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There is a lack of data from controlled experiments concerning the duty of irrigation water in Texas. Certain investigators in the past have attempted to collect such data from individual farmers. Adequate methods of water measurement were not available in all cases, and quite often the yields were estimated by the farmers. In the few cases where experiments were controlled the period was of short duration such that it is hard to draw acceptable conclusions from the results. Information will be presented herein concerning the water requirements of certain crops being irrigated in Texas with the realization that in most cases the data available are inadequate.

RICE IRRIGATION

A considerable portion of the water supplied to rice fields is lost by evaporation which cannot be materially reduced or controlled. Total evaporation largely depends on the local temperatures, percent relative humidity and wind movement, and the amount of water required in rice irrigation may be controlled to a great extent by these factors. Another factor to be considered is the type of soil; however, the tight soils on which rice does best do not lose an appreciable amount of water by percolation and deep seepage. Hence, the total requirement is chiefly composed of the amount consumed by transpiration and evaporation.

The amount of water used on certain Texas rice farms is given in Table I. It is not known how accurately the water was measured during 1909 and 1926; however, the measurements are thought to be good for the years 1947-50 inclusive. It is to be noted that in later years the length of the irrigation season has increased and the amount of water applied to the rice likewise shows an increase. Also, it seems that where water is taken from streams the tendency is to use more water than when wells are the source. Information is not available as to the yields on the various farms shown in Table I.

TABLE I

DUTY OF WATER IN RICE IRRIGATION IN TEXAS

Year	Farm and/or Location	Irrigation Period Days	Total Water Received Inches	Rainfall During Season Inches	Irrigation Water Inches	Water Source
1909[3]	Tex., Ark., La.	86	31.82	15.16	16.66	Wells & Streams
1926[6]	French Farm Rosedale	79	35.27	17.49	17.78	Stream
1926	Walker Farm Rosedale	100	31.61	13.83	17.78	Stream
1926	Gregg Farm Amerila	-	36.30	16.02	20.28	Stream
1926	Carrol Farm Nome	-	34.09	15.49	18.60	Stream
1926	Obrecht Farm Nome	-	29.05	15.49	13.56	Stream
1926	Carpenter Farm-Nome	64	31.62	15.42	16.20	Stream
1926	Neches Canal Co. Farm Nome	90	29.21	13.73	15.48	Stream
1947[1]	J.D. Wood Farm Brookshire	101	33.00	9.91	23.09	Well
1948	J.D. Wood Farm Brookshire	128	36.72	0.96	35.76	Well
1948	Ray Wood Farm Hockley	147	37.92	2.04	35.88	Well
1949	J.D. Wood Farm Brookshire	121	27.36	6.96	20.40	Well
1949	Stafford Farm-Edna	-	42.72	14.52	28.20	Stream
1950	J.D.Wood Farm Brookshire	103	41.76	17.28	24.48	Well
1950	Ray Wood Farm-Hockley	140	46.20	18.12	28.08	Well
1950	Stafford Farm-Edna	110	46.56	10.80	35.76	Well&Stream
1950	Babb Farm-Edna	145	59.28	15.00	44.28	Well&Stream
			AVERAGES			
1909 & 1926		84	32.37	15.33	19.04	
1947-50		124	41.28	10.62	30.66	
Wells - 1947-50		123	37.16	9.21	27.95	
Wells & Streams 1947-50		127	49.52	13.44	36.08	

Plans were completed in 1951 to begin some controlled experiments concerning the duty of water in rice irrigation at the Texas Agricultural Experiment Sub-Station at Beaumont, Texas. In a few years more adequate information in this regard should be available.

Time of Water Application

The general practice in the Texas rice belt is to irrigate the land thoroughly prior to planting. In some areas, where airplane seeding is being practiced, the fields are seeded while the water is on them. From the time of seeding until the rice is 6-8 inches high the fields are left dry, after which they are again flooded. In the Katy, Brookshire and Hockley Areas the water is retained on the field until the rice is mature. Occasionally a field may be drained in this area to attempt to control root grubs but this is not the general practice. In the Beaumont area the practice of draining the fields during the growing period to allow rainfall to wash some of the salts off the land is followed by some growers.

One of the big factors in flooding rice lands is the control of weeds and noxious plants; however, indications are that rice will produce heaviest under deeper flooding if allowed to stool properly prior to flooding.

Conclusions

1. It appears that the length of the irrigation period for rice has increased since 1909 and 1926.
2. If the data presented in Table I is reliable more water is being used in rice irrigation than in past years.
3. Between two and three acre-feet per acre seems to be the usual amount of irrigation water applied in the Texas rice belt, with the larger quantity being applied where surface water is used.

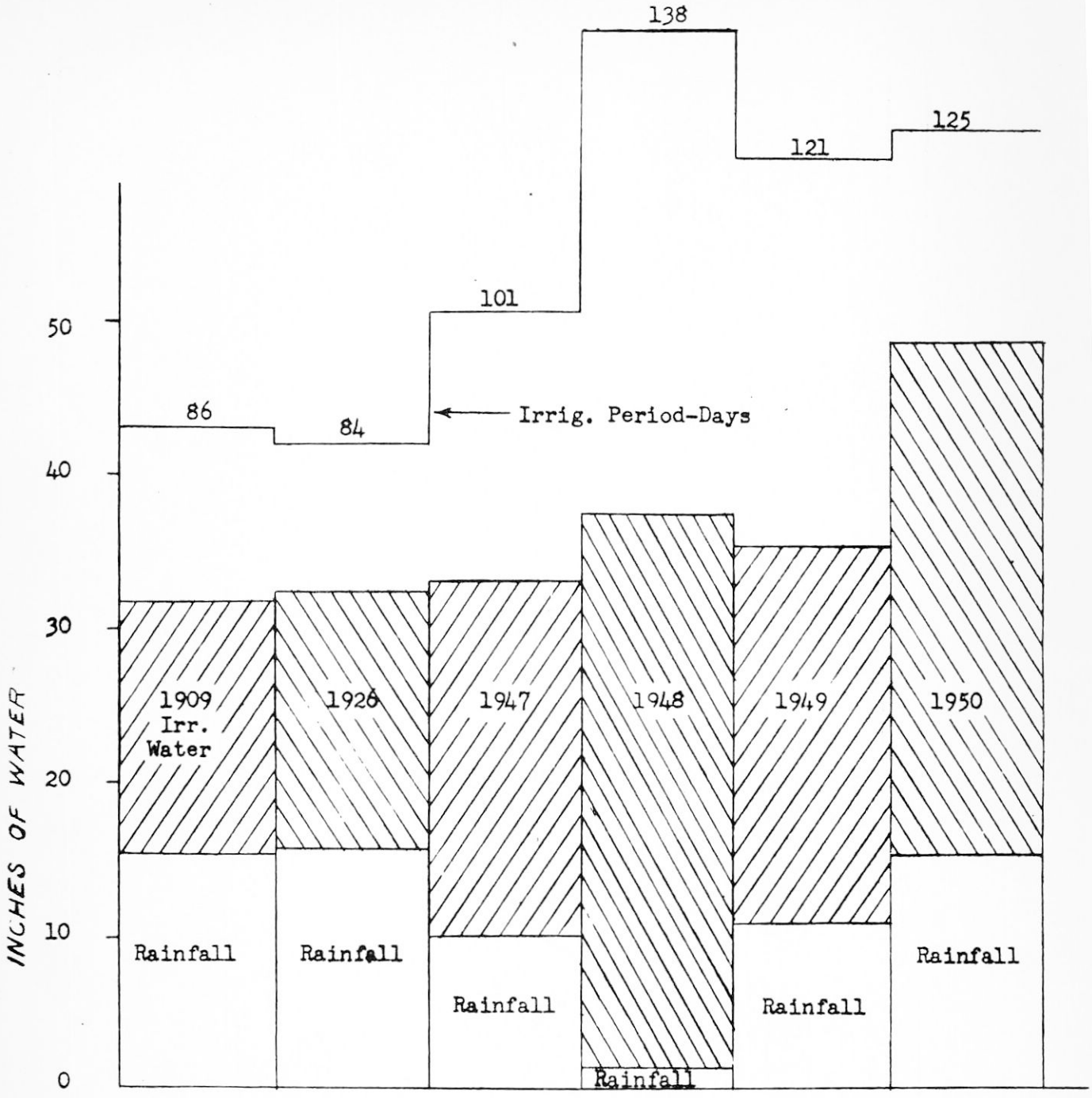

Figure 1. Total Water used for Rice and Length of Irrigating Season - Selected Farms in Texas Rice Belt.

COTTON IRRIGATION

Information regarding duty of water in cotton irrigation in Texas is inadequate just as was mentioned regarding rice. A report of experiments conducted by Hemphill[4] in 1916, 1917, and 1918 in the Lower Rio Grande Valley of Texas gives some information in this regard. This information, though perhaps good at that time, might not be truly representative of water requirements in the same general area today. For one thing, different breeds and types of cotton being grown today may require more water than the cotton plants used in these experiments. The accumulation of salts in the soil may require that the moisture content of the soil be kept at a higher level than in years past.

Because of the variety of soil and climatic conditions under which cotton is being irrigated in Texas the above mentioned data could not be used safely in other areas without certain adjustments or corrections.

In other areas of the state where cotton is irrigated such data are, in general completely lacking or have as yet not been published. Until data from controlled experiments conducted in the various sections of Texas where cotton is irrigated are available, it will be necessary to resort to estimates based on the results of experiments conducted in other areas or states.

The water requirements for cotton in various sections of Texas from the best sources available are given in Table II and Figure 2. These data were gathered under a variety of conditions and in some cases they may not be too accurate. The yields cannot be correlated with the amount of irrigation water used because of different cotton varieties grown and because of the widely varying conditions in the sections where the work was carried on.

Some of the investigators did make recommendations as to the quantity of water to be used in the locality when this work was carried on. For instance, Rockwell[11], as a result of three years of experiments carried on in the Rio Grande Valley of

Texas, 1916-18, states the yield increased to 19 inches of water applied; however, the increase was very slight beyond 17 inches, which he decided was the economical maximum. He further states that 15 inches properly applied will produce large yields under South Texas conditions.

McDowell[8] states that he obtained the highest yield of cotton in the Wichita Valley by the application of 14.00 inches of water, this being the average used for two years.

The writer has heard Mr. Don Jones, Superintendent of the Texas Agricultural Experiment Sub-Station at Lubbock, Texas, state that he obtains the most economical cotton yields with 12 inches of irrigation water, although numbers of farmers in that area use a greater quantity.

Number and Time of Irrigations

Because of the impossibility of predicting the occurrance of rain, it is not practical to attempt to set up an irrigation schedule for most areas in Texas. It is generally agreed, however, that the soil should be moist at seeding time so that a pre-planting irrigation is recommended in the absence of natural moisture. It is further agreed by authorities that the cotton should be brought along in a vigorous but slow growth in its early stages to force an extensive deep root system and to prevent too rank a growth of stalk and vegetative matter.

After blooming begins, cotton requires more mosture, when irrigation should be the heaviest. A deficiency of moisture at any time during this period usually results in shedding and may stop further fruiting.

Rockwell[11] in his experiments in the Rio Grande Valley used an average of 4 irrigations per season. McDowell[8] suggests 4 or 5 irrigations for the Wichita Valley area.

Conclusion

Based on the limited information available, the following values are given regarding the irrigation water used for cotton in the various sections of Texas:

TABLE II

DUTY OF WATER IN COTTON IRRIGATION IN TEXAS

Date	Location	Soil	Irr. Period Days	Total Water Available Inches	Rainfall Inches	Irr. Water Inches	Yield Bales Per Acre
1916[11]	Lower Rio Grande Valley	Sandy	109	15.88	9.80	6.08	.43
1916	Lower Rio Grande Valley	Sandy	109	20.31	9.80	10.51	.81
1916	Lower Rio Grande Valley	Sandy	109	23.94	9.80	14.14	.95
1917	Lower Rio Grande Valley	Sandy	49	13.50	9.50	4.00	.74
1917	Lower Rio Grande Valley	Sandy	49	16.50	9.50	7.00	.86
1917	"	"	49	20.50	9.50	11.00	.88
1918	"	"	-	11.03	9.53	1.50	.76
1918	"	"	98	11.80	9.53	2.27	.83
1918	"	"	98	12.83	9.53	3.30	.83
1915	"	Clay	91	5.05	2.26	2.79	2.33
1915	"	"	91	9.11	2.26	6.85	2.63
1915	"	"	91	14.63	2.26	12.37	2.91
1914-1920[4]	"	Loam	142	10.17	2.83	7.34	1.88
1914-1920	"	Sandy Loan	137	15.50	6.95	8.55	.83
1932[8]	Wichita Valley	Fine Sands & Silty Clay Loams	-	23.98	13.98	10.00	.97
1933	"	"	-	33.11	15.11	18.00	.83
1940[9]	Imperial Zimmermann	-	-	43.10	13.10	30.00	-
1940	Fort Stockton	-	-	41.50	17.50	24.00	-
1927-1933	Mesilla Valley New Mexico	-	-	29.50	6.00	23.50	1.54

1. Lower Rio Grande Valley - 18 inches.
2. Pecos-Balmorhea, Fort Stockton area - 24-30 inches.
3. El Paso Valley - 24 inches.
4. Wichita Valley - 12-18 inches.
5. High Plains - 12-18 inches.

ALFALFA IRRIGATION

To the writers knowledge there are no controlled experiments concerning the duty of irrigation water for alfalfa in Texas reported in the literature. However, since alfalfa is a rather heavy water user and is becoming more important in certain irrigated sections of Texas, it is realized that information regarding its water requirements are badly needed. Information contained herein may be used as a guide in arriving at water requirements for this crop; however, local conditions must be taken into account in this procedure. Information regarding the amount of water used in alfalfa irrigation is given in Table III.

The quantities given in the above mentioned table seem high when compared to some of the general recommendations found on this subject. For instance, Roe[10] states that in the Pecos Valley of Texas an average of 41 inches of water is used with an average yield of 3.6 tons. Israelsen[7] says that at Davis California the most economical depth of irrigation water was found to be between 30 and 36 inches.

From the limited information presented it is not possible to arrive at any satisfactory conclusions.

TABLE III - WATER REQUIRED FOR ALFALFA PRODUCTION IN TEXAS

Year	Location	Total Water Inches	Rainfall Inches	Irr. Water Inches	Yield-Lbs. Per Acre
1922-26[2]	Mesilla Valley, New Mexico	62.42	5.42	57.00	11,059
1940[9]	Carlsbad, New Mexico	63.30	12.30	51.00	-
1940	Imperial-Zimmermann, Tex.	63.10	13.10	50.00	-
1940	Fort Stockton, Texas	77.50	17.50	60.00	-

PASTURE IRRIGATION

Available information concerning the amount of water used in pasture irrigation is given in Table IV. As with other irrigated crops reliable data are meager for Texas conditions and the information contained herein should be used as a guide only.

Most grasses are comparatively shallow rooted (12-24 inches). Therefore, it is best, as a rule, to irrigate frequently with small amounts of water in order to keep the upper 2 feet of the soil supplied with sufficient moisture. Roe[10] states that in the Pecos Valley of New Mexico and Texas the average amount of irrigation water applied to pastures is 22 inches. He further states that for maximum growth 36 inches, or more, may be required in the Southwest.

It is generally agreed that most improved pasture grasses should have available 1 inch of moisture every 5 to 7 days. It is common practice to make a 2 inch application every 10 to 14 days when no rainfall occurs.

TABLE IV - DUTY OF WATER IN PASTURE IRRIGATION IN TEXAS

Date	Location	Soil	Total Water Applied-In.	Rainfall Inches	Irr. Water Applied-In.	Yield Lbs/Acre
1914-20[4]	Rio Grande Valley	Sand	41.25	14.52	26.73	10,200
1914-20[4]	Rio Grande Valley	Sandy Loam	26.29	19.66	26.63	10,248
1940[9]	Fort Stockton	-	39.50	17.50	22.00	-
1940[9]	Carlsbad, N. Mex.	-	30.30	12.30	18.00	-

VEGETABLE CROPS

There are a variety of truck crops grown in Texas and information regarding water requirements of all the varieties is not available. Some information has been secured for some of these crops, however, and this is presented in Table V. This data was collected a number of years ago and the yield data are perhaps not too indicative of

yields to be expected today. Improved breeds of crops, better insect control, improved fertilization practices and more efficient irrigation methods should mean higher yields from the same quantity of water. This, however, may be offset in some areas by soil depletion and salt accumulations.

CITRUS IRRIGATION

Adequate data are not available regarding duty of water in citrus production in Texas, to warrant preparing a table, only a few measurements having been reported. Hemphill[5] made 26 water measurements in citrus orchards in the Lower Rio Grande Valley in 1922 and 1923. From these studies he concluded that the average duty of water for citrus in that area was 33 inches, with 20 inches being supplied by rainfall, and 13 inches by irrigation. Roe[10] reports that in eastern Los Angeles County in California most growers apply from 20 to 24 inches of irrigation water. The average annual rainfall for this area is 18.53 inches; however, very little of this falls during the summer. Hemphill in his report, states that because of high relative humidity in the Lower Rio Grande Valley the water requirements of citrus there are not as high as in most areas of California.

TABLE V - DUTY OF WATER IN VEGETABLE PRODUCTION IN TEXAS*

Crop	Soil	Length of Season Days	Total Water Applied Inches	Rainfall Inches	Irr. Water Inches	Yield in Lbs/Acres
Cabbage	Sand	117	15.50	5.01	10.49	16,620
"	Clay	117	11.38	2.93	8.45	25,060
"	Loam	120	12.64	9.15	3.49	35,660
Lettuce	Sand	94	12.92	4.58	8.34	12,375
"	Clay	91	13.03	5.01	8.02	10,871
"	Loam	110	11.96	8.87	3.09	26,087
Cauliflower	Sand	128	18.54	10.04	8.50	10,629
"	Clay	128	18.37	10.04	8.33	15,977
Fall Tomatoes	Sand	69	13.80	3.87	9.93	12,385
" "	Clay	68	15.82	3.76	12.06	6,219
Spring Tomatoes	Sand	85	15.86	5.28	10.58	22,911
" "	Clay	91	13.24	4.23	9.01	11,870
Beets	Sand	142	10.98	1.61	9.37	15,103
"	Clay	155	13.70	1.08	12.62	17,550
Carrots	Sand	104	17.60	9.93	7.67	12,530
Garden Peas	Clay	95	11.67	7.30	4.37	1,263
Snap Beans	Sand	65	15.91	3.02	12.89	4,870
" "	Clay	63	13.55	3.24	10.31	3,784
Spinach	Sand	73	12.74	8.30	4.44	5,603
"	Clay	68	11.62	5.47	6.15	2,999

*This data taken from 1950 annual report of Dean Bloodgood, Associate Irrigation Engineer, Soil Conservation Service.

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