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Irrigation of Potatoes

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and

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CORVALLIS, OREGON

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The work herein reported is a phase of the Oregon Soil and Soil Water Investigations conducted partly in cooperation with the United States Department of Agriculture bureaus of Plant Industry and of Rural Engineering. This report is published as a phase of the work provided for by Chapter 350, General Laws of Oregon, 1919.

Irrigation of Potatoes

SUMMARY

1. Irrigation of potatoes at the Oregon Agricultural College Experiment Station, Corvallis, has been carried on for the past twelve years, under conditions where rainfall for the growing season, April 30 to October 1, is five and one-half inches, and the average evaporation about twenty-four inches for the period.

2. The Willamette silt loam on which these experiments were conducted has a maximum capillary water content of about thirty-four percent, an optimum moisture content of about twenty-four percent, and a wilting point of about fourteen percent. The minimum moisture content under field conditions is ten or eleven percent.

3. Irrigation gave a higher seasonal moisture content and this was associated with higher yields.

4. Two irrigations proved better than the same amount applied with one heavy irrigation for potatoes.

5. Most economical returns were secured with light frequent irrigations, which provide a uniform moisture content. Irrigation of one inch every ten days has given very economical returns and is good practice for gardens.

6. Potatoes do best with a uniform moisture content. The best time to irrigate potatoes in this soil is when the moisture content in the first foot drops to the twenty-percent point in percent dry weight. Two light irrigations have given good returns and three light irrigations have given economical returns with this crop, in dry seasons.

7. The most economical returns obtained with potatoes have been secured when the depth applied per season was six inches in wet seasons and two or three inches in dry seasons, while the maximum yields of potatoes have been produced with three or four inches in wet seasons, and six inches in dry seasons. Application of nine inches depth decreased the yield below that obtained with six inches of irrigation.

8. Applying water in furrows ten to eighteen rods long has proved a suitable length of run for the silt loam soil. It has been found disastrous in our experiments to neglect cultivation after irrigation.

9. Water cost of dry matter or water requirement under field conditions has been greatly reduced by the use of a moderate amount of irrigation. Water requirement varies about the same as does the most economical return per acre inch. Above the most economical yield per acre inch the water requirement increases. Growing potatoes on irrigated legume sod reduced the water requirement by about twenty-five percent below the water requirement of potatoes on dry-farmed legume sod land.

10. Water requirement can be greatly reduced in irrigation farming by practicing a good rotation, including legume crops; by using good varieties; by maintaining a good state of fertility and tilth; by irrigating at just the right time in the proper amount; and by practicing good general farm methods.

11. Proper irrigation does not injure the palatability or marketability of potatoes. Twelve years irrigation has had little appreciable effect upon soil acidity or the content of available plant food. Soil temperature was lowered by irrigation more than by shading, or above 3° in surface soil of potato plots.

12. Heavy irrigation has increased the moisture content of the potatoes, caused a higher proportion of vines to tubers, and a slight change in the chemical composition of the product.

13. Proper irrigation has decreased the percentage of culls.

14. Irrigation to be of much value in the Willamette Valley must be used only in a supplemental and proper way.

15. In Central Oregon experiments, potassium sulfate increased the yield per acre inch from twenty-four and one-half bushels on untreated to thirty-nine bushels on treated land.

16. In Eastern Oregon experiments, irrigation of five to nine inches depth an acre has given the best results in several of the potato-producing sections and frequently best returns have been obtained with six to eight inches total depth, applied in two or three doses.

IRRIGATION OF POTATOES

Potatoes constitute a leading cultivated crop in irrigated sections. They make a good cash crop in rotation following legumes, requiring but little irrigation and this rather late in the season, while giving a large cash return to the acre inch of water used. No other vegetable is so widely grown, and so regularly consumed for food. The annual production of potatoes in Oregon is about five million bushels, while for the United States it runs over three hundred fifty million bushels. The annual per capita consumption is 3.8 bushels. There are few districts in Oregon where potatoes grown on good, free-working soil will not respond readily to irrigation. The potato is sensitive to unsuitable moisture conditions, and irrigation affords a means for control of such conditions.

Herein are reported results of twelve years irrigation experiments including about two hundred plot trials on experiment fields, in both Eastern and Western Oregon. Most of the data have been obtained from potatoes grown in rotation after clover sod on the home station at Corvallis. The conditions under which these experiments have been conducted in both Eastern and Western Oregon have been described in previous bulletins.* Weather conditions during the period covered by these experiments are summarized in Table I.

Handling the Crop under Irrigation. The potato does best where the climate affords a uniformly moist, long, and fairly cool season. The long days of northern latitudes favor such conditions. Potatoes thrive best on soils that are free working, retentive of moisture, fertile, and well supplied with lime. The nitrogen which is required can be supplied by growing the crop on legume sod land. Phosphorous, nitrogen, and potash must all be readily available. Soils that are compact, water logged, alkaline, or heavy are not desirable for the crop. Good surface and under drainage is desirable.

A crop rotation is important to provide legume sod land on which to raise potatoes, thereby supplying nitrogen and organic matter in the soil, building up the water-holding capacity, and lessening the amount of irrigation required. Crop rotation also cleans up the land and avoids the insect and plant pests that develop with continuous cropping. The sod land should be disked and then plowed shallow with a sharp plow some months before planting time. A second, deep plowing should be given two or three weeks before planting, allowing time for the soil to settle.

Good solid varieties of potatoes which are not sensitive to a little over-irrigation are desirable, as the Netted Gem, or Rural New Yorker. The improved Burbank, however, does very well and may give somewhat larger yields. Hill-selected, treated seed of good-sized seed pieces should be used. Treatment for Rhizoctonia is given as follows: Immerse tubers 1½ to 2 hours in a solution of one-fourth pound corrosive sublimate to thirty gallons of water. Dissolve corrosive sublimate in a small quantity of hot water and bring up to the required thirty gallons.

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* Powers, W. L. Irrigation and Soil Moisture Investigations in Western Oregon. Oregon Agri. Col. Exp. Station Bulletin 122.

Powers, W. L. Economical Use of Irrigation Water. Oregon Agri. Col. Exp. Station Bulletin 140.

TABLE I. SUMMARY OF 13 YEARS CORVALLIS WEATHER DATA 1907-1919

Year	Temperature May	June	July	Aug.	Sept.	5 mo. total ave.	Dept. from normal	Rainfall, inches May	June	July	Aug.	Sept.	5 mo. total ave.	Dept. from normal	Evaporation May	June	July	Aug.	Sept.	Evaporation 5 mo.
1907	57.1	61.1	65.8	64.3	61.0	....	....	1.27	1.11	.24	1.15	1.17	.99	—0.22	......	......	....	....	....	....
1908	51.1	58.6	69.6	64.6	59.2	....	....	2.89	1.38	.00	1.00	.23	1.10	—0.11	......	......	....	....	....	....
1909	52.1	60.6	62.0	62.9	61.5	59.80	—1.2	1.39	.30	1.10	.11	1.16	.81	—0.40	......	......	....	....	....	....
1910	57.5	58.2	65.7	62.7	59.0	60.40	—0.6	.83	1.73	T	.01	.85	.68	—0.53	3.56	4.20	6.08	6.23	3.60	23.67+
1911	51.0	56.5	69.2	67.5	54.0	59.60	—1.4	4.21	1.05	.03	.02	4.27	1.91	+0.70	2.36	4.20	6.51	6.09	4.54	23.70+
1912	56.7	61.2	65.2	60.8	......	60.70	—0.3	2.14	1.48	.17	2.18	1.94	1.58	+0.37	......	......	4.76	4.54	....	....
1913	54.5	60.0	66.4	66.2	56.1	60.60	—0.4	1.89	2.88	.93	.37	2.34	1.70	+0.49	......	3.32	4.77	3.60	3.43	23.00+
1914	57.6	57.9	67.0	65.0	61.0	61.70	+0.7	1.59	2.15	.00	.00	3.84	1.51	+0.30	......	6.46	7.31	3.95	....	....
1915	54.7	65.1	68.3	75.4	61.4	64.90	+3.1	2.39	0.54	1.09	.00	.39	.88	—0.33	......	3.91	4.08	5.90	4.35	17.84
1916	51.8	59.5	......	67.8	59.7	59.70	—1.3	2.77	1.45	T	.03	.60	.96	—0.25	5.52	......	5.24	5.80	3.75	24.22
1917	54.7	61.6	65.8	69.3	61.5	62.60	+1.6	1.50	.86	.00	.01	2.19	.91	—0.19	3.41	5.32	6.66	7.47	3.49	26.35
1918	52.4	65.6	65.8	69.2	66.6	63.90	+3.3	1.11	.00	.45	.43	.56	.51	—0.88	4.08	7.15	7.13	6.17	4.45	29.00
1919	54.46	60.0	68.0	65.0	56.9	60.88	—0.12	1.32	.22	.10	.14	3.08	.97	—0.22	2.28	3.98	6.12	7.14	1.32	20.48
Ave.	54.28	60.45	66.56	66.2	59.8	61.35	+0.35	1.74	1.16	.32	.42	1.74	1.10	N	......	......	....	....	....	23.47

Corrosive sublimate is very poisonous and should be kept away from stock. The seed is usually cut into two-ounce or three-ounce pieces and dusted with land-plaster.

Under irrigation potatoes should be planted at a good depth, say five inches, and in rows preferably three and one-half feet apart, with seed pieces twelve inches apart in the row. Seeding can be a little deeper on sandier soils or where there is danger of frost. The seeding should be more or less heavy according to the fertility of the soil. About fourteen bushels of seed an acre can be used to good advantage on rich loam soil.

Cultivation and Soil Moisture for Potatoes. Cultivation should begin promptly after planting in order to loosen the soil and encourage deep rooting. The first cultivation should be deep and cultivation should be continued and thorough. By planting with rows far apart, and thick in the row, it is possible to cultivate after irrigation so as to mulch down the furrows without injuring the crop roots. Cultivation after each irrigation is important to restore the mulch and the structure of the soil, and to conserve moisture. The "regulation" of the small furrow at head ditches need not be disturbed by cultivation. Less water with more frequent application gives better quality of product. The roots should not be disturbed after the plant begins to bloom.

Potato ground should have a good, uniform supply of moisture at planting time, and should be irrigated before plowing if the winter and spring rains have not provided this. "Irrigating up" is not advisable except possibly in loose sandy soils. Irrigation should be delayed as long as possible after planting without affecting the vigorous, healthy growth of the vines. The aim in irrigating potatoes is to provide a uniform, moderate moisture content, so as to keep the crop growing at a uniform rate. Ordinarily the first irrigation is applied at the time the vines begin to bloom. A second irrigation may be applied, if needed, when the blooming is about over. Where the soil is sandy it is liable to dry out in parts; light irrigation may then be necessary when the vines are several inches high, in order to provide a more uniform moisture supply and a more uniform temperature in case there is danger of a late spring frost. The last irrigation should always be fifty days or so before harvest to permit the water in the soil to be used up before marketing the crop and to permit proper maturity. Potatoes are sensitive to excess water. Cold, wet soils favor scab. A moderate slope is better than flat ground, especially on heavy soil. Irregular moisture content is caused by delay or through heavy irrigation, which results in a second growth and ill-shaped potatoes. Good potato soil will store about fifty percent of the moisture needed by the crop, and examination of the soil for moisture is the safest guide as to when to irrigate potatoes.

Irrigation Methods. Furrow irrigation is the only practical method for potatoes.

The furrow should be made deep so as to allow the water to be drawn up to the vines by capillarity and also to avoid wetting the surface mulch. The soil should not become saturated and puddled in the tuber bed. The deep furrow provides for loose earth placed around the tubers to protect them and form a mulch after irrigation; it prevents excess of water or light around the tubers and checks loss by evaporation.

A smooth furrow, such as made by a sled, or a block following the shovel plow in light, sandy soil will carry water farther, while in heavy soil a loose furrow such as would be left by a shovel plow or cultivator shovel encourages percolation or absorption.

The water is led along the head ditch and is turned into the furrows between every two rows through openings cut in the bank with a shovel or through the lath tubes called "spiles." A one-inch stream may be allowed to run into the furrows until they are wet down to the lower end, after which the stream may be closed down to one-half the former size, or just sufficient to keep free water in the furrow to the lower end and permit soaking throughout its entire length. Water in the furrow should run clear and not puddle the soil.

FIG. 1. FURROW IRRIGATION OF POTATOES

The time to allow water to soak into the soil will depend upon the soil type. With fine sandy loam, from one to two hours will be sufficient. A shovel or soil auger may be used to see how far the ground is wet down and out from the furrow. Drainage furrows should be opened across the lower end of the rows so as to equalize the water reaching the lower end, and to secure more uniform distribution without puddling or flooding. With careful irrigation there should be little or no drainage, and no flooding should occur.

The length of run will depend upon the soil type and the amount of surface slope. Twelve rods is a good length of run in sandy loam soil. In heavier soil the runs may be as much as four hundred forty feet, or one-third the width of a forty-acre tract. The greater the slope, the smaller the stream of water; while on flatter ground the larger head will push over the furrow faster and farther.

RESULTS OF IRRIGATION EXPERIMENTS

Irrigation Versus No Irrigation. The results of a seven-year trial with potatoes under irrigation as compared to no irrigation in light clay loam soil at the Oregon Agricultural College Experiment Station, Corvallis, is given in Table II.

TABLE II. SUMMARY, IRRIGATION VS. NO IRRIGATION, POTATOES

Years tested	Yield per acre		Gain	
	Irrigated	Dry	Per acre	Per acre inch
	bu.	bu.	bu.	bu.
7	222.2	122.0	100.2	21.7

On the average five and one-half acre inches depth of irrigation was used in this experiment, and potatoes, although a cultivated crop, gave greater cash returns than any other field crop included in irrigation trials. During this seven-year period the increase was one hundred bushels an acre or 21.7 bushels an acre inch.

Value of One Versus Two Irrigations. An experiment was conducted to determine the value of one compared to two irrigations, extending through a period of three years. In one case a depth of five inches irrigation was supplied and in the other the amount was divided between two applications. This is illustrated by results given in Table III. The crop gave a larger return where the water was applied in two applications, which provided a more moderate and uniform moisture content.

TABLE III. VALUE OF ONE VS. TWO IRRIGATIONS, POTATOES

Irrigation	Yield	Gain	Gain per acre inch
	bu.	bu.	bu.
2x2½"*	240.7	105.6	21.1
1x5"	190.9	55.8	11.9
Dry	135.1	....	......

* 2x2½", an abbreviation used in tables in this bulletin; indicates two irrigations of two and one-half inches depth each.

Time of Irrigation. If ground is dry at planting time it is best to irrigate before plowing. Irrigation should be withheld till necessary so as to encourage deep rooting. After beginning irrigation there should be no delay or interruption. When the vines have become large enough to bloom they will usually have dried out the soil to a point where irrigation is needed. The proper time may be indicated (1) by the darkening of the vines to a deep green color. (2) Weather conditions should be watched, as they may indicate the time when irrigation is needed. Evaporation from a free water surface is a good means of determining the drying influences of the weather element. Relative amount of evaporation gives a good indication of the dryness of the weather. (3) The moisture content of the soil near the feeding roots of the potatoes is also a good guide. Soils should be moist enough to mold readily in the hand, and leave the hand moist; when such is the condition irrigation is not needed.

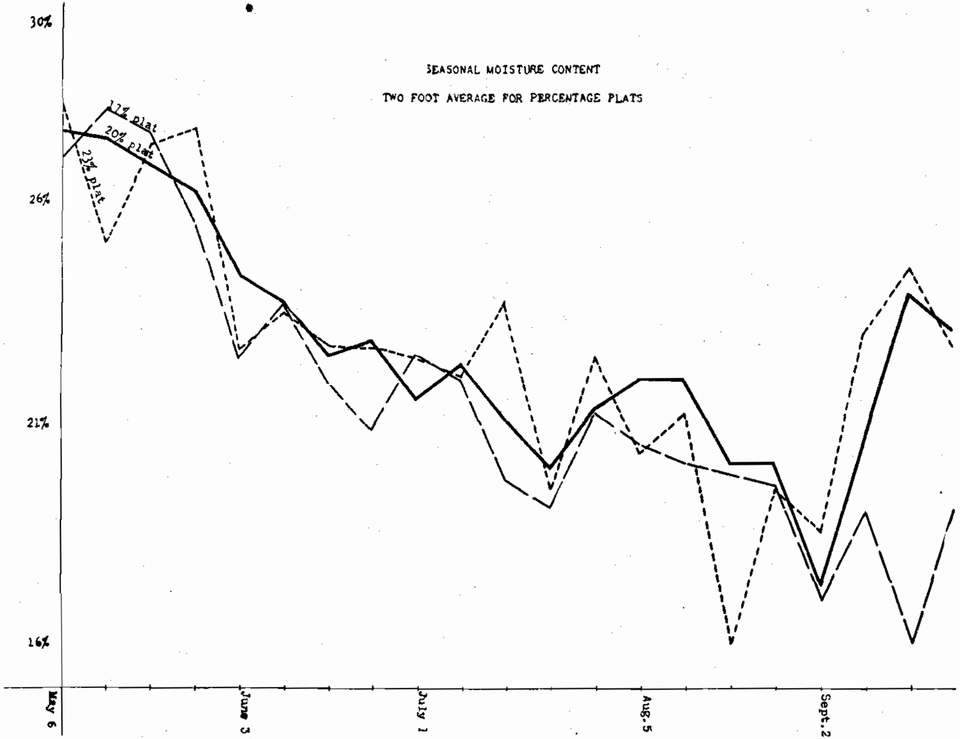

FIG. 2. SEASONAL MOISTURE CONTENT, CURVES OF PERCENTAGE PLOTS

The exact percentage at which irrigation of any soil type is needed can be learned by moisture determinations either by air drying or oven drying. In experiments at Corvallis fifty bushels more potatoes have been secured where the water has been applied to light, clay loam when the moisture content dropped to the twenty-one percent point; when watered at a higher or lower point, the yield was decreased. An experiment was outlined to determine the best time to irrigate by the moisture content of the soil, since the appearance of the crop in this sub-humid climate is not a definite indicator. When the history of the moisture content of irrigation plots was obtained by weekly determinations in 1910, it was found that the potatoes began to show indications of wilting when the moisture content of the first foot dropped to seventeen percent, dry weight. It was planned, therefore, to irrigate one plot of potatoes whenever the moisture dropped to seventeen percent, the second at twenty percent, and the third at twenty-three percent. Results of this experiment showing the value of soil-moisture determinations as indicating the exact time to irrigate are given in Table IV.

TABLE IV. VALUE OF SOIL-MOISTURE DETERMINATIONS IN DETERMINING THE EXACT TIME TO IRRIGATE (POTATOES)

Year	Amt. of irrigation and soil moisture when applied	Yield per acre	Gain over dry plot	Percent gain over dry plot	Increase per acre in.	Water requirement
		bu.	bu.	%	bu.	
1911	Irrig. 23% Recd. 3x3"	292.5	157.4	117	17.5	1058
	Irrig. 20% Recd. 2x3"	308.5	173.4	128	28.9	799
	Irrig. 17% Recd. 1x3"	176.4	41.3	31	13.8	1326
1913	Irrig. 23% Recd. 2x2"	260.0	—40.5	—13.0	—10.1	973
	Irrig. 20% Recd. 1x2"	342.0	41.5	18.0	10.4	655
	Irrig. 17% Recd. no irrigation	300.5	....	.....	.....	629

Irrigations were applied at different moisture contents in a wet season and in a dry season. Each year the twenty-percent plot gave the greatest number of bushels to the acre inch and also the most economical production of dry matter. Twenty-percent moisture content seemed to be the minimum desirable for potatoes in this soil, and the moisture content is shown to be an indicator of the exact time to irrigate this crop. The twenty-percent plot had the most uniform moisture content throughout the season as shown by Fig. 2. It just happened that these plots called for irrigation to the amount of 3, 6, and 9 inches depth so that this same experiment shows indications as to the amount of irrigation for potatoes as well as the value of early or late irrigation.

Time-of-irrigation experiments have been conducted at the Utah and Nevada stations. At the latter station 3-, 6-, and 9-inch applications were applied at different periods of growth. The best results* were obtained when irrigation was applied at the time the plants showed the first

* Knight, C. S. & Hardman Geo. Irrigation of Field Crops in Nevada—pp. 32-37, Nevada Experiment Station Bulletin 96, 1919.

tendency to wilt. Delaying the irrigation until the plants had wilted caused development of second growth. The best results were obtained in Nevada when the first irrigation was withheld until the vines turned a dark green color, but had not wilted. This was regarded as aiding root development, so as to secure a maximum amount of plant food. Early irrigation decreased the yield, and interfered with root development. The experiments indicated that the best time for a single irrigation is at full bloom. In Utah experiments* later irrigation caused larger potatoes and more vines, while early irrigation gave more tubers to the hill. Irrigation before emergence decreased the yield. The California Experiment Station** recommends beginning irrigation when the plants approach full growth, and continuing applications from fourteen to eighteen days, or until the vines begin to show signs of maturity.

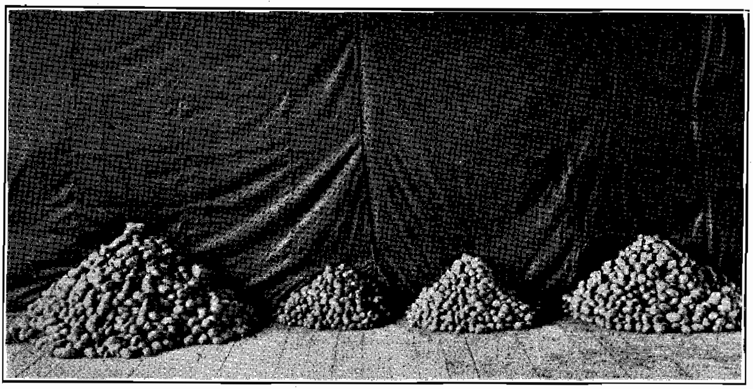

FIG. 3. RESULT OF GRADING CROP FROM PLOTS IRRIGATED VS. DRY POTATOES

Frequency and Amount of Irrigation. (Table V.) The most economical yield obtained in the course of the Oregon experiments was secured with the aid of three one-inch irrigations applied ten days apart and gave a yield of 38.6 bushels to the acre inch. This agrees with experiments conducted simultaneously at the Utah Station. Experiments bearing on amount and frequency of irrigation for a dry season (1911) and for a wet season (1913) are presented in Table V. Three irrigations of one inch each applied ten days apart gave comparatively good results and constitute good practice for gardens. Amount and frequency of irrigation are factors which depend upon the usable water capacity of the soil, weather conditions, and rate of loss of soil moisture. Irrigation should be applied when the soil is dried out in the root zone nearly to the wilting point, and in amount sufficient to raise it to the excess point, but no more. The ordinary fine sandy loam used for potatoes may hold an inch and a half of usable water or rainfall in a foot of soil. To irrigate the two feet of soil occupied by feeding roots of potatoes an equivalent to a three-inch rainfall is good average soaking. On the heavier soils, this can be increased, and on the lighter soils the amount

*Harris, F. S. The Irrigation of Potatoes. Utah Exp. Sta. Bul. 157. 1917.
**Gilmore, J. W. Potatoes in California. California Sta. Cir. 161.

TABLE V. PROPER AMOUNT AND FREQUENCY OF IRRIGATION FOR POTATOES

Year	Treatment	Yield		Gain over dry	Gain per acre
1911	(Dry season)	bu.	bu.	%	bu.
	Dry	135.1	....	....	....
	3x1"	250.9	115.8	85.0	38.6
	1x3", 17%	176.4	41.3	31.0	13.8
	2x2½"	240.7	105.6	78.0	21.1
	1x5"	190.9	55.8	41.0	11.2
	3x2"	254.9	119.8	89.0	20.0
	2x3"	258.1	123.0	91.0	20.5
	2x3", 20% after irrigated clover	308.5	173.4	128.0	28.9
	3x3", 23% after irrigated clover	292.5	157.4	117.0	17.5
1913	(Wet season)				
	Dry, after dry alfalfa	109.8	....	....	....
	1x2", after dry alfalfa	172.2	62.4	57.0	28.5
	1x3", after dry alfalfa	213.3	105.5	96.0	35.2
	2x2", after dry alfalfa	145.2	35.4	32.0	8.8
	After irrigated alfalfa				
	Dry, irrigated at 17%	300.5	....	....	....
	1x2", at 20%	342.0	41.5	14.0	10.4
	3x1", ten days apart	329.0	28.5	10.0	9.7
	2x2", at 23%	260.0	—40.5	—13.0	—10.1

of irrigation should be less. Two or three irrigations will generally be sufficient and it is usually better to give two moderate irrigations than it is to give one heavy soaking. Late irrigation after the soil has become very dry causes second growth. Irrigation when in early bloom may cause many small potatoes, according to some investigators; others prefer irrigation in full bloom, when only one application can be given.

Amount per Season, or Duty of Water. Experiments at Corvallis during the past twelve years have included plots that are irrigated and as near as could be judged at the proper quantity. Adjoining plots were given lighter irrigation and other adjoining plots were given heavier irrigation. There are also dry-farm plots included in the trials. Table VI has been arranged by hand picking the individual plot records for each season. Section one shows the plot giving the largest yield to the acre inch. Section two shows the plot which gave the maximum yield to the acre. Section three shows the plot which gave the maximum profit to the acre. The last section shows the amount of irrigation supplied, the total moisture used by the crop, including soil and rain water, the yield, and water cost per pound of dry matter produced.

The average amount of water giving the most profitable returns is shown to be 3.7 inches depth an acre a season. The total water consumed including soil and rain water was nine and one-half inches. The average yield was 280.6 bushels, obtained with a water cost of five hundred sixty-five pounds of total water consumed to the pound of dry matter produced.

The depth of water required for potatoes will not be over six to twelve inches a season in most places in Oregon, except on the sandier soils. On medium sand at the Umatilla Branch Experiment Station, twenty-six inches depth has been required for potatoes. Generally the most economical returns will be secured with from four to eight inches of irrigation. This should give the most economical production of dry matter and the best profit per acre inch of water. Frequently in Oregon experiments yields and profits have been decreased where more than six inches an acre depth was applied. The quantity of irrigation giving most profitable returns in the experiments at the home station at Corvallis is shown in Table VI.

TABLE VI. QUANTITY OF IRRIGATION GIVING MOST PROFITABLE RETURNS, POTATOES

Year	Greatest yield an acre inch			Max. yield an acre			Max. profit an acre			
	Irrigation	Yield	Water cost	Irrigation	Yield	Water cost	Irrigation	Total ins. used	Yield	Water cost
	in.	bu.		in.	bu.		in.		bu.	
1911	3x1	250.9	730	2x3	308.5	799	2x3	....	308.5	799
1913	1x3	213.3	806	1x2	342	655	1x2	15.69	342.0	655
1914	2x2	400.6	383	2x2	400	383	2x2	9.58	400.0	383
1915	3½	260.2	357	3½	260	357	3½	7.92	260.0	357
1916	2½	346.5	396	3½	408.8	468.5	3½	10.17	408.8	468
1917	2½	215.3	169	4½	299.1	192	4½	7.64	229.1	192
1918	2	166.0	602	3	183	777	3	10.16	183	777
1919	2	114.0	893	2	114	893	2	5.43	114	893
Average	2.8	245.8	542	3.70	280.6	565	3.70	9.51	280.6	565

In Utah experiments the highest yield of potatoes was secured with 12.8 inches. Sixteen inches irrigation reduced the yield below that of unirrigated plots. The California Station finds 1.75 acre feet necessary, and to be applied in three or four doses. McClatchie, experimenting in Arizona, concluded that 18 to 24 inches total depth of irrigation was sufficient for potatoes there. Parsons obtained the best yield and the largest yield per acre inch from 16.3-inch depth of irrigation at the Wyoming Station. Idaho experiments gave best results with 18 to 24 inches depth. At the Nevada Station the average depth of irrigation per season giving highest yields was 16.5" given in 3-inch applications.

Water Requirement of Potatoes. The term, water requirement, or water cost, used in the tables, refers to the total pounds of soil, rain, and irrigation water consumed by the crop per pound of dry matter produced. The water requirement has been determined in practically all of our field trials, and checked by means of soil-moisture determinations, to measure the initial moisture content of the soil and the residual moisture at harvest time. This difference in moisture content has been converted into inches and added to the inches of irrigation and rain to secure the total water consumed by the crop. Moisture determinations of the plant parts have been made of both marketable and unmarketable portions, and the total inches of water consumed reduced to pounds to determine the ratio of water to dry matter, or the water requirement of the crop. These determinations have been made for the total crop and also for the increase in yield due to the application of a given number of inches or pounds of irrigation water. Detailed data for earlier years of the experiment are presented in Table VII.

TABLE VII. WATER REQUIREMENT OF POTATOES FOR INCREASE AND FOR TOTAL CROP

Year	Treatment	Increase per acre in.	Water cost ratio increase	Total water used	Yield	Water cost tl. crop
				in.	bu.	
1910	Dry	......	....	7.50	56	1797
	1x5"	15.9	309	10.27	140	985
1911	Dry	......	....	15.02	135	1493
	1x3", 17%	13.8	1076	15.58	176	1326
	3x1"	38.6	350	17.20	251	930
	2x2½	21.1	697	16.89	241	1034
	1x5"	11.2	1275	17.06	191	1263
	2x3", 20%	28.9	450	....	309	799
	2x3", 15 da.	20.5	789	19.08	258	1212
	3x2", 10 da.	20.0	772	18.81	255	1294
	3x3", 23%	17.5	930	....	293	1056
1913	Dry after dry rotation	......	....	10.18	110	1139
	Dry after irrigation rotation	......	....	13.60	300	629
	1x2", after dry rotation	28.5	414	11.72	172	783
	1x2", after irrigation rotation	10.4	1370	15.69	342	655
	1x3", after dry rotation	35.2	337	14.56	213	806
	3x1", after irrigation rotation	9.7	1566	15.86	329	683
	2x2", after dry rotation	10.1	1225	14.00	145	1101
	2x2", after irrigation rotation	8.9	1438	17.42	260	973
Average		......	866	....	....	1050

The experiments show that the water requirement of the increase from irrigation comes from applying water during the best growing weather. The average water requirement of the increased yield due to irrigation for all trials in those years is 806 pounds, compared to 1,050 pounds for the total crop. In other words, a greater efficiency was secured from the irrigation water applied just at the right time than from the total water available during the whole growing season.

Irrigation requirement is used to refer to that portion of the total water requirement needed to be applied artificially.

Effect of Irrigation versus No Irrigation on Water Requirement. The water requirement for several years for the unirrigated potatoes averaged 1,265 pounds of water to the pound dry matter, while for the irrigated plots it averaged 927 pounds to the pound of dry matter for all the plots in the earlier years of the experiment. A moderate amount of irrigation has frequently reduced the water requirement per pound of dry matter by twenty-five percent.

Effects of Irrigation and Legumes in Rotation on Yield and Water Requirement. (Table VIII.) The potatoes in the Corvallis experiment field in 1913 were on alfalfa sod land, four plots of which had been dry farmed in alfalfa the four previous years, and four of which had received irrigation during the same time. One irrigated plot and one unirrigated sod land plot were dry farmed, using potatoes, in 1913. Two more of these plots received a light irrigation for the season. Two others were given a moderate amount of irrigation. Two others were rather heavily irrigated. In each case where the potatoes followed the irrigated sod land the yield was strikingly higher and the water cost was lower than on the dry-farmed alfalfa sod land.

TABLE VIII. EFFECT ON YIELD AND WATER REQUIREMENT OF IRRIGATED LEGUMES IN ROTATION, POTATOES, CORVALLIS, 1913

Treatment	Increase per acre	Total water	Yield per acre	Ratio—Total crop water to dry matter
....	bu.	in.	bu.	
Dry after dry alfalfa	......	10.18	110	1139
Dry after irrigating alfalfa	......	13.60	300	629
1x2" after dry alfalfa	28.5	11.72	172	783
1x2" after irrigating alfalfa	10.4	15.69	342	655
1x3" after dry alfalfa	35.2	14.56	213	806
1x3" after irrigating alfalfa	9.7	15.86	329	683
2x2" after dry alfalfa	10.1	14.00	145	1101
2x2" after irrigating alfalfa	3.9	8.9	260	973

Crop rotation is necessary if the highest production of potatoes under irrigation is to be obtained. In experiments with potatoes in Eastern Oregon large increases in yields have been obtained by rotation. Necessity for irrigation has been greatly decreased by providing a large supply of humus and available fertility, such as is encouraged by proper rotation. In its effect upon the yield and water cost crop rotation is very important and involves little expense.

Potatoes feed rather heavily on certain elements, which legumes like alfalfa obtain from the air and from the deep subsoil. The humus added by these legumes builds up the water capacity of the soil and improves soil structure, so that it is more easily handled and retains moisture to better advantage. Such rotation also permits better control of insect pests and plant diseases, and makes it possible to secure a higher return per unit of water used, as such cultivated crops require relatively little water.

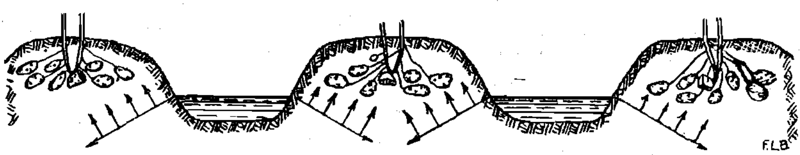

FIG. 4. IRRIGATION BY CAPILLARITY AVOIDS PUDDLING SOIL IN TUBER BEDS —Courtesy Nevada Experiment Station.

There is too high a percentage of meadow crop in many irrigated sections of this State. Increase in cultivated cash crops such as potatoes, with the development of intensive farming, will help increase the duty of water. Suitable crop rotations for potatoes are: (1) Grain—clover 1 or 2 years—potatoes. (2) Alfalfa 3 to 6 years—potatoes—grain.

Effect of Fertilizer on Irrigation Requirement. Applying any needed fertilizer makes it possible to reduce the water cost due to the enrichment of the plant food solution. To illustrate: half an acre of potatoes on the demonstration experiment field near Redmond in 1912 were given a pound per square rod sulfate of potash, at the normal cost at that time of $4.00 an acre. The whole acre was given a uniform irrigation of six acre inches an acre. The fertilized part yielded at a rate of 235 bushels an acre, or 39 bushels per acre inch, while the unfertilized half yielded 147 bushels, or 24½ bushels an acre inch. (Table IX.)

Fertilizer experiments in the Deschutes Valley in Central Oregon extending over six years indicate that under normal conditions light applications of sulfate of potash on potatoes will prove profitable. According to Van Slyke* 300 bushels of potatoes remove about 63 pounds of nitrogen, 27 pounds of phosphoric acid (P_2O_5) and 90 pounds of potash (K_2O). This amount of plant food would be returned by 9 tons of barnyard manure, or is contained in the tops and roots of a fair crop of red clover. On red hill soil in Multnomah county the past season (1919) superphosphate increased the total yield of potatoes from 276 bushels untreated to 458 bushels for the fertilized plot. Under irrigation the nitrogen required for this crop should be secured by growing in rotation with legume crops. Complete fertilizer experiments with potatoes are under way this season in the Klamath Basin, and fertilizer trials are also under way in the Deschutes Basin. These will be reported later. The point is that anything that provides a better balanced or more nearly perfect plant-food solution, decreases irrigation requirement and increases the returns per unit of water used.

TABLE IX. POTASSIUM SULFATE ON IRRIGATED POTATOES

Irrigation	Fertilizer treatment	Yield Total	Yield Per acre inch	Profit per acre	Cost fertilizer per acre
		bu.	bu.		
2x3"	Potassium sulfate 160 lbs.	235	39.2	$40.00	$4.00
2x3"	None	147	24.5	....	....

Water Requirement of Potatoes Grown in Tanks. During the past two years potatoes have been grown in tanks in duplicate series to study the wilting point and the water requirement of this crop. Six tanks were planted to potatoes each year and the pair receiving like treatment show a probable error ranging from 10 to 100 pounds. The data in Table X show that water requirement in tanks set in the ground conforms fairly well to field data under good conditions.

TABLE X. WATER REQUIREMENT OF POTATOES GROWN IN TANKS

Time of Irrigation	1918 Irrigation	1918 Water cost	1919 Irrigation	1919 Water cost
	in.		in.	
Wilted	11	368	6	378
Slightly wilted	13	524	8	342
Not wilted	17	456	10	596

Crop-Producing Power of Water. The average water requirement for all years for the plot which each year gave the maximum profit an acre, is 565 pounds. As an acre inch of water weighs approximately 226,000 pounds and since potatoes contain 80 percent moisture, it therefore requires three acre inches to produce one hundred bushels of potatoes, or six acre inches to produce a 200-bushel yield. This statement is based on the average water requirement for the plots giving the most economical returns for all years and under field conditions. On this basis a 400-bushel yield would not be likely to be produced with less than 12-inch depth of usable water an acre. This water requirement indicates the highest probable duty of water for potatoes.

*Van Slyke, L. L. Fertilizers and Crops, p. 613. Orange Judd Co. 1917.

Where part of this could be secured from soil and rain water the irrigation requirement would be the balance needed. (Table XI.)

TABLE XI. EFFECT OF TWELVE YEARS IRRIGATION ON POTATOES

Year	Irrigation	Yield		Increase from irrigation				Net profit whole crop		Water cost total product	
		Dry	Irriga-tion	Gain per acre	Gain per acre inch	$ per acre net	$ per acre inch net	Dry	Irriga-tion	Dry	Irri-gated
1907	......	43.0	125.0	82.0	....	....	......	....	....	....	....
1908	......	60.0	86.0	26.0	....	....	......	....	....	....	....
1909	......	150.0	215.0	65.0	10.00	....	......	....	....	....	....
1910	5.35	55.9	140.0	84.1	15.70	34.17	6.38	7.99	42.15	1797	985
1911	5.41	135.1	246.6	111.5	20.60	47.04	9.08	47.55	94.59	1493	1114
1913	3.00	205.1	243.6	38.5	12.80	14.88	6.37	82.57	97.62	884	833
1914	3.29	234.3	309.2	74.9	22.70	32.22	9.14	97.18	129.03	324	473
1915	2.50	201.0	239.1	38.1	15.20	15.48	5.06	80.55	95.93	345	406
1916	2.50	317.6	365.1	47.5	7.06	20.00	8.08	138.80	158.37	268	355
1917	4.50	197.0	225.6	28.6	6.35	8.95	1.99	78.50	87.45	111	198
1918	3.00	127.3	175.6	48.3	16.10	19.71	6.57	43.65	63.36	680	788
1919	2.00	61.0	91.0	30.0	15.00	13.34	6.67	....	....	....	....
Ave.	3.51	150.0	205.15	56.21	14.15	22.87	6.59	72.10	96.06	738	644

Value of Twelve Years Irrigation on Potatoes—Summary. (Table XI.) In Table XI is arranged a summary of twelve years experiments with irrigation on potatoes at Corvallis, showing the yield with and without irrigation, the average amount of water applied each season, increase from irrigation, net profit, and water requirement. This is an average of all trials, and is not a weighted average. A weighted average would be obtained by repeating the dry yield as many times as there were irrigated plots for the same year. The figures, however, indicate the average possibilities with and without irrigation, and the amount of water it is necessary to apply artificially to meet the moisture requirements for maximum yield. Included in this table are the plots that were over-irrigated and under-irrigated, as well as those receiving the proper amount, so that the general average is presented for all trials.

TABLE XII. CROP-PRODUCING POWER OF WATER—POTATOES

Based on good average water requirement, 565 pounds

Yield per acre	Requirement
bu.	acre inches
50	1.5
100	3.0
200	6.0
150	4.5
250	7.5
300	9.0
400	12.0

The total annual cost, obtained by careful calculation by methods previously explained, amounts to $1.00 an acre inch (a maximum figure); while the crop value used in calculating net profit is an old 10-year average, or $0.50 a bushel. Under present conditions the net profits should be about twice those shown in the table. The table is, however, a valuable basis for comparing results.

EFFECTS OF IRRIGATION ON POTATOES

The question is often raised as to the quality and marketability of irrigated potatoes, and a study has been made as to the effects of irrigation upon the potatoes produced.

Effect on Soil Moisture Content. Irrigation has made it possible to provide a uniform moisture content which the potatoes require, and to provide usable moisture during the best growing weather.

Yield. During the earlier years of the irrigation experiments at Corvallis, yields of potatoes have been increased by irrigation by about one hundred bushels an acre. During these years rotation with clover has increased the water capacity of soil even on dry-farming plots, so the difference between irrigation and no irrigation has been somewhat reduced. Irrigation has substantially increased yields and net profit, as compared to no irrigation.

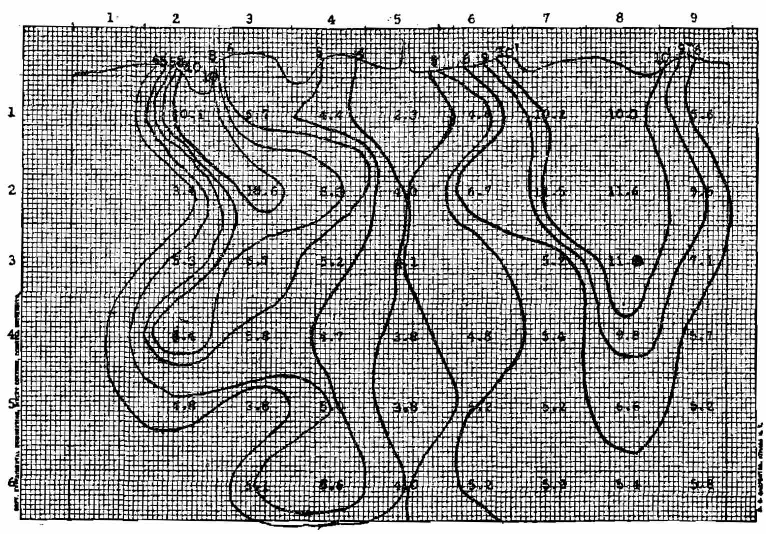

FIG. 5. FINAL DISTRIBUTION FURROW IRRIGATION, SANDY SOIL, UMATILLA BRANCH EXPERIMENT STATION

Effect of Irrigation on Water Requirement. Proper irrigation has reduced the water requirement of potatoes about twenty to twenty-five percent; that is, irrigation has decreased the number of pounds of water to pounds of dry matter produced by about one-fourth, as shown in previous tables.

The Effect of Irrigation on Percentage of Cull Potatoes. (Table XIII.) During several seasons the potatoes have been graded from all the plots included in the irrigation experiments. Representative data for years 1911, 1915, and 1916 (Table XIII) show that proper irrigation reduced the percentage of cull and unmarketable potatoes. This is further illustrated in Fig. 3.

TABLE XIII. EFFECT OF IRRIGATION ON PERCENTAGE OF CULL POTATOES

Year		Treatment	Culls
			%
1911		Dry	15.0
	17%	1x3″	17.9
		3x1″	14.6
		3x2″	13.4
		2x3″	12.2
		1x5″	11.9
	23%	3x3″	11.2
		2x2½″	10.8
	20%	2x3″	7.1
1915		1	19
		0	35
		2	20
		3	25
		2	15
		0	29
		3	22
		4	20
1916			
		0	30
		1½	17
		2½	10
		3½	9
		0	24
		1½	......
		2½	30
		3½	28

The Effect of Irrigation on Ratio of Dry Matter in Plant Parts. Table XIV.) Irrigation of potatoes above the most economical amount caused an increase in proportion of vines to that of tubers. Where there is much irrigation water left in the soil, the vines are likely to be later in maturing and make a larger growth. The effect of irrigation on ratio of dry matter in plant parts is shown from representative data for several years.

The Effect of Irrigation on Palatability and Composition. At the suggestion of the late Dr. Withycombe samples of irrigated potatoes were delivered to fourteen different householders in 1911, with the understanding that they should cook each of the samples in the same manner, and determine any possible difference in quality. Dry potatoes were marked (y); irrigated ones, receiving two irrigations of 2½ inches each or a total of 5 inches depth, were designated (x). The people were not informed as to the difference in the production until after the reports were made. Four favored the irrigated product, five the unirrigated, and five were unable to detect any difference. The difference of opinion is illustrated by the following replies.

Reply No. 7. "We tried different samples of potatoes in two different ways; namely, as baked and mashed potatoes. We could not see any difference in flavor of the two samples, but it is our judgment that the sample labelled (y) was considerably better in texture than that labelled (x). Although perhaps a little coarser in texture, it was more mealy and especially when coming on the table as mashed potatoes."

TABLE XIV. EFFECT OF IRRIGATION ON RATIO OF DRY MATTER IN PLANT PARTS, POTATOES

Year	Treatment	Parts tubers to to one of vines
1913	2x2½	2.50
	2x1	2.60
	0	2.80
1914	3	1.88
	2x2	2.27
	0	1.49
	3	2.56
	2x2	2.70
	0	1.39
	3	2.29
	4	3.00
	2	3.12
	0	1.88
1915	1	5.80
	0	3.60
	2	4.20
	3	2.50
	2	1.60
	0	1.80
	3	1.70
	4	2.20
1916	2½	5.00
	3½	2.00
	2½	6.00
	3½	9.00
1919	0	4.00
	1	2.50
	2	3.50
	3	4.50

Reply No. 14. "Our observations on the cooking quality of these samples, one (x) and one (y), indicates that (x) seems to be more mealy and to work up lighter than (y). The difference between the two seems to be very slight."

From these replies it appears that the difference in palatability of potatoes due to a moderate amount of irrigation is very slight indeed. For a crop given the proper amount of moisture for growth, and where

TABLE XV. EFFECT OF IRRIGATION ON COMPOSITION

	Irrigated 2x2½"	Dry
	%	%
Moisture	78.120	75.6100
Protein	2.010	2.5570
Fat	.044	.0440
Ash	.920	1.0400
Fiber	.270	.3400
Starch	16.850	18.0000
Undetermined	1.790	2.2409

the soil receives no water within sixty days of the time to harvest, so that the crop will mature, it does not seem to matter whether this needed moisture comes as rain or irrigation. Amounts above the optimum may be detrimental. Analyses of potatoes from the plots used in the above tests were made by H. V. Tartar, Station Chemist, and are given in Table XIV.

Irrigation appears to cause a slight increase in the water content, and corresponding decrease in starch, protein, and other constituents except fat.

Effect of Different Amounts of Irrigation on Moisture Content. (Fig. 8.) A study of the moisture content of irrigated and unirrigated products has been made for different plots each season. Tests were made at harvest time and the moisture content of the product as affected by different amounts of irrigation is illustrated by the moisture content of the potatoes as given in Fig. 8. From these determinations it appears that the moisture content is not appreciably increased by irrigation except where more than the most economical amount of water is applied. Irrigation up to the point where it gives the most economical returns has no appreciable effect upon the moisture content of the product, but above this there has been a slight increase in the moisture content, about as much as 2 percent more moisture with maximum irrigation. Over-irrigation is associated with immaturity, and this is especially noticeable with potatoes. These potatoes do not have as firm a skin and are not as solid as those properly irrigated, or produced without irrigation.

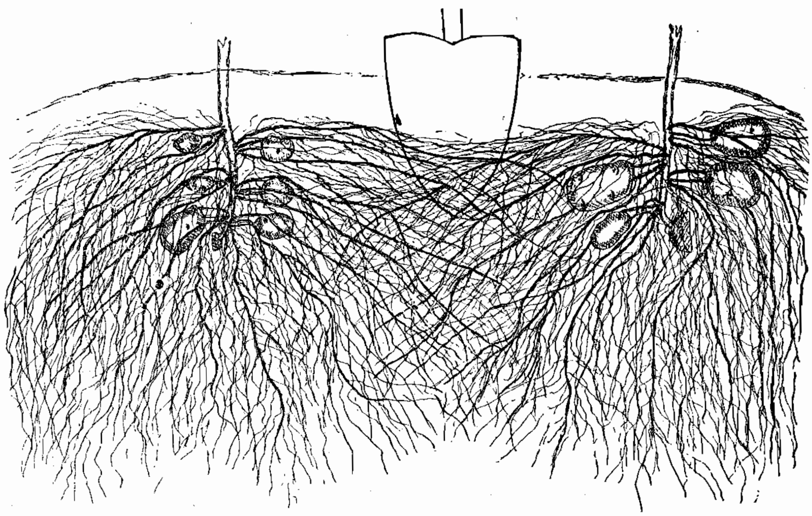

FIG. 6. CULTIVATOR SHOVEL PRUNING SHALLOW ROOTS
—Courtesy Utah Experiment Station.

Effect on Seed Conditions. Irrigated potatoes have frequently been used for seed purposes. Over-irrigated potatoes which are soggy, do not have proper skins and are undesirable for seed. Potatoes properly irrigated have been found to be firm and as desirable for seed purposes as unirrigated potatoes.

Other Effects of Irrigation. King found that irrigation lessened tip burn on potatoes in Wisconsin. A decrease in weight per hill with increase in irrigation was noted in the Utah experiments. Weekly irrigations of one inch gave the best-sized tubers and increased the height of vines. At the Arizona Station less water and more cultivation increased the quality of potatoes.

TABLE XVI. TWELVE YEARS EXPERIMENTS IRRIGATION OF POTATOES, CORVALLIS

Year	Irrigation	Rain and soil water	Total	Yield Per acre	Per acre in.	Profit per acre ins.	Net profit whole crop	Water cost
1907	Irr.	....	....	125.0	......	....	....	....
	0	....	....	43.0	......	....	....	....
1908	Irr.	....	....	86.0	......	....	....	....
	0	....	....	60.0	......	....	....	....
1909	Irr.	....	....	215.0	10	....	....	....
	0	....	....	150.0	......	....	....	....
1910	5.35"	4.92	10.27	140.0	15.7	6.38	42.15	985
	0	7.50	7.50	55.9	......	....	7.99	1797
1911	2x2½	11.89	16.89	240.7	21.1	8.93	92.20	1034
	1x5	12.06	17.06	190.9	11.2	4.25	68.78	1263
	Dry	15.02	15.02	135.1	......	....	47.55	1493
	3x1	14.20	17.20	250.9	38.6	17.15	99.00	930
	2x3	13.08	19.08	258.1	20.5	8.63	99.35	1212
	3x2	12.81	18.81	254.9	20.0	8.38	97.85	1294
	3x3 C23%	....	....	292.5	17.5	7.22	112.55	1326
	2x3 C20%	....	....	308.5	28.9	12.58	123.05	799
	1x3 C17%	12.58	15.58	176.4	13.8	5.47	63.96	1056
1913								
After alfalfa	3x1	12.86	15.86	329.0	9.5	3.46	140.65	683
After alfalfa	2x2 C23%	13.42	17.42	260.0	—10.1	—6.06	106.00	973
After alfalfa	1x2 C20%	13.69	15.69	342.0	10.7	8.76	147.75	655
None	C17%	13.60	13.60	300.5	......	....	130.25	629
After dry alfalfa	2x2	10.00	14.00	145.2	8.85	3.16	47.54	1101
After dry alfalfa	1x3	11.56	14.56	213.3	34.5	10.23	80.55	806
After dry alfalfa	1x2	9.72	11.72	172.2	30.2	13.67	62.23	783
After dry alfalfa	None	10.18	10.18	109.8	......	....	34.90	1139
1914	1x3	5.67	8.67	313.0	26.5	11.15	131.11	439
	2x2	5.58	9.58	355.5	30.4	13.32	150.10	383
	....	6.57	6.57	233.6	......	....	96.80	315
	1x3	6.59	9.59	262.5	10.1	3.78	107.34	474
	2x2	6.04	10.04	400.6	42.1	18.81	171.24	342
	....	7.24	7.24	232.0	......	....	96.00	386
	1x3	9.65	12.65	515.0	25.8	11.14	132.18	528
	1x4	6.85	10.85	266.2	9.6	3.54	107.94	595
	1x2	7.33	9.33	251.5	7.0	2.29	103.33	554
	....	4.94	4.94	237.5	......	....	98.75	271
Duplicate plots 1915	0	6.28	6.28	201.1	......	....	805.5	386
	1½	6.14	7.64	219.0	12.0	3.72	87.48	420
	2½	5.69	8.19	233.2	11.8	4.51	93.16	444
	3½	4.42	7.92	260.0	16.8	6.89	107.15	256
Duplicate 1916	0	6.00	6.00	317.6	......	....	138.80	268
	1½	6.50	8.00	371.2	247.6	17.08	162.37	329
	2½	6.23	8.73	342.1	136.8	3.60	147.81	361
	3½	6.65	10.15	385.0	110.0	8.05	166.98	373
Duplicate 1917	0	4.77	4.77	195.0	......	....	78.52	110
	2½	5.14	7.64	215.3	82.1	4.22	83.90	169
	4½	5.41	9.91	229.1	59.0	3.46	89.40	192
	6½	3.89	10.39	222.1	34.2	1.71	84.02	233
1918	0	6.65	6.65	127.3	......	....	43.66	680
	2	5.38	7.38	166.0	19.35	8.09	59.84	602
	3	7.16	10.16	183.0	18.57	7.73	66.83	777
	4	5.25	9.25	178.0	12.67	4.93	63.48	986
1919	0	3.36	3.36	61.0	......	....	10.50	894
	1	2.97	3.67	78.00	17.0	6.99	17.49	761
	2	3.43	5.43	114.0	26.5	11.45	33.41	893
	3	7.84	10.84	82.0	7.0	2.29	14.67	2142

Summary of Potato Experiments at Corvallis. (Table XVI.) Table XVI is a summary of all representative potato trials at the Corvallis Station, showing the year that the experiment was carried on, amount of irrigation applied in inches, rain and soil water in inches, total water in inches consumed, yield per acre inch of water, yield per acre, amount per acre inch, net profit on the whole crop, and water requirement.

Eastern Oregon Experiments. (Table XVII.) A summary has been arranged, giving data for trials on potatoes in different valleys

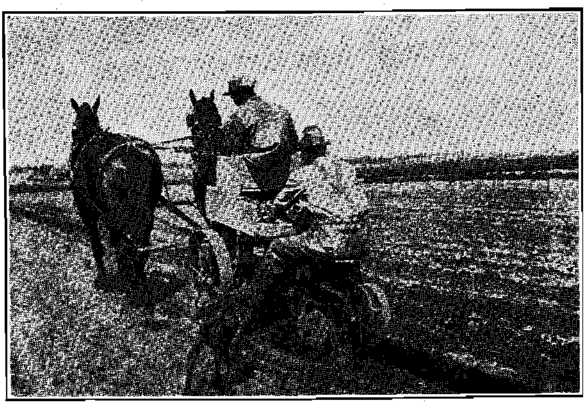

FIG. 7. POTATO PLANTER —Courtesy Utah Experiment Station.

in Eastern Oregon. The maximum yield was obtained in Powder Valley with less than eight inches of water and in Goose Lake Valley with five inches. This was also the best amount in the 1912 experiment in the Deschutes Valley. Irrigation of 8¾ inches was better than heavier irrigation, and in the 1918 experiment in the Deschutes Valley the maximum yield was secured with 6½ inches irrigation. During the same season near Tumalo, in the Deschutes Valley, 11 inches gave the maximum yield, while 8 inches gave the maximum yield at Redmond. Irrigation of 6.9 inches gave twenty bushels greater yield than was obtained with other amounts in Klamath in 1917. These experiments indicate that for most places in Eastern Oregon from 5 to 9 inches of water is sufficient for potatoes for securing maximum yield.

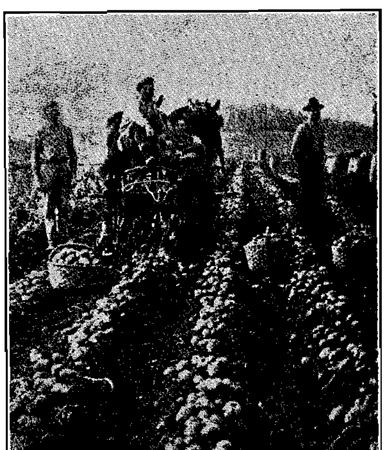

FIG. 9. POTATO DIGGER
—Courtesy Utah Experiment Station.

Harvesting, Grading, Marketing, and Profits. Commercial potato growers generally use a potato

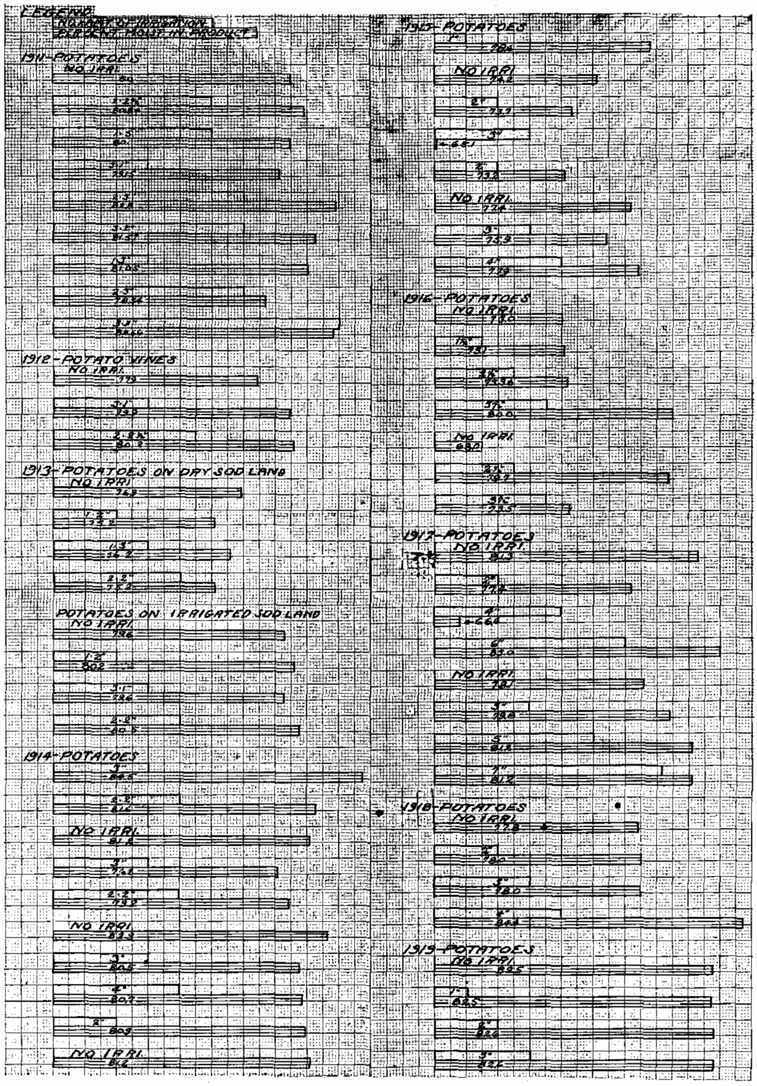

FIG. 8. EFFECT OF IRRIGATION ON MOISTURE CONTENT

TABLE XVII. SUMMARY OF WATER VARIATION TRIALS ON POTATOES, EASTERN OREGON

Location		Year	Irrigation depth	Rain and soil water	Yield per acre	Yield per acre inch
			in.		bu.	
		1915	7.79	7.13	133.3	17.10
			5.62	4.86	125.0	20.40
Powder Valley			4.49	6.45	116.6	25.90
		1915	7.50	4.21	27.3	3.64
			5.00	4.21	108.6	21.72
Goose Lake Valley			0.00	4.21	75.0	....
	O. A. C. Demonstration Farm—Redmond	1912	2.50	....	92.0	36.80
			5.00	....	161.3	32.26
		1917	4.00	....	90.0	2.25
			6.00	....	100.0	1.66
			8.00	....	166.0	2.07
	Powell Butte	1918	12.00	....	140.0	11.67
Deschutes Valley			8.75	....	170.0	18.888
			6.50	....	180.0	27.692
	1 mile N. Tumalo		14.00	....	233.0	16.65
			11.00	....	283.0	25.73
			9.00	....	204.0	23.31
	2 miles N. Redmond		8.00	....	356.0	40.75
			12.00	....	228.0	19.00
			6.50	....	247.0	38.00
Klamath Basin	8 mi. S. E. Klamath Falls	1917	6.90	15.00	150.0	21.80
			3.00	13.00	130.0	43.60

digger. Small acreages may be plowed out with a shaker digger, the good potatoes being picked up first and the culls later.

Careful grading after harvesting is essential either for storage or for market. Higher prices may be expected and cull potatoes saved to feed on the farm. Good storage is also important to assure safe keeping. Pits can be used with safety if carefully constructed and where there is good drainage. A study of the average price for potatoes for the past decade indicates that a moderate acreage grown year after year in rotation with other crops constitutes a good cash crop on the average soil. Recent surveys place the cost of growing an acre of irrigated potatoes around $60 an acre. At one cent a pound it would take the first hundred bushels to return the cost of production. The average yield for properly irrigated plots for the past twelve years near Corvallis has been 280.6 bushels an acre.