Free Acid Important in Cotton Seed Value Index

Description of Basis Cotton Seed and Formulae for Determining Value Index in Relation to Basis Seed Quotations

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THE plan that has been suggested for evaluating or grading cotton seed contemplates the adoption of the following definition of Basis Cotton Seed and that all quotations for cotton seed shall be made on seed meeting the definition:

"Basis Cotton Seed shall be cotton seed that analyze 19.00% oil, 3.5% ammonia, 11% tare and not to exceed 2% Free Fatty Acids at time of purchase."

It contemplates further that seed analyzing other than as defined shall be evaluated by an index. That the index shall be ascertained in the following manner: The seed shall be analyzed for oil, ammonia, tare and Free Fatty Acids. To the pounds of oil as indicated by such analysis add a figure found by dividing the indicated pounds of 8% cake by the ratio of the price of a pound of 8% cake to the price of a pound of crude oil. The figure so found, referred to herein as the reciprocal, for Basis cotton seed shall be taken as par or Index 190. The index of seed analyzing other than as in the basis analysis is determined by dividing its reciprocal by the reciprocal of Basis cotton seed. And further, that discounts shall be applied to the index value at a rate not to exceed .3% for each .1% increase in Free Fatty Acids in the seed at time of purchase, provided that no additional discount shall be permitted on account of Free Fatty Acids above 18.5%. The average ratio of value of units of 8% cake and prime crude cotton seed oil is 5 and this ratio with its resultant reciprocal 555.0 has been suggested for use as a constant.

At the annual Convention of the Interstate Cotton Seed Crushers' Association held in New Orleans, La., May 16, 1929, it was suggested that if the percentage of both oil and ammonia were always calculated and reported on the basis of a constant and standardized tare, and that the actual tare be determined and reported, the method would have material advantages. The index may, of course, be determined from the "as is" analyses of seed, but the suggestion that the percentages of oil and of ammonia be reported on a standard tare has the following advantages.

First, that every analytical report will give a direct picture of any lot of seed both "on arrival" and after it has been cleaned and conditioned for crushing operations. Second, that we will thereby build up a series of data to show the relation, if any there be, between the oil and the ammonia content of cotton seed and the variety of seed, soil, fertilizer, rainfall, cultural practices and any other natural or controlled factors that may affect seed production.

Third, if a table of repetends for oil and ammonia is prepared, the index may be determined at any price radical, by simply dividing the difference between the analysis of Basis cotton Seed and the actual percentage of oil and/or ammonia, and/or tare, by the proper repetends.

For convenience in determining the index the following terms and formulae are useful.

The *Reciprocal*† is the figure representing the indicated pounds of oil, plus the indicated pounds of 8% cake divided by the radical. The *Radical* is the ratio of the value of a pound of oil to that of a pound of 8% cake. *Index 100* is the reciprocal resulting from seed analyzing 19.00% oil, 3.5% ammonia and 11% tare. *Standard tare* is 11%.

The Quantitative Index is determined by dividing the reciprocal resulting from the analysis of "As is" seed by the reciprocal of basis seed, or, from analysis of oil and ammonia on the basis of a standard tare, by the use of repetends.

*Bureau of Agric. Economics, U. S. Dept. of Agric.

† Sometimes referred to as the cake-oil value. Meloy, G. S., The Cotton Oil Press, May 1928, p. 28, and June 1929, p. 43.

The *Repetends* are the percentages of oil, of ammonia, and of tare which cause a unit change in the index, and by which the difference between the percentage of these factors, as found by analysis, and the corresponding percentages in the Basis Seed Analysis, may be divided to determine the total change in the index.

Let a = Reciprocal
" b = Radical
" c = Repetend for oil
" d = Repetend for ammonia
" e = % discount on account of F. F. A.
" f = Change in Index on account of oil
" g = Change in Index on account of ammonia
" h = Change in Index on account of tare
and the following formulae may be used to advantage:

(1) $\frac{\text{Price of pound of oil}}{\text{Price of pound of 8\% cake}} = b$

(2) $\frac{(\%\ \text{oil} \times 2000)}{100} + \frac{(\%\ NH_3 \times 2000)}{8/b} = a$

(3) $\frac{a}{2000} = c$

(4) $\frac{8ab \div 100}{2000} = d$

(5) $10\ (\%\ \text{F.F.A.} - 2) \times .3 = e$

(6) $\left\{\begin{matrix}\%\text{ of oil}\\ \text{As is seed}\end{matrix}\right\} : (2000 - \text{Excess tare}) :: \left\{\begin{matrix}\%\text{ of oil}\\ \text{Standard tare}\end{matrix}\right\} : (2000)$

(7) $\left\{\begin{matrix}\%\text{ of } NH_3\\ \text{As is seed}\end{matrix}\right\} : (2000 - \text{Excess tare}) :: \left\{\begin{matrix}\%\text{ of } NH_3\\ \text{Standard tare}\end{matrix}\right\} : (2000)$

(8) $\frac{(\%\ \text{oil} - 19.00)}{c} = +f$

(9) $\frac{(19.00 - \%\ \text{oil})}{c} = -f$

(10) $\frac{(\%\ NH_3 - 3.50)}{d} = +g$

(11) $\frac{(3.50 - \%\ NH_3)}{d} = -g$

(12) $(11.00 - \text{actual tare}) = +h$

(13) $(\text{actual tare} - 11) = -h$

(14) $100 \pm f \pm g \pm h = \text{Index}$

(15) $\text{Index} \times (100\% - e) = \text{Qualitative Index of value.}$

The above formulae may be used to make the following determinations.

No. 1 to determine the radical on any market.
No. 2 to determine the basis reciprocal on any market.
No. 3 to determine the percentage of oil in relation to the base 19.00%, causing a unit change in the index.
No. 4 to determine the percentage of ammonia in relation to the base 3.50%, causing a unit change in the index.
No. 5 to determine the percentage of discounts.
No. 6 & 7 to reduce "as is" determinations to the basis of the standard tare.
No. 8 & 9 to determine the number of units of change in the index on account of oil.
No. 10 & 11 to determine the number of units of change in the index on account of ammonia.
No. 12 & 13 to determine the number of units of change in the index on account of tare other than standard.
No. 14 to determine the final index based on oil, ammonia and tare.
No. 15 to determine the relation to the basis quotation on account of both the quantitative and the qualitative analyses.

In previous discussions we have found that over a period of years the radical has averaged 5, which figure has been used in determining the reciprocal, 555, that has been used as par, or Index 100. In normal seasons there would probably be no criticism to the constant use of the radical 5, but in seasons such as the present when the price of oil is low and the price of cake is relatively high, possibly the actual radical should be used. With 7 cent oil and $35.00 cake the radical is 4.00. Using the radical 4.00 gives a reciprocal of 598.7 as index 100. In other words our standard or Basis Seed analysis would be

Oil	NH_3	Tare	Reciprocal	Index
19.00	— 3.50	— 11 =	598.7	= 100

This would change the repetends for oil and for ammonia but not for tare.

The repetend for oil would be $\frac{598.7}{2000} = .2993$

and for ammonia $\frac{(598.7 \times 8 \times 4.00)}{100} \div 2000 = .0958$

A few examples might help to an understanding of the theory. First let us consider the extremes of the probable variations in the prices of oil and cake. For example what is the index in seed analyzing 20.00% oil, 3.70% ammonia and 11% tare?

(a) when oil is 7 cents and cake $35.00
(b) when oil is 10 cents and cake $40.00
(c) when oil is 13.5 cents and cake $45.00

From formulae Nos. 2, 3 and 4 we find first as follows:

	Radical	Reciprocal	Repetends Oil	Repetends NH_3
(a)	4.00	598.75	.2993	.0958
(b)	5.00	555.00	.2775	.1110
(c)	6.00	525.83	.2629	.1262

Example (a) $\frac{20.00 - 19.00}{.2993} = \text{Plus } 3.3$ on account of oil

$\frac{3.70 - 3.50}{.0958} = \text{Plus } 2.0$ — on account of ammonia

5.3 or Index 105.3

Example (b) $\frac{20.00 - 19.00}{.2775}$ = Plus 3.6 on account of oil

$\frac{3.70 - 3.50}{.111}$ = Plus 1.8 — 5.4 on account of ammonia

or Index 105.4

Example (c) $\frac{20.00 - 19.00}{.2629}$ = Plus 3.8 on account of oil

$\frac{3.70 - 3.50}{.1262}$ = Plus 1.5 — 5.3 on account of ammonia

or Index 105.3

The repetends are variable and properly so since they represent the weight to be given to each of the two items, oil and ammonia, in the determination of the index of seed under varying prices of the products. When the value of oil is low, relative to the value of cake, more oil and less cake effects a unit change in the index, than is the case when the value of oil is high relative to the value of cake.

One other example of the use of repetends in discovering the quantitative index of cotton seed, might clarify the proposed plan.

For example, suppose the report of the chemists shows that, on the basis of the standard tare, a certain lot of seed analyze 20.11% oil, 3.056% ammonia and that the actual tare was 16%; what is the quantitative index when the radical is 5?

By formula No. 8
20.11 minus 19 equals 1.111
which divided by the oil repetend .2775 gives ..... plus 4.0 on oil
By formula No. 11
3.50 minus 3.056 equals .444
which divided by the ammonia repetend .111 gives ..... minus 4.0 on ammonia
By formula No. 12
16 minus 11 equals ..... minus 5.0 on tare
By formula No. 14
100 plus 4, minus 4, minus 5, equals index 95

Proof:

The analysis is basis standard tare 11, actual tare is 16. Therefore the quantity of seed at standard tare is 1900 pounds, which will produce 725.8 pounds of 8% cake which divided by the radical 5 gives 145.16 as the number to be added to the indicated pounds of oil.

1900 pounds seed at 20.11% oil gives ..... 382.09 pounds of oil
add ammonia converted to oil as above 145.16

Divide by standard reciprocal ..... 555) 527.25

95 (Index)

Or the example may be proved by first converting the analysis, from the basis of standard tare, to the basis of the actual tare. Using formulae 6 and 7, the analysis would be

19.1045% oil — 2.90032% NH_3 — 16% tare

This analysis on the basis of 2000 pounds to the ton will give ..... 382.09 pounds of oil and 8% cake divided by 5 ..... 145.16

Reciprocal 527.25

527.25 divided by 555 gives index of 95.0

If this sample also analyzed 5% Free Fatty Acids by formula No. 5 we find the discount to be 9%

$$10\ (5 - 2) \times .3 = 9.00$$

And by formula No. 15 that the qualitative index is 86.45

$$95 \times (100 - 9) = 86.45$$

The index method of evaluating cotton seed would, of course, be much simplified if the use of a constant radical can be justified. The limits of the variation of the radical during a ten year period, including the immediate post war period, has been shown to extend from 4.00 to 6.00*.

The radical 4.00 gives a basis reciprocal of 598.7. The radical 5.00 gives a basis reciprocal of 555.0. The radical 6.00 gives a basis reciprocal of 525.8. When the basis reciprocal is 598.7 the repetend for oil is .2993%. When the basis reciprocal is 555.0 the repetend for oil is .2775%. When the basis reciprocal is 525.8 the repetend for oil is .2629%.

The maximum deviation from the repetend of the suggested constant is .0218% of oil, which is well within the usual error of check analyses of cotton seed. In addition this error represents .436 pounds of oil per ton of seed, which when oil is 10 cents a pound amounts to 4.36 cents error per ton of seed. Moreover, the variation in price relations during a season would doubtless result in plus and minus errors that would average or balance during each season. There appears, therefore, to be no reason why a constant radical cannot be used with the resulting constant basis reciprocal.

The adoption of a constant radical makes possible the use of a simple table of analyses from which the index of any lot of seed may be seen at a glance, provided the analyses for oil and ammonia are calculated and reported on a constant tare and the actual tare is determined. Table I is such a table in which the figures in each column above the basis analysis result in plus changes in the index, and those below the basis analysis minus changes. The three columns, oil, ammonia and tare, may com-

*The Cotton Oil Press, May 1928, page 24.

plement or offset each other in the resulting index. They complement as in a-a-a-a and b-b-b-b. They offset as in c-c-c-c and d-d-d-d.

Table II shows the index of seed containing excesses of Free Fatty Acids. The quantitative index is found first, as in Table I; then the discount is applied as in Table II.

TABLE I

TABLE OF ANALYSES
SHOWING THE QUANTITATIVE INDEX
Analyses

	% Oil (Basis Standard Tare)		% Ammonia		% Tare (Actual)		Index	
	21.77		4.61		1		110	
	21.49		4.49		2		109	
	21.22		4.38		3		108	
	20.94		4.27		4		107	
	20.66		4.16		5		106	
	20.38		4.05		6		105(a)	
	20.11(c)		3.94		7		104	
	19.83(a)		3.83		8		103	
	19.55		3.72(d)		9		102	
	19.27(d)		3.61(a)		10(a)		101	
B	19.00	A	3.50	S	11(c)	I	100(c)	S
	18.72		3.38		12		99(d)	
	18.44(b)		3.27(b)		13(b)		98	
	18.16		3.16		14		97	
	17.89		3.05(c)		15(d)		96	
	17.61		2.94		16		95	
	17.33		2.83		17		94(b)	
	17.05		2.72		18		93	
	16.78		2.61		19		92	
	16.50		2.50		20		91	
	16.22		2.39		21		90	

TABLE II

TABLE SHOWING THE APPLICATION OF DISCOUNTS ON ACCOUNT OF EXCESSES OF FREE FATTY ACIDS.*

The Index of Seed Containing not over	The Index of seed containing excesses of Free Fatty Acids.							
2% Free Fatty Acids.	2.1%	2.2%	2.3%	2.4%	2.5%	3.0%	4.0%	*18.5
110	109.6	109.3	109.0	108.6	108.3	106.7	103.4	*55.5
109	108.6	108.3	108.0	107.6	107.3	105.7	102.4	55.0
108	107.6	107.3	107.0	106.7	106.3	104.7	101.5	54.5
107	106.6	106.3	106.0	105.7	105.3	103.7	100.5	54.0
106	105.6	105.3	105.0	104.7	104.4	102.8	99.6	53.5
105	104.6	104.3	104.0	103.7	103.4	101.8	98.7	53.0
104	103.6	103.3	103.0	102.7	102.4	100.8	97.7	52.5
103	102.6	102.3	102.0	101.7	101.4	99.9	96.8	52.0
102	101.6	101.3	101.0	100.7	100.4	98.9	95.8	51.5
101	100.6	100.3	100.0	99.7	99.4	97.9	94.9	51.0
100	99.7	99.4	99.1	98.8	98.5	97.0	94.0	50.5
99	98.7	98.4	98.1	97.8	97.5	96.0	93.0	49.9
98	97.7	97.4	97.1	96.8	96.5	95.0	92.1	49.4
97	96.7	96.4	96.1	95.8	95.5	94.0	91.1	48.9
96	95.7	95.4	95.1	94.8	94.5	93.1	90.2	48.4
95	94.7	94.4	94.1	93.8	93.5	92.1	89.3	47.9
94	93.7	93.4	93.1	92.8	92.5	91.1	88.3	47.4
93	92.7	92.4	92.1	91.8	91.6	90.2	87.4	46.9
92	91.7	91.4	91.1	90.8	90.6	89.2	86.4	46.4
91	90.7	90.4	90.1	89.9	89.6	88.2	85.5	45.9
90	89.7	89.4	89.1	88.9	88.6	87.3	84.6	45.4

*First determine the index as if there were no excess of Free Fatty Acids and then read across to the index under the percentage of acidity as reported in the analysis.