CROPS ADAPTED TO THE ARID REGION.

by

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The study of crop adaptation to the arid region is a question that has been under much consideration by the student of agriculture for the past few years. The cry for more land for the oncoming generation is awakening the student to the fact that if possible this western land must be put under cultivation rather than that it be used entirely for grazing purposes. The soil of this western country is of fine texture and with little cultivation will produce good crops if the proper amount of moisture can be had. During the year there is usually enough rainfall to produce a crop but the irregularity of the rainfall does not warrent that a crop can be produced every year.

The most important divisions of this subject are:

1. The irregularity of rainfall.
2. Conserving the soil moisture.
3. Method of tillage.
4. Effect of Subsoiling.
5. Moisture required by crops.

Conserving soil moisture by plowing. Shortly after the season's crop has been removed fall plowing should begin. By plowing early a mulch is formed which prevents evaporation, and also the fall rains will be taken into the soil and retained much better than if the soil were compact, and percolation would be much more rapid. In a country where there is plenty of moisture this plan is not advisable as the moisture tends

to develop nitrates and these if not saved by a cover crop will be lost by percolation.

In the spring there is a tendency for the soil to become very dry. As soon as Possible after the frost is out of the ground the plow should be put in use. By this means the compactmess of the surface is broken and evaporation does not take place nearly so rapidly, as we know that capillarity is not nearly so rapid in loose as in compact soil. Soil moisture may be conserved by tillage by the use of the plow, harrow and subsoil plow.

No definite rule can be given as to the depth of plowing. This must be determined by the farmer himself after he has made a careful study of the land he is tending. But as a rule in dry climates the plowing should never go deeper than the dark colored layer of soil. If the unweathered soil is turned up the crop yield will be reduced. But there should always be a good depth of plowing. As the result of deep soil observe the difference in the growth of plants upon the back furrows as compared with the ordinary field. If the best soil is thin it is not advisable to plow deep at first but each time the ground is plowed set the plow so as to turn up a thin layer of the subsoil.

Our small grains do best upon a shallow seed-bed but the larger grains require deeper cultivation. The ground should never be plowed when it is too wet, if there is too much moisture the ground will not pulverize. The same will hold true if the ground is too dry. If the ground is a little wet when plowed it should be allowed to dry out just enough so that when it is harrowed the soil will pulverize and the roughened places will smooth down. If the

ground is dry the harrow should follow the plow at once so as to form the mulch on the surface.

The amount of water saved by subsoiling is of no small importance to the western farmer. King in his Physics of Agriculture discussed the subject very thoroughly and from his work I have taken the following data;

Table showing the ability of subsoiled ground to hold water against gravity.

	Subsoiled. pounds.	Not Subsoiled. pounds.	Difference. pounds.
First foot	124.60	102.10	22.50
Second foot	72.57	10.34	62.23
Third foot	38.22	12.05	26.17
Fourth foot	32.26	3.82	29.43
Total water gained	268.65	128.31	
Total water added	254.41	254.41	
Difference	+ 14.24	-126.10	

The subsoiled ground had therefore not only retained all the water added, but had gained 14.24 pounds by capillarity; while the soil that was not subsoiled lost 126.1 pounds.

It is easily seen that the capacity of the soil for holding water is increased by subsoiling. When the ground is compact it does not have so large a space to hold water as when it is stirred. The moisture adheres to the soil particles in thin films, and up to a certain point the looser the soil is the more water it will hold. When the plowed ground has become saturated with water the surface water will pass off more rapidly than if the ground was compact and hard. There is always a certain amount of water in the soil that is not

available to plants and in order for the plants to grow the moisture must exceed that which is always retained by the soil. All plants do not have the same power of taking moisture from the soil. This will be discussed later on. As subsoiling has proven to be one of the ways by which the water capacity of the soil has been increased, the western farmer must farm the land in a way that the most moisture will be retained in the soil.

Moisture Required by Crops.

Experiments have shown that from 275 pounds to 375 pounds of water are required to produce one pound of dry matter in a grain crop. Different crops require different amounts of moisture. The amount of water required for the production of an average acre of the various crops, as given in Snyder's Agricultural Chemistry, is as follows:

Crop.	Average amount of water required per acre.	Amount of water required per acre.
	tons.	tons.
Clover.	400	310
Potatoes.	400	325
Wheat.	350	300
Oats.	375	300
Peas.	375	300
Corn.	300	___

The rainfall during the time of growth is generally more than the amount of water required for the production of a crop. Am aver-

age rainfall of two inches per month during the three months of crop growth would be equivalent to only 680 tons of water per acre, a variable part of which is lost by evaporation. Hence it may be possible that the available rainfall during an average growing season may be less than the amount of water required to produce the average crop. The moisture that is stored up in the soil must be drawn upon to supply the water for crop growth. In as much as the soil's reserve supply of water is such an important matter in crop production, it follows that the capacity of the soil for storing water and giving it up as needed by the crop is a very important factor in crop production and particularly so since the power of absorbing and retaining water in the soil is influenced so largely by cultivation.

Although we have had no chance to take data from the western part of the state, some samples were taken at the Kansas State Agricultural College and the moisture content determined. The samples were taken from different fields, being land which was similar in character but which had been planted with different crops the previous season. Kafir-corn and corn; and wheat, corn and grasses were compared. The object of the study was to determine the crop that conserved the most soil moisture, also the crop that would withstand a drouth. The samples were taken in foot sections to the depth of six feet. A brass tube was used with a sharp steel cutting edge, this tube was driven down one foot at a time and the tube then lifted out, and the sample of soil removed and placed in a tin box or tray, the weight of which was taken before we left the laboratory. All the tin boxes were numbered and the record was kept in taking the samples of the number of the tray used for each sample. In this way there could be no error as to the identification

of the sample of soil. The tin boxes were covered with a tight fitting lid so as to prevent evaporation of moisture. The boxes were placed in a large galvanized chest to further prevent evaporation and taken to the laboratory where the boxes were weighed. The soil was then placed in an oven and heated until the temperature became constant; and the boxes were then taken out and weighed, the difference in the two weights being the loss by evaporation of water. From this data the percentage of moisture in the soil was calculated. The following data was taken from an article published in the Industrialist, July 9, 1904, written by Mr. C. H. Kyle, assistant in agriculture at the Kansas State Agricultural College:

Prairie grass meadow and kafir-corn fields compared:

Samples taken Apr. 2, 1903.

Crops.	First foot.	Second foot.	Third foot.	Fourth foot.	Fifth foot.	Sixth foot.
	per cent	per cent	per cent	per cent	per cent	per cent
Prairie grass	28.8	25.3	22.5	21.1	20.7	20.5
Kafir-corn	26.1	24.9	21.6	20.0	20.1	20.4
Difference	2.7	.4	.9	1.1	.6	.1

The average difference is .97 per cent in favor of the grass land.

Alfalfa meadow and kafir-corn fields compared:

Samples taken Apr. 2, 1903.

Crops.	First foot	Second foot	Third foot	Fourth foot	Fifth foot	Sixth foot
	per cent	per cent	per cent	per cent	per cent	per cent
Alfalfa meadow	27.5	28.6	25.00	22.9	23.3	22.6
Kafir-corn	23.3	24.9	24.65	20.1	21.1	23.5
Difference	4.2	3.7	.35	2.8	2.2	.9

The average difference is 2.06 per cent in favor of the kafir-corn field. In this trial an explanation of the reason for the kafir-corn field having a larger per cent of moisture, is that the alfalfa starts growing early in the spring while there was no plant growth on the kafir-corn field.

Listed corn compared with level planted corn; samples taken May 4,

Crop.	First foot PER cent	second foot per cent	third foot per cent	fourth foot per cent	fifth foot per cent	sixth foot per cent
Listed Corn	29.0	31.1	25.7	24.8	24.1	24.0
Level-planted corn	27.6	30.9	26.7	25.2	26.2	24.3
Differences	1.4	0.2	-1.0	-0.4	-2.1	-0.3

The average difference is 0.37 per cent in favor of the level planted corn.

Samples taken June 4.

Crop.	First ft. per cent	second ft. per cent	third ft. per cent	fourth ft. per cent
Listed corn	32.17	31.61	28.76	25.18
Level-planted corn	30.49	31.17	28.32	27.64
Differences	1.68	0.44	-0.44	-2.46

The average difference is 0.15 per cent in favor of the level-planted corn.

The rainfall from May 4 to June 4 was 13.36 inches.

Samples taken July 1.

Crop.	first foot per cent	second foot per cent	third foot per cent	fourth foot per cent	fifth foot per cent	sixth foot per cent
Listed corn	24.73	28.37	25.39	25.74	26.32	24.21
Level-planted corn	25.08	28.29	25.47	25.66	27.69	25.50
Differences	-0.35	0.08	-0.08	0.08	-1.37	-1.29

The average difference is 0.49 per cent in favor of the level-planted corn.

Rainfall from June 4, to July 1, 1.12 inches.

Samples taken July 16.

Crops.	First foot	second foot	third foot	fourth foot	fifth foot	sixth foot
	per cent	per cent	per cent	per cent	per cent	per cent
Listed corn	21.6	27.4	21.7	24.7	23.0	22.4
Level planted	21.7	25.2	25.4	22.4	21.8	21.7

The average difference is .48 per cent in favor of the listed corn.

Rainfall from July 1, to July 16, was 2.26 inches.

Samples taken July 29.

Crop.	First foot	second foot	third foot	fourth foot	fifth foot	sixth fooot
	per cent	percent	per cemt	per cent	per cent	per cent
Listed corn	14.7	22.3	23.1	21.2	20.8	20.3
Level planted	12.6	20.1	20.8	18.3	18.8	19.0

The average difference 2.12 per cent in favor of listed corn.

Rainfall from July 16, to July 29, was 1.54 inches.

From these data we see that the soil moisture is about the same umtil July 1, then the listed corn ground seemed to hold the moisture better. The listed corn ground is usually in better condition when the corn is laid by, but the roots are deeper set. The first part of the season of 1903 when samples were taken was wet and cold and the listed corn did not do so well as the level planted corn. The yield for the level planted corn was 52.3 bushels per acre, while th that of the listed corn was 44.4 bushels.

Moisture at the close of the season: Different crops compared.

Crop grown on plot	1-ft.	2-ft.	3-ft.	4-ft.	5-ft.	6-ft.	Average difference compared with corn plot.
Corn	20.28	22.07	20.75	21.21	20.53	19.79	.....
Kafir-corn	16.16	19.09	18.50	19.42	17.59	16.57	-2.88
Sorghum (sowed)	18.24	20.05	17.85	16.71	15.48	15.24	-3.51
Soy beans	22.07	24.61	21.37	24.01	21.95	21.12	1.75

In some experiments done by Mr. H. Umberger and myself the same apparatus was used as was used by Mr. C. H. Kyle. Our experiments were carried on in a field west of College. One part of it was in Bromus inermis and Emmer and the other was in corn the year previous but had been disked to make a soil mulch. The ground was of a clayey nature but there was some sand in it. By this experiment we tried to find which of the crops retained the moisture in soil the better.

Samples taken April 3, 1905.

Crops.	Wet weight	Dry weight	Moisture.
	pounds	pounds	per cent
Corn field			
1st foot	879.5	816.0	19.6
2nd "	745.9	704.6	19.5
3rd "	850.5	749.9	____
4th "	913.5	860.5	14.1

	Wet weight pounds	Dry weight pounds	moisture per cent
Bromus inermis			
1st foot	863.5	7797.6	2i.5
2nd foot	820.3	766.8	23.0
3rd foot	841.6	784.8	17.8
4th foot	874.0	Lost	lost

Samples taken April 4, 1905.

Corn field			
1st foot	876.9	808.5	21.6
2nd foot	768.7	717.4	20.9
3rd foot	864.5	807.2	18.4
2th foot	902.6	854.2	13.5
Bromus inermis.			
1st foot	850.3	786.6	22.2
2nd foot	824.0	767.1	19.4
3rd foot	775.0	731.4	19.2
4th foot	927.0	861.4	17.2

Samples taken April 6, 1905.

Corn field			
1st foot	817.6	763.2	19.9
2nd foot	907.4	841.3	19.8
3rd foot	843.1	791.4	18.0
4th foot	929.7	873.1	14.4

	Wet weight pounds	Dry weight pounds	Moisture. per cent
Bromus inermis			
1st foot	863.3	800.1	20.9
2nd foot	898.3	832.6	19.6
3rd foot	781.9	736.0	19.7
4th foot	955.6	889.4	16.2

Samples taken April 8, 1905.

Corn field			
1st foot	815.4	762.1	18.8
2nd foot	886.9	824.1	19.1
3rd foot	850.2	798.9	17.7
4th foot	867.7	815.5	16.1
5th foot	796.8	757.2	13.4
Bromus inermis			
1st foot	782.3	735.5	19.0
2nd foot	919.9	854.7	19.9
3rd foot	858.9	799.8	18.2
4th foot	864.5	811.8	16.8
5th foot	752.2	718.0	13.6

Samples taken April 11, 1905.

Corn field.

1st foot	821.1	761.2	19.6
2nd foot	863.5	799.6	19.6
3rd foot	882.2	826.0	17.5
4th foot	898.9	842.9	16.3
5th foot	778.4	738.7	14.4

Bromus inermis

1st foot	840.3	812.2	8.3?
2nd foot	897.4	831.7	19.5
3rd foot	816.9	769.8	17.6
4th foot	827.2	784.7	14.4
5th foot	1023.1	948.4	16.1

Samples taken April 15, 1905.

Corn field.

1st foot	871.2	810.0	18.8
2nd foot	888.7	825.2	19.8
3rd foot	862.1	805.2	18.3
4th foot	837.1	790.6	16.0
5th foot	870.7	825.9	13.6

Bromus inermis.

1st foot	821.0	783.3	13.7
2nd foot	916.9	825.3	27.6 ?
3rd foot	861.6	811.1	16.3
4th foot	885.8	840.2	4.5
5th foot	816.5	778.1	12.2

Sanyhlestation April 20, 1905.

Corn field.

1st foot	711.5	674.2	20.8
2nd foot	842.4	783.9	20.3
3rd foot	861.6	808.8	17.5
4th foot	690.2	662.2	15.9
5th foot	823.0	777.8	15.2

Bromus inermis

1st foot	1047.4	957.5	19.8
2nd foot	697.5	666.1	25.7 ?
3rd foot	922.0	859.8	17.1
4th foot	697.8	661.1	16.1
5th foot	862.2	815.5	14.8

Sanyhlestation April 21, 1905.

Corn field.

1st foot	870.8	806.2	20.1
2nd foot	878.7	820.0	17.7
3rd foot	905.0	846.0	16.5
4th foot	862.7	812.2	14.9
5th foot	627.6	610.8	15.1

Bromus inermis.

1st foot	757.8	713.6	18.1
2nd foot	926.1	855.2	19.5
3rd foot	857.2	802.6	16.7
4th foot	756.1	719.9	15.4
5th foot	690.3	665.9	1.5

This data was taken with two objects in view, to study the capillarity and to see if the ground with a cover crop or the open ground was in best condition to hold moisture.

From the data we see that the ground with the cover crop has more moisture in the spring than the ground which is exposed. In the western part of the State where rainfall is light the crops which are sown in the fall and mature early in the summer, would be best crops to grow.

In the study of capillarity -- Compare the data of April 3rd and 4th.

April 4th, the wind was blowing twenty-two miles an hour, the moisture in the first foot was about two per cent more in the corn field on Apr. 4th than on Apr. 3rd, no rain having fallen. In the Bromus field there was less than one per cent more moisture on Apr. 4 than on Apr. 3rd. Showing that the wind on an open field will cause capillary action to be very rapid.

April 6th, the per cent of moisture was just about as it was April 3rd.

In the table of April 16th, in the Bromus field the samples were taken about twelve feet from where they were taken before and we noticed at the time that they were not as good samples as we had been getting. I think the data of April 16th is of little value.

We notice that the samples taken April 20th and 21st have a larger per cent of moisture. This I think can be explained as follows: The Bromus inermis field had grown to pretty fair size and was using considerable moisture, while the corn field had nothing upon it.