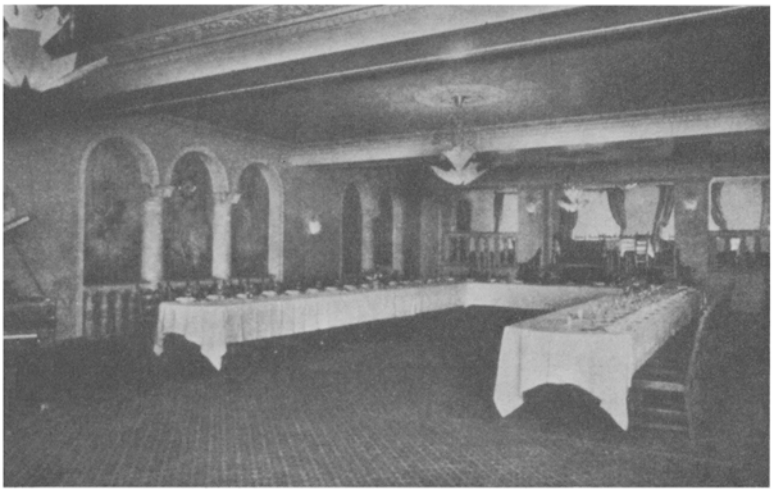

ADDITI

ON THE RELATION OF MOISTURE THE FREE FATTY ACID CONTENT

One of the banes of an oil miller's existence is excessive moisture in his cottonseed. The deterioration that sets in as a result of this condition is too well known to require general discussion at this point. Let it suffice to state simply that the seed begin to go "off" when placed in storage, and the change is accompanied by spontaneous heating, which accelerates the change. It is most notably made manifest by the increase of the free fatty acid content and the attendant souring and darkening of the oil. The important result is, of course, a loss in value of the seed. This is limited by trading rules, in the case of deterioration before delivery at the mill, to 50% of the normal value. Once the seed is stored in the mill, however, no arbitrary rules can limit the extent of the loss resulting from excessive moisture. A rule of the National Cottonseed Products Association makes allowance for this fact in requiring the deduction of one unit from the qualitative index for each per cent of moisture in the seed in excess of twelve per cent.

Apparently very little quantitative study has been made of the effect of moisture on fat splitting in the seed. Robertson and Campbell made determinations on a number of different cottonseed samples from a variety of sources after storing over periods ranging up to fifteen months. Their conclusions were as follows:

The Effect of Temperature

"Cottonseed having less than 10% moisture will remain stable under ordinary storage conditions.

"Seed of 10% to 14% moisture may or may not remain stable, while seed having 14% or more moisture will deteriorate in storage with a rapid increase of free fatty acid.

"Deterioration of high moisture seed is inhibited either by cold storage or by heating seed to reduce moisture content.

"Seed pre-heated to 175° F. to kill the germ is more sensitive than live seed to the formation of free fatty acid in moist atmosphere.

Sherwood, Andrews, Wade and Bailey[2] studied the increase of free fatty acid content in wheat germ under various storage conditions. Their attention was directed to the effect of temperature, and of storing in various gases and in vacuum. Moisture content was not considered. In this work, under the conditions studied, the order of increase was comparatively small, but was greater at higher temperatures, as is the case with cottonseed, and less when storage is in vacuum or in a gaseous atmosphere not containing oxygen. These facts agree with some unpublished results of experiments of a similar nature made by the writer on cottonseed. From these it was apparent that moisture content and temperature are the most important factors involved in the fat splitting in this species of oil seed. These factors are linked in practice by the circumstance that moist seed are the ones that suffer increase of temperature in storage.

Not Easily Obtained

Accurate results are not easily obtained in studying this problem because of the well known difficulties in taking a representative sample for the free fatty acid test, and in the test itself. Nevertheless, if a sufficient number of tests are made, definite trends are indicated, such as are reported here.

During the summer and fall of 1933 the Weather Bureau reported a record number of tropical disturbances in Gulf and Caribbean areas. One of these went inland near the mouth of the Rio Grande on July 6th and the attendant torrential rains caused heavy damage to the seed in the neighboring counties. The average moisture content of all samples received by a local mill in the period July 1st to 25th was 12.7%. On July 22nd a disturbance entered the Houston area and curved eastward accompanied by increased precipitation over a wide area along its path. The average moisture content of twenty-four seed samples from the affected zones during a two weeks period was 15.3% and the seasonal average through October 10th was 12.9% moisture. On August 6th a second storm passed inland at the Rio Grande's mouth causing further damage to the cottonseed. The effect of these disturbances is shown in Table I and Figure I, where are recorded the average free fatty acid content of extracted oil and average moisture content of cottonseed from different zones in southeastern Texas: (1) The Valley zone which was visited by two storms; (2) the Houston area, visited by one storm; (3) the Corpus Christi area, which was affected to some extent by one or all of these storms; (4) the Austin section, where normal weather prevailed.

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ONAL DATA

CONTENT TO THE INCREASE OF OF COTTONSEED IN STORAGE

TABLE 1

INCREASE OF FREE FATTY ACID IN SEED FROM DIFFERENT AREAS SUBJECTED TO RAINS ACCOMPANYING TROPICAL DISTURBANCES

(2 storms) (Nr. 2 stormS S

ZONE AREA		1 VALLEY (2 Storms)	2 CORPUS CHRISTI (Near 2 Stm. Areas)	6 & 8 HOUSTON (1 Storm)	—NORMAL— 4 SAN ANTONIO	5 AUSTIN
July 1, to July 25,	FFA	1.0%	0.6%	...%	0.3%	*3.4%
	MOISTURE	11.6	11.5	...	8.2	2.2
July 25, to Aug. 3,	FFA	0.3	0.6	...	0.45	*4.7
	MOISTURE	10.0	9.8	...	7.9	9.1
Aug. 3, to Aug. 18,	FFA	1.7	0.7	2.0	...	0.7
	MOISTURE	12.8	11.8	15.3	...	11.1
Aug. 19, to Aug. 28,	FFA	5.8	1.7	1.3	...	0.5
	MOISTURE	12.1	12.1	14.5	...	10.0
Aug. 29, to Sept. 11,	FFA	5.2	3.0	1.5	...	0.3
	MOISTURE	11.0	11.0	13.4	...	10.0
Sept. 12, to Sept. 26,	FFA	7.9	4.2	2.2	...	0.4
	MOISTURE	11.4	11.5	11.8	...	9.4
Oct. 10, to Oct. 30,	FFA	10.6	4.8	3.0	...	0.5
	MOISTURE	11.2	11.4	10.2	...	9.0
Oct. 30, to Nov. 27,	FFA	7.1	3.4	5.2	...	0.7
	MOISTURE	11.3	11.3	10.8	...	9.7

On the graph some moisture contents are indicated near the points for the corresponding free fatty acid values. In this particular set of curves no close correspondence over a narrow range between moisture and free fatty acid content can be expected because of the complication of the time element and of the effect of the different distribution of individual values around the mean values. For example, if an average free fatty acid value were obtained for six samples, all with moisture contents of 11.5%, this average value would be, according to the second lowest curve of Figure 2, 2.8% F. F. A. However, if five of the samples contained

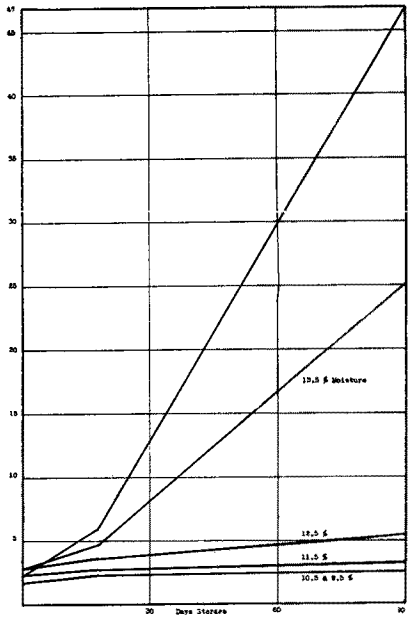
Interior Views of the Medinah Club Where the Fall Meeting of the A.O.C.S. Will Be Held

TABLE 2

CHANGE OF FREE FATTY ACID CONTENT OF COTTONSEED SAMPLES OF VARIOUS MOISTURE CONTENTS OVER A THREE MONTH STORAGE PERIOD

Avg. Moisture & No. of Samples		Free Fatty Acid Original	18 days	Increase	90 days	Increase
9.5%, 6	High	4.5%	5.0%	0.8%	5.3	0.8
	Low	0.5	0.7	0.1	0.9	0.4
	Average	1.8	2.3	0.4	0.6	0.6
10.5%, 20	High	5.3	13.3	7.9	15.2	9.8
	Low	0.3	0.4	0.1	0.5	0.0
	Average	1.5	2.3	0.3*	..	0.6
	*High value not included					
11.5%, 26	High	7.3	8.6	..	9.5	2.2
	Low	0.9	1.0	..	1.2	0.0
	Average	2.3	2.8	0.5	3.2	0.9
12.5%, 9	High	6.6	10.0	..	33	27
	Low	1.0	1.1	..	1.4	0.4
	Average	2.7	3.6	0.9	5.4	6.0
13.5%, 5	High	5.2	6.8	..	42	48
	Low	1.1	1.8	..	9.3	4.1
	Average	2.6	4.6	2.0	25	23
14.5%, 2	High	1.9	6.2	..	50	48
	Low	2.2	5.6	..	43	41
	Average	2.0	5.9	3.9	47	45

10% moisture and the sixth, 14.5%, then, for a thirty-day storage period, according to the two moisture-free fatty acid curves, the average free fatty acid value would be 3.1%, whereas the average moisture content of the six samples would be less than in the first case, namely 10.7%.



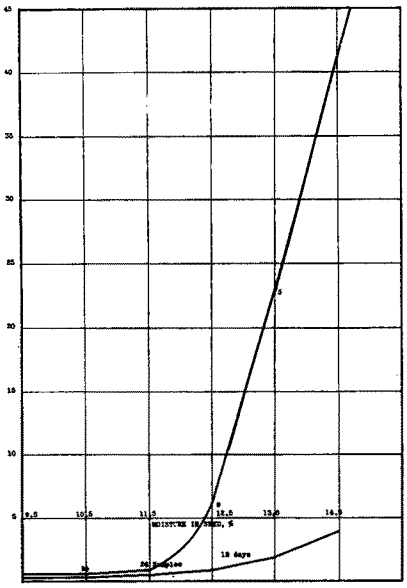
Increase of F.F.A. in cottonseed samples of various moisture contents during storage at 70-80° F.

With the idea of obtaining information on the probable deterioration to be expected in this high moisture seed, samples were taken from various parts of the seed houses of several mills in the storm areas. Free fatty acid and moisture deteriorations were made on receipt at the laboratory and the free fatty acid tests repeated at the end of 18 and 90 day storage periods. The moisture tests were not repeated because it was shown by the work of Robertson and Campbell that moisture loss or gain was negligible in seed stored in closed cans.

A summary of the data is shown in Table II.

It is arranged in six groups of different average moisture contents. For each group is given the highest, the lowest, and the average values of the free fatty acid for that group, both on the original sample and on the samples after the two storage periods, together with the corresponding increases in these values taking place during the storage.

The significance of these data is best seen in the graphs. In Figure I is shown the increase of the free fatty acid content during storage for the groups of different moisture contents. Here is strikingly shown the deterioration effects of moisture contents in excess of 12.5%. A further point to be noticed in this graph is that, as the storage progresses, the rate of increase slackens somewhat for the groups of comparatively low moisture contents, whereas this rate increases rapidly for the groups of 13.5 and 14.5% average moisture contents.



Effect of moisture content on free fatty acid increase in cottonseed during 3-month storage in cans.

In Figure II is plotted the increase in free fatty acid content against the moisture content, both at the end of eighteen days and at the end of three months'

(*Continued on page* 176)