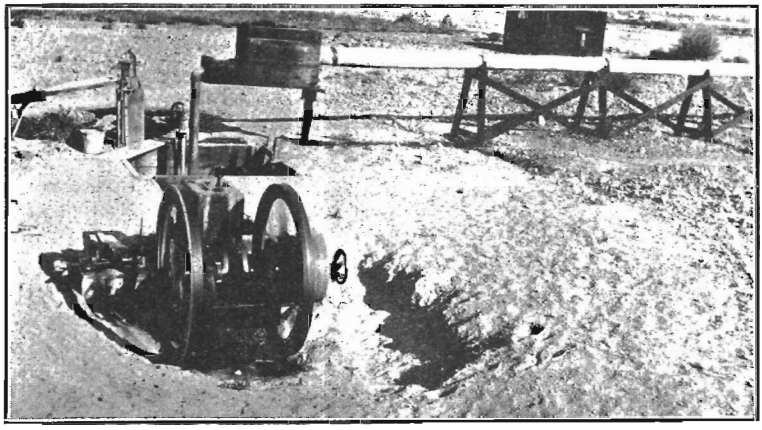

Fig. 1. The pumping plant in operation at the Burns Station.

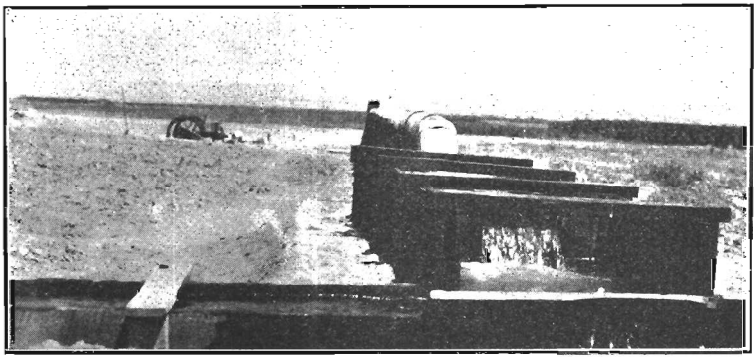

Fig. 2. Weir box on Burns Station.

CLIMATE

The general climate of Harney Valley is dry. The average elevation is about 4,100 feet. The extreme temperatures range from 100° Fahrenheit in summer to minus 30° in winter. Summer frosts are frequent.

The annual average precipitation from 1914 to 1921 was 9.02 inches. Most of the precipitation comes in the winter and early spring. The average annual evaporation from a free water surface for the past eight

years, April to October inclusive, was 42.6 inches. The average wind velocity from 1914 to 1921 was 4.1 miles per hour.

PREPARATION OF LAND FOR IRRIGATION

Make a Contour Map. First, a contour map of the field to be irrigated should be made, noting the high and low places, general slopes and natural drainage. Second, the system of irrigation should then be decided upon, whether contour flooding, border, check irrigation, or sub irrigation. This will depend on the contour of the field, type of soil. and head of water.

Clearing and plowing on the Station in 1912 cost approximately $5.00 an acre.

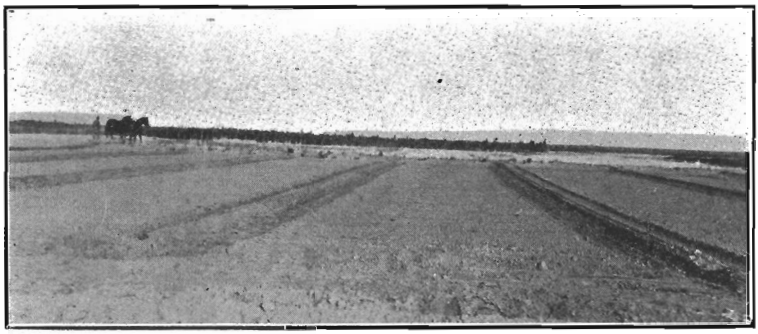

Fig. 3. The finished field, ready for seeding.

Leveling. To succeed with irrigation it is important that the land be properly leveled. Land well leveled at the start affords larger returns, requires less water and less labor for proper irrigation. A small farm level is very useful in preparing the land for irrigation. With this instrument all guess work is eliminated and the increased yields from well leveled fields will more than pay for the instrument on the first crop harvested.

How to Level. The best method of land leveling is to plow or double disk all of the high spots; and then fill all of the low places by scraping in this soil with a Fresno, buck-scraper, or some form of wheel scraper. This permits the moving of the soil over solid ground, making the work lighter on both man and team. About an acre a day may be leveled with a four-horse Fresno under rather level conditions.

Irrigate to Settle Soil. The fields should then be double disked or spring toothed and floated. This fills minor depressions. A trial irrigation should then be made to settle the ground and prove the leveling. When the field is again dry enough to work it should be plowed six to eight inches deep and immediately double disked or spring toothed.

During the winter this should settle into a good seed bed. As soon as possible in the spring, the land should be double disked and harrowed, or spring toothed, floated, and laid out according to the irrigation system to be used. If, in making dikes or borders, the soil is removed to any

extent, it is a good plan to refloat the edges. Leveling land in the fall is best, but good results have been secured with spring leveling. An orchard or reversible disk harrow, with disks reversed to throw the dirt in, is useful in making borders.

SYSTEM OF IRRIGATION TO USE

The system to select will depend upon the contour of the field, irrigation head, type of soil, and kind of crop. The general or wild flooding system is not to be recommended; it wastes water, injures the soil, gives low returns, and in the end proves to be very expensive.

Fig. 4. Making the borders. A round trip completes the border or dike.

The Border System. The border system in many irrigated sections is becoming quite popular. If the land is fairly level or gently sloping, it proves very efficient. The borders or dikes can run down the slope and may be from thirty to fifty feet apart, depending upon the soil type and head of water to be used. These are made ten inches high by three to five feet wide, by plowing a dike furrow and following with a ridger as shown in Fig. 4. Care should be taken to remove the side slope when leveling. A table should be provided by grading to a level plane a strip ten to fifteen feet wide at the head of the strip. This facilitates the distribution of water. The length of borders will depend upon the type of soil, short runs being used on sandy soil and running up to four hundred feet on the heavier types. A good head of water is needed, ranging from one-half cubic foot per second up to two or three second feet.*

The Check System. This method can be used only on rather flat land. It is an efficient system but requires more leveling than the border system, and is not so satisfactory for local conditions.

The Corrugation System. This consists of making a series of small parallel furrows, eighteen to thirty-six inches apart, after the crop is

*Oregon Agri. Col. Exp. Sta. Bulletin 177. The Management of Sandy Soils Under Irrigation, by H. K. Dean.

seeded. It is a good system for rather uneven ground where the field slopes several ways. Where the slope is pronounced, the corrugation should follow the contour of the land in order to prevent washing.

The Furrow System. This system is adapted to the irrigation of row crops where the land has a fairly uniform slope. It enables the irrigator to supply the water to the lower part of the rooting system of the plant without causing the soil surface to become hard and compact.

Sub Irrigation. This method is very efficient where the soil formation permits a rapid horizontal movement of water without great loss by downward percolation. It is practiced in portions of the Harney Valley on alfalfa and grain. The water is held in fairly wide ditches at a rather high level and sub irrigates the soil. These main ditches vary in distance apart from fifty to three hundred yards.

FIRST CROPS FOR NEW LAND

Use **Annuals.** The first and second crops should be annual, preferably cereal, annual legumes or row crops, as sunflowers or roots. It

Fig. 5. Irrigated spring wheat varieties, 1920, 13 varieties averaged 61.2 bushels per acre. The federation made 82.4 bushels per acre.

is poor practice to seed newly prepared and unsettled land to a permanent crop, as alfalfa or other meadow crops. Low spots that have been filled in will settle; these low places will get too much water and often the crop kills out, which results in thin stands and low yields. By growing annual crops for one or two years, an opportunity is given for re-leveling before the permanent alfalfa crop is established.

THE PRODUCTION OF IRRIGATED CROPS

CEREALS

Wheat, barley, oats, and rye yield well in the Harney Valley and as irrigated grain crops rank in importance in the order named. Only high yields of grain can pay on irrigated land. High yields can be secured most easily by the following method:

1. Grow nothing but the highest yielding variety.

2. Carefully clean and grade the seed through a good fanning mill to eliminate all weed seeds and all small, light, broken and damaged seed.

3. Treat wheat, oats, and barley to avoid losses by smut.

4. Plant early and shallow to medium in depth as these methods secure the best stand.

5. Grow cereals in rotation with legumes, as the Harney Valley soils are naturally somewhat deficient in nitrogen and this element is supplied by the legume crop in the rotation.

STANDARD VARIETIES

The experiments of five seasons show Turkey Red to be the best variety of winter wheat; Federation the best variety of spring wheat; Trebi or Hannchen the best of the spring barleys, and Swedish Select and Silvermine the best spring oats. To grow other varieties than these in the high irrigated districts results automatically in a loss.

PREPARATION OF SEED FOR PLANTING

Cleaning and Grading Seed. Sowing seed just as it comes from the threshing machine is an expensive and wasteful practice, since it results in lower yields, and a waste of material that might otherwise be used for feeding purposes. All seed should be put through a fanning mill and grain grader to blow out the light seed, and sort out weed seeds, broken and undersized kernels, which may in many cases be used for feed. By cleaning and grading the seed, better stands of stronger and more vigorous plants may be secured. Table I shows individual and average differences of yields from cleaned grain as compared with grain direct from the threshing machine. There was an average gain of 5.6 bushels an acre from carefully cleaned seed over that of seed directly from the thresher.

TABLE I. YIELDS OF SPRING WHEAT FROM THRESHER RUN AND FROM CAREFULLY CLEANED AND GRADED SEED ON IRRIGATED LAND AT THE BURNS STATION, 1921

Cereal Inv. No.	Variety	Yield in bushels per acre: Thresher run	Cleaned and graded seed	Increase
		bu.	bu.	bu.
2826-1	White Bobs	42.0	45.8	3.8
6255	Red Bobs	45.1	45.8	0.7
4158	Marquis	44.0	51.8	7.8
5284	Acme Durum	40.6	47.6	7.0
1697	Early Baart	49.1	58.1	9.0
Average		44.2	49.8	5.6

Treatment for Smut. All wheat, oats, and barley should be treated for smut previous to seeding. This treatment is applied after the seed has been cleaned and graded. The formaldehyde treatment is probably best for the irrigated cereals. One pint of formaldehyde is mixed in forty-five gallons of water. With carefully recleaned grain, this solution may be sprinkled on the seed at the rate of about one-half gallon per bushel. The dampened grain should be thoroughly shoveled over two or three times to get it all uniformly wet. It is then covered with wet

sacks or canvas and left covered for a period of two to three hours. It should then be shoveled out so that the remaining formaldehyde may escape. Seeding should take place as soon as it will run through the drill.

Where seed has not been properly cleaned, it should be treated in the formaldehyde solution for three to five minutes, then drained of the solution and planted within twenty-four hours in soil sufficiently moist for prompt growth. Oats are usually dipped in sacks, while it is best to treat the wheat or barley loose in vats so that smut balls may be skimmed off. When treating grain loose, it should be thoroughly stirred and skimmed to remove floating smut balls and other light material.

SPRING WHEAT

Federation is Best. Seventeen varieties of spring wheat have been grown on the Burns Station under irrigation. Federation, C. I. 4734, is the best variety. It was introduced into the United States from Australia by the United States Department of Agriculture. It was first grown by Superintendent D. E. Stephens at the Branch Experiment Station at Moro, Oregon, and seed for the Burns Station was secured from this place. It is now being extensively grown in Southern Idaho, where under irrigation it is superseding Dicklow.

Federation is a beardless, brown-chaffed wheat that grades from soft to hard white, depending upon the conditions under which it is grown. It has a stiff straw. Among the seventeen spring wheat varieties, it stood up 100 percent while the remaining varieties lodged 10 percent to 100 percent. It is an excellent yielder, matures moderately early, does not shatter badly, and is rather a good milling wheat.

TABLE II. ANNUAL AND AVERAGE YIELDS OF SPRING WHEAT ON IRRIGATED LAND AT THE BURNS STATION FOR 1920 AND 1921

C. I. No.	Variety	Yield, bushels per acre 1920	1921	Average
		bu.	bu.	bu.
1697	Early Baart	65.0	36.4	50.7
3663	Dicklow	77.1	45.4	61.2
4067	Pacific Bluestem	57.5	42.7	50.1
4158	Marquis	64.0	36.0	50.0
4066	Little Club	.....	38.0	38.0
4734	Federation	82.4	50.9	66.6
6227	Golden Ball (Durum)	55.3	43.4	49.3
2826-1	White Bobs	64.0	33.7	48.8
5284	Acme Durum	50.9	42.0	46.4
6255	Red Bobs (from Canada)	60.0	31.1	45.5
4733	Hard Federation	55.1	28.5	41.8
4981	White Federation	.....	23.3	23.3

WINTER WHEAT

Turkey Red the Standard Variety. Winter wheat will do very well under irrigation in some sections of Harney Valley. It is doubtful if it will prove as satisfactory as the best spring varieties. Turkey Red is the leading winter variety, but has rather weak straw and is apt to lodge, unless the water is carefully applied. It should not be heavily irrigated. Irrigation should stop rather early so the crop may mature.

TABLE III. ANNUAL AND AVERAGE YIELDS OF WINTER WHEATS GROWN ON IRRIGATED LAND AT THE BURNS STATION FOR THE YEARS 1919 TO 1921 INCLUSIVE

C. I. No.	Variety	Yield in bushels per acre 1919	1920	1921	Ave.	Percent of Kharkov
		bu.	bu.	bu.	bu.	%
1558	Turkey Red	18.6	38.0	70.0	42.2	104
1442	Kharkov	21.3	34.9	64.7	40.3	100
5146	Kanred	20.0	30.8	64.4	38.4	95
4512	Washington Hybrid 128	22.6	34.3	58.1	38.3	95
4066	Little Club	21.3	38.6	48.3	36.0	89

BARLEY

Barley Good Hog Feed. Barley is a good yielder in Harney Valley and should be grown more extensively for feed. Ground or rolled barley is an excellent feed for horses and will produce a better grade of pork than corn. The meat will be firmer and not so fat.

Of the twelve varieties grown under irrigation at the Station, two are very good. These are Hannchen, a white, bearded, two-row barley and Trebi, a blue, bearded, six-row barley. Both yielded at the rate of 105 bushels an acre in a rate of seeding test. Both varieties mature moderately early and have rather stiff medium length straw.

Fig. 6. Hannchen barley yields well under irrigation.

OATS

Oats do well in Harney Valley and are excellent for feeding horses. The crop is hardy and yields well under irrigation.

Of the nine varieties grown at the Station, the Rustless Selection, Swedish Select and Silvermine are best, although the Rustless Selection has rather a light kernel.

TABLE IV. ANNUAL AND AVERAGE YIELDS OF SPRING OATS UNDER IRRIGATION AT THE BURNS STATION FOR THE YEARS 1919 TO 1921 INCLUSIVE

C. I. No.	Variety	Yield, bushels per acre 1919	1920	1921	Ave.	Percent of Swedish Select
		bu.	bu.	bu.	bu.	%
724	Rustless Selection	45.0	127.3	70.8	81.0	111.0
134	Swedish Select	38.0	117.1	63.5	72.8	100.0
625	Sixty Day	35.5	91.7	52.4	59.9	80.9
720	Silvermine	35.8	106.8	61.8	68.1	93.5
658	Big Four	33.0	94.5	70.8	66.1	90.7
841	Nebraska 21	.....	96.4	55.5	75.6	103.0
.....	Hulless	.....	81.3	62.0	71.6	98.2
708	Fulghum	.....	87.9	48.2	68.0	93.4

Fig. 7. Irrigated oat varieties, 1920. Five varieties exceeded 100 bushels per acre.

RYE

While rye yields fairly well under irrigation, it cannot be considered a paying crop except where it is produced for seed. There is quite a demand for the true spring rye, which is rapidly replacing the winter varieties.

TABLE V. ANNUAL AND AVERAGE YIELD OF IRRIGATED SPRING RYE AT THE BURNS STATION

Variety	Yield, bushels per acre 1917	1918	1919	1920	Average
	bu.	bu.	bu.	bu.	bu.
Vern, S. P. I. No. 26101	12.9	13.0	18.2	38.9	20.7

FORAGE CROPS

Forage Production Vital. As Harney Valley is essentially a range stock country, forage crops for winter feed are of prime importance. Excellent yields of Grimm alfalfa, field peas, and sunflowers have been produced in the Valley, under irrigation. The old type of farming—that of raising one-half to three-fourths of a ton of wild meadow hay to the acre, with approximately three acre feet of water—is being replaced by

alfalfa and grain fields with the water controlled. This results in increased production and better feed with half of the amount of water formerly used.* (See Table 15.)

ALFALFA

Sow Seed Shallow. The seed bed for alfalfa must be fine and firm. It is best to sow shallow with a drill, as it insures uniform distribution of the seed. Care must be taken to prevent deep seeding. One inch is deep enough for alfalfa. The pressure springs should be released from the furrow openers of the drills so they will not run too deep.

Good stands can be secured by broadcasting and harrowing, but this method requires from 30 to 50 percent more seed and the stand is apt to be uneven.

Grimm is the Best Variety. Grimm alfalfa has proved to be the hardiest, highest yielding variety, both for hay and seed in Harney Valley.

TABLE VI. ANNUAL AND AVERAGE YIELDS OF ALFALFA UNDER IRRIGATION AT THE BURNS STATION FOR THE YEARS 1918 TO 1920 INCLUSIVE

Variety	Yield, tons per acre, cured hay 1918	1919	1920	Average
	tons	tons	tons	tons
Grimm (Baltic)	2.7	4.4	4.9	4.0
Grimm	1.7	4.3	4.7	3.6
Turkestan	1.7	3.9	4.8	3.5
Common	1.7	3.7	4.4	3.3

TABLE VII. ANNUAL AND AVERAGE YIELD OF ALFALFA SEEDED IN 1920 AND GROWN AT THE BURNS STATION UNDER IRRIGATION IN 1920 AND 1921

Variety	Yield, tons per acre, cured hay 1920	1921	Average
	tons	tons	tons
Grimm	.7	7.0	3.9
Dakota Diamond	1.1	6.4	3.7
Martin's Acclimated	.9	6.3	3.6
Cossack	.8	6.2	3.5
Turkestan	.6	5.8	3.2
Liscolm	1.0	5.3	3.1
Smooth Peruvian	1.2	4.8	2.9
Hairy Peruvian	1.3	3.3	2.3

FIELD PEAS

Good for Silage. Field peas are valuable in Harney Valley for silage, for hay, and as a grain crop, when grown alone, or in combination with wheat or oats, and for their fertilizing effect when grown in the short rotation. Field peas produce excellent pork when fed in combination with wheat or barley.

*The Improvement and Irrigation Requirement of Wild Meadow and Tule Land, Oregon Agri. Col. Exp. Sta. Bulletin No. 167, by W. L. Powers and W. W. Johnston.

TABLE VIII. ANNUAL AND AVERAGE YIELDS OF FIELD PEAS FOR HAY AND GRAIN, GROWN UNDER IRRIGATION AT THE BURNS STATION

	Yield, tons of hay* and bushels grain per acre							
	1919		1920		1921		Average	
Variety	tons	bu.	tons	bu.	tons	bu.	tons	bu.
Kaiser	2.5	36.5	4.1	0.0	4.5	48.6	3.7	42.5

*All peas were cut for hay in 1920.

Fig. 8. Grimm alfalfa, the best forage crop for Harney Valley. Yielded 7.0 tons per acre 1921.

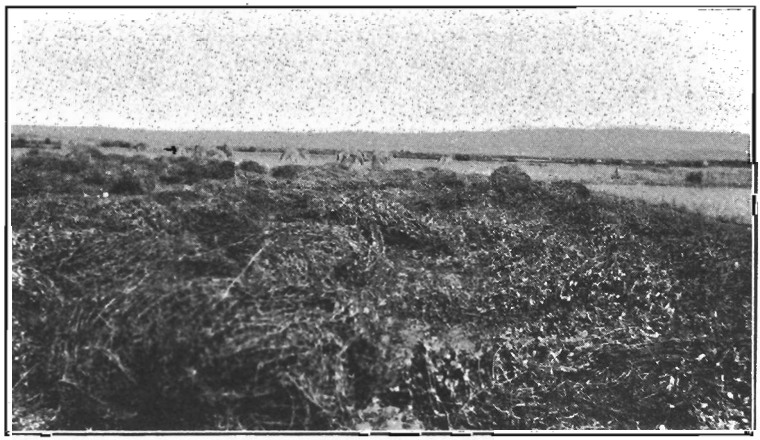

Fig. 9. Field peas for grain, yield 48.6 bushels.

CLOVERS

Clovers Not as Good as Alfalfa. Red clover and white sweet clover have not done very well at the Station. White sweet clover makes a wonderful growth in some sections of the Valley. This crop is very good for green manure in reclaiming some of the poorer soils and also makes good silage when grown alone or in combination with oats.

It is difficult to secure a uniform stand of sweet clover in some sections. The seed has a hard or waterproof seed coat and should be scarified before sowing. The seed bed should be finely worked and firm. The seed may be drilled shallow or it may be broadcasted, but the former method is preferable.

TABLE IX. ANNUAL AND AVERAGE YIELDS OF RED CLOVER AND WHITE SWEET CLOVER, UNDER IRRIGATION, AT THE BURNS STATION

Kind	Yield, tons per acre cured hay 1920	1921	Average
	tons	tons	tons
Red clover	2.2	3.4	2.8
White sweet clover	2.2	4.3	3.2

SILAGE CROPS

SUNFLOWERS

Sunflowers Yield Well. Sunflowers, as a silage crop, have proved to be a leader in Harney Valley during the past two years. Splendid yields were secured in 1920 and 1921. The best way to handle sunflowers as indicated by the available data, is to seed them in rows 21 inches apart, with a regular grain drill, at the rate of 25 to 35 pounds an acre. Two rows at a time can be harvested with an ordinary mower. A sharp sickle and plenty of speed are essential. The crop should be cut close to the ground.

When to Harvest. They may be harvested any time from full bloom until the seeds are in the stiff dough. About 13 tons of whole, green, sunflowers were fed to Station stock, horses and cows, and were readily consumed. The stock left choice alfalfa hay to eat sunflowers.

TABLE X. ANNUAL AND AVERAGE YIELD OF MAMMOTH RUSSIAN SUNFLOWERS GROWN UNDER IRRIGATION WITHOUT CULTIVATION, AT THE BURNS STATION FOR THE YEARS 1920 AND 1921

Variety	Rate of seeding	Distance apart of rows	Acre inches irrigation	Year	Yield per acre
	lb.	in.	in.		ton
Mammoth Russian	5	36	19.5	1920	27.6
Mammoth Russian	30	21	19.5	1920	54.7
Mammoth Russian	15	14	19.5	1920	43.6
Mammoth Russian	30	7	19.5	1920	42.8
Mammoth Russian	35	21	15.0	1921	31.0
Mammoth Russian	35	21	20.0	1921	38.3
Mammoth Russian	35	21	25.0	1921	38.1
Mammoth Russian	35	21	24.0	1921	54.1
Mammoth Russian	35	21	27.0	1921	51.5

Note: Yields are reported as green weight in tons per acre at the silage stage.

The highest yield was secured when the sunflowers were sowed thickly in twenty-one inch rows and were heavily irrigated. It is important that sunflowers be planted and irrigated so they will head out and reach a good stage of maturity. Probably water should be kept off late in the season. Early varieties should be grown.

Some work with sunflowers has indicated that when green or dry plants such as corn or oats can be cut into the silo with sunflowers, better silage is secured.

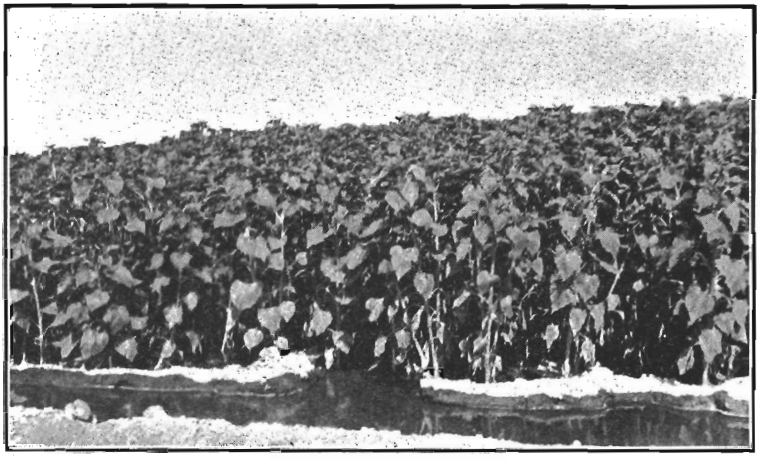

Fig. 10. Irrigating sunflowers. Yield 54.7 tons per acre green weight.

OTHER SILAGE COMBINATIONS

A combination of field peas and wheat seeded at the rate of 1 and 2 bushels respectively, yielded at the rate of 14.1 tons per acre for silage, and 6.2 tons when cured for hay.

A combination of field peas and Silvermine oats seeded at the rate of 1 and 2 bushels respectively, yielded at the rate of 14.8 tons of silage and 6 tons of cured hay per acre.

Fig. 11. Peas and oats for hay or silage. Yield for hay 6.2 tons, for silage 14.8 tons

POTATOES

Potatoes Best on Slopes. Potatoes make excellent yields in some of the more sheltered sections of the Valley, especially along the foot hills. On the Valley floor proper the crop is sometimes killed by frost. However, some very good yields have been secured.

In most sections, this crop should not be planted until the latter part of May. In some sections potatoes may be planted early in April.

TABLE XI. ANNUAL YIELDS OF POTATOES UNDER IRRIGATION AT THE BURNS STATION

Variety	Yield, bushels per acre 1919	1921
	tons	tons
Early Six Weeks (Geer)	79.2	.....
Early Ohio	83.3	176.0
Bliss Red Triumph	73.3	.....
Irish Cobbler	81.6	.....
Extra Early Rose	124.2	.....
White Pinkeye (Local)	75.0	195.0
Eureka	85.8	.....
Netted Gem	91.6	161.0
Red Pinkeye (Local)	.....	220.0

ROOT CROPS

Root crops are not as sure in the Harney Valley as cereal or forage crops, but good yields have been secured.

SUGAR BEETS AND HALF SUGAR MANGELS

Sugar beets and mangels, like potatoes, are rather uncertain crops for the Valley proper, but can be grown to advantage in the warmer sections. Mangels make excellent feed for all kinds of stock, and several tons have been fed to Station stock with good results. Sugar beets and mangels require a finely worked, firm seed bed. They should be seeded in rows 30 to 36 inches apart, and thinned to single plants, ten inches apart in the row, when the fourth leaf appears. They should be well cultivated.

TABLE XII. AVERAGE YIELDS IN TONS AN ACRE OF HALF SUGAR MANGELS AND SUGAR BEETS GROWN UNDER IRRIGATION AT THE BURNS STATION

Half sugar mangels 1919	Sugar beets 1921
6.2	6.1

RUTABAGAS

Rutabagas are hardy and make good yields. The half sugar mangel is more readily eaten by stock.

RATE AND DATE OF SEEDING

Table XIII gives the best rates of seeding for the various crops according to the present data. The dates of seeding will vary more or less, according to locality, but are reasonably correct for the Valley proper.

TABLE XIII. RECOMMENDED RATES AND DATES OF SEEDING IRRIGATED CROPS AS WORKED OUT AT THE BURNS STATION FOR HARNEY VALLEY

Crop	Rate of seeding			Date of seeding
Spring wheat		2	bushels	April 1 to 25
Winter wheat		2	bushels	Sept. 1 to 15
Spring barley	2½ to	3	bushels	April 20 to May 10
Spring oats	2½ to	3½	bushels	April 1 to 25
Spring rye	2 to	2½	bushels	April 1 to 25
Grimm alfalfa	10 to	20	pounds	April 25 to June 1
Clover	10 to	15	pounds	April 25 to June 1
Field peas	1 to	2	bushels	April 1 to 25
Sunflowers	20 to	25	pounds	May 1 to 25
Peas and grain combination	2 to	3	bushels	April 1 to 25
Potatoes	1½ to	2	ounce piece per hill	May 15 to 25
Sugar beets	8 to	12	pounds	May 15 to 25
Mangels	8 to	12	pounds	May 15 to 25
Rutabagas	3 to	5	pounds	April 15 to 25

Fig. 12. Irrigated rotations. Grain continuous, yield 23.3 bushels per acre.

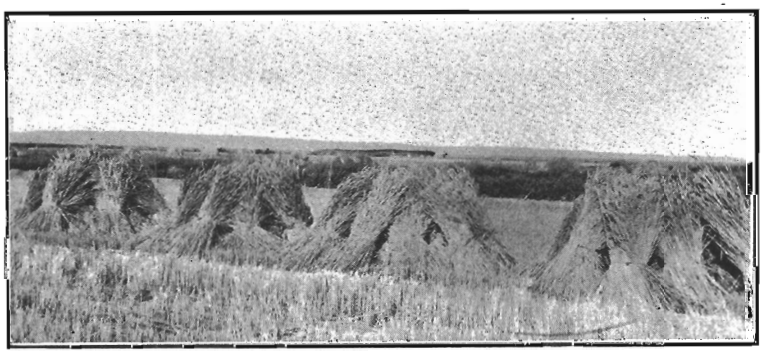

Fig. 13. Irrigated rotations. Grain on field pea stubble, yield 61.1 bushels per acre.

IRRIGATED ROTATIONS

Several rotations are being tried at the Station. The two giving the best results to date are the two- and six-year rotations.

The two-year rotation, grain following field peas, has given excellent results. The yield of Federation spring wheat seeded on field pea stubble was 61.1 bushels per acre, while the yield of the same variety of wheat grown on a plot of land that had been cropped to grain continuously since 1917 was 23.3 bushels per acre. This represents a gain of 37.8 bushels per acre in favor of the rotation. Effect of rotation upon yield of grain is shown in Table XIV. As the depth of irrigation is about 12 inches a year, rotation has caused the increase in yield of two bushels per acre inch.

TABLE XIV. AVERAGES IN SUMMARY—GRAIN IN IRRIGATED ROTATION. BURNS STATION

Rotation No.	Crop sequence	Barley 1917	Barley 1918	Barley 1919	Barley 1920	Wheat 1921	Average of barley (all yrs.)
		bu.	bu.	bu.	bu.	bu.	bu.
1	Grain Continuous	21.26	30.76	29.2	[1]6.26	32.6	31.87
	Grain after field peas[4]	[3]18.3	59.85	36.76	81.8	47.9	59.47
[2]2 and 5	Gain over continuous	.....	29.09	7.56	35.54	15.3	34.26
4	Grain after roots	[5]14.9	[1]58.0	27.4	83.5	45.5	55.4
	Gain over continuous	.....	[1]27.24	-1.8	37.2	12.9	17.7
3	Grain after green manure[2]	[5]14.0	56.3	34.0	.....	33.8	45.1
	Gain over continuous	.....	25.5	4.8	.....	1.2	15.1
6	Grain — rye hay — pea hay	[5]7.3	35.6	27.76	.....	.....	31.68
	Gain over continuous	.....	4.9	-1.4	.....	.....	1.75
7	Alfalfa 4 yrs. Grain 2 yrs.	[5]21.2	.....	.....	.....	39.1	.....
	Gain over continuous	.....	.....	.....	.....	6.5	.....
	Average all rotated grain	.....	50.58	31.38	82.6	41.5	54.85
	Average increase all rotation	.....	19.83	2.18	46.34	8.9	22.78

[1]After fallow 1918 not included in average.
[2]Pea hay.
[3]Grain and alfalfa (alfalfa not completely eradicated).
[4]Field peas substituted for sweet clover in rotation 5.
[5]Grain first in rotation. Not included in average.

Fig. 14. Fertilizer experiment with Federation wheat. The first four plots from right to left yielded at the rate of 79.5, 80.0, 80.7, and 80.0 bushels per acre.

Crop rotations that include leguminous crops, not only maintain the nitrogen of the soil but may build it up, thus increasing the producing power and returns per unit of water.

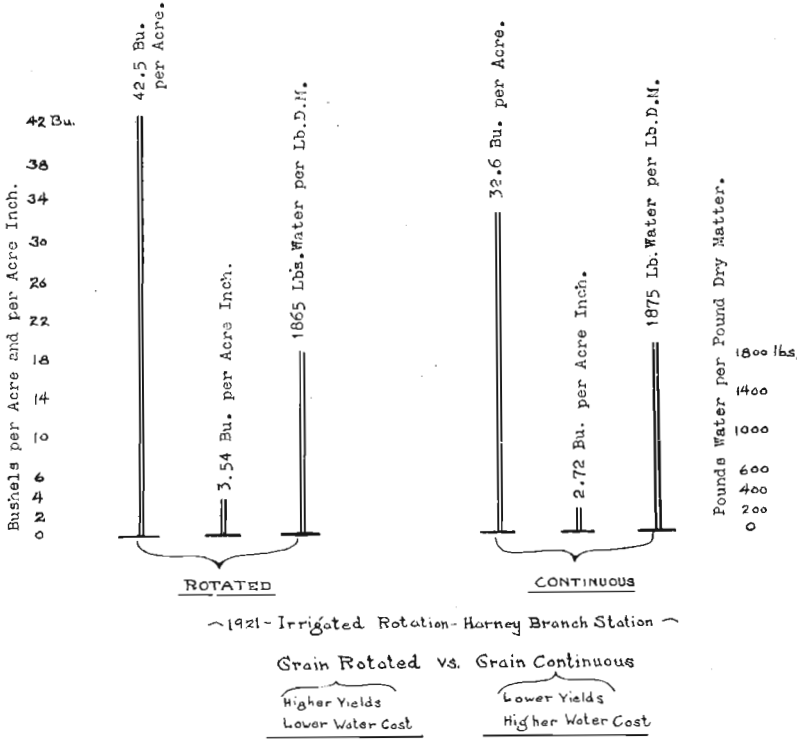

Fig. 15. Irrigated rotation, 1921, Burns Experiment Station.

TIME AND FREQUENCY OF IRRIGATION

The object of irrigation is to maintain a favorable supply of water for the crop through its period of development.

It is not possible to lay down any hard and fast rules for the irrigation of crops. The man who has handled crops to any extent will be able to tell from the general appearance of the crop, and condition of the soil, when to apply water. The crop should not be allowed to burn before water is applied as this will check growth to a marked extent. As a rule, when the plants have a dull green color and begin to droop, they are very near the danger point. Crops that have plenty of water have a bright green color and a thrifty appearance.

An excess amount of moisture will cause a rank straw growth at the expense of the yield of grain, will cause lodging and delay maturity. Over-irrigation prevents the proper circulation of air through the soil about the roots and causes the plants to turn yellow.

Frequent, light irrigations, are better than heavy irrigations at long intervals. The irrigation season should be shortened, depending on the

locality, so that the crop will have time to mature before danger from fall frosts. Late irrigation delays maturity and causes a great deal of lodging.

DUTY OF WATER

While this experiment is still incomplete, the results to date warrant the recommendation of the following amounts of water for the crops listed below:

TABLE XV. SHOWING THE ACRE INCHES OF IRRIGATION GIVING THE BEST RESULTS AT THE BURNS STATION

Crop	Variety	Total acre inches of water applied to crop
Spring wheat	Federation	12
Winter wheat	Turkey 1558	12
Barley	Hannchen and Trebi	12
Oats	Rustless Selection	12
Spring rye	Vern, S. P. I. (26101)	12
Alfalfa	Grimm	18
Clover	White Sweet	15
Field peas	Kaiser	12
Sunflowers	Mammoth Russian	20
Combinations	Kaiser peas and Silvermine oats	2-15
Potatoes	Red pinkeye	10
Sugar beets	Sperling elite type A	12
Mangels	Half Sugar	12
Rutabagas		12

COMPARATIVE YIELDS OF DRY LAND AND IRRIGATED CROPS

The object of introducing this paragraph, and Table XVI, is to afford the prospective irrigator a working basis for a comparison of the two methods of farming. The results in this table represent average yields of two to five years, for the various crops grown.

TABLE XVI. SHOWS THE COMPARATIVE, AVERAGE YIELDS, OF DRY AND IRRIGATED CROPS, IN BUSHELS OR TONS PER ACRE, THE GAIN OF IRRIGATED OVER DRY LAND CROPS, AND THE NUMBER OF YEARS GROWN

Crop	—Yields, in bushels or tons per acre— Dry land	Irrigated	Years grown	Gain irrigation over dry land
Spring wheat	19.5	36.6	5	17.1 bu.
Winter wheat	13.0	49.0	3	36.0 bu.
Barley	16.1	52.5	5	36.0 bu.
Oats	18.2	59.8	5	31.1 bu.
Spring rye	15.4	20.7	4	5.3 bu.
Alfalfa (Grimm)	1.2	4.8	4	3.6 tons
Field peas	7.2	28.7	4	21.7 bu.
Sunflowers (silage)	23.0	54.4	2	31.4 tons
Potatoes	77.3	144.3	4	67.0 bu.

Note: Yields for the years 1917 and 1918 under irrigation, are abnormally low, due to heavy grading and do not represent the productive power of average Harney Valley soils.

THE COST OF IRRIGATION BY PUMPING

In order that the settlers in Harney Valley who are thinking about the installation of pumping plants, may have some basis for estimating the probable costs, the data on the plant at the Burns Station are herein presented.

The plant as it has been operated consists of one eight-inch well, drilled 218 feet deep, and cased down 100 feet from the surface. The pump is a 4-inch horizontal, centrifugal, and is located in the bottom of a pit about 8 feet from the surface of the ground. The intake is not fastened to the casing, direct, but extends down into the 8-inch casing, 20 feet, and is attached to the top of the casing with an air-tight collar. This pump is operated with an 8-horse-power gasoline engine.

The water is of semi-artesian flow and stands within five feet of the surface of the ground when the pump is not operating. When the pump is throwing ¾ of a second foot, the water stands at about 12 feet below the level of the pump.

In order to arrive at the actual cost of irrigation, by pumping, the subject must be considered in its several divisions. In this report, they will be handled under the following headings:

1. **First cost.** This includes drilling and casing the well, engine, pump, belt, retaining walls, and installation. The engine may be used for threshing and other purposes.

2. **Operating expenses.** This includes labor, fuel, and lubricating oil.

3. **Maintenance charges.** Covering interest on the first cost, depreciation (figuring that the entire plant except the well must be renewed in ten years), and repairs.

4. **Total annual cost.** This equals the sum of (2) and (3).

The cost, operating expenses, and maintenance charges of the Burns Station pumping plant are given below:

1. **First cost.**

Drilling well 218 feet	$ 298.00
Casing for well	391.32
4-inch centrifugal pump and belt	75.00
Installation of pump	60.00
8 Horse-power gasoline engine	240.00
Lumber for retaining walls and belt incline	10.00
Total first cost	$1074.32
First cost per acre	26.86

(Not including leveling and ditches which are considered fairly permanent land improvements.)

2. **Operating expenses.**

	Per hour
Labor @ $2.50 per day	$0.25
Fuel, 10 gal. (1 pt. per H. P. per hour)	.32
Lubricating oil (5 mills per hour)	.005
	.575

This plant will furnish ¾ of one second-foot, or will cover one acre 9 inches deep in 12 hours. To cover 40 acres one foot deep, it will take 640 hours, or 64 days of 10 hours.

3. **Maintenance charges.**

Interest on "First cost" of plant @ 6 percent	$ 64.46
Depreciation and repairs (replace plant in 10 years)	107.43

4. **Total annual cost.**

Fuel at 32c per hour, 10 hours, 64 days	$204.80
Labor at 25c per hour, 10 hours, 64 days	160.00
Lubrication, 5 mills per hour, 10 hours, 64 days	3.20
Total annual cost of irrigating 40 acres one foot deep	539.89
Cost per acre foot	13.50
Cost per acre foot per foot pumping lift	.60
Cost per acre inch	1.125

TABLE XVII. COST, VALUE, AND PROFIT FROM IRRIGATION

Crop	Ave gain irrig. over dry per acre (Table 16)	Value of gain per acre	Depth of irrig. (Table 15)	Irrig. total annual cost per acre	Net gain or loss per acre	Net gain or loss per acre inch
	T. or bu.		in.			
Spring wheat	17.1	$17.10	12	$13.50	$3.60	$0 30
Winter wheat	36.0	36.00	12	13 50	22.50	1.88
Barley	36.0	27.00	12	13 50	13.50	1.125
Oats	31.1	15.55	12	13.50	2.05	.17
Spring rye	5.3	5.30	12	13.50	8.20 loss	.68 loss
Alfa'fa	3.6 T.	25.20	18	20.25	4.95	.28
Field peas	21.7 bu.	65.10	15	16.88	48.22	3.21
Sunflowers	31.4 T.	125.60	20	22.50	103.10	5.16
Potatoes	67.0 bu.	80.40	10	11.25	69.15	6.92

In Table XVII crop increases have been valued as follows:

Wheat and rye at $1.00 bushel; barley 75c bushel; oats 50c bushel; field peas $3.00 and potatoes $1.20 bushel. Alfalfa at $7.00 ton and sunflowers at $4.00. The high yield of sunflowers and low yield of potatoes causes the former to assume a high rank as to net profit from irrigation. This would be reduced if the value of fertility removed by sunflowers were deducted. Rye is found to be unprofitable at any reasonable price while field peas show a very good net return.

Net gain as figured here does not include original cost and maintenance cost of distribution ditches or preparation of land for irrigation, since these are considered fairly permanent improvements. Nor does it take into account the increase in cost of harvesting and marketing the increase in yield per acre. On the other hand, by irrigation a crop is produced each year, while under dry farming the land is in fallow one year out of two. There is more profit in large crops and fallow involves expense.

The figures given, therefore, are only an approximation to be used as a guide by the individual farmer until yields and costs are available over a longer period of years.

The following tables give the flow of water over weirs, and the time required for application of a given amount of water in irrigation.

APPENDIX

Table XVIII gives the flow of water over weirs in cubic feet per second.

TABLE XVIII. DISCHARGE OF STANDARD CIPPOLETTI AND STANDARD SUPPRESSED RECTANGULAR WEIRS IN CUBIC FEET PER SECOND

Head depth in inches	Head depth in feet	Width of weir in feet					
		1.0	1.5	2.0	2.5	3.0	4.0
	.20	.30	.45	.60	.75	.90	1.20
2½	.21	.32	.49	.65	.81	.97	1.30
	.22	.35	.52	.69	.87	1.04	1.39
2¾	.23	.37	.56	.74	.93	1.11	1.48
	.24	.40	.59	.79	.99	1.19	1.58
3	.25	.42	.63	.84	1.05	1.26	1.68
	.26	.45	.67	.89	1.11	1.34	1.78
3¼	.27	.47	.71	.94	1.18	1.42	1.89
	.28	.50	.75	1.00	1.25	1.50	1.99
3½	.29	.53	.79	1.05	1.32	1.58	2.10
	.30	.55	.83	1.11	1.39	1.66	2.21
3¾	.31	.58	.87	1.16	1.45	1.74	2.32
	.32	.61	.91	1.22	1.53	1.83	2.44
4	.33	.64	.96	1.28	1.60	1.91	2.56
	.34	.67	1.00	1.33	1.69	2.00	2.67
4¼	.35	.70	1.05	1.39	1.74	2.09	2.79
	.36	.73	1.09	1.45	1.82	2.18	2.91
4½	.37	.76	1.14	1.52	1.90	2.27	3.03
	.38	.79	1.18	1.58	1.98	2.37	3.15
	.39	.82	1.23	1.64	2.05	2.46	3.28
4¾	.40	.85	1.28	1.70	2.13	2.56	3.41
	.41	.88	1.33	1.77	2.21	2.65	3.53
5	.42	.92	1.37	1.83	2.29	2.75	3.66
	.43	.95	1.42	1.90	2.38	2.85	3.80
5¼	.44	.98	1.47	1.97	2.46	2.95	3.93
	.45	1.02	1.52	2.03	2.54	3.05	4.06
5½	.46	1.05	1.58	2.10	2.63	3.15	4.20
	.47	1.09	1.63	2.17	2.71	3.25	4.34
5¾	.48	1.12	1.68	2.24	2.80	3.36	4.48
	.49	1.16	1.73	2.31	2.89	3.46	4.62
6	.50	1.19	1.79	2.38	2.98	3.57	4.76
	.51	1.23	1.84	2.45	3.07	3.68	4.90
6¼	.52	1.26	1.89	2.52	3.16	3.79	5.05
	.53	1.30	1.95	2.60	3.25	3.90	5.20
6½	.54	1.34	2.00	2.67	3.34	4.01	5.34
	.55	1.37	2.06	2.75	3.44	4.12	5.49
6¾	.56	1.41	2.12	2.82	3.53	4.23	5.64
	.57	1.45	2.17	2.90	3.63	4.35	5.79
7	.58	1.49	2.23	2.97	3.72	4.46	5.95

The body of the table gives the flow in second-feet when given depths of water flow over weirs of various widths.

Example: A stream 4½ inches deep over a two-foot weir delivers 1.52 cubic feet per second.

The Management of Sandy Soils Under Irrigation. Oregon Agri. Col. Exp. Sta. Bulletin 177, by H. K. Dean.