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The Relation of Soil Texture to Soluble Salt Accumulation in 29 Irrigated Soils in Oklahoma

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Increased interest in irrigation in Oklahoma raised a question as to the likelihood of soils being damaged by accumulation of salts contained in the irrigation water. Many potential sources of irrigation water in this State are known to carry a large quantity of various salts.

Experience gained under desert irrigation could not be used as a guide, since irrigation in Oklahoma is on a supplemental basis.

The study reported herein was made to determine the relation between soil texture and the accumulation of soluble salts in the soil profile from the use of irrigation water under Oklahoma conditions. This study was made in 1941 and 1943. Other studies of the soil problems involved in irrigation in Oklahoma are currently under way.

METHODS

Composite soil samples were taken from 29 areas of irrigated land and from adjacent areas of non-irrigated land similar to that of the fields which had been irrigated. Samples were collected either from 6-inch or 12-inch layers to a depth of 12 inches, and by 12-inch layers from 12 to 48 or 60 inches deep. Samples of the water used for irrigation were obtained when possible.

The soils were first analyzed only for total chloride and sulfate, since harmful concentrations of nitrate or carbonate have not been observed in the normal soils of this region. Then samples in which the chloride and sulfate content was found to be rather high were analyzed for total salts. Soil samples were also analyzed mechanically for percent of sand, silt, and clay, by the hydrometer method.

The water samples were analyzed for calcium, sodium, potassium, chloride, and sulfate content, and the milliequivalent ratio of calcium to sodium in each water was calculated.

RESULTS AND DISCUSSION

Results of the chemical analyses of the soils are given in Table I, and Table II shows the results of the chemical analyses of the water. Table III presents the mechanical analyses of the soils. (See pages 11-27).

In general, soluble salts did not accumulate in those profiles which varied in texture from sandy loam to clay loam when the water used for irrigation was low in total salt content. There was an increase of salts in the soil profile with increases in either salt content of the water, clay content of the soil, or both. Only one area was sampled where crop injury had resulted from the use of irrigation water high in soluble salts. Several soils showed that salts were accumulating, but rainfall had carried most of the soluble salts from the surface downward below a depth of 12 inches.

Conditions found in the various areas are discussed in the following paragraphs:

Alfalfa County

Land on the Paul LaBrue farm which had been irrigated for about 20 years from Powell Creek contained a relatively small quantity of soluble salts. A slight accumulation of salt had occurred in the 0- to 6-inch layer of two of the five profiles analyzed.

Beaver County

Soils on the C. A. Allen farm near Beaver showed no increase in salt content after nearly fifty years of irrigation with water from Clear Creek. One of the non-irrigated profiles contained a much larger quantity of soluble salts in the 12- to 48-inch layer than was present in similar layers on the irrigated land. The 20-inch average annual rainfall in this area appears to be sufficient to leach soluble salts out of the surface 12 inches of sandy land.

Cimarron County

Studies on the Julius Kohler farm near Boise City and the O. W. Tucker farm near Kenton show that the Cimarron River above Edith in Woods county is a satisfactory source of water for irrigation. Soils on the Kohler farm showed no appreciable increase in salt content after 9 years of irrigation. After 20 years of irrigation, the Tucker land showed no accumulation except for a large quantity of sulfate in the 24- to 48-inch layer of one of the four profiles analyzed.

Two of the surface soils on the Kohler land had a clay surface texture, and all of the others were a sandy loam. All profiles on the Tucker land were a clay loam in the surface horizon with the clay content gradually increasing with depth.

Comanche County

Two of the profiles from the Cameron Junior College farm contained a very high percentage of clay in the subsurface layers, but water

Bare land in a wheat field where soluble salts have accumulated in the surface soil in sufficient quantities to kill the wheat seedlings.

had not been applied long enough to cause an appreciable accumulation of salts. It had been irrigated only five years. The soils were quite variable in composition, and it is probable that a considerable quantity of salt was present in the subsoil of two of the three irrigated profiles before irrigation was started.

Cotton County

Land irrigated from Cache Creek on the Jess Monroe and E. H. Hickman farms near Temple contained more chloride and sulfate than the non-irrigated soil. The clay loam and clay texture of the surface soils were probably responsible for this accumulation. However, rainfall had removed the soluble salts from the surface 12 inches of all these soils except one profile on the Monroe farm, and the accumulation in the lower layers had not reached a concentration harmful to plant growth. The Monroe and Hickman tracts had been irrigated 9 and 10 years, respectively. More time is needed to determine whether salts would eventually accumulate in sufficient quantity to injure crops.

Custer County

Although Washita River water is high in calcium sulfate, there was no accumulation of soluble salts in soils irrigated from the Washita for nine years on the J. H. Kenny farm near Foss. The soils were quite variable. Some were high in clay content at the surface with a sandy subsoil, while other profiles had a sandy loam surface with a clay subsoil. This variation is often encountered in river deposits.

Garvin County

Apparently normal rainfall is sufficient to leach chlorides and sulfates out of a well drained soil in this area. Soils on the J. H. Watson farm near Paoli and the Doughtery and Whitaker farm near Wynnewood, irrigated 8 and 11 years, respectively, from wells in the Washita bottom, had not accumulated any soluble salts. The surface soils were clay loams and clays, with the subsurface layers varying from sandy loam to clay. Water movement in these soils apparently is enough to prevent salt accumulation.

Harper County

Soils in the low lands along the North Canadian river in this area often contain so much salt that salt grass is the dominant type of vegetation growing on them. Occasionally salts also are found in the lower part of soil profiles on higher areas of bottomland because leaching has been retarded, either due to a high watertable, or an impervious subsoil. This condition probably accounts for a rather high salt content in the lower horizons of one of the four irrigated profiles on the W. A. Plummer farm near Laverne. This land had been irrigated only four years, from wells. Three of the profiles had a large percentage of clay, and the fourth profile was very sandy.

On the Clarence Pile farm near May more salts were found in the subsoil of a non-irrigated field than in the subsoil of an area irrigated six years from wells. A similar condition was found on the J. C. Holmes farm near Laverne, after 10 years of irrigation from a well. There was no accumulation of soluble salts on the irrigated portions of either of these farms. The surface soils on the Holmes farm varied from sandy loam to clay, with sandy subsoils. The Pile profiles showed a much higher percentage of clay.

Land on the Lawrence Drake farm in the northwest corner of Harper County had been irrigated for 35 years from the Cimarron River. The soils vary from sandy loam to clay loam in the surface layers, with only a few subsurface layers which would be classified as clay. One of the profiles showed an excessive concentration of soluble salts, due to a high water table under the area. Water from a well on the Drake farm (not used for irrigation) showed 114.6 parts per million of calcium, 450 of sodium, 17.6 potassium, 1,552.9 chloride and 1085 of sulfate. The quantity of chloride in this water is too high to be used for irrigation in low rainfall areas.

Jackson County

Soils from the Frank Simpson farm near Altus are quite similar to many of the soils in the W. C. Austin irrigation project using water from the Altus-Lugert lake. The surface soils were principally clay

The white spots on the surface of the soil in this field are produced by an accumulation of soluble salts, resulting from the upward movement and subsequent evaporation of capillary water.

loams. One surface soil was a silt loam. The subsurface layers were high in clay content. Drainage water probably would move downward at a slower rate in these soils than in many of the samples collected.

Salt accumulation has been low during the 13 years the Simpson land has been irrigated, principally with water (from Altus-Lugert lake) containing slightly less than one thousand parts per million of total soluble salts. Two of the profiles apparently contained some soluble salts in the lower horizons before irrigation began. The salt content of the subsoil in this area is quite variable.

Irrigated soils on the H. C. McCaleb farm near Olustee had accumulated a considerable quantity of sulfate during 30 years of irrigation from Turkey Creek. Row crops had not been injured by salt accumulation, although the water was very high in both chloride and sulfate. The soils were mostly loams and clay loams. The 25-inch annual rainfall in this area apparently had been sufficient to remove soluble salts from the soil. Chlorides do not seem to accumulate in the soil profile in this particular area. (No sodium determinations were made on these samples, since the sodium-calcium ratio in the irrigation water is not wide enough to be favorable for an increase in the sodium content of the total exchange capacity of this soil.)

Two areas on the Will Moorehead land near Eldorado, which had been irrigated for 30 years from a gypsum sink, accumulated enough salts to kill alfalfa. (No data are available to show the amount of salt

in the soil at the time the alfalfa was killed.) The quantity of chloride and sulfate was much higher in the irrigated profiles than in the non-irrigated portion of the field. The soils in both cases were loams at the surface, changing to clay loams or clay in the subsurface horizon. The water, of course, was high in total salts.

Soil samples taken in 1948 from the formerly irrigated portion of the Moorehead farm showed that rainfall averaging 24 inches annually from 1942 to 1947 had removed most of the soluble salts from the profile. Wheat made a normal growth on the land during 1947-48.

Kay County

No salts had accumulated in land at the Chilocco Indian School which had been irrigated for six years with water from a spring. The soil texture was favorable for water penetration, the water was low in total salts, and the higher rainfall in this area probably helped reduce any tendency toward salt accumulation.

Major County

Sandy land on the George Ball farm near Chester showed a very low concentration of soluble salts after 21 years of irrigation. The salt content of the well water applied to this land was very low.

Okfuskee County

Only one of the eight profiles analyzed from the Camp Brothers farm near Castle had a clay loam texture in both surface and subsoil. None of the samples showed an accumulation of soluble salts after 6 years of irrigation from a well and 28 years using water from the North Canadian River. (It had been necessary to discontinue use of the North Canadian water for irrigation because of increasing salinity due to oil field development.)

Texas County

No evidence of soluble salt accumulation was found on either the W. H. Ballinger land near Guymon or the Kimball and Chance farm near Texhoma. They had been irrigated for six and eight years, respectively, from wells. Both have soils favorable to removal of soluble salts, and the water sample from the Ballinger well showed a low content of total salts, with no sulfate.

Some salt was accumulating in sandy land with sandy subsoil on the Harold Gibson farm near Hardesty after seven years of irrigation with water from Palo Duro Creek. In this low-rainfall area this accumulation might eventually become toxic to plants. However, the

The irregular white patches in the soil profile are soluble salts that may move upward during dry weather, and accumulate in harmful quantities in the surface soil where a watertable occurs at a depth of less than five feet.

quantity of chloride in this soil is low; and the sulfates may be principally calcium sulfate, which is not harmful to plant growth.

Tillman County

A very fine sandy loam at the Southwest Oklahoma Cotton Station near Tipton showed no appreciable accumulation of soluble salts after being irrigated for 10 years with well water. This soil appears to be well drained, although more lime was present in the lower part of the profiles from the non-irrigated area. One of the subsoil samples from the irrigated area filtered very slowly when soluble salts were being determined, yet the sodium concentration in the exchange complex was low. The use of gypsum on soils watered with an unfavorable calcium-sodium ratio may be needed to improve the physical structure.

Woodward County

Samples were obtained from four Woodward County farms which had been irrigated from five to ten years with water low in soluble salts.

In no case was there any appreciable accumulation of soluble salts in the soil. However, at the Western Oklahoma Hospital at Fort Supply water soluble salts were present in the subsoils of both irrigated and non-irrigated land. The important problem here is to prevent development of a water table shallow enough so capillary action would bring soluble salts from the subsurface to the surface layer in damaging amounts.

Only one of the irrigated profiles from the four Woodward County farms contained a clay loam layer in the subsurface horizons. The J. W. Cavin land near Mutual had a loam or sandy loam surface with a loamy subsoil and is therefore very suitable for irrigation. The samples from the Jess Hufford farm near Mooreland were very sandy; water losses normally are high on this type of land unless the water can be applied rapidly or through a sprinkler system. The soils on the Western Oklahoma Hospital farm and on the J. G. Young farm near Woodward were principally sandy loams or silt loams.

SUMMARY

Soil samples were collected from 29 farms in Oklahoma where irrigation water of varying chemical composition had been applied for varying periods of time. In most cases samples were also taken from adjacent areas of non-irrigated land. Samples of the water used for irrigation were obtained from 18 of these farms. The soils were analyzed chemically for chloride and sulfate content and mechanically to determine the percentage of sand, silt and clay in each sample. The water samples were analyzed for total calcium, sodium, chloride and sulfate content.

Although the ratio of sodium to calcium is quite unfavorable in many of the water samples collected, a harmful effect on the physical properties of the soil is not likely to occur since the total concentration of salts in these waters was low and all of the soils studied contained a very low percentage of exchangeable sodium and a very high percentage of exchangeable calcium.

Soluble salts had not accumulated in soil profiles varying in texture from sandy loam to clay loam when irrigation water low in total salt content was applied. As the salt content of the water and the clay content of the soil increased, more salt was found in the soil profile.

Only one area was sampled where crop injury had occurred from salt accumulation resulting from the use of irrigation water high in soluble salts.

Several soils showed that salts were accumulating; however, rainfall had carried most of the soluble salts from the surface downward below a depth of 12 inches.

TABLE I.—Salt Content of Soil Samples from Irrigated and Non-irrigated Land at 29 Locations in Oklahoma.

Depth of soil (inches)	Salt Content of Soil (parts per million)							
	Irrigated Areas				Non-irrigated Areas			
	Crop Grown*		Chloride	Sulfate	Total salts	Crop Grown*	Chloride	Sulfate	Total salts
ALFALFA COUNTY									
Paul LaBrue Farm, Jet									
Irrigated 20 years with water from Powell Creek									
0-6		(2)	548	145	151				
6-12			127	47	596				
12-24			16	6					
24-36			26	4					
36-48			10	12					
0-6		(3)	5	20					
6-12			14	13					
12-24			14	5					
24-36			17	4					
36-48			33	5					
BEAVER COUNTY									
C. A. Allen Farm, Beaver									
Irrigated 50 years with water from Clear Creek									
0-6	Alfalfa	(3)	18	26		Alfalfa (1)	4	28	
6-12			9	24			4	46	
12-24			10	20			4	8	
24-36			12	28			4	28	
36-48			8	20			4	12	
0-6	Alfalfa	(1)	8	20		Pasture (1)	4	28	
6-12			16	12			40	32	
12-24			32	24			549	354	1608
24-36			149	619	1396		801	900	2152
36-48			227	579	1472		426	927	2276
CIMARRON COUNTY									
Julius Kohler Farm, Boise City									
Irrigated 9 years with water from the Cimarron River									
0-6	Alfalfa	(4)	12.5	36		Pasture (2)	16	42	
6-12			89.5	49	976		10	28	
12-24			19.5	36			8	30	
24-36			51.5	80	828		75	49	644
36-48			14.5	50	388		20	36	
O. W. Tucker Farm, Kenton									
Irrigated 20 years with water from the Cimarron River									
0-6	Alfalfa	(3)	13	82		Alfalfa (1)	8	16	
6-12			10	72			12	12	
12-24			16	37			12	16	
24-36			13	22					
36-48			16	28					
0-6	Alfalfa	(1)	16	60					
6-12			8	60					
12-24			4	40					
24-36			78	2623	4728				
36-48			94	3682	6692				

TABLE I.—Continued.

Depth soil of (inches)	Salt Content of Soil (parts per million)							
	Irrigated Areas				Non-irrigated Areas			
	Crop Grown*	Chloride	Sulfate	Total salts	Crop Grown*	Chloride	Sulfate	Total salts
	COMANCHE COUNTY							
	Cameron Junior College Farm, Lawton							
	Irrigated 5 years from a deep well							
0-6	(3)	13	14					
6-12		14	49					
12-24		22	10					
24-36		16	6					
0-6	(2)	6	14		(1)	4	4	
6-12		6	16			12	4	
12-24		15	31	298		4	4	
24-36		81	256	814		12	4	
36-48		220	437	175		40	20	
48-60		289	349	1852		91	128	1164
	COTTON COUNTY							
	E. H. Hickman Farm, Temple							
	Irrigated 10 years with water from Cache Creek							
0-6	Cotton (4)	35	16		Cotton (2)	8	30	
6-12		40	39			8	6	
12-24		75	127			8	6	
24-36		13	549			12	4	
36-48		222	350			12	4	
48-60		264	385			10	6	
	Jess Monroe Farm, Temple							
	Irrigated 9 years with water from Cache Creek							
0-6	(2)	276	276	1932	(1)	18	37	100
6-12		88	72	580		54	38	212
12-24		199	259	1252		36	40	188
24-36		326	205	1298		54	61	244
36-48		425	246	1418		144	77	540
48-60		506	148	1772		452	225	1384
	CUSTER COUNTY							
	J. H. Kenney Farm, Foss							
	Irrigated 7 years with water from Washita River							
0-6	(4)	8	28		(2)	8	28	
6-12		10	43			16	46	
12-24		5	57			16	14	
24-36		11	36			12	14	
36-48		8	20			16	12	
48-60		13	11			10	10	
	GARVIN COUNTY							
	Dougherty and Whitaker Farm, Wynnewood							
	Irrigated 11 years with water from a well							
0-12	Vegetables (4)	5	23		Vegetables (2)	4	16	
12-24	and Fruit	5	9		and Fruit	4	12	
24-36		5	5			8	6	
36-48		6	8			8	4	
48-60		9	5			12	4	

TABLE I.—Continued.

Depth of soil (inches)	Salt Content of Soil (parts per million)						
	Irrigated Areas				Non-irrigated Areas		
	Crop Grown*	Chloride	Sulfate	Total salts	Crop Grown*	Chloride	Sulfate	Total salts
		J. H. Watson Farm, Paoli						
		Irrigated 8 years with water from a well						
0-12	Vegetables (4)	5	21		Vegetables (1)	4	36	
12-24		6	9			20	8	
24-36		16	4			6	4	
36-48		10	4			6	4	
48-60		15	6					
		HARPER COUNTY						
		J. C. Holmes Farm, Laverne						
		Irrigated 10 years with water from a well						
0-6	Alfalfa (3)	5	28		(2)	4	20	
6-12		10	18			6	46	
12-24		14	24			53	45	440
24-36		21	2			187	389	912
36-48		2	16			8	26	
		Clarence Pile Farm, May						
		Irrigated 6 years with water from wells						
0-6	Alfalfa (5)	16	42		(1)	32	40	
6-12		8	24			8	80	
12-24		6	19			40	40	
24-36		19	24			121	181	1568
36-48		55	68	680		235	484	2024
		W. A. Plummer Farm, Laverne						
		Irrigated 4 years with water from wells						
0-6	Alfalfa (2)	6	40		(2)	4	40	
6-12		12	30			4	22	
12-24		10	20			4	30	
24-36		6	16			42	53	324
36-48		20	16			9	45	314
0-6	(2)	14	46					
6-12		16	20					
12-24		74	116	796				
24-36		168	255	487				
36-48		217	325	1571				
		HARPER COUNTY						
		Lawrence Drake Farm, N. W. Corner						
		Irrigated 35 years with water from the Cimarron River						
0-6	(5)	631	445	876				
6-12		13	6					
12-24		130	27	740				
24-36		130	191	1552				
36-48		350	228	2963				
0-6	(1)	579	502	2636				
6-12		1654	2308	7132				
12-24		1649	996	5028				
24-36		2528	835	4348				
36-48		1016	427	3188				

TABLE 1.—Continued.

Depth of soil (inches)	Salt Content of Soil (parts per million)							
	Irrigated Areas				Non-irrigated Areas			
	Crop Grown*		Chloride	Sulfate	Total salts	Crop Grown*	Chloride	Sulfate	Total salts
				JACKSON COUNTY					
				H. C. McCaleb Farm, Olustee					
				Irrigated 30 years with water from Turkey Creek					
0-6	Cotton,	(4)	8	25		(2)	8	10	
6-12	Grain,		9	24			8	8	
12-24	Sorghum,		158	521	1205		10	12	
24-36	and		34	693	1488		14	6	
36-48	Vegetables		40	993	1669		6	6	
48-60			51	887	1788		10	30	
				Will Moorehead Farm, Eldorado					
				Irrigated 30 years with water from Gypsum Sink					
0-6	Alfalfa	(2)	123	209	672	(2)	54	30	532
6-12			312	586	1268		36	24	496
12-24			158	834	1528		20	28	346
24-36			207	1903	3180		27	46	500
36-48			1086	1329	5364		52	111	600
48-60			1554	2671	7184		65	192	1474
				Frank Simpson Farm, Altus					
				Irrigated 13 years with water from Altus Lake					
0-6	Cotton	(5)	11	63					
6-12	Alfalfa		8	16					
12-24			23	144	1116				
24-36			20	147	1140				
36-48			45	150	1212				
48-60			44	114	760				
0-6		(2)	8	20					
6-12			16	28					
12-24			32	80					
24-36			91	334	988				
36-48			134	254	1168				
48-60			220	221	1004				
				KAY COUNTY					
				Chilocco Indian School Farm, Chilocco					
				Irrigated 6 years with water from a spring					
0-12	Vegetables	(4)	8	25		(2)	8	50	
12-24			10	12			10	66	
24-36			17	7			12	18	
36-48			17	5			18	6	
48-60			13	13			12	6	
				MAJOR COUNTY					
				George Ball Farm, Chester					
				Irrigated 21 years with water from a well					
0-6		(6)	6	27					
6-12			6	21					
12-24			8	18					
24-36			9	8					
36-48			10	10					
48-60			9	13					

TABLE I.—Continued.

Depth of soil (inches)	Salt Content of Soil (parts per million)							
	Irrigated Areas				Non-irrigated Areas			
	Crop Grown*	Chloride	Sulfate	Total salts	Crop Grown*	Chloride	Sulfate	Total salts
			OKFUSKEE COUNTY					
		Camp Brothers Farm, Castle						
		Irrigated 6 years with water from a well						
0-12	(4)	7	14		(2)	6	18	
12-24		5	15			6	14	
24-36		8	7			6	8	
36-48		6	5			6	6	
48-60		5	7			4	10	
		Camp Brothers Farm, Castle						
		Irrigated 28 years with water from the North Canadian River**						
0-12	(4)	4	26		(1)	8	20	
12-24		6	11			4	8	
24-36		7	6			4	12	
36-48		10	4			4	12	
48-60		11	4			4	4	
			TEXAS COUNTY					
		W. N. Ballinger Farm, Guymon						
		Irrigated 6 years with water from wells						
0-6	(4)	17	22		(2)	4	28	
6-12		12	24			8	16	
12-24		12	24			38	90	664
24-36		24	20			20	36	
36-48		48	50	696		18	26	
		Kimball and Chance Farm, Texhoma						
		Irrigated 8 years with water from wells						
0-6	(5)	4	29		(2)	6	40	
6-12		4	20			12	16	
12-24		3	19			10	20	
24-36		5	8			92	67	
36-48		9	16			282	86	768
		Harold Gibson Farm, Hardesty						
		Irrigated 7 years with water from Palo Duro Creek						
0-6	(3)	61	125	461	(1)	54	52	340
6-12		7	311	1005		18	61	344
12-24		22	204	862		36	39	176
24-36		29	361	809		18	54	232
36-48		25	510	1016		18	51	256

**Irrigation from the North Canadian has been discontinued due to the increasing salinity arising from oil operations.

TABLE I.—Continued.

Depth of soil (inches)	Salt Content of Soil (parts per million)							
	Irrigated Areas				Non-irrigated Areas			
	Crop Grown*	Chloride	Sulfate	Total salts	Crop Grown*	Chloride	Sulfate	Total salts
	TILLMAN COUNTY							
	Cotton Sub-Station Farm, Tipton							
	Irrigated 10 years with water from a well							
0-6	Cotton (1)	18	0		Cotton (1)	9	0	
6-12		0	0			9	0	
12-18		27	0			18	0	
18-24		45	0			18	0	
24-30		18	24			9	0	
30-42		18	0			18	0	
42-50		18	60			18	0	
	WOODWARD COUNTY							
	J. W. Cavin Farm, Mutual							
	Irrigated 5 years with water from a well							
0-6	Alfalfa (4)	10	20		(2)	14	24	
6-12		8	18			6	24	
12-24		8	12			8	22	
24-36		5	7			8	14	
36-48		8	15			14	20	
48-56		10	16			22	26	
	Jess Hufford Farm, Mooreland							
	Irrigated 6 years with water from wells							
0-6	(6)	6	19					
6-12		10	18					
12-24		10	8					
24-36		6	8					
36-48		6	14					
	WOODWARD COUNTY							
	Western Oklahoma Hospital Farm, Supply							
	Irrigated 10 years with water from wells and the North Canadian River							
0-6	Garden (1)	4	20		Garden (1)	8	40	
6-12		4	20			8	12	
12-24		4	12			12	8	
24-36		4	4			4	20	
36-48		4	4			8	4	
48-56		8	32			12	8	
0-6	Garden (3)	10	22		Garden (1)	4	32	
6-12		5	37			32	6	
12-24		52	107	818		243	101	1532
24-36		119	349	1245		73	88	1596
36-48		152	1619	3120		109	66	1360
48-56		88	609	2142		353	185	1524

TABLE I.—Continued.

Depth of soil (inches)	Salt Content of Soil (parts per million)								
	Irrigated Areas					Non-irrigated Areas			
	Crop	Grown*	Chloride	Sulfate	Total salts	Crop	Grown*	Chloride	Sulfate	Total salts
			J. G. Young Farm, Woodward Irrigated 9 years with water from wells							
0-6		(3)	5	24						
6-12			5	46						
12-24			6	34						
24-36			22	30	672					
36-48			28	26	652					

* Numeral in parentheses indicates number of profiles averaged; data presented are averages of this number of profiles.

TABLE II.—Chemical Composition of Water Used for Irrigation at Various Locations in Oklahoma.

County and location	Source of water	Ca/Na m. e. ratio*	Chemical composition (parts per million)				
			Calcium	Sodium	Potassium	Chloride	Sulfate
Comanche							
Cameron Junior College, Lawton	Deep well	2.24	33.2	17	10.5	6.1	Trace
Cotton							
Jess Monroe, Temple	Cache Creek	.12	14.2	160	22.5	92.1	Trace
Custer							
J. H. Kenney, Foss	Washita River	3.13	171.5	63	17.6	18.4	460
Harper							
Clarence Pile, May	Well	.46	31.4	79	15.0	51.5	Trace
J. C. Holmes, Laverne	Well	1.56	132.9	95	15.0	86.0	Trace
W. A. Plummer, Laverne	Well	.24	20.0	98	16.3	62.0	Trace
Jackson							
Frank Simpson, Altus	Altus-Lugert Lake	1.22	108.6	100	22.8	75.5	444
Frank Simpson, Altus	Well**	.59	504.5	990	13.5	13.4	1115
Will Moorehead, Eldorado	Gypsum sink	.58	813.1	1700	13.5	1788.5	2757
F. C. McCaleb, Olustee	Turkey Creek	1.07	629.8	675	15.0	522.0	2066
Kay							
Chilocco Indian School, Chilocco	Spring	.35	17.9	59	15.0	12.3	Trace
Major							
George Ball, Chester	Well	.32	15.8	56	12.0	6.1	Trace
George Ball, Chester	Well	1.07	27.0	29	12.0	12.3	Trace
Texas							
W. N. Ballinger, Guymon	Well	.07	12.1	200	43.7	49.1	None
Harold Gibson, Hardesty	Palo Duro Creek	3.73	229.8	71	20.2	47.9	823
Tillman							
Cotton Station, Tipton	Well	.55	90.4	189	7.0	168.0	125
Woodward							
Jess Hufford, Mooreland	Well	.36	18.2	59	13.5	15.3	Trace
J. G. Young, Woodward	Lake	.18	18.7	120	22.8	43.0	Trace
Western Oklahoma Hospital, Supply	North Canadian River	.27	19.0	81	13.5	19.9	Trace

* Milliequivalent ratios used in making calculation.

**Not extensively used for irrigation.

TABLE III.—Mechanical Analyses of Soils from Irrigated and Non-irrigated Land at 29 Locations in Oklahoma.

County, Name of Farmer, and Nearest Town	Irrigated or non-irrigated*	Depth of soil (inches)	Mechanical composition (percent)		
			Sand	Silt	Clay
ALFALFA COUNTY					
		Paul LaBrue Farm Jet			
	Irrigated (5)	0-6	36.9	52.0	11.0
		6-12	34.3	48.5	17.0
		12-24	47.4	34.9	17.6
		24-36	60.8	26.1	13.0
		36-48	46.8	38.6	14.4
BEAVER COUNTY					
		C. A. Allen Farm Beaver			
	Irrigated (4)	0-6	41.8	34.0	24.1
		6-12	51.3	29.8	18.8
		12-24	53.3	26.9	19.7
		24-36	61.3	25.6	13.0
		36-48	76.6	16.3	7.0
	Non-Irrigated (1)	0-6	38.4	37.0	24.6
		6-12	52.4	33.6	14.0
		12-24	66.4	20.8	12.8
		24-36	84.4	8.6	7.0
		36-48	86.4	7.4	6.2
CIMARRON COUNTY					
		Julius Kohler Farm Boise City			
	Irrigated (4)	0-6	44.3	27.7	27.9
		6-12	42.4	34.1	23.5
		12-24	46.3	32.7	20.9
		24-36	46.6	28.7	24.6
		36-48	54.3	23.4	22.2
	Non-Irrigated (2)	0-6	63.5	21.7	14.8
		6-12	64.8	20.9	14.3
		12-24	67.6	11.4	21.0
		24-36	60.0	19.2	20.8
		36-48	56.3	27.0	16.7
		O. W. Tucker Farm Kenton			
	Irrigated (4)	0-6	37.0	33.3	29.7
		6-12	32.7	34.8	32.4
		12-24	32.3	33.7	34.0
		24-36	32.7	34.1	33.1
		36-48	35.6	31.8	32.5
		O. W. Tucker Farm Kenton			
	Non-irrigated (1)	0-6	39.2	31.8	29.0
		6-12	35.2	29.0	35.8
		12-24	32.6	30.0	37.4
		36-48			

TABLE III.—Continued.

County, Name of Farmer, and Nearest Town	Irrigated or non-irrigated*	Depth of soil (inches)	Mechanical composition (percent)		
			Sand	Silt	Clay
COTTON COUNTY					
		E. H. Hickman Farm Temple			
	Irrigated (4)	0-6	14.8	46.6	38.5
		6-12	13.6	40.8	45.6
		12-24	13.5	37.3	49.1
		24-36	16.5	35.0	48.1
		36-48	15.9	41.1	40.8
		48-60	18.0	32.6	49.3
	Non-irrigated (2)	0-6	20.0	50.4	29.6
		6-12	17.7	45.4	36.9
		12-24	24.2	32.3	43.5
		24-36	29.9	31.9	38.2
		36-48	20.3	47.5	32.2
		48-60	21.3	45.4	33.3
		Jesse Monroe Farm Temple			
	Irrigated (2)	0-6	12.0	41.0	47.0
		6-12	11.7	38.8	49.5
		12-24	28.3	28.1	43.6
		24-36	14.3	39.5	46.2
		36-48	22.1	34.6	43.2
		48-60	26.1	38.4	35.5
	Non-irrigated (1)	0-6	11.4	53.6	35.0
		6-12	11.6	54.4	34.0
		12-24	29.6	47.0	23.4
		24-36	19.0	53.0	28.0
		36-48	11.4	60.0	28.6
		48-60	17.6	52.4	30.0
COMANCHE COUNTY					
		Cameron Junior College Farm Lawton			
	Irrigated (4)	0-6	29.0	38.0	32.9
		6-12	31.0	35.1	33.8
		12-24	34.2	35.3	30.4
		24-36	34.9	31.2	33.8
	Non-irrigated (1)	0-6	34.0	35.0	31.0
		6-12	24.4	36.0	39.6
		12-24	22.0	31.0	47.0
		24-36	22.2	28.8	49.0

TABLE III.—Continued.

County, Name of Farmer, and Nearest Town	Irrigated or non-irrigated*	Depth of soil (inches)	Mechanical composition (percent)		
			Sand	Silt	Clay
CUSTER COUNTY					
		J. H. Kenney Farm Foss			
	Irrigated (4)	0-6	32.2	36.8	30.9
		6-12	30.6	36.5	32.8
		12-24	35.8	33.9	30.2
		24-36	29.9	35.8	34.2
		36-48	26.4	38.3	35.3
		48-60	32.4	31.5	36.0
	Non-irrigated (2)	0-6	38.5	36.9	24.6
		6-12	38.1	39.6	22.3
		12-24	44.4	34.7	20.9
		24-36	39.8	38.3	21.9
		36-48	32.3	40.1	27.6
		48-60	33.2	37.5	29.3
GARVIN COUNTY					
		Dougherty & Whitaker Farm Wynnewood			
	Irrigated (4)	0-12	19.4	44.6	35.9
		12-24	18.0	41.1	40.8
		24-36	28.5	36.1	35.3
		36-48	46.8	27.8	25.3
		48-60	42.4	29.8	27.8
	Non-irrigated (2)	0-12	31.5	40.7	27.8
		12-24	27.3	42.9	29.8
		24-36	30.7	45.9	23.4
		36-48	39.8	34.5	25.7
		48-60	18.3	43.2	38.5
		J. H. Watson Farm Paoli			
	Irrigated (3)	0-12	57.1	30.5	12.3
		12-24	55.4	31.4	13.2
		24-36	51.7	32.2	16.0
		36-48	39.8	34.6	25.6
		48-60	17.5	41.6	40.8
	Non-irrigated (2)	0-12	35.8	42.2	22.0
		12-24	37.3	41.3	21.4
		24-36	36.4	37.1	26.5
		36-48	31.8	42.9	25.3
		48-60			

TABLE III.—Continued.

County, Name of Farmer, and Nearest Town	Irrigated or non-irrigated*	Depth of soil (inches)	Mechanical composition (percent)		
			Sand	Silt	Clay
HARPER COUNTY					
		J. C. Holmes Farm Laverne			
	Irrigated (1)	0-6	30.8	14.8	54.4
		6-12	21.0	27.4	51.6
		12-24	52.0	12.4	35.6
		24-36	74.8	8.8	16.4
		36-48	82.0	7.6	10.4
	Irrigated (2)	0-6	64.5	18.0	17.5
		6-12	73.5	16.1	10.4
		12-24	66.3	24.5	9.2
		24-36	82.0	10.2	7.8
		36-48	86.2	7.8	6.0
	Non-irrigated (2)	0-6	60.8	13.4	25.8
		6-12	47.6	14.1	38.3
		12-24	64.3	15.2	20.5
		24-36	61.7	14.8	23.5
		Clarence Pile Farm May			
	Irrigated (5)	0-6	42.9	36.1	20.9
		6-12	46.5	28.3	25.1
		12-24	43.1	26.2	30.5
		24-36	34.5	28.6	36.7
		36-48	28.1	31.6	40.2
	Non-irrigated (1)	0-6	22.4	50.8	26.8
		6-12	42.8	17.4	39.8
		12-24	19.8	38.4	41.8
		24-36	20.6	27.6	51.8
		36-48	29.6	33.6	36.8
		W. A. Plummer Farm Laverne			
	Irrigated (2)	0-6	78.6	14.6	6.3
		6-12	71.8	20.0	8.2
		12-24	57.4	24.8	17.8
		24-36	65.0	24.5	10.5
		36-48	57.7	28.9	13.4
	Irrigated (2)	0-6	33.1	41.5	25.4
		6-12	35.5	41.5	23.0
		12-24	39.1	31.8	29.1
		24-36	14.2	43.6	42.2
		36-48	27.7	41.9	30.4
	Non-irrigated (2)	0-6	45.4	31.0	23.6
		6-12	38.8	25.1	36.1
		12-24	30.7	27.0	42.3
		24-36	29.2	24.3	46.5

TABLE III.—Continued.

County, Name of Farmer, and Nearest Town	Irrigated or non-irrigated*	Depth of soil (inches)	Mechanical composition (percent)		
			Sand	Silt	Clay
HARPER COUNTY (continued)					
		Lawrence Drake Farm Gate			
	Irrigated (4)	0-6	43.7	40.9	15.3
		6-12	46.7	37.8	15.4
		12-24	44.0	38.2	17.7
		24-36	46.0	34.0	19.8
		36-48	35.6	43.3	21.0
	Irrigated (1)	0-6	27.8	45.6	26.6
		6-12	18.0	51.6	30.4
		12-24	22.2	52.0	25.8
		24-36	11.6	61.0	27.4
		36-48	28.2	48.0	23.8
JACKSON COUNTY					
		H. C. McCaleb Farm Olustee			
	Irrigated (4)	0-6	41.2	35.3	23.4
		6-12	38.0	35.6	26.3
		12-24	41.5	32.0	26.4
		24-36	45.5	30.9	23.5
		36-48	40.7	35.5	23.8
		48-60	43.9	30.2	25.8
	Non-irrigated (3)	0-6	53.5	26.7	19.8
		6-12	37.8	38.9	23.3
		12-24	37.2	36.5	26.3
		24-36	39.2	36.0	24.8
		36-48	44.4	32.0	23.6
		48-60	43.9	30.9	25.2
		Will Moorehead Farm Eldorado			
	Irrigated (2)	0-6	41.7	42.5	15.8
		6-12	40.7	38.0	21.3
		12-24	40.6	33.8	25.6
		24-36	31.0	38.8	30.2
		36-48	26.7	43.5	28.8
		48-60	36.5	36.9	26.6
	Non-irrigated (1)	0-6	35.8	41.6	22.6
		6-12	35.2	38.8	26.0
		12-24	37.2	39.2	23.6
		24-36	26.0	38.0	36.0
		36-48	27.4	31.8	40.8
		48-60	41.0	37.4	21.6
		Frank Simpson Farm Altus			
	Irrigated (4)	0-6	26.0	44.4	29.6
		6-12	24.9	36.1	39.4
		12-24	21.4	30.1	48.4
		24-36	22.7	29.1	48.1

TABLE III.—Continued.

County, Name of Farmer, and Nearest Town	Irrigated or non-irrigated*	Depth of soil (inches)	Mechanical composition (percent)		
			Sand	Silt	Clay
JACKSON COUNTY (continued)					
		36-48	22.4	30.0	47.5
		48-60	21.3	30.2	48.5
	Non-irrigated (2)	0-6	23.1	41.9	35.0
		6-12	20.6	30.9	48.5
		12-24	20.1	30.1	49.8
		24-36	22.0	29.7	48.3
		36-48	23.4	31.0	45.6
		48-60	33.0	17.9	49.1
KAY COUNTY					
		Chilocco Indian School Farm Chilocco			
	Irrigated (4)	0-12	21.0	58.1	20.8
		12-24	21.4	55.9	22.6
		24-36	23.9	51.5	24.5
		36-48	23.4	52.7	23.9
		48-60	23.5	48.7	27.8
	Non-irrigated (2)	0-12	21.2	56.6	22.2
		12-24	24.0	52.9	23.1
		24-36	30.4	47.6	22.0
		36-48	27.5	48.1	24.4
		48-60	31.2	43.2	25.6
MAJOR COUNTY					
		George Ball Farm Chester			
	Irrigated (5)	0-6	73.1	18.9	8.0
		6-12	70.7	19.1	10.1
		12-24	69.0	17.9	13.0
		24-36	79.0	11.1	9.8
		36-48	79.5	11.4	8.9
		48-60	80.8	11.4	7.7
OKFUSKEE COUNTY					
		Camp Brothers Farm Castle			
	Irrigated (4)	0-12	65.3	24.3	10.3
		12-24	62.3	27.2	10.4
		24-36	68.5	25.0	6.5
		36-48	71.5	21.3	7.1
		48-60	75.1	18.7	6.2
	Non-irrigated (2)	0-12	70.8	22.1	7.1
		12-24	73.8	18.4	7.8
		24-36	82.9	11.3	5.8
		36-48	90.3	6.1	3.6
		48-60	88.9	6.9	4.2

TABLE III.—Continued.

County, Name of Farmer and Nearest Town	Irrigated or non-irrigated*	Depth of soil (inches)	Mechanical composition (percent)		
			Sand	Silt	Clay
OKFUSKEE COUNTY (continued)					
		Camp Brothers Farm near North Canadian River			
	Irrigated (4)	0-12	35.1	45.8	19.1
		12-24	35.3	37.2	27.5
		24-36	34.4	40.1	25.4
		36-48	42.8	35.0	22.1
		48-60	39.3	38.2	22.4
	Non-irrigated (1)	0-12	42.4	45.0	12.6
		12-24	35.4	40.8	23.8
		24-36	34.4	38.8	26.8
		36-48	56.6	35.6	7.8
		48-60	49.4	44.0	6.6
TEXAS COUNTY					
		Kimball and Chance Farm Texhoma			
	Irrigated (5)	0-6	47.6	32.8	19.5
		6-12	60.1	23.2	16.6
		12-24	52.7	27.5	19.6
		24-36	50.1	28.7	20.7
		36-48	46.9	29.4	23.6
	Non-irrigated (2)	0-6	39.6	38.6	21.8
		6-12	36.7	37.3	26.0
		12-24	41.9	33.8	24.3
		24-36	40.6	34.3	25.1
		36-48	37.8	32.0	30.2
		Ballinger, W. N. Guymon			
	Irrigated	0-6	37.8	37.0	25.1
		6-12	42.9	32.5	24.5
		12-24	58.7	26.0	15.2
		24-36	71.7	18.8	9.5
		36-48	70.6	18.5	10.9
	Non-irrigated (2)	0-6	50.0	31.8	18.2
		6-12	60.0	24.4	15.6
		12-24	58.8	27.0	14.2
		24-36	61.0	13.0	26.0
		36-48	64.2	9.3	26.5
		Harold Gibson Farm Hardesty			
	Irrigated (3)	0-6	28.1	44.8	27.0
		6-12	16.7	50.4	32.8
		12-24	36.3	44.6	19.0
		24-36	80.4	12.6	7.0
		36-48	80.8	14.6	4.5
	Non-irrigated (1)	0-6	38.4	38.8	22.8
		6-12	33.0	43.8	23.2
		12-24	71.2	18.0	10.8
		24-36	70.8	16.2	13.0
		36-48	86.0	8.6	5.4

TABLE III.—Continued.

County, Name of Farmer and Nearest Town	Irrigated or non-irrigated*	Depth of soil (inches)	Mechanical composition (percent)		
			Sand	Silt	Clay
TILLMAN COUNTY					
		Cotton Substation Farm Tipton			
	Irrigated (1)	0-6	46.8	33.6	19.4
		6-12	49.0	29.8	21.2
		12-18	48.8	30.4	20.8
		18-24	44.2	35.8	20.0
		24-30	50.2	28.8	21.2
		30-36	50.6	34.2	16.4
		36-42	50.2	30.4	19.4
	Non-irrigated (1)	0-6	54.2	30.3	15.5
		6-12	47.6	36.6	15.8
		12-18	52.2	27.4	20.4
		18-24	50.2	30.0	19.8
		24-30	51.0	29.8	19.2
		30-36	47.6	30.6	21.8
		36-42	47.6	28.6	23.8
WOODWARD COUNTY					
		J. W. Cavin Farm Mutual			
	Irrigated (4)	0-6	46.8	39.8	13.3
		6-12	46.6	39.9	13.0
		12-24	48.7	36.9	14.3
		24-36	40.8	40.0	19.1
		36-48	41.3	39.9	18.7
		48-56	36.0	38.5	25.4
	Non-irrigated (2)	0-6	43.9	42.9	13.2
		6-12	39.5	46.8	13.7
		12-24	49.4	35.2	15.4
		24-36	48.7	33.4	17.9
		36-48	28.8	49.0	22.2
		48-56	28.7	45.1	26.2
		Jess Hufford Farm Mooreland			
	Irrigated (6)	0-6	81.2	11.2	7.5
		6-12	82.2	10.2	7.5
		12-24	84.9	8.5	6.5
		24-36	83.8	8.6	7.2
		36-48	84.8	8.3	6.7
		Western Oklahoma Hospital Farm Supply			
	Irrigated (4)	0-6	39.1	41.7	18.6
		6-12	38.9	41.5	19.5
		12-24	39.3	40.2	20.5
		24-36	45.7	34.5	19.7
		36-48	48.0	30.5	21.4
		48-56	53.2	29.2	17.5

TABLE III.—Continued.

County, Name of Farmer and Nearest Town	Irrigated or non-irrigated*	Depth of soil (inches)	Mechanical composition (percent)		
			Sand	Silt	Clay
WOODWARD COUNTY (continued)					
	Non-irrigated (2)	0-6	41.3	48.3	10.4
		6-12	38.5	45.4	16.1
		12-24	37.0	44.6	18.4
		24-36	51.2	32.1	16.7
		36-48	55.5	20.7	23.8
		48-56	56.0	26.8	17.2
		J. G. Young Farm Woodward			
	Irrigated (3)	0-6	58.3	29.8	11.8
		6-12	60.1	25.2	14.6
		12-24	58.8	25.2	15.9
		24-36	55.2	26.5	18.2
		36-48	52.4	30.0	17.6

*Numeral in parentheses indicates number of profiles sampled; data presented are averages for this number of profiles.