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Irrigation Efficiency, Consumptive Use, Certain Soil Characteristics

of the

North Unit, Deschutes Irrigation Project, Oregon

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AGRICULTURAL EXPERIMENT STATION • OREGON STATE COLLEGE • CORVALLIS

This is a final report of an investigation made under a cooperative agreement between the Oregon Agricultural Experiment Station and the United States Bureau of Reclamation.

IRRIGATION EFFICIENCY, CONSUMPTIVE USE, AND CERTAIN SOIL CHARACTERISTICS OF THE NORTH UNIT OF THE DESCHUTES IRRIGATION PROJECT, OREGON

J. A. Currie, J. W. Wolfe, and L. R. Swarner*

Summary

A field study was made on the North Unit of the Deschutes Irrigation Project near Madras, Oregon to determine disposition of irrigation water delivered to farms. Total seasonal application, surface runoff, application efficiency, and consumptive use are reported for 22 farm fields. Farm efficiencies were obtained for six farms.

A supplementary study compared the border method of irrigation with the corrugation method. Another study correlated consumptive use with pan evaporation. In addition, measurement of certain physical properties of soil were made on several sites of major soil types.

Introduction

Complete control and regulation of water at all times is essential for good crop production under successful irrigation. Such control and regulation should assure an adequate supply of available moisture in the soil throughout the growing season. Too much water may reduce yields or destroy crops. Even though the crop is not damaged, over-irrigation causes unnecessary loss of plant nutrients by leaching and contributes greatly to drainage problems of an irrigated area.

Most efficient utilization of irrigation water under acceptable methods of application, cultural practices, and land preparation requires considerable information. Relationships among soil moisture-holding capacities, intake rates, length of runs, and width of corrugation spacings must be developed by actual experimentation or trial on the land.

To determine and demonstrate irrigation principles and practices leading to more efficient and economic utilization of irrigation water in irrigated areas of central Oregon, a cooperative memorandum of agreement was drawn up between the Bureau of Reclamation and Oregon State College. This cooperative work began in July, 1950, and continued throughout the 1951, 1952, and 1953 irrigation seasons. Although the information developed was applicable to the entire central Oregon area as well as to other irrigated areas in the Northwest, most irrigation trials were conducted at locations on the North Unit of the Deschutes Project as shown on the map on the following page.

This is a summary report of the results of irrigation studies carried out over the 3-year period.

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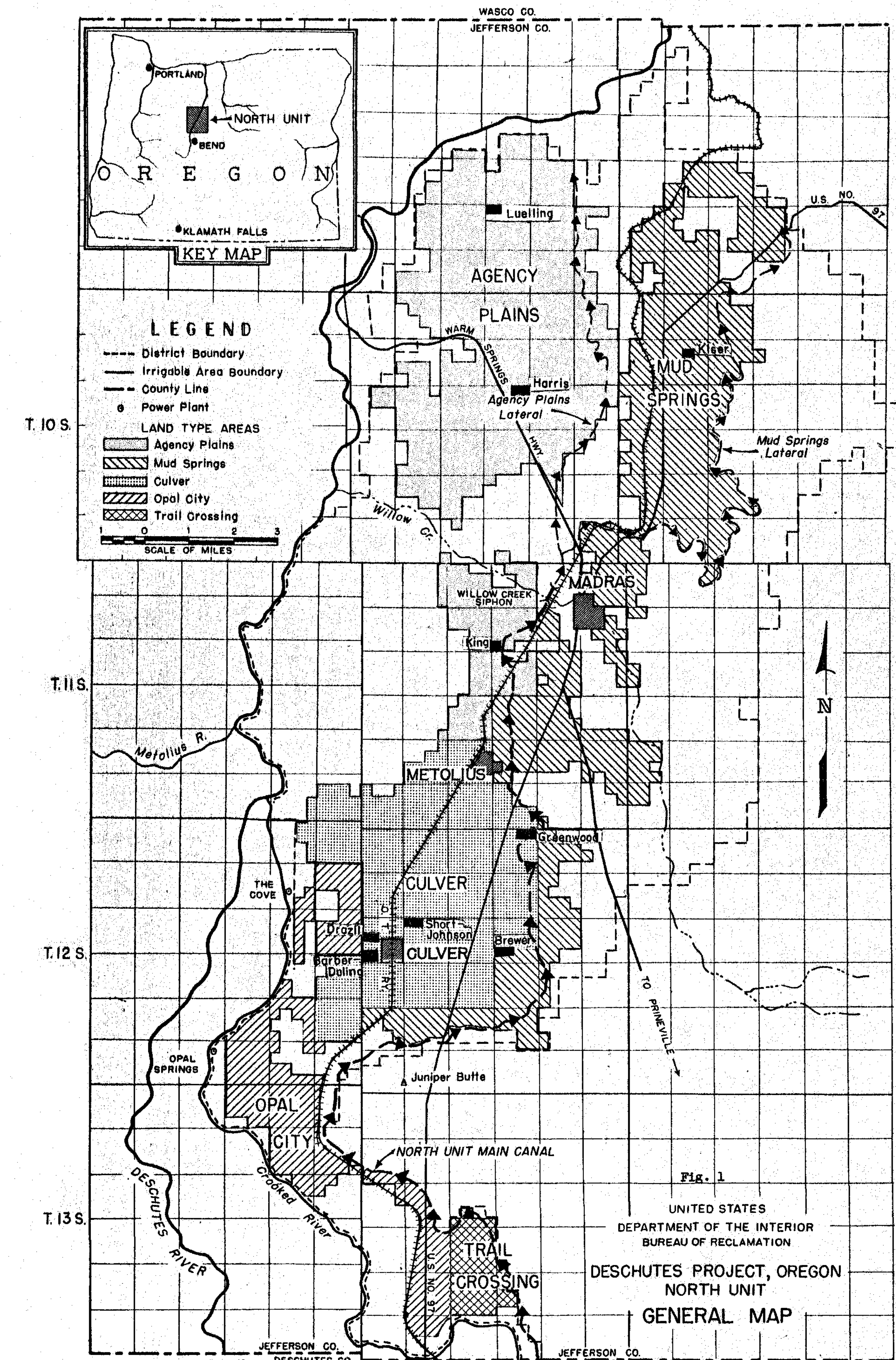


Fig. 1

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

DESCHUTES PROJECT, OREGON
NORTH UNIT
GENERAL MAP

DESCRIPTION OF THE AREA

The Central Oregon area is comprised of Crook, Deschutes, and Jefferson Counties. The first irrigation projects in the area were developed in Crook and Deschutes Counties about 1910. The first water was delivered to the North Unit of the Deschutes Project in Jefferson County in 1946. Water was available for the entire North Unit in 1949 for the first time.

Much of the area is a semiarid intermountain plain, sloping from elevations of around 3600 feet in the South to about 2300 feet in the North. The growing season is approximately 130 days in length. The whole area is underlain by lava formations.

In general soils are of shallow depth and may contain considerable quantities of pumice. Soils, especially on the North Unit of the Deschutes Project, are underlain by a gray conglomeratic-like caliche hardpan of variable thickness, which grades into semi-cemented basalt fragments, then into basalt rock. Internal drainage in the soils is impeded and in many cases entirely stopped by this hardpan.

Predominate crops of the Central Oregon area are potatoes and clover seed, but grains and alfalfa for hay occupy considerable acreages. Many farmers have small livestock enterprises, especially in older irrigated areas.

Table 1. Irrigated Acreages on Various Tributaries of and on the Deschutes River in the Central Oregon Experimental Area.

Stream or River		Acreage
Crooked River		55,492
Deschutes River		111,658
Paulina Creek		503
Squaw Creek		14,680
Lake Creek		394
Trout Creek		4,507
Willow Creek		230
	Total	187,464

Soil Type Acreages Under Irrigation

Table 2 shows irrigated acreage of each soil type by slopes and the percentage each soil type is of the total irrigated acreage. The main types in descending order are Madras loam, Madras sandy loam, Metolius sandy loam, Agency loam, Era sandy loam, Agency sandy loam, and Lamonta loam. This breakdown is only for the North Unit of the Deschutes Project. Adequate information was not available for calculations in Deschutes County.

Soil Characteristics

Moisture equivalent, 15-atmosphere percentage and volume weight soil characteristics were determined for the predominant soil types. The characteristics are listed in detail in Appendix Table 1. Volume weights for the

Table 2. Soil Type Acreages North Unit Project

Number	Soil Series and Type	Group*	Slope: A-0 to 3%	B-4 to 7%	C-8 to 12%	D-13 to 20%	Total	Percent of total
39	Madras Loam	1	12,110.6	2,426.7	170.1		14,707.4	29.4
28	" "	6	1,334.9	105.0			1,439.9	2.9
40	" Sandy Loam	1	8,398.2	1,398.2	44.9	11.4	9,853.3	19.7
27	" " "	6	1,592.0	1,045.3	297.2	14.0	2,948.5	5.9
10	" " "	6	15.5	74.1	11.4	4.3	105.3	0.2
12	" " "	6	74.5	22.1			96.6	0.2
68	" Stony "	1	59.2	95.9	11.0	7.3	173.4	0.4
13	" Stony Sandy Loam	6	123.2	56.5	13.0		192.7	0.4
42	Metolius Sandy Loam	2	5,610.3	511.9	8.6		6,130.8	12.3
60	" " "	2	865.3	85.4			950.7	1.9
62	" " "	2	58.6				58.6	0.1
92	" Loamy Sand	2		9.5			9.5	--
36	Agency Loam	3	3,928.9	220.4			4,151.1	8.3
35	" Sandy Loam	3	2,654.4	44.9			2,699.3	5.4
37	" Gravelly Loam	3	82.0	197.1	31.0	7.0	317.1	0.6
63	" Stony Loam	3	154.1	33.2			187.3	0.4
43	Era Sandy Loam	4	1,968.8	1,077.1	107.2		3,153.1	6.3
30	Lamonta Loam	5	844.6	1,257.5	73.8	10.0	2,185.9	4.4
84	" "	5			20.5		20.5	--
33	" Stony Loam	5	81.6	56.0	23.4		161.0	0.3
34	" Sandy Clay Loam	5	55.9	59.3	3.0		118.2	0.2
31	" " " "	5	6.0	1.0			7.0	--
75	Redmond Sandy Loam	7	55.6	26.7			82.3	0.1
75d	" " "	7	60.6				60.6	0.1
3	Deschutes Sandy Loam	4	39.0	11.6			50.6	0.1
L3	" Loamy Sand	4	7.4				7.4	--
26	" " "	6	82.8				82.8	0.1
5	" Stony Sandy Loam	4	5.0				5.0	--
51	Odin Clay Loam	8	17.0				17.0	--
						Total	49,972.9	

*Groups
1. Light to heavy textured soils with heavy textured subsoils over lime hardpan.
2. Light textured soil with deep, light textured subsoil over permeable materials.
3. Light to heavy textured soil with moderately heavy textured subsoils over basalt or similar materials.
4. Light and coarse textured soil with light textured subsoils over basalt or similar material.
5. Light to heavy textured soils with heavy textured subsoils over mixed moderately consolidated materials.
6. Light and medium textured soil with light textured subsoils over moderately consolidated material.
7. Light to heavy textured soil with heavy textured subsoils over moderately consolidated materials.
8. Poorly drained, light textured surface soil with heavy textured subsoil over basalt or mixed consolidated materials.

most part are uniform and vary little from the standard 1.3 used for average arable soils. Moisture equivalents varied somewhat, with differences mainly between surface soil and clayey subsoils. Little difference is noted between loams and sandy loams. Surface depth moisture equivalents ranged from 16 to 27% with an average somewhere near 24% and clayey subsoils gave some values as high as 40%. Values for the 15-atmosphere determination varied in the same relative magnitudes as the moisture equivalents. An average value would probably be about 12% with subsoils somewhat higher. In general soils sampled in Deschutes County were not as heavy in the subsoil area. Surface values for both determinations were secured throughout the profile.

Weather Records

The Madras weather station is located in a depression or drainage channel approximately 200 feet lower in elevation than the surrounding farm area. Many people thought the weather records were not representative of the farming area. However, records from the Metolius station four miles southwest of Madras and from the airport station two miles north do not seem to indicate any great climatic variations. A study being conducted by the Weather Bureau may at a later time show some significant variation.

Wind and evaporation measurements were made at the airport station in 1952 and 1953. No attempt was made to average the values.

Average rainfall for the May through September growing season is 2.70 inches. Average monthly temperature varies from a low of 52 degrees in May to a high of 66 degrees in July. Wind movement is greatest in spring and lowest in October. Evaporation is greatest in July when nearly 10 inches evaporates. Table 3 gives monthly totals or averages. Daily fluctuations are plotted in Figures 2 and 3.

Table 3. Temperature, Wind, Rain, and Evaporation for 1952-1953, measured at Madras and at Madras Airport.

	Madras Average		Madras Airport 1952		Madras Airport 1953	
	Temp.	Rain	Wind Miles	Evap.	Wind Miles	Evap.
	degrees	inches	per month	inches	per month	inches
January	29.7	1.09				
February	34.6	0.69				
March	40.9	0.64				
April	46.2	0.63	2432	5.81	1990	3.82
May	52.6	0.86	2128	7.13	2278	5.45
June	59.5	0.70	2019	6.69	1851	6.12
July	66.5	0.20	1832	9.87	1937	10.51
August	64.2	0.28	1713	8.14	1623	7.81
September	56.8	0.66	1565	6.14	1531	6.26
October	48.0	0.65	1146	3.48	1280	2.57
November	38.2	1.30				
December	31.5	1.10				

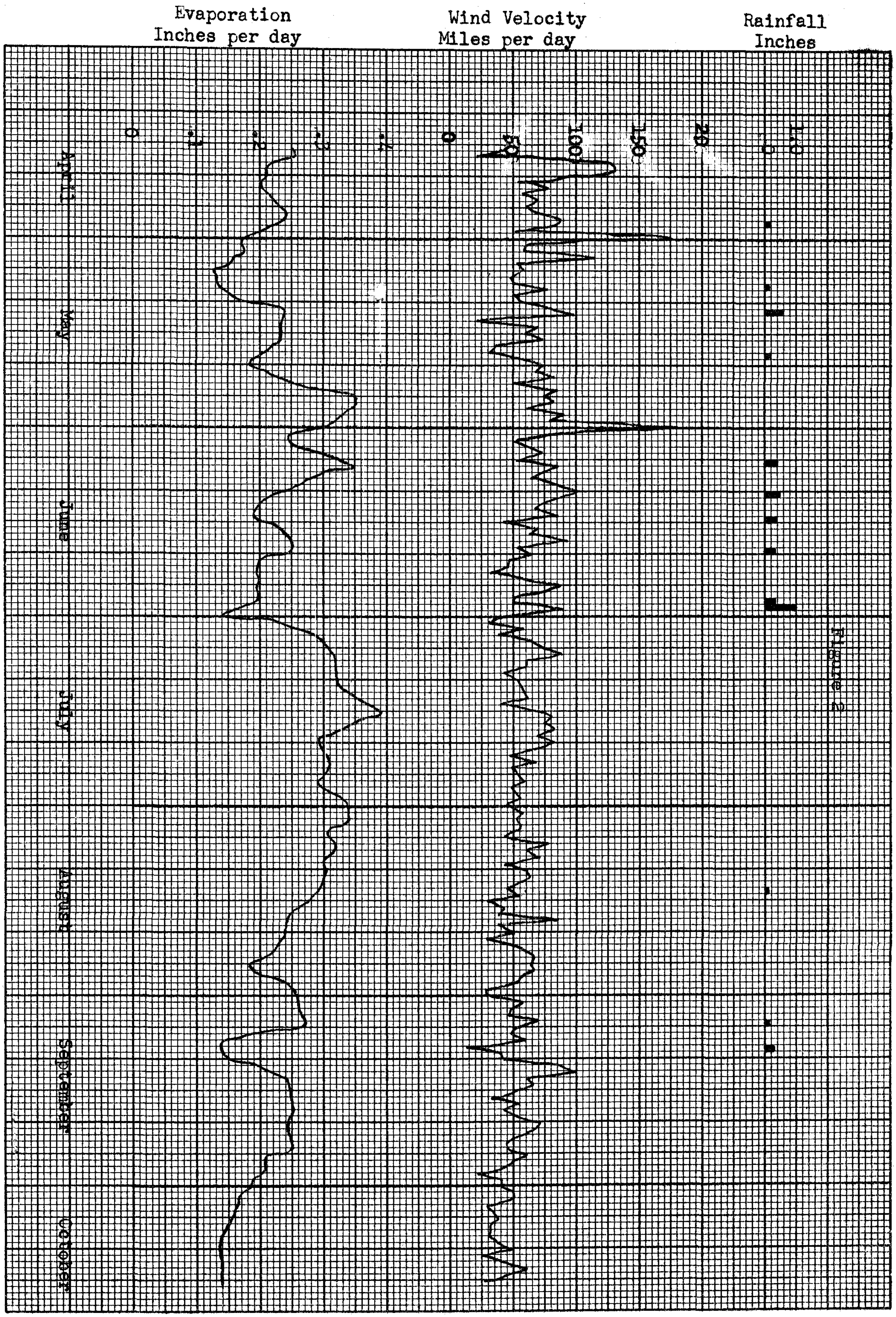
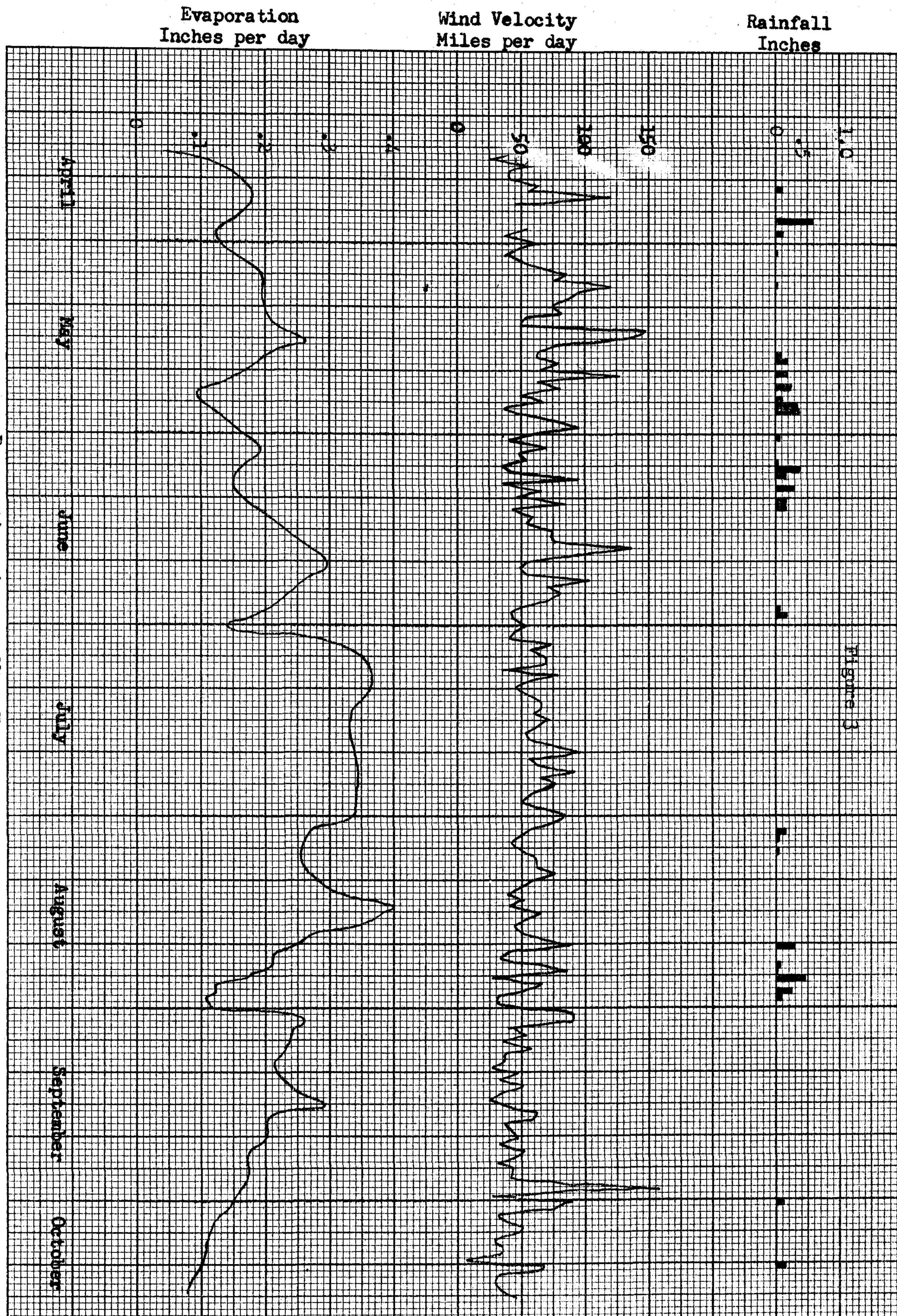


Figure 2

Evaporation, Average Wind Velocity, and Rainfall
Observed at Madras 2N Weather Station
1952



Evaporation, Average Wind Velocity, and Rainfall
Observed at Madras 2N Weather Station
1953

Terms and Formulas Used

1. Field water application efficiency (percent):

$$\frac{\text{Water stored in the soil during irrigation, as determined from soil moisture samples plus that moisture calculated as used during irrigation}}{\text{Water delivered to the field.}} \times 100$$

2. Farm water application efficiency (percent):

$$\frac{\text{Water stored in soil during irrigation, as determined from soil moisture samples plus that moisture calculated as used during irrigation}}{\text{Water delivered to the farm.}} \times 100$$

3. Consumptive use:

Consumptive use is the quantity of water, in inches per acre, absorbed by the crop and transpired or used directly in the building of plant tissue, together with that evaporated from the soil surface.

Conversion of percent moisture to inches of water:

Percent moisture x volume weight x inches of soil sampled = inches of water in the depth of soil sampled.

Procedures

Sampling of Soils and Determination of Soil Moisture Percentages

Soil moisture samples were obtained with a 1-inch King tube. Samples were taken at three depths, 0 to 6 inches, 6 to 12 inches, and 12 inches to hardpan. At least two cores were composited to make a sample. Samples obtained before and after the irrigation season were taken from random locations over the whole field being sampled. During the irrigation season samples were taken before and after each irrigation. At each irrigation the portion of field being irrigated in one "set" of water was divided arbitrarily into an upper, middle, and lower third and separate composite samples were taken from each portion. Data obtained were averaged for each sampling depth. On exceptionally long or short runs, fields were divided into quarters or halved as sampling areas for each set of water. Samples were dried at least 24 hours in a forced draft "Precision" Thelco Oven at 105 degrees Centigrade.

Consumptive Use Calculations

Total consumptive use consists of three separately determined values. First is the quantity determined from soil moisture sampling after one irrigation and before the next. Second is the quantity calculated for the period during irrigation, from the daily use determination after irrigation. Third is the moisture added as rain during the periods between irrigations. Any rain which fell during an irrigation is omitted.

Insofar as possible the before-irrigation samples were obtained immediately prior to the time water was placed on a particular "set" in the field. The after-irrigation samples were taken as soon as the soil had drained so it could be walked upon. The moisture content of the soil at the time the field could be walked upon without miring down is, in this report, considered the field capacity. On most fields, during the hot days of summer, field capacity was reached in about 24 hours after irrigation was completed. During cooler weather, early and late in the irrigation season, up to 96 hours were required for field capacity to be reached.

Water Measurements

Water flow measurements were made by means of weirs and water stage recorders. Cipolletti weirs were used to measure farm delivery flow. Field and set runoff measurements were obtained with portable "V"-notch (90 degree) rectangular, and trapezoidal (Cipolletti) weirs. Application heads at the farm turnout were found to be nearly constant. Because of that and the small number of instruments available, stage recorders with few exceptions were used primarily in measurement of runoff flow. Where possible, weirs were set in runoff ditches and left for the season. Semi-permanent supports for water stage recorders were set up at these runoff weirs. However, the instruments themselves were not left permanently in one location, but were moved from place to place as needed.

Nine water stage recorders were used. Five were Stevens type E, using 48-hour charts. One was a Stevens type L with an 8-day chart. The remaining three instruments were Freiz type F W with 24-hour, 4-day, and 8-day chart time intervals. All instruments performed satisfactorily, but the Stevens type E was found to be superior for the completely portable water measurement set-up.

Flows over the various weirs were so variable that it was necessary to integrate all of the recorder charts by finding the average head for short periods of time. Planimeter integration of the recorder charts from the Cipolletti and rectangular weirs was used in 1951.

Some difficulty was encountered in measuring runoff water. All ditches had sufficient head for proper operation of weirs. Only rarely did weed-clogged ditches cause submerged weir conditions and then only until the weeds were removed. Co-efficients determined by Clemens Herschel, as described in the Bureau of Reclamation "Manual for Measurement of Irrigation Water," were used to integrate the recorder charts for any submerged weir conditions.

Moisture Equivalent and 15-Atmosphere Percentage

Samples for moisture equivalent and 15-atmosphere percentage determinations were taken from 0 to 6, 6 to 12, and 12-inch to hardpan depths. Sampling locations were selected at random in various fields or plots. A 3-inch orchard auger was used to secure samples. Material from two borings 10 to 12 feet apart was composited to make one sample. Samples were air-dried, bagged, and sent to the Soils Department of Oregon State College where determinations were made. The 15-atmosphere percentage was determined by Richard's pressure plate apparatus.

Volume Weight

The modified Pomona sampler, obtained from the Utah Scientific Research Foundation, was employed to obtain samples for volume weight determinations. Cores secured with the Pomona sampler were 2 inches in diameter and 1 1/2 inches long. Sampling was done in the same random locations selected for moisture equivalent and 15-atmosphere percentage sampling. At least two locations in each field were selected. The soil profile was sampled at 3-inch depth intervals at each sampling location. Samples were oven-dried at 105 degrees Centigrade. Results of the 3-inch depth determinations for each farm were averaged to give 0 to 6, 6 to 12, and 12-inch to hardpan depths. Average volume weights were used in converting soil moisture percentages to inches depth of water. Cores taken were carefully checked for rocks. None were found which would alter the results--even in the second decimal place.

Crop Yields

Crop yields were obtained on the whole field basis. All hay harvested from fields in these studies was baled, and a bale weight average for the field was secured by weighing a sample number of bales at each cutting of hay. Grain was handled in bulk and total weight at time of marketing or bin measurements were secured. Each 2.19 acre plot in the irrigation method comparison study was treated as a separate field and harvested with a self-propelled combine. The portion of the field not included in the plots was harvested first. All adjustments to the combine were made in the portion of the field not occupied by plots. Seed from each plot was bagged, weighed, and cleaned separately at the seed cleaning plant. Before entering the first plot and at completion of harvest on each plot, the combine was cleaned as thoroughly as possible.

Selection of Farms for Study

Farms were selected on the basis of soil uniformity and water measurement facilities. Considerable time was spent on farms selected from soil map studies to further confirm soil consistency. The farm layout and irrigation procedure were carefully checked to make sure various water measurements would be possible. Portable and semi-permanent weirs and stage recorders were established within the farmer's system. The farmer's permission for and acceptance of the structures and many soil samplings were carefully determined. Close cooperation was necessary throughout the entire season between farmer and technician.

Results and Discussion

A summary of data from twenty-two fields is presented in Table 4. The figures in this table are seasonal totals or averages, and are taken from the more complete presentation in Appendix Table 2.

Total application ranged from 20 inches to 174 inches, whereas consumptive use ranged from 14 to a maximum of 34 inches. The water applied in excess of the consumptive use requirement left the field as deep percolation or as surface runoff. Considering the mean of the figures for all fields, only 39% of the water applied was stored for consumptive use, 46% was lost as surface runoff, and the remainder was presumed lost to deep percolation.

Seasonal consumptive use was highest for pasture and lowest for potatoes and wheat. Alfalfa and clover consumptive use were close enough to that for pasture that differences could have been due to error.

Peak consumptive use rates show a wide variation, indicating a possible failure of the sample values to represent the average field conditions. The high value for potatoes could be questioned on the basis that the sampling error would be spread over fewer days, thus raising the per day error. On the other hand, high consumptive use is known to be associated with frequent irrigations. The peak rate for pasture could be questioned because of the large difference between the two measurements. It could also be questioned whether or not the peak rate of alsike clover would consistently be so much lower than ladino and kenland. The mean peak use rates for ladino clover and for wheat are considered good estimates for the corresponding mean length of use period because of the greater number of fields measured. None of the data have been subjected to statistical analysis.

Overall farm irrigation efficiencies were obtained on six farms with the following results: Harris, 35.2%; Short-Johnson, 39.8%; Brewer, 49%; Drazil-Griffin, 41%; Kizer, 37.6%; Greenwood, 38%. The average of these six is 40%. Only the last four of these six are represented in the field summary in Table 4. The average of these four farm efficiencies is 41.4%. This compares with the 39% average of the respective field efficiencies. It is believed that the apparent difference in these values can be attributed to the re-use of waste water by applying the runoff from one field onto another field on the same farm.

Appendix Table 2 contains the principal results of this investigation, not all of which have been thoroughly discussed.

Supplementary Studies

Comparison of Border Strip and Corrugation Methods of Irrigation

It is a common practice of farmers on the North Unit to irrigate fields by means of corrugations. Even large relatively flat fields are irrigated without the aid of border strips to confine heads of water to relatively narrow strips. Often the corrugations become filled with sediment, or, especially in clover fields, obstructed by plant leaves or other plant debris, causing the streams of water to leave the corrugations and resulting in wild flooding. In efforts to moisten the whole soil surface and to irrigate all

Table 4. Disposition of Water Applied to 22 Fields Seasonal Totals or Averages

Crop	Seasonal Application Inches	Runoff %	Application Efficiency %	Seasonal Consumptive Use Inches	Peak Use Rate between irrigations Inches/day	Length of period of peak use Days
Ladino	74	51	36	32.3	0.40	8
	66	51	34	26A	0.31	22
	53	53	50	29.8	0.33	10
	47	51	45	26.8	0.27	9
	104	51	24	22.7	0.32	13
Mean	68.8	51.4	37.8	27.6	0.326	12.4
Wheat	36	50	28	14.0	0.22	21
	24	40	45	17.8	0.24	19
	28	41	47	17.4	0.32	17
	40	49	48	26.7	0.30	15
	26	24	45	18.3	0.26	15
	26	42	35	16.6	0.17	30
	20	32	62	17.1	0.35	14
Mean	28.6	39.7	44.3	18.3	0.266	18.7
Alfalfa	151	73	13	25.1	0.38	7
	40	31	50	26.2	0.22	38
Mean	95.5	52.0	31.5	25.7	0.30	22.5
Kenland	51	38	46	28.0	0.29	10
Pasture	174	48	22	34.1	0.56	5
	43	38	41	26.3	0.18	15
Mean	108.5	43.0	31.5	30.2	0.37	10
Potatoes	63	71	20	17.1	0.47	3
	35	55	44	17.3	0.50	3
	43	42	40	18.1	0.40	17
Mean	47.0	56.0	34.7	17.50	0.457	7.7
Alsike	27	45	48	20.2	0.19	11
	49	33	42	24.8	0.24	18
Mean	38	39	45	22.50	0.215	14.5
Grand Mean	55	46	39	22.9		

portions of their fields under these conditions, farmers may allow water to flow for periods as long as 48 hours with much subsequent runoff, or they may greatly increase the size of stream on a small area to "force" water over obstructions, resulting also in much runoff.

In irrigating by the border strip method, water is confined to a relatively narrow portion of a field and not allowed to flood land outside the area intended to be irrigated. Large streams of water are used so that the entire strip is flooded and moisture in infiltrated over the entire soil surface. When confined in this manner, the stream of water will usually flow over and wet a given area of land in less time than is required when attempts are made to irrigate through filled or obstructed corrugations. The border strip method usually calls for more frequent changes of sets than the corrugation method. The number of irrigations is also sometimes increased by use of border strips if infiltration is slow. For these reasons some increase in labor is required--an argument against the border strip method in the opinions of North Unit operators.

To study the relative efficiencies of the two methods, comparison of the border strip and corrugation methods was continued on the same field of the Chester Luelling farm in 1951, 1952, and 1953. The plots were selected at random across the portion of the field available for studies.

Border strips were laid out after a rough topographic survey had been made to determine slope, direction of flow, and width of each border strip. Factors entering into choice of border strip spacings were: amount of side fall, size of stream of water available, size of stream that could be applied without causing excessive erosion. Borders or dikes were prepared by the farmer who also performed all tillage operations.

The corrugations were irrigated in the manner determined best for this field. Runoff was kept to a minimum and inspection of runoff stage recorder charts indicated that runoff at each irrigation was just at the peak, or had not reached the peak when irrigation was stopped on the corrugations. In irrigating border strips one second foot of water was considered the proper head to get the best distribution in 30-foot strips. This head was allowed to run until it was estimated that the advance would irrigate the remaining portion of the strip. Corrugation spacing was 24 inches.

Results

Irrigation efficiency on the border strip method was higher than on the corrugation method throughout the three-year study. The values for each are 60, 88, and 94% on the border strips and 47, 55, and 73% on the corrugations. Runoff percentage varied from 6 to 13% of the total application on the strips and 23 to 31% on the corrugations. The 1953 results are shown in detail in Appendix Table 2.

Results indicate that under certain conditions a change in irrigation method could save water.

Pan Evaporation vs. Consumptive Use

Measurements of evaporation of water from small pans or other devices is being used in some places as an estimate of consumptive use of crops. If a high correlation is obtained between these two factors, measurement of evaporation can be used to predict when and how much to irrigate. The consumptive use data from this project has been correlated with evaporation from standard class A weather bureau pan at the Madras 2N station. The results appear in Figures 4 through 11.

Each point on each one of these graphs represents a consumptive use measurement between two irrigations. Usually the points which represent high values of evaporation and consumptive use were measured either early or late in the season. Because the irrigation intervals during most of the season were of approximately equal length there are many points clustered in a small area on most of the graphs.

Some of the graphs show a fairly large group of points at some distance from the line of regression. Whenever these groupings could be identified with rainfall characteristics, the identification has been shown on the graphs. Because some of the fields measured were located several miles from the weather station it is believed that some of the rains recorded at the weather station would not have been recorded at the field in the same amount. Had the rain been measured at each field it is believed that higher correlation coefficients would have been obtained on most of the regression lines.

Correlation coefficients ranged from 0.9650 to 0.5934. They were computed for the following crops, listed in order of decreasing correlation coefficients: alfalfa, pasture, alsike clover, kenland clover, ladino clover, wheat, and potatoes. Each of the perennial crops showed a higher correlation coefficient than any of the annual crops.

The results of this study appear promising, especially for alfalfa, pasture, and alsike clover. On alfalfa, for instance, the regression line indicates that when three inches of water have been evaporated from the pan, the consumptive use has been almost two inches. If the crop is growing on a soil which will permit the removal of 2 inches of water without reducing yield, irrigation can be applied at this time. Assuming an irrigation efficiency of 50%, a 4-inch application of water would be sufficient. These results appear to warrant further investigation.

Pan Evaporation vs. Consumptive Use of Alfalfa
Each point represents a period between irrigations.

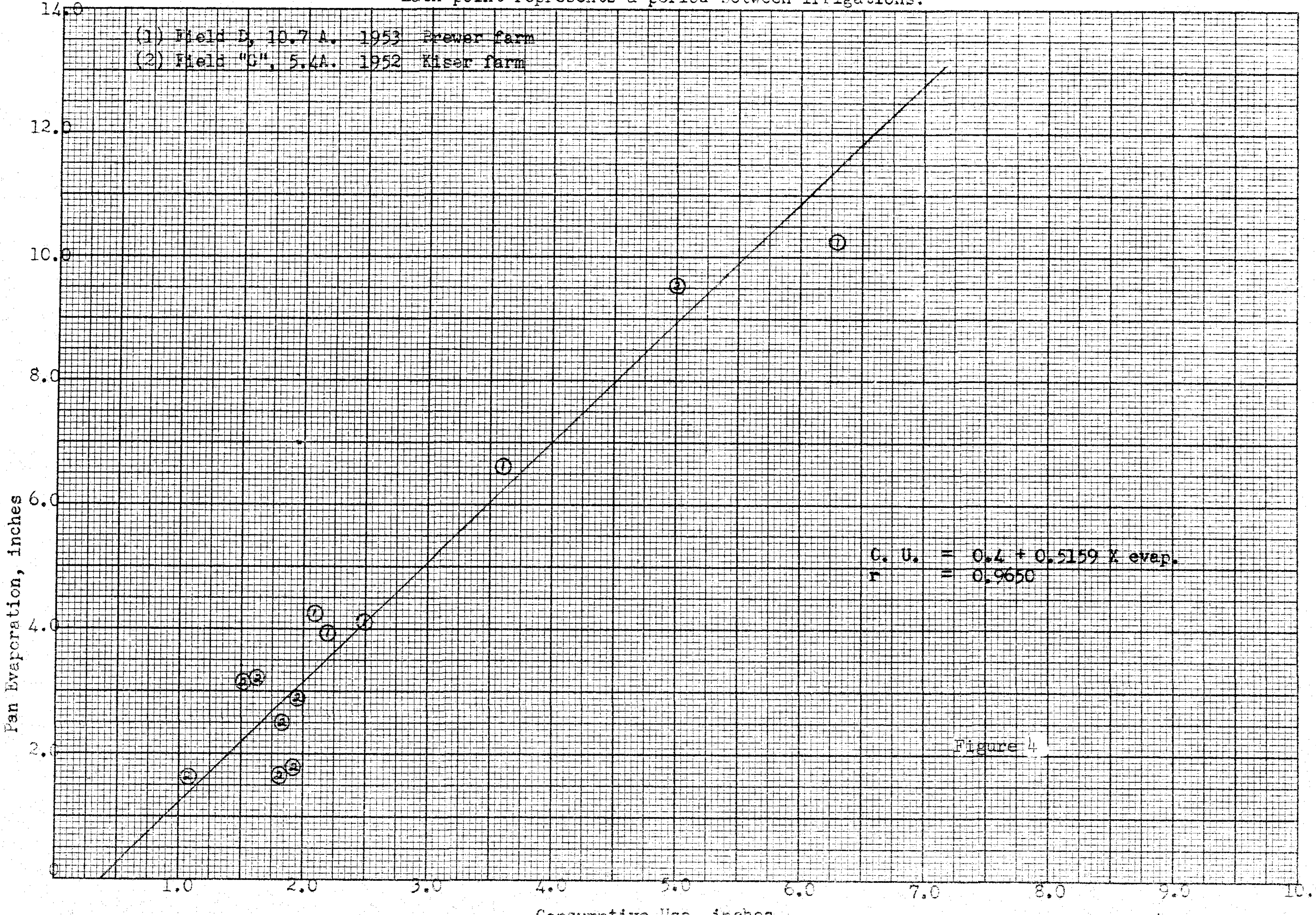


Figure 4

Pan Evaporation vs. Consumptive Use of Alsike Clover.
Each point represents a period between irrigations.

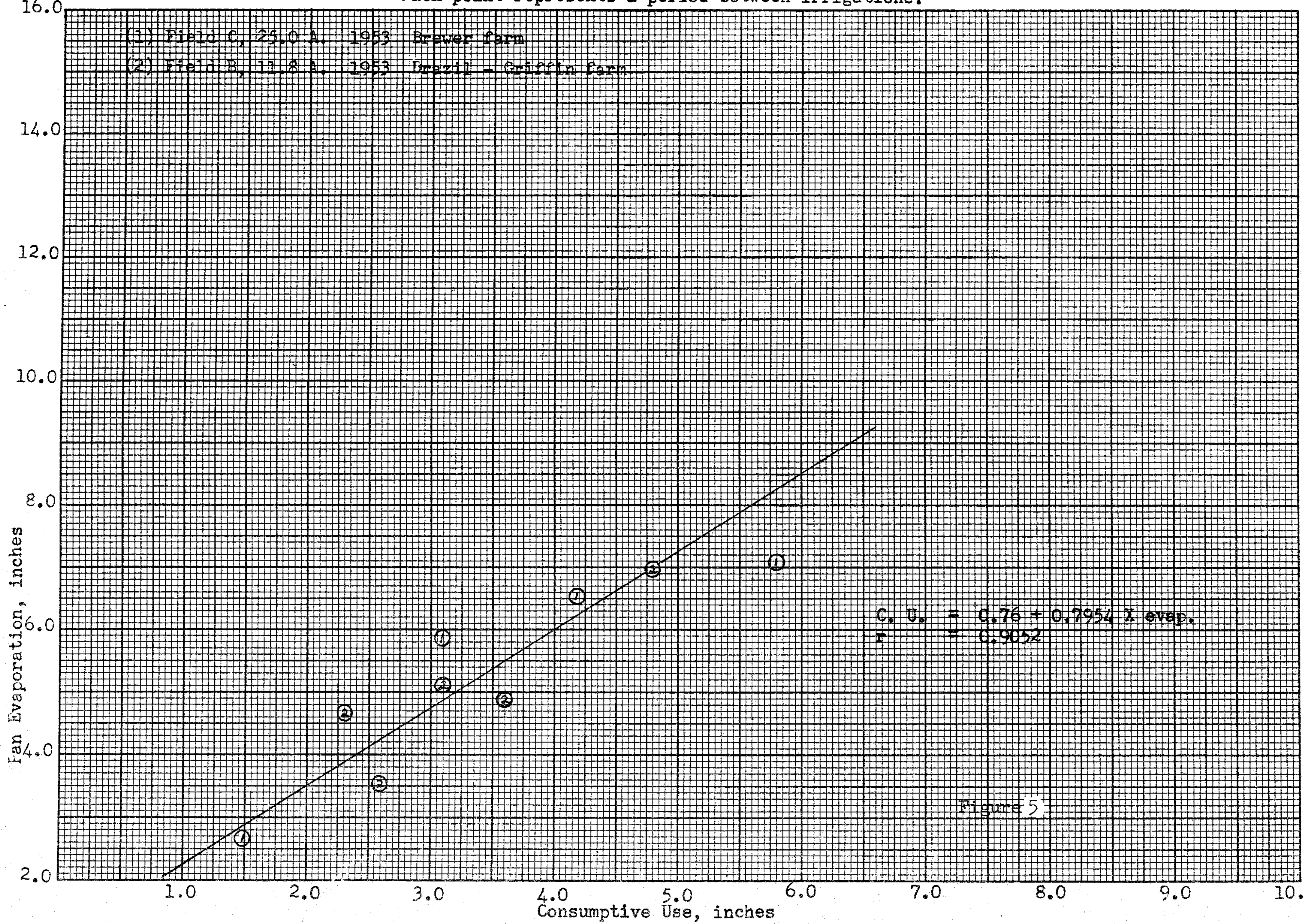


Figure 5

Pan Evaporation vs. Consumptive Use of Pasture
Each point represents a period between irrigations.

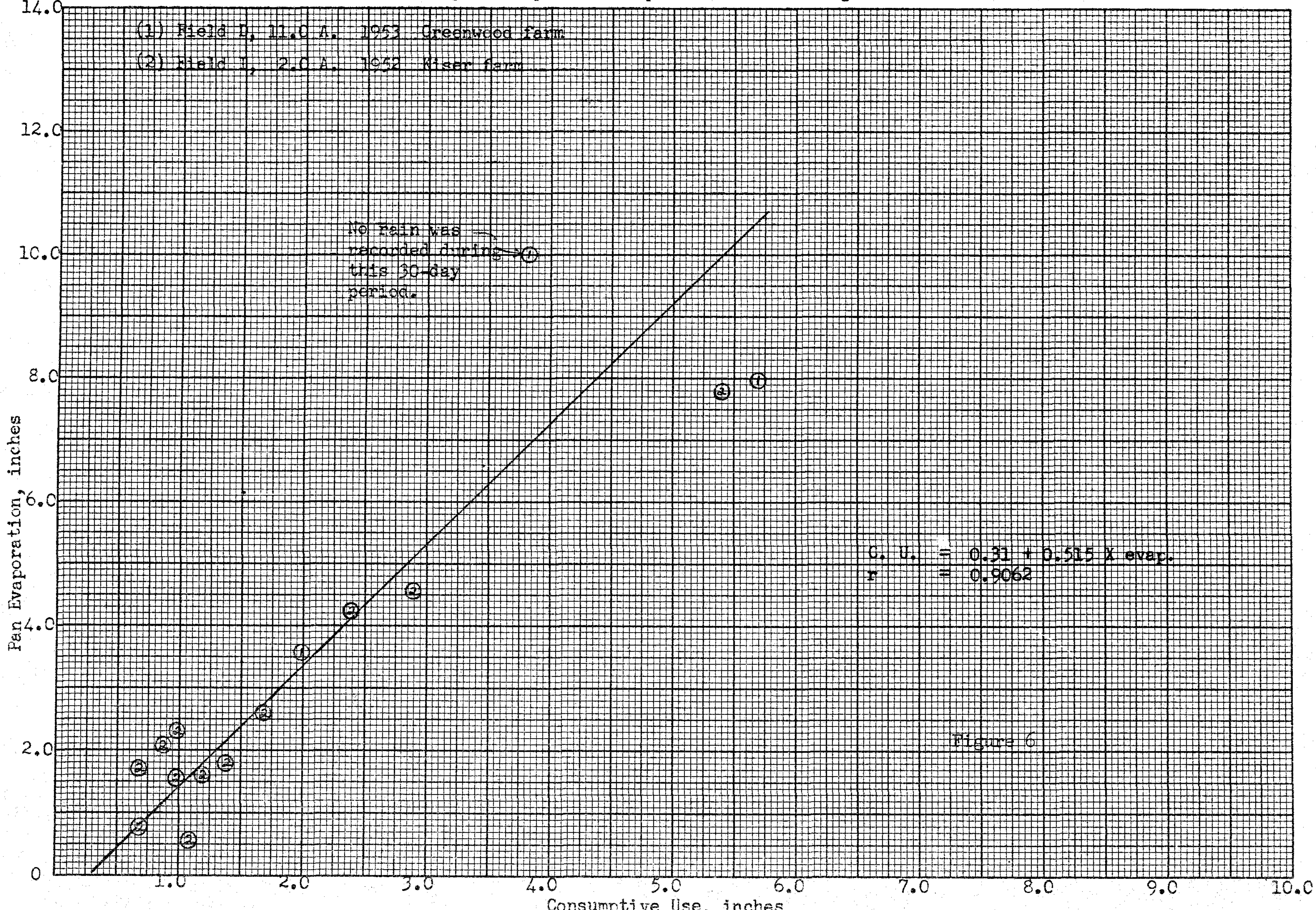


Figure 6

Pan Evaporation vs. Consumptive Use of Kenland Clover
Each point represents a period between irrigations.

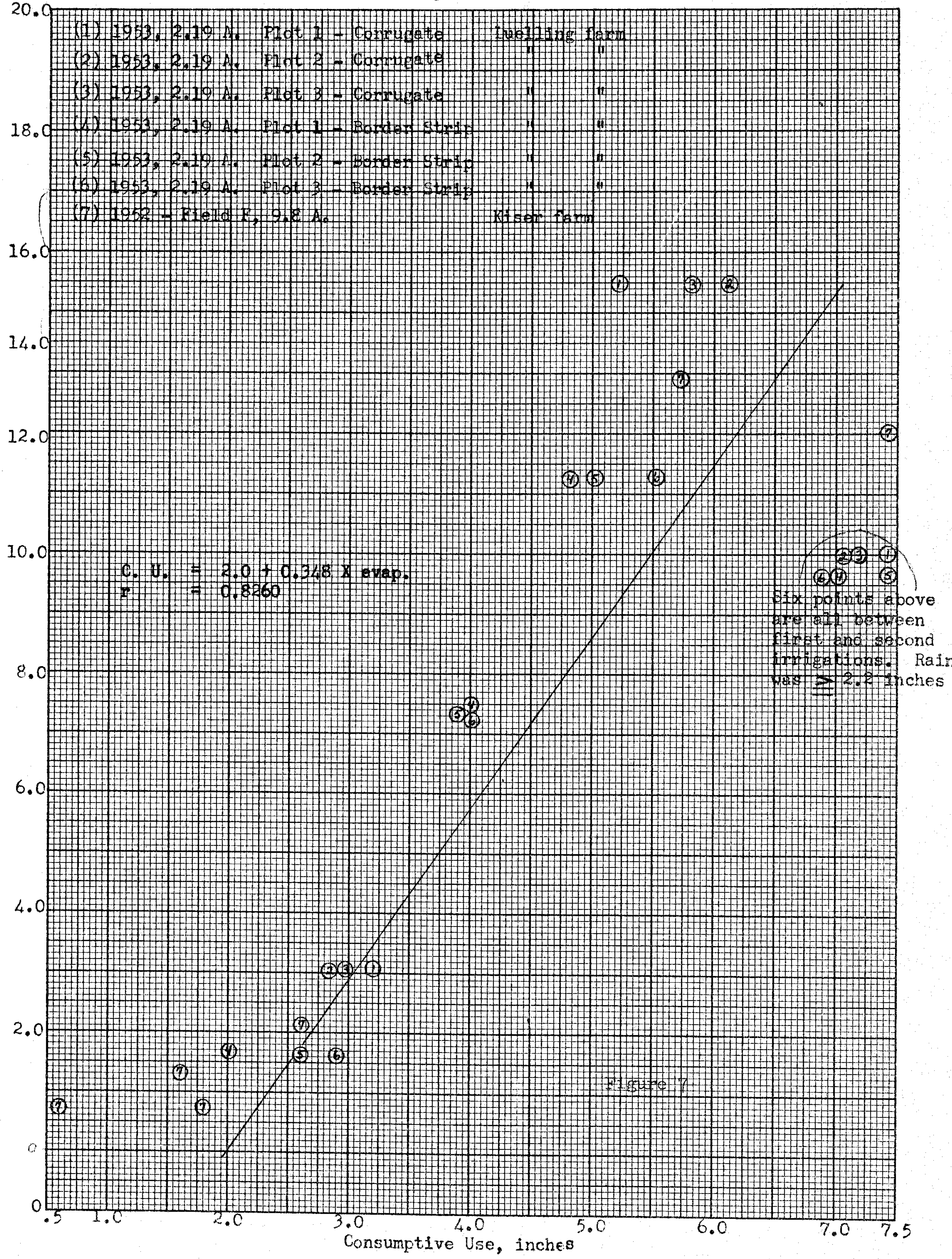
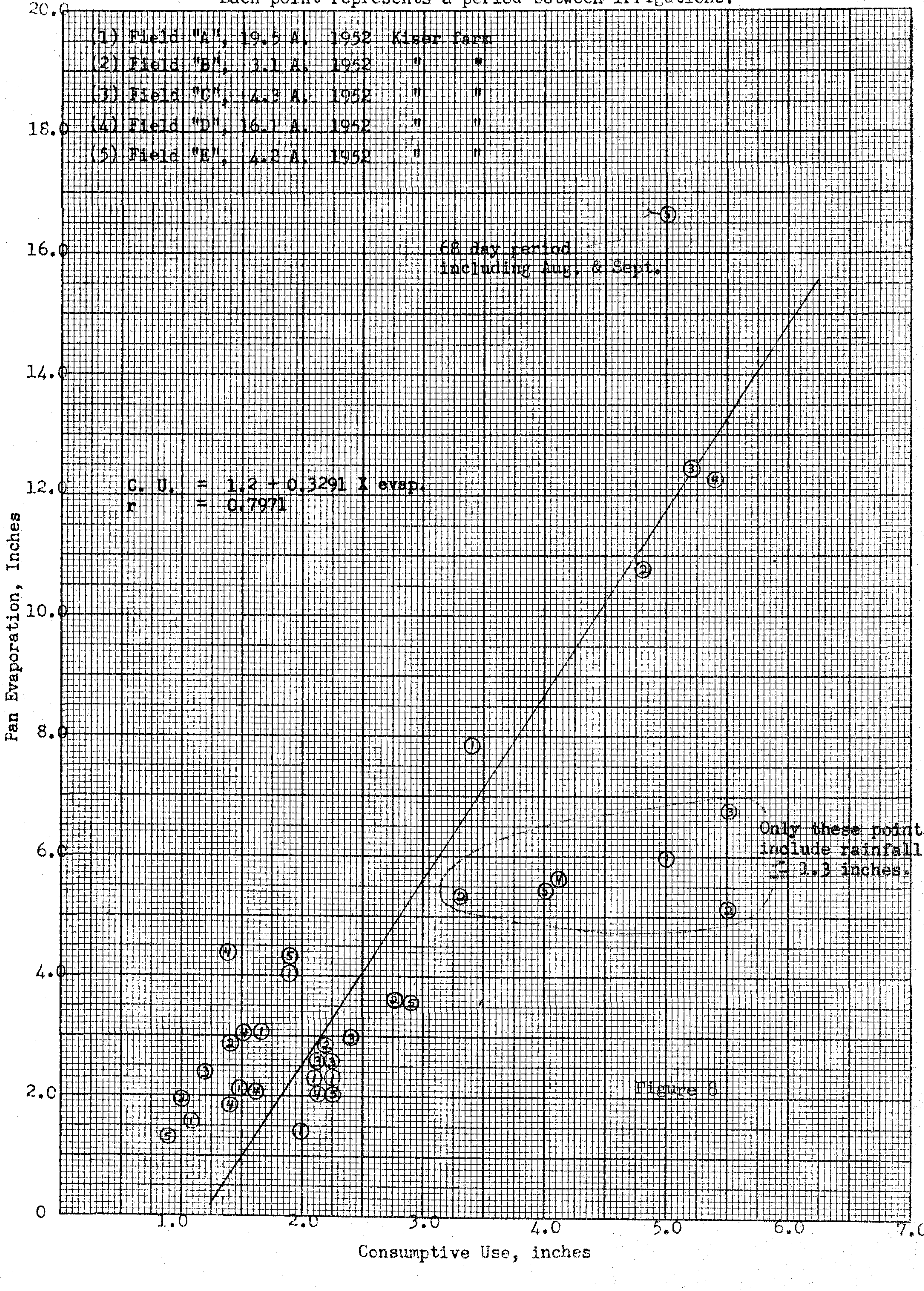


Figure 7

Pan Evaporation vs. Consumptive Use of Ladino Clover
Each point represents a period between irrigations.



Pan Evaporation vs. Consumptive Use of Wheat
Each point represents a period between irrigations.

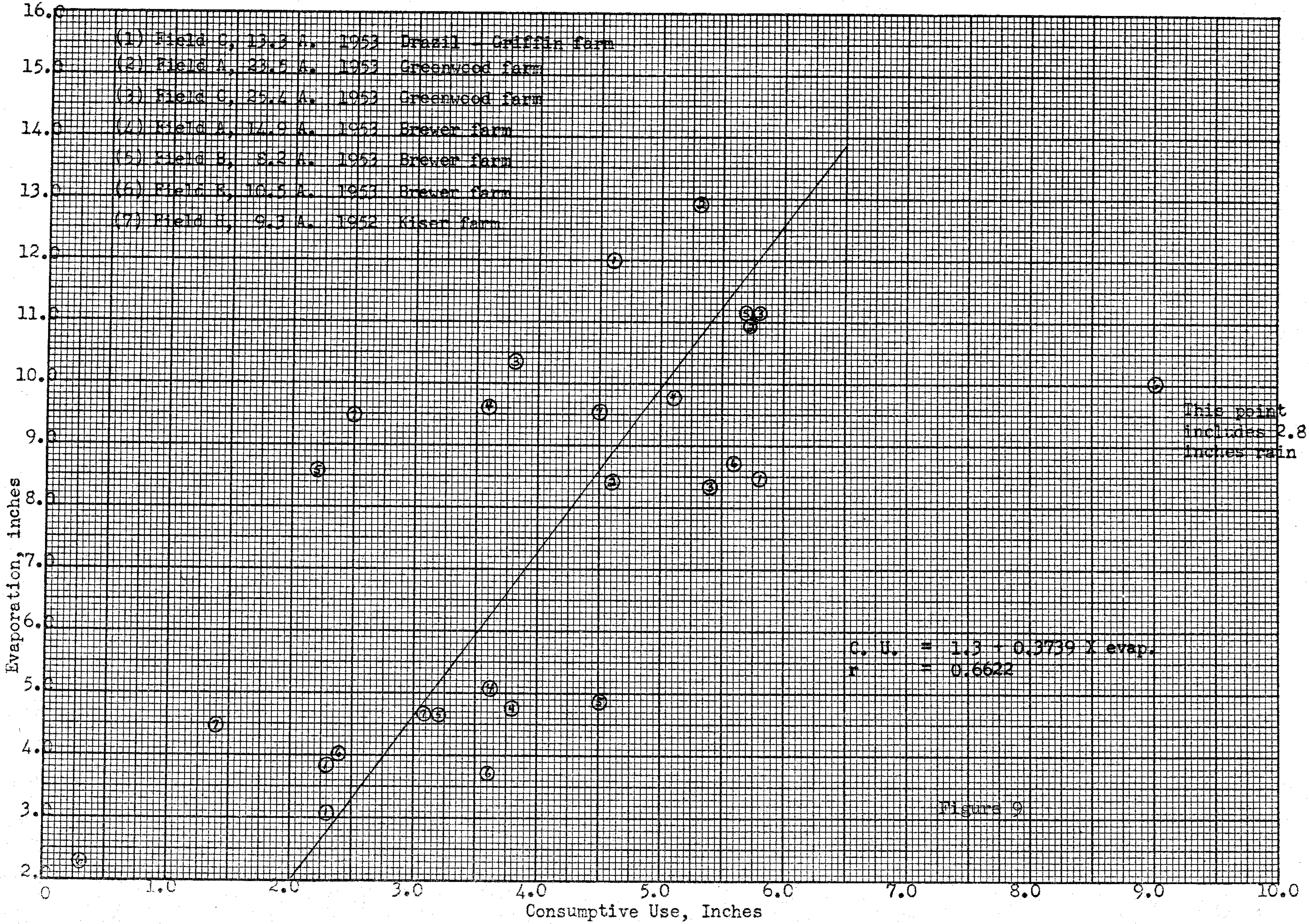
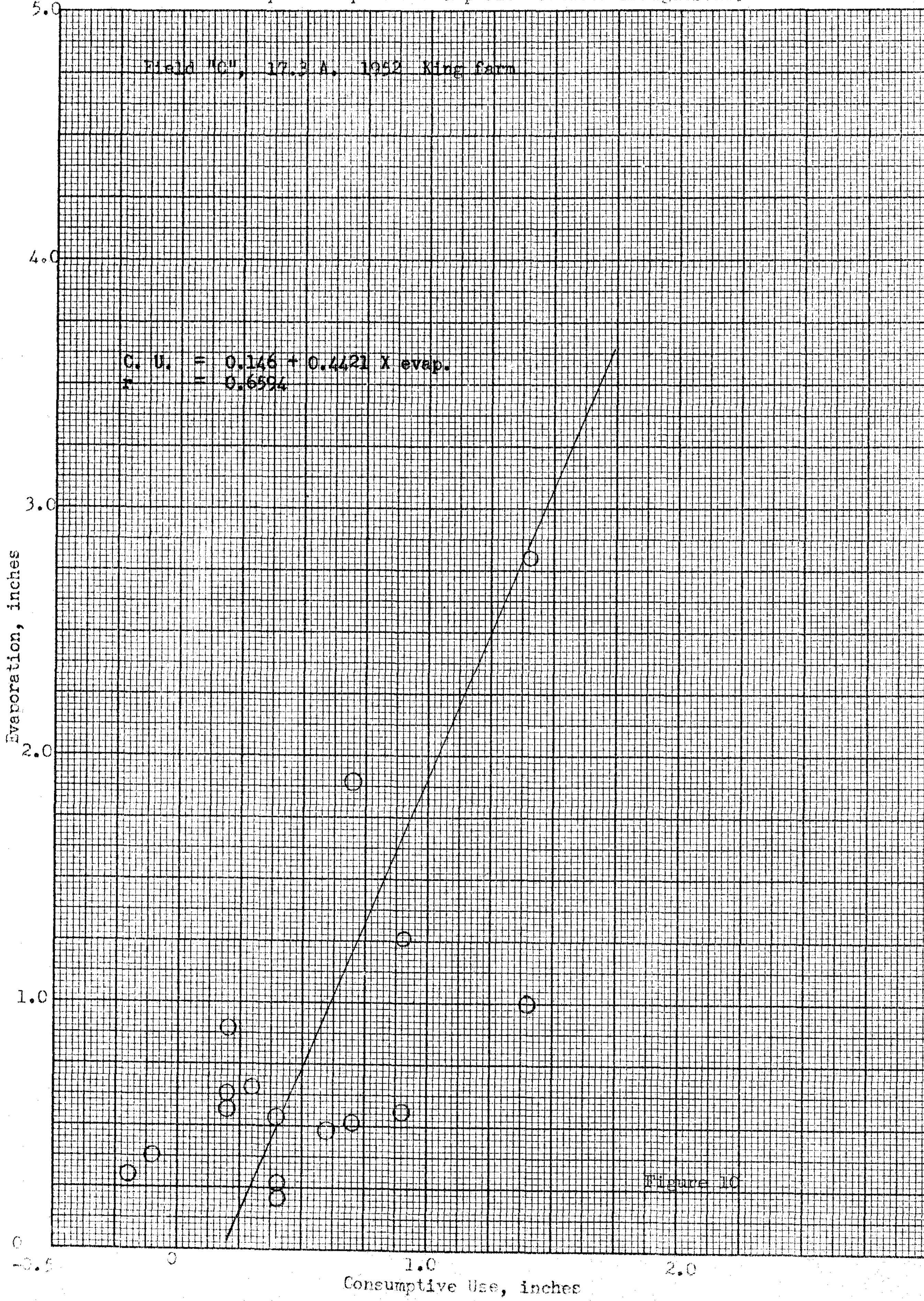


Figure 9

Pan Evaporation vs. Consumptive Use of Potatoes
Each point represents a period between irrigations.



Pan Evaporation vs. Consumptive Use of Potatoes
Each point represents a period between irrigations.

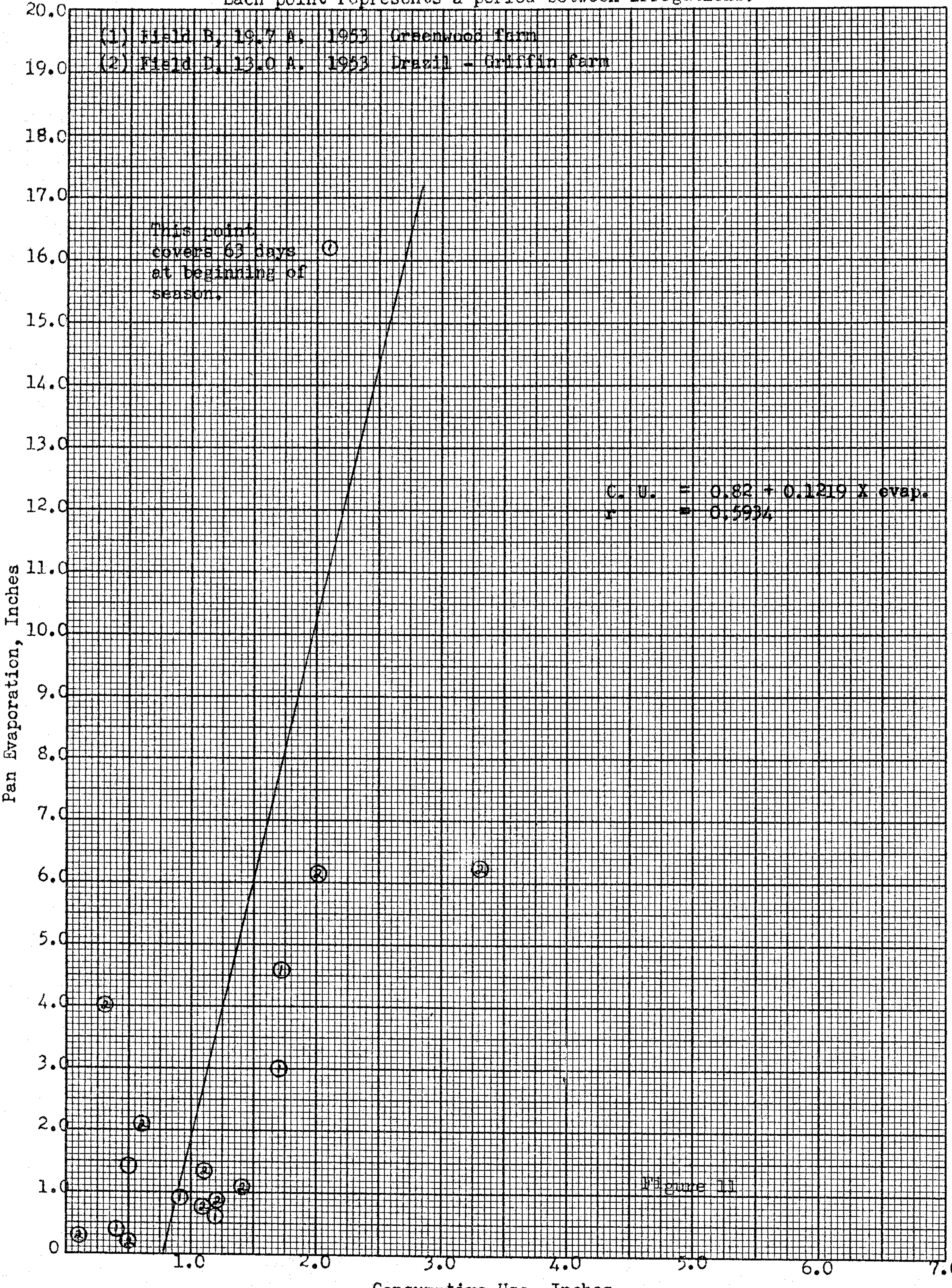


Figure 11

APPENDIX

Appendix Table 1. Soil Characteristics.

Soil	Farm	Location	Depth Inches	Moisture Equivalent %	Wilting Point 15-atm%	Volume Weight
Madras	Ellis	S.E.4	0-6	22.72	10.76	1.39
Loam	Kiser	N.W.4	6-12	26.17	13.85	1.15
		and	12-23	34.39	20.37	1.32
		S. W.4	0-6	21.40	10.04	1.27
		N.E.4	6-12	22.35	11.51	1.23
		Sec.8	12-23	29.83	17.74	1.22
		T.10S				
		R.14E	0-6	21.44	11.13	1.30
			6-12	25.66	14.18	1.26
			12-25	29.21	16.56	1.27
			0-6	21.62	10.51	1.39
			6-12	23.27	11.90	1.37
			12-24	27.58	14.90	1.31
			0-6	21.82	11.98	1.27
			6-12	24.91	13.94	1.20
			12-21	33.60	19.20	1.44
			0-6	22.40	10.56	1.39
			6-12	23.53	11.04	1.36
			12-29	24.70	12.77	1.32
Madras	Chester	S.W.4	0-6	18.07	8.10	1.24
Loam	Luelling	N.W.4	6-12	18.43	8.37	1.27
		Sec.27	12-27	16.50	7.57	1.37
		T.9S				
		R.13E	0-6	23.70	9.46	1.21
			6-12	22.69	9.85	1.26
			12-23	21.88	9.77	1.31
			0-6	20.33	10.0	1.29
			6-12	21.64	9.5	1.23
			12-21	23.58	10.8	1.17
			0-6	21.10	10.2	1.30
			6-12	22.08	10.0	1.24
			12-21	25.31	12.6	1.16
			0-6	19.50	10.0	1.22
			6-12	20.74	10.8	1.16
			12-24	27.10	16.4	1.20
	Lydy	S.E.4 NE4	First ft.	30.25	11.30	1.37
		Sec 28	Second ft	22.74	12.01	1.44
		T9S	Hardpan	21.85	13.33	
		R13E				

Soil	Farm	Location	Depth Inches	Moisture Equivalent %	Wilting Point 15 Atm%	Volume Weight
Madras Loam	Harris	NE4 NE4	First ft.	24.42	13.28	1.40
		Sec 15	Second ft	26.01	15.09	1.33
		T 10S	First ft.	23.63	13.12	1.31
		R 13E	Second ft	22.18	11.01	1.39
			Hardpan	23.65	11.75	-
			0-6	23.08	10.2	1.42
			6-9	25.99	12.3	1.24
			9-17	27.33	14.2	1.24
			17-20	26.84	13.2	1.29
			0-6	22.71	10.6	1.51
			6-11	24.58	11.5	1.37
			11-23	26.04	12.4	1.39
			0-6	22.89	11.6	1.35
			6-12	23.16	11.2	1.51
			12-16	23.14	10.6	1.50
			16-30	23.01	11.0	1.54
	Leach-Corwin	SE4 SE4	First ft	18.60	10.81	1.29
		Sec 9	Second ft	20.99	13.68	1.37
		T 12S	First ft	19.83	10.94	1.28
		R 13E	Second ft	21.65	11.53	1.33
			First ft	21.67	12.37	1.37
			Second ft	23.18	14.32	1.23
			Hardpan	29.23		
	Clowers	NE4 NE4	First ft	23.41	11.82	1.29
		Sec 28	Second ft	27.37	13.36	1.30
		T9S	Hardpan	29.78	16.55	
			First ft	25.00	11.54	1.41
			Second ft	27.07	13.59	1.41
			Hardpan	23.43	11.08	
Madras	Dean King	S.W.4	0-6	22.39	10.68	1.34
		Sec.10	6-12	26.18	14.29	1.36
		T.11S	12-21	36.35	21.51	1.36
		R.13E				
			0-6	21.70	11.38	1.28
			6-12	29.57	16.81	1.20
			12-24	32.64	19.97	1.23
			0-6	21.79	11.36	1.33
			6-12	26.42	14.02	1.19
			12-23	28.50	16.53	1.26
			0-6	23.12	11.08	1.23
			6-12	25.05	13.65	1.25
			12-18	28.27	16.03	1.20

Soil	Farm	Location	Depth Inches	Moisture Equivalent %	Wilting Point 15 Atm%	Volume Weight
Madras Sandy Loam	Jim Brooks	SW4 SE4 Sec.15 T 10 S R 13 E	0-6	25.26	11.86	1.47
			6-12	25.00	11.66	1.35
			12-17	26.85	16.02	1.34
			17-20	29.09	17.80	1.35
			0-6	25.52	12.17	1.41
			6-12	27.60	14.80	1.40
			12-18	27.86	15.86	1.41
			18-22	31.88	20.21	-
			22-26	36.47	25.21	-
	Duling	SE4 NW4 Sec.17 T 12 S R 14 E	0-8	25.87	13.49	1.22
			8-16	39.03	25.92	1.17
			16-22	38.99	26.36	-
			0-8	26.52	13.14	1.23
			8-16	44.53	32.62	1.17
			16-22	43.85	33.66	-
			Hardpan	35.96	23.20	-
	Short-Johnson	W2 NW4 Sec.17 T 12 S R 13 E	0-6	22.73	11.6	1.43
			6-12	25.55	13.6	1.14
			12-24	26.11	14.5	1.14
			0-6	22.87	12.2	1.43
			6-15	24.35	12.8	1.26
			15-24	26.30	13.7	1.38
			0-6	21.06	11.3	1.39
			6-14	24.40	12.6	1.32
			14-22	25.39	13.1	1.28
			0-6	22.45	11.2	1.45
			6-12	24.73	12.5	1.35
			12-20	24.95	19.7	1.28
			0-6	29.17	10.7	1.29
			6-11	23.37	11.3	1.45
			11-16	23.98	18.6	1.44
			16-20	28.56	22.9	1.24
			0-6	24.76	11.6	1.37
			6-9	30.60	16.0	1.29
			9-25	30.57	16.0	1.16
42A Metolius Sandy Loam	Barber	NW4 SE4 Sec.18 T 12 S R 13 E	First ft	24.29	13.13	1.44
			Second ft	30.25	17.00	1.36
			First ft	25.76	13.39	1.55
			Second ft	30.85	18.14	1.35
	Lute-Barber	SW 4 Sec.18 T 12 S R 13 E	0-6	22.59	10.5	1.30
			6-12	23.26	11.2	1.30
			12-21	25.83	12.0	1.28
			0-6	22.42	11.2	1.40
			6-13	22.87	11.1	1.38
			13-29	25.00	11.7	1.25
60A Metolius Sandy Loam	Coad	SW4 SE4 Sec. 21 T 13 S R 13 E	Upper 4 ft	22.53	11.82	1.37
			Upper 4 ft	19.16	9.10	1.33

Soil	Farm	Location	Depth Inches	Moisture Equivalent %	Wilting Point 15 Atm%	Volume Weight
Metolius Sandy Loam	William E. Wood	N.E.4 S.W.4 Sec.3 T.12.S R.13E	0-6	27.48	11.22	1.09
			6-12	26.40	10.90	1.12
			12-48	22.88	9.47	1.04
	Frank Crocker	S.E.4 N.W.4 Sec.10 T.12S R.13E	0-6	26.98	13.12	1.18
			6-12	25.31	12.14	1.24
			12-46	24.40	11.36	1.17
Metolius Sandy Loam	Jerry Drazil	Lot 4 Sec 18 T12S R13E	0-6	19.39	8.34	1.29
			6-12	18.84	9.15	1.38
			12-32	20.77	8.82	1.45
			0-6	21.39	9.38	1.20
			6-12	20.75	9.40	1.26
			12-32	24.62	11.72	1.35
			0-6	19.08	9.29	1.24
			6-12	20.28	10.80	1.32
			12-34	22.41	9.59	1.43
Agency Sandy Loam	Greenwood & Sons	Lots 1 & 2 Sec. 3 T12S R13E	0-6	18.76	9.37	1.40
			6-12	23.74	12.32	1.35
			12-22	30.51	16.90	1.22
			0-6	19.06	9.40	1.47
			6-12	25.69	13.55	1.26
			12-20	29.38	16.01	1.34
			0-6	19.99	9.24	1.29
			6-12	26.12	13.72	1.30
			12-28	35.62	20.86	1.27
			0-6	21.49	10.32	1.42
			6-12	21.76	10.94	1.41
			12-24	22.72	11.41	1.52
			0-6	20.51	9.79	1.37
			6-12	22.94	11.17	1.34
			12-26	26.20	13.03	1.34
			0-6	18.08	8.57	1.53
			6-12	18.97	9.12	1.31
			12-24	27.27	14.21	1.42
			0-6	21.02	14.57	1.37
			6-12	23.08	17.68	1.41
			12-30	24.89	19.24	1.21

Soil	Farm	Location	Depth Inches	Moisture Equivalent %	Wilting Point 15 Atm%	Volume Weight
Agency Sandy Loam	Duling-Barber	SE4 SW4 Sec. 8 T 12 S R 13 E	0-6	23.69	11.93	1.36
			6-12	25.63	13.48	1.39
			12-24	25.09	13.04	1.27
			Above Hardpan	26.01	13.52	-
			Hardpan	32.23	19.00	-
			0-6	24.38	11.81	1.31
			6-12	26.06	13.08	1.40
			12-18	28.57	13.46	1.40
			18-20	28.37	15.10	-
Agency Sandy Loam	A. Ramsey	N.E.4 N.E.4 Sec.9 T.10.S R.135	0-6	17.03	8.16	1.37
			6-12	17.86	8.24	1.44
			12-30	18.32	8.25	1.42
	L. A. Bailey	S.W.4 S.W.4 Sec.36 T.9.S R.13E	0-6	21.90	10.58	1.36
			6-12	23.46	11.82	1.40
			12-18	26.10	14.41	1.34
	George Clowers	S.E.4 N.E.4 Sec.2 T.10.S E.13E	0-6	20.90	9.94	1.09
			6-12	21.68	10.22	1.12
			12-22	19.07	8.70	1.04
Agency Loam	Floyd Brewer	N½ SW4 Sec 15 T12S R13E	0-6	26.79	9.56	1.36
			6-12	31.50	11.11	1.33
			12-24	33.36	13.08	1.36
			0-6	25.18	11.60	1.42
			6-12	27.11	13.21	1.39
			12-24	27.22	15.46	1.31
			0-6	24.98	14.03	1.50
			6-12	24.69	13.37	1.31
			12-26	27.31	14.74	1.28
			0-6	21.09	11.04	1.34
			6-12	20.24	10.69	1.33
			12-30	20.59	10.40	1.36
Agency Loam	Guy Corwin	S.W.4 N.W.4 Sec.15 T.12S R.13E	0-6	23.38	12.36	1.35
			6-12	24.02	12.99	1.24
			12-34	25.17	12.42	1.23
	W. V. Merchant	N.W.4 S.W.4 Sec.15 T.12S R.13E	0-6	22.70	11.34	1.47
			6-12	23.53	11.47	1.34
			12-27	35.70	21.80	1.36

Soil	Farm	Location	Depth Inches	Moisture Equivalent %	Wilting Point 15 Atm%	Volume Weight
Agency Loam	Gibson-Corwin	SW4 NW4 Sec. 15 T 12 S R 13 E	0-14	25.73	13.44	1.42
			14-26	30.07	17.43	1.39
			0-18	23.32	11.81	1.30
			18-36	22.97	10.98	1.24
			Hardpan 26-32	33.45	18.38	
Agency Gravely Loam	Short Johnson	W2 NW4 Sec 17 T12S R13E	0-6	23.86	12.2	
			6-12	27.36	14.6	
			12-20	26.70	14.0	
			0-6	23.96	12.1	
			6-12	28.51	14.7	
			12-23	28.01	15.9	
Lamonta Loam	H. P. Woodworth	N.W.4 S.W.4 Sec.14 T.12S R.13E	0-6	17.01	9.80	1.25
			6-12	16.76	9.68	1.20
			12-36	14.04	7.75	1.18
Lamonta Loam	Grover Douglas	N.E.4 N.W.4 Sec.27 T.12S R.13E	0-6	16.00	8.32	1.39
			6-12	17.48	7.88	1.32
			12-36	21.42	9.82	1.28
			0-6	23.08	11.88	1.38
			6-12	24.00	12.75	1.20
			12-35	36.70	20.97	1.20
	A. B. Cook	S.W.4 N.E.4 Sec.22 T.12S R.13E	0-6	25.12	14.22	1.43
			6-12	28.88	16.04	1.33
			12-18	41.08	26.85	1.16
Era Sandy Loam	Fred Silver	S.W.4 S.W.4 Sec.4 T.12S R.13E	0-6	20.53	10.48	1.39
			6-12	24.93	13.10	1.25
			12-20	37.04	24.47	1.28
			0-6	23.08	11.88	1.33
			6-12	24.00	12.75	1.25
			12-35	36.70	20.92	1.38

Soil	Farm	Location	Depth Inches	Moisture Equivalent %	Wilting Point 15 Atm%	Volume Weight
Redmond	Florian	E2 NW2	0-6	23.74	10.29	1.24
Sandy	Meng	Sec 4	6-12	31.18	17.57	1.23
Loam (deep phase)		T11S R14E	12-60+	34.14	17.54	1.18
			0-6	22.14	9.64	1.05
			6-12	33.02	17.49	1.18
			12-60+	40.66	20.93	1.08
Deschutes	William	SW4 SW4	0-6	19.57	9.31	1.13
Sandy	Greene	Sec 33	6-12	26.97	11.31	1.02
Loam		T10S R14E	12-48	27.48	12.14	1.11
			0-6	23.54	10.28	1.17
			6-12	27.95	11.68	1.22
			12-48	27.93	11.68	1.15
Deschutes	Redmond	SW4 SE4	0-6	18.69	7.25	1.22
Sandy	Fairgrounds	Sec 16	0-6	17.70	7.29	1.27
Loam		T15S R13E	12-30	16.85	6.99	1.24
Deschutes	Hostetler	NE4 NE4	0-6	17.02	6.09	1.26
Sandy		Sec. 31	6-12	15.48	5.48	1.32
Loam		T15S R13E	12-26	16.37	6.23	1.39
Deschutes	Cole	NE4 NE4	0-6	16.69	6.50	1.16
Loamy		Sec. 6	6-12	15.66	6.66	1.36
Sand		T15S R11E	12-24	15.99	6.57	1.43
Deschutes	Griswold	SW4 SW4	0-6	11.23	4.40	1.53
Coarse Sandy		Sec 5	6-12	11.37	4.80	1.41
Loam		T15S R11E	12-42	11.53	4.82	1.48
Deschutes	Unknown	NE4 NE4	0-6	15.25	5.41	1.13
Loamy		Sec 28	6-12	15.16	5.87	1.31
Sand		T16S R12E	12-22	14.88	6.47	1.32
Redmond	Unknown	SE4 SE4	0-6	20.58	8.75	1.18
Sandy		Sec 13	6-12	20.22	8.62	1.23
Loam		T14S R13E	12-36	19.78	8.33	1.33
Un-	Clifford		0-18	18.02	10.3	
classed	Dickson		18-24	18.18	9.7	
	Powell		0-18	17.99	10.0	
	Butte		18-24	18.10	9.5	
			0-7	20.28	10.2	
			7-27	36.86	21.1	
			27-36	20.26*	10.9	
			27-37	32.89#	20.8	
Un-classed	Lewie		0-13	17.19	9.5	
	Stahancyk		13-20	24.92	12.8	
	Prineville		20-0	18.30	10.5	

Appendix Table 2. Summary of Disposition of Water Applied to Fields

The following explanation of the columns of this Table may be helpful. The left margin contains the yield, the average land slope, and the length of the irrigation run in addition to field identification. When column 1 has two dates, they bracket the time that water was on the field. When there is only one date, no irrigation occurred. The source of the water in column 3 was surface runoff from another field on the same farm. Column 4 is the sum of columns 2 and 3 plus delivered water from the canal. Column 7 is the measured increase in soil moisture during an irrigation plus the estimated consumptive use during the irrigation. Column 8 was obtained by subtracting columns 5 and 7 from column 4. Column 9 is column 7 divided by column 4. Column 11 was computed from the start of one irrigation to the start of the next, and column 12 is the average daily use for this period.

Description of Farm	Date of Irr. Mo/day	Rain During Irr.	Waste Water Applied Inches	Total Application Inches	Runoff Inches	Runoff Percent	Soil Moisture Added Inches	Deep Percolation Inches	Application Efficiency Percent	Rain Between Irr. Inches	Consumptive Use: Since Last Irrigation	Consumptive Use: Per Day Inches
Field "A"	4/16-21	0	0	8.18	3.19	39.0	1.96	3.03	24.0		1.96*	
Ladino	5/8-13	.5	0	6.43	3.11	48.4	1.53	1.79	23.8	.3	1.98	.09
Kiser	5/23-27	0	0	6.88	3.58	52.0	1.83	1.47	26.6	.1	2.25	.15
Farm	6/12-14	0	0	8.62	4.88	56.6	2.91	.83	33.8	.8	3.23	.17
1952	7/9-13	0	0	8.37	4.36	52.1	3.48	.53	41.6	1.8	5.40	.20
58 lbs/ac	7/20-23	0	0	6.96	3.86	55.5	2.73	.37	39.2	0	3.41	.31
	7/30-8/2	0	0	6.48	4.19	64.7	2.54	-.25	39.2	0	3.00	.30
2.9% slope	8/7-10	0	0	4.39	2.22	50.6	1.97	.20	44.9	0	2.07	.23
650' run	8/15-19	0	0	4.18	2.32	55.5	2.04	-.18	48.8	.1	3.20	.40
	9/26-10/2	0	0	13.79	5.42	39.3	4.89	3.48	35.5	.5	3.69	.09
	11/3									0	2.10	.06
Total or Average		.5	0	74.28	37.13	51.37A	25.88	11.27	35.74A	3.6	32.3	.20A
Field "B"	4/26-5/1	.2	0	8.72	2.47	28.3	1.68	4.57	19.3		1.68*	
Ladino	5/17-22	.2	0	6.14	2.33	37.9	2.24	1.57	36.5	.6	1.89	.09
Kiser	5/28-6/1	0	0	5.65	3.86	68.3	.93	.86	16.5	0	1.76	.16
Farm	6/22-26	0	0	7.74	4.77	61.6	4.08	-1.11	52.7	1.5	3.84	.16
1952	7/14-18	0	0	8.58	3.50	40.8	4.13	.95	48.1	1.3	6.82	.31
58 lbs/ac	7/30-8/1	0	0	10.68	5.91	55.3	1.90	2.87	17.8	0	3.68	.23
	8/9-12	0	0	6.32	4.08	64.6	2.61	-.37	41.3	0	2.52	.28
2.1% slope	10/2-6	0	0	12.45	6.29	50.5	5.30	.86	42.6	.7	2.30	.10
370' run	11/3									0	1.86	.06
Total or Average		.4	0	66.28	33.21	50.91A	22.87	10.20	34.35A	4.1	26.4	.17A

*Consumptive use before first irrigation was estimated as equal to the soil moisture added at the first irrigation.

Summary of Disposition of Water Applied to Fields

Field "C"	4/18-23	0	5.83	5.83	2.53	43.4	1.20	2.10	20.6		1.20*	
Ladino	5/6-10	.1	2.69	2.79	1.53	54.8	1.57	- .31	56.3	.2	1.62	.09
Kiser	5/22-26	0	3.43	3.43	1.85	53.9	2.63	-1.05	76.7	.6	2.88	.18
Farm	6/6-10	0	4.13	4.13	1.53	37.0	2.68	- .08	64.9	.4	3.36	.24
1952	7/9-11	0	8.77	8.77	4.18	47.7	3.10	1.49	35.3	2.4	6.27	.19
123 lbs/ac	7/18-21	0	4.00	4.00	2.61	65.2	2.97	-1.58	74.2	0	2.88	.32
	7/28-31	0	10.79	11.18	6.44	57.6	2.76	1.98	24.7	0	3.30	.33
2.1% slope	9/22-27	0	5.77	12.70	7.84	61.7	5.67	- .81	44.6	.7	5.40	.10
610' run	11/3									0	2.87	.07
Total or Average		.1	45.41	52.83	28.51	52.66A	22.58	1.74	49.66A	4.3	29.8	.19A
Field "D"	4/16-22	0	4.05	6.28	2.92	46.5	2.82	.54	44.9	0	1.72	.11
Ladino	5/9-14	.5	3.04	5.96	2.14	35.9	1.99	1.83	33.4	.3	2.07	.09
Kiser	5/22-27	0	4.51	4.85	2.44	50.3	1.36	1.05	28.0	.1	2.34	.18
Farm	6/13-17	.4	6.24	6.83	3.13	45.8	2.36	1.34	34.6	0	1.89	.09
1952	7/10-13	0	4.77	5.18	2.32	44.8	1.99	.87	38.4	1.6	4.86	.18
123 lbs/ac	7/19-23	0	4.06	4.54	2.63	57.9	3.30	-1.39	72.7	0	2.43	.27
	7/30-8/2	0	4.62	5.35	3.62	67.7	2.30	- .57	43.0	0	3.41	.31
2.5% slope	9/24-10/2	0	6.47	8.23	4.62	56.1	5.56	-1.95	67.6	.7	5.40	.10
620' run	11/3									0	2.73	.07
Total or Average		.9	37.76	47.22	23.82	50.62A	21.68	1.72	45.32A	2.7	26.8	.16A
Field "E"	4/25-5/1	.2	14.70	14.90	5.91	39.7	2.31	6.68	15.5	0	0.4	.02
Ladino	5/10-13	0	14.97	14.97	8.69	58.0	1.05	5.23	7.0	.1	1.35	.09
Kiser	5/29-6/3	0	14.80	14.80	9.14	61.8	3.29	2.37	22.2	.1	2.28	.12
Farm	6/26-7/2	1.2	5.09	6.29	1.56	24.8	3.56	1.17	56.6	1.5	4.59	.17
	7/9-11	0	12.22	12.22	4.32	35.4	3.86	4.04	31.6	0	4.16	.32
5.4% slope	7/22-26	0	20.73	20.73	11.15	53.8	2.09	7.49	10.1	0	3.38	.26
270' run	10/4-11	0	0	19.77	10.27	51.9	5.60	3.90	28.3	.7	5.04	.07
	11/4	0									1.50	.05
Total or Average		1.4	82.51	103.68	51.04	46.49A	21.76	30.88	24.47A	2.4	22.7	.14A

*Consumptive use before first irrigation was estimated as equal to the soil moisture added at the first irrigation.

Summary of Disposition of Water Applied to Fields

Field "F"	4/24-28	.2	.48	7.44	1.51	20.3	3.38	2.55	45.4	0	1.93	.08
Kenland	5/12-20	.1	0	3.92	2.57	65.6	1.08	.27	27.6	.6	2.16	.12
Kiser	5/26-31	0	0	6.40	2.92	45.6	2.56	.92	40.0	0	1.40	.10
Farm	6/12-18	.4	0	8.47	3.64	43.0	2.60	2.23	30.7	.8	3.68	.23
1952	7/13-17	0	0	6.51	1.58	24.3	4.87	.06	74.8	1.6	6.56	.16
127 lbs/ac	7/23-25	0	0	7.27	2.92	40.2	3.17	1.18	43.6	0	2.90	.29
	7/18-25	0	0	11.28	3.15	27.9	6.72	1.41	59.6	.7	7.70	.14
2.5% slope	10/21	0	0								.5	.05
680' run												
Total or Average		.7	.48	51.29	18.29	38.13A	24.38	8.62	45.96A	3.7	28.0	.15A
Field "G"	4/21-25	0	0	19.78	14.39	72.8	2.69	2.70	13.6		1.09	.05
Alfalfa	5/10-14	.5	0	21.17	16.47	77.8	1.24	3.46	5.9	.3	2.28	.12
Kiser	5/27-30	0	0	18.22	13.68	75.1	1.52	3.02	8.3	.1	2.04	.12
Farm	7/9-11	0	0	16.42	11.34	69.1	3.39	1.69	20.6	2.8	5.46	.13
1952	7/16-19	0	0	13.87	9.55	68.9	1.78	2.54	12.8	0	2.66	.38
5.8 T/ac	7/25-28	0	0	16.74	12.32	73.6	1.74	2.68	10.4	0	1.62	.18
	8/8-13	0	0	13.11	8.35	63.7	3.11	1.65	23.7	0	2.08	.16
3.5% slope	8/20-23	0	0	16.00	13.11	81.9	2.25	.64	14.1	.1	3.12	.26
290' run	9/7-9	.4	0	16.14	11.38	70.5	1.37	3.39	8.5	.2	2.38	.14
	10/24	0	0								2.35	.05
Total or Average		.9	0	151.45	110.59	72.60A	19.09	21.77	13.10A	3.5	25.1	.16A
Field "H"	5/12-16	0	1.56	10.36	4.22	40.7	2.38	3.76	23.0	.8	1.41	.06
Wheat	6/24-7/1	1.2	1.60	12.29	6.70	54.5	4.29	1.30	34.9	1.8	5.04	.12
Kiser	7/15-19	0	1.17	13.13	7.30	55.6	3.38	2.45	25.7	0	4.62	.22
Farm	8/22	0								.1	2.96	.08
1952												
54 bu./ac												
1.9% slope												
550' run												
Total or Average		1.2	4.33	35.78	18.22	50.27A	10.05	7.51	27.87A	2.7	14.0	.12A

Summary of Disposition of Water Applied to Fields

Field "I"	4/18-22	0	7.97	7.97	2.42	30.4	2.54	3.01	31.9	.2	1.24	.07
Pasture	5/2-7	0	11.12	11.12	5.24	47.1	1.70	4.18	15.3	.2	2.38	.17
Kiser	5/15-18	0	6.74	6.74	4.55	67.5	.85	1.34	12.6	.6	1.95	.15
Farm	5/26-29	0	8.35	8.35	4.41	52.8	1.38	2.56	16.5	.1	1.21	.11
1952	6/2-4	0	5.65	5.65	1.32	23.4	1.34	2.99	23.7	0	1.44	.24
	7/7-10	0	4.96	4.96	2.16	43.5	2.74	.06	55.2	2.8	5.60	.16
9.3% slope	7/15-18	0	10.58	10.58	4.52	42.7	1.82	4.24	17.2	0	2.24	.28
150' run	7/24-27	0	17.10	17.10	12.13	70.9	1.69	3.28	9.9	0	1.08	.12
	8/3-6	0	0	9.65	5.00	51.8	2.61	2.04	27.0	0	1.53	.17
	8/8-12	0	20.74	20.74	11.93	57.5	2.44	6.37	11.8	0	2.80	.56
	8/18-26	0	9.78	9.78	3.75	38.3	4.34	1.69	44.4	.1	1.60	.16
	9/3-12	0	34.70	34.70	13.63	39.3	3.50	17.57	10.1	0	5.25	.35
	10/3-9	.7	0	26.38	13.94	52.8	2.73	9.71	10.3	0	4.20	.14
	11/4									0	1.55	.05
Total or Average		.7	137.69	173.72	85.00	47.54A	29.68	59.04	21.99A	4.0	34.1	.20A
Field "C"	6/10-13	.4	0	6.21	.85	13.7	2.29	3.07	36.9	.4	0.4	.07
Potatoes	6/26-7/2	1.2	0	5.59	1.68	30.1	2.04	1.87	36.5	.4	1.44	.09
King Farm	7/6-8	0	0	3.99	2.95	73.9	1.06	- .02	26.6	0	2.30	.23
1952	7/11-15	0	0	2.45	2.02	82.4	.29	.14	11.8	0	2.30	.46
16 T /ac	7/16-18	0	0	2.73	1.82	66.7	.05	.86	1.8	0	0	0
	7/20-21	0	0	2.26	1.86	82.3	- .88	.48	38.9	0	.40	.10
	7/23-26	0	0	3.33	2.46	73.9	.04	.83	1.2	0	1.41	.47
0.6% slope	7/27-29	0	0	4.00	3.04	76.0	.74	.22	18.5	0	0	0
660' run	7/31-8/5	0	0	4.31	3.88	90.0	.04	.39	0.9	0	1.36	.34
	8/7-9	0	0	3.99	2.92	73.2	.48	.59	12.0	0	.48	.08
	8/12-14	.3	0	4.40	3.36	76.4	1.20	- .16	27.3	0	.40	.08
	8/15-17	0	0	2.38	2.22	93.3	.95	- .79	39.9	0	1.32	.44
	8/18-20	0	0	4.16	3.25	78.1	.50	.41	12.0	0	1.08	.36
	8/23-25	0	0	4.08	2.90	71.1	.62	.56	15.2	0	.50	.10
	8/28-31	0	0	4.60	3.42	74.3	1.73	- .55	37.6	0	.60	.12
	9/2-4	0	0	4.16	3.24	77.9	.38	.54	9.1	0	2.20	.44
	9/15									.4	.91	.07
Total or Average		1.9	0	62.64	41.87	70.83A	13.29	7.48	20.39A	1.2	17.1	.20

Summary of Disposition of Water Applied to Fields

Field "A"	6/22-25	0	0	7.3	2.4	32.9	3.32	1.58	45.5	2.6	5.1	.10
Wheat and	7/11-14	0	0	7.8	3.3	42.3	3.62	.88	46.4	.2	4.56	.24
Alsike Seed-	7/29-8/2	0	0	8.9	4.1	46.1	3.77	1.03	42.4	0	4.32	.24
ing	9/11									1.4	3.78	.09
Brewer Farm												
1953												
71 bu/ac.												
1.4% slope												
490' run												
Total or Average		0	0	24.0	9.8	40.43A	10.71	3.49	44.77A	4.2	17.8	.17A
Field "B"	6/28-7/1	.2	0	9.5	3.6	37.9	4.66	1.24	49.1	2.8	5.7	.10
Wheat and Al-	7/15-18	0	0	9.5	3.2	33.7	4.09	2.21	43.1	0	5.44	.32
sike clover	8/2-6	0	0	8.7	4.5	51.7	4.24	- .04	48.7	0	3.91	.23
Brewer Farm	9/11									1.2	2.34	.06
1953												
66 bu./ac.												
0.8% slope												
430' run												
Total or Average		.2	0	27.7	11.3	41.10A	12.99	3.41	46.97A	4.0	17.4	.18A
Field "C"	5/17-21	.3	0	6.0	1.1	18.3	4.00	.90	66.7	.8	3.5	.08
Alsike	6/29-7/2	0	1.2	6.7	3.5	52.2	3.24	- .04	48.4	2.1	6.30	.15
Brewer	7/19-22	0	1.1	7.1	3.6	50.7	3.27	.23	46.1	0	3.60	.18
Farm	7/30-8/3	.1	1.5	7.3	4.4	60.3	2.24	.66	30.7	0	2.09	.19
1953	9/29									1.4	4.72	.08
380 lbs/ac.												
0.8% slope												
430' run												
Total or Average		.4	3.8	27.1	12.6	45.38A	12.75	1.75	47.98A	4.3	20.2	.14A

Summary of Disposition of Water Applied to Fields

Field "D"	5/11-14	0	2.9	5.5	1.0	18.2	3.36	1.14	61.1	.8	3.0	.08
Alfalfa	7/5-8	0	4.3	7.8	2.4	30.8	4.27	1.13	54.7	2.8	6.48	.12
Brewer	7/21-24	0	3.7	6.6	2.8	42.4	2.31	1.49	35.0	0	3.04	.19
Farm	8/7-10	0	2.1	10.0	4.0	40.0	2.82	3.18	28.2	.1	2.72	.17
1953	8/25-29	.8	0	10.5	2.3	21.9	7.50	.70	71.4	.3	2.52	.14
5.7 T/ac.	10/2									0	8.40	.22
0.7% slope												
400' run												
Total or Average		.8	13.0	40.4	12.5	30.66A	20.26	7.64	50.08A	4.0	26.2	.15A
Field "E"	5/11-15	0	0	7.0	3.7	52.9	2.72	.58	38.9	0	0.3	.02
Wheat and	7/5-8	0	0	10.2	5.4	52.9	5.70	- .90	55.9	2.8	9.72	.18
Alfalfa	7/20-23	0	0	10.6	4.8	45.3	4.44	1.36	41.9	0	4.50	.30
Seeding	8/6-10	0	0	11.9	5.3	44.5	6.62	- .02	55.6	.1	2.88	.18
Brewer Farm	9/16									1.2	9.30	.23
59 bu/ac.												
1.0% slope												
380' run												
Total or Average		0	0	39.7	19.2	48.90A	19.48	1.02	48.08A	4.1	26.7	.18A
Field "B"	5/20-26	.8	.8	11.8	3.3	28.0	5.72	2.78	48.5	.9	3.9	.08
Alsike	6/22-29	.3	0	8.4	3.4	40.5	3.68	1.32	43.8	1.2	3.84	.12
Drazil -	7/10-15	0	0	9.9	3.4	34.3	2.80	3.70	28.3	0	4.32	.24
Griffin Farm	7/29-8/3	.1	0	8.1	2.2	27.2	3.78	2.12	46.7	0	3.04	.16
1953	8/19-24	.3	0	10.7	3.5	32.7	4.55	2.65	42.5	0	4.40	.22
100 lbs/ac.	9/30									.8	5.33	.13
0.5% slope												
660' run												
Total or Average		1.5	.8	48.9	15.8	32.54A	20.53	12.57	41.96A	2.9	24.8	.16A

Summary of Disposition of Water Applied to Fields

Field "C"	6/18-24	0	1.6	11.3	1.6	14.2	4.76	4.94	42.1	3.3	5.8	.11
Wheat	7/8-14	0	.7	8.0	3.0	37.5	3.76	1.24	47.0	.2	3.20	.16
Drazil-	7/23-29	0	0	6.6	1.4	21.2	3.00	2.20	45.5	0	3.90	.26
Griffin	9/17									1.4	5.40	.10
Farm, 1953												
83 bu/ac.												
0.3% slope												
580' run												
Total or Average		0	2.3	25.9	6.0	24.30A	11.52	8.38	44.87A	4.9	18.3	.16A
Field "D"	7/3-6	0	0	6.1	1.7	27.9	2.10	2.30	34.4	1.4	2.0	.07
Potatoes	7/12-15	0	0	6.6	2.3	34.8	- .15	4.45	- 2.3	0	.90	.10
Drazil -	7/21-24	0	0	1.9	1.4	73.7	.60	- .10	31.6	0	.45	.05
Griffin Farm	7/25-27	0	0	1.4	.9	64.3	.70	- .20	50.0	0	.40	.10
1953	7/28-31	0	0	2.5	1.5	60.0				.2	1.50	.50
20.6 T/ac.	8/3-6	0	0	3.0	1.6	53.3	1.96	- .56	65.3	0		
0.3% slope	8/11-13	0	0	3.6	1.9	52.8	1.34	.36	37.2	0	1.76	.22
	8/16-19	0	0	3.1	2.0	64.5	2.05	- .95	66.1	0	1.85	.37
1066' run	8/23-26	.5	0	4.0	2.3	57.5	2.90	-1.20	72.5	.3	2.45	.35
	8/29-9/2	0	0	2.6	1.5	57.7	1.00	.10	38.5	.3	2.40	.40
	10/5									0	3.60	.10
Total or Average		.5	0	34.8	17.1	54.65A	12.50	4.20	43.70A	2.2	17.3	.23A
Field "A"	6/22-25	0	0	13.9	5.5	39.6	4.91	3.49	35.3	3.4	5.7	.09
Wheat	7/22-25	0	0	12.0	5.3	44.2	4.23	2.47	35.2	.2	5.10	.17
Greenwood	9/15									1.4	5.83	.11
Farm												
1953												
66 bu/ac.												
1.4% slope												
510' run												
Total or Average		0	0	25.9	10.8	41.90A	9.14	5.96	35.25A	5.0	16.6	.14A

Summary of Disposition of Water Applied to Fields

Field "B"	5/17-24(pre)	.6	0	13.0	4.6	35.4	4.91	3.49	37.8	0	0	0
Potatoes	7/27-8/1	0	0	10.4	2.1	20.2	2.04	6.26	19.6	1.8	2.10	.03
Greenwood	8/16-20	.3	0	4.8	1.6	33.3	1.74	1.46	36.2	.2	2.09	.11
Farm	9/6-9	0	0	6.1	2.6	42.6	1.00	2.50	16.4	.9	2.20	.11
1953	9/11-14	0	0	3.0	1.6	53.3	1.30	.10	43.3	0	1.00	.20
9 T/ac	9/17-20	0	0	3.0	1.5	50.0	1.00	.50	33.3	0	1.80	.30
0.9% slope	9/24-28	0	0	3.0	1.7	56.7	2.80	-1.50	93.3	0	2.10	.30
1320' run	10/11									0	6.80	.40
Total or Average		.9	0	43.3	15.7	41.64A	14.79	12.81	39.99A	2.9	18.1	.21A
Field "C"	6/27-7/2	.3	0	11.0	3.3	30.0	5.70	2.00	51.8	2.7	5.8	.10
Wheat	7/26-29	0	0	8.5	2.9	34.1	6.15	- .55	72.4	0	6.38	.22
Greenwood	9/10									1.4	4.90	.35
Farm												
1953												
69 bu/ac.												
0.9% slope												
1320' run												
Total or Average		.3	0	19.5	6.2	32.05A	11.85	1.45	62.10A	4.1	17.1	.22A
Field "D"	5/13-17	0	0	7.8	2.5	32.1	4.52	.78	57.9	.8	4.2	.10
Pasture	6/30-7/4	0	0	13.3	6.7	50.4	3.52	3.08	26.5	2.8	6.11	.13
Greenwood	8/4-8	0	0	10.4	4.0	38.5	4.72	1.68	45.4	.1	4.42	.13
Farm	8/19-23	.3	0	11.2	3.5	31.2	3.98	3.72	35.5	0	2.70	.18
1953	10/22									.9	8.91	.14
1.6 T hay/ac.												
1422 cow-days per acre												
0.8% slope												
1320' run												
Total or Average		.3	0	42.7	16.7	38.05A	16.74	9.26	41.32A	4.60	26.3	.14

Summary of Disposition of Water Applied to Fields

Plot 1 Border strip Kenland Clover	4/22-30	.7	0	5.0	0	0	3.66	1.34	73.2	0	0.3	.01
	6/26-29	.3	0	4.2	0	0	3.28	.92	78.1	2.7	7.68	.12
Luelling Farm, 1953 129 lbs/ac. 0.3% slope 636' run	7/24-27	0	0	3.8	.7	18.4	3.56	- .46	93.7	0	4.48	.16
	8/6-9	0	0	3.1	.4	12.9	3.11	- .41	100.3	.2	2.64	.22
	10/7-12	0	0	3.3	0	0				1.2	5.27	.17
Total or Average		1.0	0	19.4	1.1	6.26A	13.61	1.39	86.32A	4.10	20.4	.14A
Plot 2 Border Strip Kenland Clover	4/22-30	.7	0	4.8	0	0	3.74	1.06	77.9	0	0.8	.04
	6/26-29	.3	0	3.4	0	0	3.18	.22	93.5	2.7	8.32	.13
	7/24-27	0	0	3.9	.8	20.5	4.77	-1.67	122.3	0	4.48	.16
Luelling Farm, 1953 119 lbs/ac. 0.3% slope 636' run	8/6-9	0	0	3.3	.3	9.1	3.14	- .14	95.2	.2	3.48	.29
	10/7-12	0	0	3.4	0	0				1.2	5.58	.18
Total or Average		1.0	0	18.8	1.1	5.92A	14.83	- .53	97.2	4.10	22.7	.16A
Plot 3 Border strip Kenland Clover	4/22-30	.7	0	5.4	0	0	3.26	2.14	60.4	0	0.9	.04
	6/26-29	.3	0	4.2	0	0	3.38	.82	80.5	2.7	7.68	.12
Luelling Farm 1953 100 lbs/ac. 0.3% slope 636' run	7/24-27	0	0	4.1	.8	19.5	5.66	-2.36	138.0	0	4.48	.16
	8/6-9	0	0	3.7	.3	8.1	3.50	- .10	94.6	.2	3.84	.32
	10/6-12	0	0	3.4	0	0				1.2	6.20	.20
Total or Average		1.0	0	20.8	1.1	5.52	15.80	.50	93.38A	4.1	23.1	.17A

Summary of Disposition of Water Applied to Fields

Plot 1	5/13-20	.2	0	6.6	.8	12.1	4.25	1.55	64.4	.8	3.1	.07
Corrugations	7/9-13	0	0	5.7	1.4	24.6	4.58	- .28	80.4	2.2	8.40	.15
Kenland												
Clover												
Luelling	7/25-28	0	0	5.5	1.8	32.7	3.35	.35	60.9	0	4.32	.27
Farm, 1953	10/8-13	0	0	5.1	1.1	21.6				1.4	.65	.05
75 lbs/ac.												
0.3% slope												
636' run												
Total or Average		.2	0	22.9	5.1	22.75A	12.18	1.62	68.57A	4.4	16.5	.14A
Plot 2	5/13-20	.2	0	6.6	1.4	21.2	3.58	1.62	54.2	.8	2.8	.06
Corrugations	7/9-13	0	0	5.7	1.5	26.3	4.66	- .46	81.8	2.2	7.84	.14
Kenland												
Clover												
Luelling	7/25-28	0	0	5.5	1.5	27.3	3.43	-1.43	98.7	0	3.84	.24
Farm, 1953	10/9-13	0	0	5.1	1.4	27.5				1.4	7.93	.61
87 lbs/ac												
0.3% slope												
636' run												
Total or Average		2	0	22.9	5.8	25.58A	13.67	- .27	78.23A	4.4	22.4	.26A
Plot 3	5/13-20	.2	0	6.6	1.2	18.2	4.68	.72	70.9	.8	3.4	.08
Corrugations	7/9-13	0	0	5.5	1.0	18.2	3.96	.54	72.0	2.2	7.84	.14
Kenland												
Clover												
Luelling	7/25-28	0	0	5.5	1.6	29.1	5.34	-1.44	97.1	0	2.24	.14
Farm												
62 lbs/ac	10/8-13	0	0	5.1	1.2	23.5				1.4	7.54	.58
0.3% slope												
636' run												
Total or Average		.2	0	22.7	5.0	22.25A	13.98	- .18	80.00A	4.4	21.0	.24A