THE UNIVERSITY OF TEXAS AT AUSTIN
NATURAL FIBERS INFORMATION CENTER
P. O. Box 8180, University Station
AUSTIN, TEXAS 78712

November 15, 1982

Don:

Attached is some material along the line you requested.

Joel

FORMERLY NATURAL FIBERS ECONOMIC RESEARCH

"PRICING ON FIBER PROPERTIES AND COTTON MARKETING ANALYSIS"

Purpose, Scope and Objectives: Cotton accounts for approximately 14% or $1.3 billion of the agricultural income of the state, but producers are not realizing the optimum income for their crop since the current system of price quotations reflects only the conventional system of classification, in use for the past 50 years. This system does not take into consideration important fiber properties, strength, length uniformity, white color and yellow color of the fiber. High speed techniques for measuring fiber properties are now available, and through this knowledge maximum utilization of the fiber can be realized by the producer, breeder, ginner, merchant, and mill. Under the present system the producer does not realize a greater return for quality cotton. The present system, therefore, not only discourages the production of quality cotton, but encourages the use of synthetics since their fibers are described scientifically. Under the present system, the classer's evaluation of cotton samples are associated with 25 to 35 percent of the variation in yarn strength, but fiber properties as determined by instruments are associated with 88 to 94 percent of the variation in yarn strength. Instrument classing gives better control of the cost of the raw cotton and its production through the mill, alleviating the shading of price because of the uncertainty inherent in the use of conventional classing as a means for evaluating raw stock. Fiber strength and length uniformity are increasingly important because of the new open-end spinning technique. Quality Texas cotton is especially suited to this new technique of open-end spinning, but needs a pricing system that rewards the production of these two properties.

Along with the high volume testing line, the present system of pricing and quoting the price of cotton using properties needs to be updated. The market news service of the Cotton Division of the United States Department of Agriculture reports the price of cotton from California, El Paso, Texas, Delta and Eastern growth as landed mill prices--Group 201 Mill Points. The price for each growth area takes into account the difference in fiber properties when we look at average prices paid to farmers, but all of the fiber properties are included on the "green card" classers call that follows each bale. It is well known that El Paso and California cotton command a premium and the premium is primarily a matter of fiber strength. The United States Department of Agriculture publishes the results of spinning tests made on cotton with different fiber properties. By combining the 201 mill point price data and the fiber property data reported for the spinning tests, it becomes possible to tie price to fiber properties. The combination of price with fiber properties makes it possible to analyze data by linear regression techniques and other related methods. If fiber strength and fiber length uniformity are considered reason for the differences between the price by areas, this analysis should point it out. This will make it possible to sort out the importance of the various fiber properties. These data are the nearest thing to having all of the various growths of cotton in the same warehouse and this is a consideration that must be taken into account because it eliminates the factor of location. The importance of the fiber strength and fiber length uniformity changes from season to season because of supply and demand considerations, however, by working with prices as a deviation from their average, it becomes possible to reduce the year to year influence of supply and demand considerations. Another technique to arrive at the role price of fiber strength plays would be to construct an index of fiber quality which would include the seven fiber properties. This has been done and can be repeated. It was used to analyze the price of the various kind of cotton for sale in the Liverpool market. The weight values used for the index become an indicator of the importance of each fiber property. The correlation between the Liverpool price and the quality index is very high. The importance of each of the fiber properties to mills can be shown through the medium of linear regression analysis involving the seven fiber properties and yarn strength. This is a benchmark because it tells what each fiber property means in processing. Ability to put a price on specific fiber properties not only will increase the efficiency of the entire cotton economy, but will mean greater returns to Texas producers because it will open the market to mills using open-end spinning equipment. High fiber strength in short staple Texas cotton is an ideal combination for open-end spinning.

The objective of the work is to modernize the pricing system for cotton as well as the method of quoting prices. The strength of the fiber and the uniformity of fiber length are two extremely important properties of the cotton fiber. Under the present pricing system, they are not considered. Consequently, there is no incentive from the standpoint of price for the producer to grow a better cotton, since good or bad fiber properties bring the same price in the market place. The following table reveals a substantial difference in the fiber properties of two varieties of cotton grown in Texas.

Fiber Property	Variety No. 1	Variety No. 2
Length	32	32
Uniformity	77	78
Micronaire	4.6	4.4
Strength	19	24
Leaf	4	4
White	30	30
Yellow	30	30
Yarn Strength	1753	1983

The difference in strength of 230 units is extremely important. The cotton that will make a yarn with a strength of 1753 units is not suitable for quality denim yet it brings the same price in the market place. It is this inequity that must be corrected. The objective of this research is to do just that. Payment for quality will enhance the position of the Texas producer and place cotton in a better competitive position.

FIBER PROPERTIES AND THEIR USE

JOEL F. HEMBREE

PLAINS COTTON COOPERATIVE ASSOCIATION

LUBBOCK, TEXAS

FIBER PROPERTIES AND THEIR USE

Some of what I have to present to you may seem very dry. However, if you are acquainted with the material, forgive me for imposing on you. If you are not, I hope what I have to say will be helpful in your decisions as to how instrument data can improve the efficiency of your operations. Before we get into the information on the accuracy of instrument data and how it can be used to select cotton that will reduce your raw cotton cost and improve efficiency of mill operations, permit me to show you a figure that reveals what instrument data makes possible, see Figure 1.

The figure is not scaled to prevent the recognition of the data source. The bottom line represents the contract specification. The second line is instrument data and the third line represents the data for another firm manufacturing the same product. You will note the minimum amount of variation in the line that represents the HVI data compared with that for the other firm. The area between the two lines is economic waste. This means better cotton was used than was necessary, which translates into dollars lost.

The customer establishes a specification. When cotton is used that is better than that needed to produce a product that will meet the specifications with a desired safety margin, any cotton used better than that is a waste of cotton and money. Calculation of the desired level above the specification set is relatively simple.

Now, let's move on to fiber properties (cotton), how they are measured, the accuracy of the measurements and how they may be used to increase operational efficiency.

Measurement of the cotton fiber is not something new. However, this is hardly the place for a history of the measurement techniques that have been used. What we are concerned with today is the so-called HVI type of equipment. There are two firms that make such equipment. About the only difference in the equipment in use in the fifties and today (HVI) is the time required to make a test. With our equipment the average test time is ten seconds. We make two tests on a sample. Under average production conditions this is three bales a minute or some 180 bales an hour. Considering rest breaks and time lost testing calibration cottons (calibration testing is more for psychology than anything else) an average for the day (eight hours) is about 1250 bales per line a shift. Tests are made for length, uniformity, micronaire, strength, leaf, white and yellow color. Leaf is estimated by eye. In recent months different instrument makers have developed trash meters. I do not know whether the meters can distinguish between leaf, bark, grass and other foreign matter. However, we have a trash tester that can make the distinction. As you can see, the meter is five feet four at 125 pounds with red hair and blue eyes. Testing experience is over 1,000,000 bales.

Two calibration cottons are used and if the values for an average of 10 tests for each fiber property (length, uniformity and the strength) fall inside the control limits for the cotton, testing starts. At intervals of 45 minutes two calibration cottons are sent down the line. Two tests are made and the average of the two tests must be inside the control limits for that number of tests.

As the cotton is tested the data are stored on tape. Stored in the computer is a set of control limits for two tests for each fiber property. These are shown as Table 1. If the difference exceeds the control limit the cotton is tested a second time. If on the second test the permissable limits are exceeded the computer automatically writes in the low values. At the time the data is being recorded on tape the computer transmits the data to a printer that records the individual measurement and the average for the two tests for each fiber property. The data are illustrated by Table 2. You will also see as a part of Table 2 an estimate of the yarn strength to be expected from each bale. The yarn strength figures were arrived at by the use of an equation developed from USDA Report No. 12 crop 1980. The equation we use in selecting cotton for the mill was developed from tests done for PCCA by Textile Research Center of Texas Tech University. The computer is programmed to give us on request data that show the results for the calibration bales sent down the line. On request, the number of bales that are suited for the mill will be shown as will those that are not. The data are also converted to percent for ease of comparison. The number of bales that failed are shown with the reason for failure, i.e. length, strength, micronaire or whatever the cause may be. A bale can fail by being too good. The two printed records give us a complete history of the days operations, see Table 3. Needless to say, all of the testing is done at 70°F and 65% RH. This is the equivalent of 7.5 per cent moisture content in the cotton. If conditions in the laboratory drift more than plus or minus 2 units, testing ceases. A difference in moisture content of 1 percent is associated with a change in strength of about 2 gpt.

There has been considerable discussion about the variabilty of measurements made by the instruments. Where does the variance come from? How much of the variance comes from the instrument and how much from the cotton?

The source of the variance is shown by Table 4 and Figure 2. It is evident from these data the instruments are a minimal source of the variance. This was arrived at as follows: the equivalent of 500 tests were made on a bale of cotton. The variability inherent in the 500 tests includes both cotton and instrument. Next the equivalent of 300 tests were made on the same beard. Obviously the variability in this situation is that injected by the instrument. Since the variance can be manipulated in different ways all that need be done is subtract the variance for the instrument from that for instrument plus cotton. The remainder is the variance attributable to the cotton. Reference to Table 4 reveals the variance attributable to the instrument is small. The instruments are highly accurate.

The total variation to be expected in what may be thought of as an average bale of cotton is shown by Table 5. The distribution for length and micronaire are illustrated by Figures 3 and 4. The data represent the equivalent of 500 tests on a bale. Given 500 tests on a bale it is possible to derive 124,750 combinations of 2 tests. The data of Table 6 shows the nature of variation that may occur for length. While this is not shown, Table 7 reveals the combinations to be had when 50 tests are made on a bale of cotton. This amounts to 1225 combinations. Any one average is as good as another because (unless the bale is two sided or false packed) the distribution of the fiber inside the bale is random. This can be seen from Table 8, which shows the results found when an analysis of variance was done for length on two different bales of cotton.

All of this is preliminary. Now that it is evident the instruments give accurate results and the contribution of cotton to the variance is established, let's look at the use of the data. This can be done by using fiber data and open end spinning results published by the Cotton Division of the USDA in Report No. 12 for the crop of 1981. The average fiber properties and yarn results are shown by Table 9. The yarn is 8/1. A linear regression analysis reveals the correlation between the fiber properties and yarn strength is .92. This means that 85 percent of the variance in yarn strength and fiber properties is associated. The data are shown by Table 10. The relative importance of each fiber property as it is associated with yarn strength is shown by Table 11. The actual yarn strength values and yarn strength estimated for each of the 18 USDA tests are shown by Table 12.

There is no difference between estimating the strength of yarn from fiber properties than what occurs when the strength of concrete is estimated from the amount of sand, gravel, water and cement used. Both estimates are made using the linear regression technique. In both cases the problem is one of strength of materials. One is flexible and the other solid. The important factor is the reliability of the technique used to measure the property of the individual components.

Using the fiber properties shown by Table 13 and the equation derived from USDA Report No. 12 for the crop of 1980, five blends were selected to illustrate how fiber properties may be used to secure a constant level of processing in the mill. Table 14 illustrates a blend. The rest are shown by Tables 14 through 18. The average data for each blend are shown by Table 19.

Selection of the blends is a relatively simple matter. Any good programmer given the fiber data and estimated CSP along with the constraints to be observed with respect to fiber properties can develop a program that will select the bales to yield a required level of yarn strength and the mixes will have the same average fiber properties. It is essential that micronaire be held at the same average from blend to blend. The average for other fiber properties can vary because of the compensating relationship between fiber properties.

The manner in which the fiber properties compensate can be seen from Table 20. The estimated CSP is the same for the two comparisons, but the average fiber properties are different for each of the blends.

The manner in which the fiber properties contribute to yarn strength can be seen from Table 21. The table reveals how much of the contribution of each fiber property is direct and how much is indirect. (These are PCCA data and are not to be confused with the USDA data used in prior illustrations). Examiniation of Table 22 reveals that 50.8 percent of the explained variance has its origin in the direct and indirect contribution of fiber strength to yarn strength.

So far we have been concerned with the properties measured by the instrument and accuracy of results. Some have asked what about the classer? The data shown by Table 23 compares the results of five classers and five instruments for duplicate tests made on the same cotton. The second set of tests were made one month after the first tests. It is evident the instrument is superior to the classer. In fact, the classers' results were no better than chance.

If you are going to develop an equation to estimate yarn strength from fiber properties I cannot over-emphasize the importance of using a wide spread of fiber properties. If such is not done you run the risk of estimating from fiber properties that are at the limits of the reliability of the equation. This can mean disaster. Developing an equation from the general run of the cotton you usually use is hazardous for the above reason.

Please remember that every bale of cotton that is used by the mill of American Cotton Growers is selected from instrument measurements using a computer and a strength formula worked out for High Plains cotton. No classer has ever seen a bale of the cotton used by the mill and the mill has used over 300,000 bales of cotton selected by objective means. We were told we could not select cotton without a classer. We were also told we could never make acceptable denim using only High Plains cotton. We were told we could not make suitable open-end warp. All of these things and more have been done. This is not to say there has not been trouble from time to time, no cotton mill escapes such. However, there has never been a "blow-up" in the several years of operation. Finally, it has been said we use the "cream of the crop." We would be fools to do so. We use the kind of cotton it takes to make a product acceptable to Levi Strauss - no more - no less. Others have said they cannot operate in the fashion of American Cotton Growers because of warehousing constraints. We bring blends of 28 bales together from as far apart as 425 miles. Some bales may come from Sweetwater, Texas, some from Lubbock, Texas or Plainview, Texas and others come from as far away as Altus, Oklahoma. Every blend has a code number, and there are 28 bales to a blend. Let us use as a code number 2000. With 7 bales of 2000 code in Sweetwater, 8 bales of 2000 in Plainview, 10 of 2000 in Lubbock and 3 of 2000 in Altus, Oklahoma, the bales are brought to Littlefield and all stored together under code 2000 and so used. If American Cotton Growers can bring blends together from warehouses as far apart as 425 miles, surely it is possible to devise a way to handle cotton in a single or nearby warehouses.

Although Einstein's theory of relativity came in 1905 the theory had not been accepted as late as 1919. There was to be an eclipse of the sun in 1919. The English government sent astronomers to Principe (West Africa) and to Sobral, Brazil to observe the position of certain stars and determine if their position was as calculated by Einstein. The results of the astronomers' measurements confirmed the theory of relativity. The correlation between Einstein's calculations and the astronomers' observed values is .9949. The explained variance is 98.9826 percent. It would seem that if the theory of relativity was accepted on a correlation of .9949, which is an explained variance of 98.98 percent, it should be possible to operate something as mundane as a cotton mill utilizing fiber properties where a correlation of .95 exists between fiber properties and yarn strength. This is an explained variance of 90.25 percent, high by any standard of research.

The conventional method (human classification) correlates .74 with yarn strength. This means that only 55 percent of the variance in yarn strength is associated with the conventional way of estimating certain fiber properties. Instrument data are associated with some 90 percent of the explained variance, see Table 24. If you went to Las Vegas, would you rather stake your money on 55 per cent or 90 per cent? The problem is not the accuracy of the instruments as some would have us believe. The important thing is which technique, instrument or classer, has the greatest potential for saving. A price comparison of the cost of cotton by each technique will answer the question. Such a comparison is shown by Figure 5. The price has been converted to dollars a bale with no allowance made for internal waste. The qualities are not shown. To do so would give away an advantage. The qualities used for the classer are a combination of High Plains, Delta, Southeast and Far West cotton as a blend that was described to me. I should think the advantage of the instrument over the classer in terms of the dollars saved is enough to show management the inefficiency of a convention that is unchanged after 100 years.

When instruments are considered, the problem is that faced with change. The biggest obstacle to human progress is human beings. The dollar sign though is a great convincer, as can be seen from Figure 5. There is ever interest in the product of the competition. As you can see, the product is exceptional and the pockets are a perfect fit.

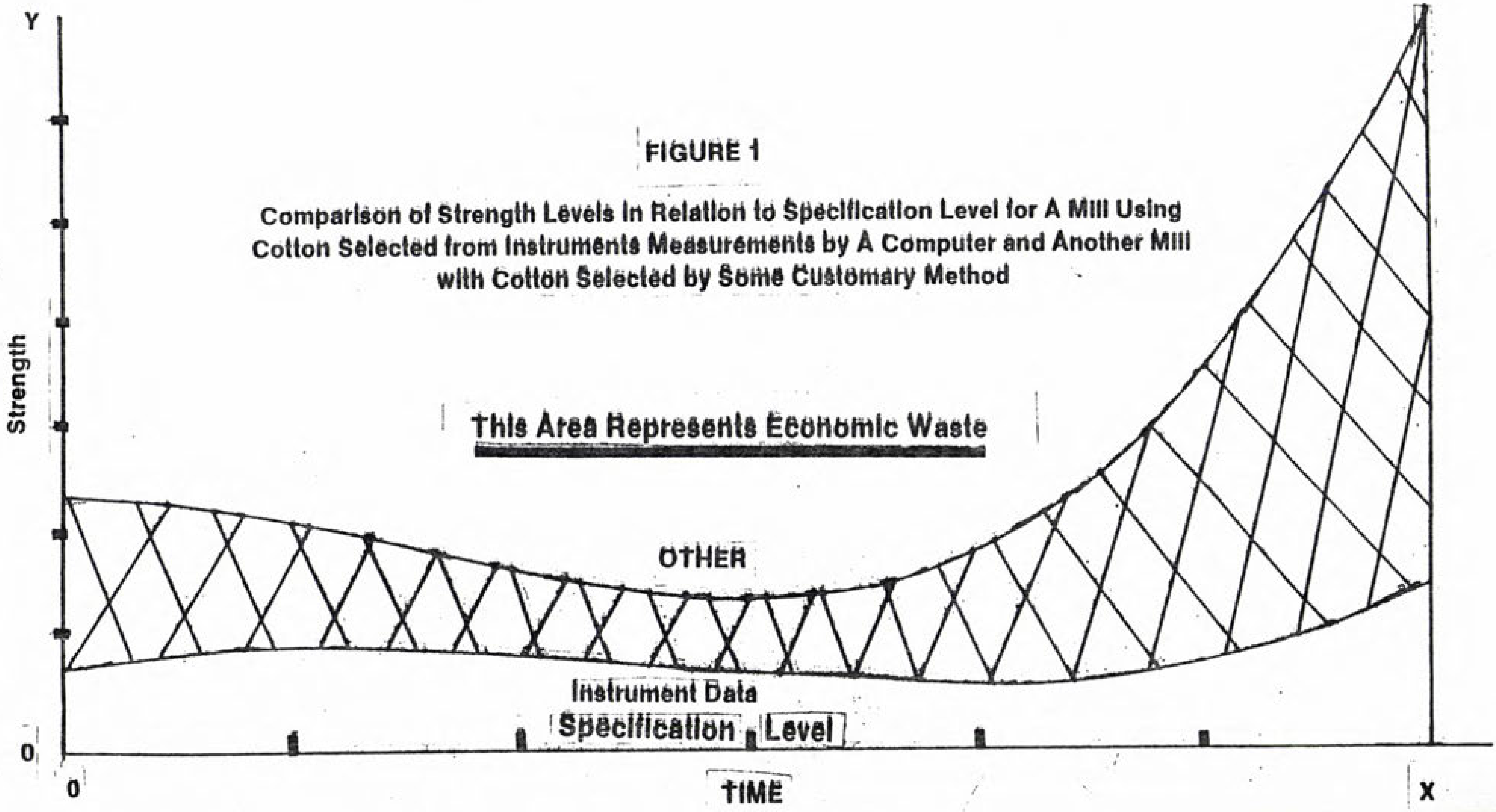


FIGURE 1

Comparison of Strength Levels In Relation to Specification Level for A Mill Using Cotton Selected from Instruments Measurements by A Computer and Another Mill with Cotton Selected by Some Customary Method

TABLE 1

Control Limit For Difference Between The Sides One Test on Each Side

Fiber Property	Control Limit	Unit
Length	.09	.00 Inch
Uniformity	7	Per Cent
Strength	6	Gms Per Tex
Micronaire*	4	Wt. Per Inch
Leaf	2	Grade Units
White**	18	1 Unit
Yellow**	9	1 Unit

*Micronaire reading x 10.

**Motion Control color scale.

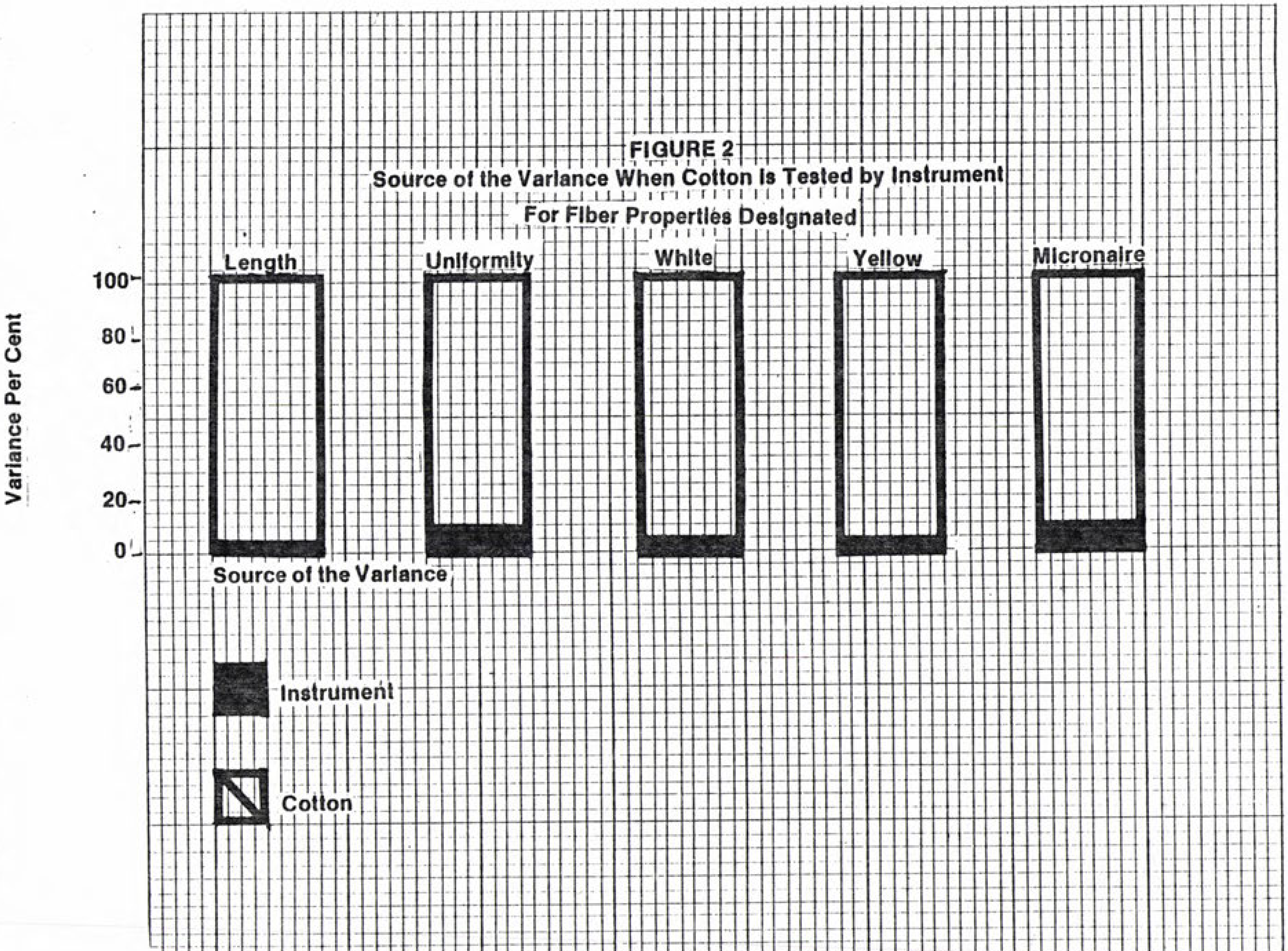


FIGURE 2
Source of the Variance When Cotton Is Tested by Instrument
For Fiber Properties Designated
Length
Uniformity
White
Yellow
Micronaire
Variance Per Cent
100
80
60
40
20
0
Source of the Variance
Instrument
Cotton

TABLE 2

Sample Of Printout By Bales And Estimated Yarn Strength 8/1

Bale	Length	Mic*	Unif.	Str.	Leaf	White	Yellow	Est. CSP
1	29	38	77	20	4	23	35	1940
2	33	34	80	25	4	38	48	2170
3	31	34	81	25	3	22	37	2288
4	32	34	79	25	4	25	35	2230
5	31	34	79	23	4	27	36	2206

*Micronaire value x 10.

Table 3
Record Of The Tests Made On Line 1 And Test Data For
The Long And Short Calibration Bales

```
STANDARD BALE LINE  1 15:13
  000040      93 93  48 50  83 81  22 24  40 40  48 48  42 42     1901  1
  000040      33     49     82     23     40     48     42      204307  1

STANDARD BALE LINE  1 15:13
* 000044      11 09  42 41  91 81  25 28  40 40  48 48  42 42     1782  1
* 000044      35     41     81<    26     40     48     42      204307  1

STANDARD BALE LINE  2 15:16
  000040      91 94  46 44  80 79  20 19  40 40  47 46  43 43     2105  2
  000040      29     45     79     19     40     46     43      204309  2

STANDARD BALE LINE  2 15:16
  000044      08 12  39 38  81 85  26 26  40 40  46 48  43 43     2116  2
  000044      35     38     83     26     40     47     43      204309  2

STANDARD BALE LINE  1 15:19
  000044      10 09  40 42  88 82  25 28  40 40  48 48  42 42     1772  1
  000044      35     41     85     26     40     48     42      204308  1
```

09:36

	REP	SUS	MUX	DAT	SID	ABT	SBN	INV	STD	NET
TOTAL	32	11	0	0	6	5	1	6	8	267
LINE 1	32	11	0	0	6	5	1	6	8	267
LINE 2	0	0	0	0	0	0	0	0	0	0

BETWEEN SIDE LIMITS EXCEEDED

	LF	CD	MF	LN	UR	ST	SR	YE
TOTAL	0	1	16	3	4	7	19	4
LINE 1	0	1	16	3	4	7	19	4
LINE 2	0	0	0	0	0	0	0	0

INVALID VALUES

	LF	CD	MF	LN	UR	ST	SR	YE
TOTAL	0	3	0	0	2	1	0	0
LINE 1	0	3	0	0	2	1	0	0
LINE 2	0	0	0	0	0	0	0	0

TOTALRUN 336
TOTAL UNSATISFACTORY BALES = 69
NUMBER OF RECORDS ON MAG TAPE = 278
ALL RERUNS HAVE BEEN RETESTED.
TAPE NUMBER 305

	TOTAL
MILL	268
SALES	10
TOTAL	278
YIELD	96.4029

Table 4
Contribution Of The Instrument And Cotton To The Total Variance Of Instrument And Cotton

Source Of Variance	Length		Uniformity	
	Variance	Per Cent	Variance	Per Cent
Cotton and instrument	.00044041	100.00	2.59596500	100.00
Instrument	.00001328	3.02	.21463300	8.27
Cotton	.00042713	96.98	2.38133200	91.73

Source Of Variance	White		Yellow	
	Variance	Per Cent	Variance	Per Cent
Cotton and instrument	8.61187716	100.00	4.25596900	100.00
Instrument	.10560000	1.23	.12040000	2.83
Cotton	8.5627716	98.77	4.13556900	97.17

Source Of Variance	Micronaire		Strength
	Variance	Per Cent	
Cotton and instrument	.0203347	100.00	Strength is a destructive test.
Instrument	.0008236	4.05	
Cotton	.0195111	95.95	

Table 5

Deviation From Average For 50 Tests Per Bale On 10 Bales Combined Into The Equivalent Of 500 Tests On One Bale

Deviation	Length	Uniformity	Strength	Micronaire	White	Yellow
12					1	
11					1	
10					2	
9					1	1
8	1				4	1
7	1				4	1
6	2	1	1		3	1
5	4	3	2		7	5
4	12	6	3		17	12
3	30	15	18	2	34	21
2	67	50	51	25	54	58
1	86	107	100	112	78	96
0	94	136	150	222	88	108
- 1	86	107	100	112	78	96
- 2	67	50	51	25	54	58
- 3	30	15	18	2	34	21
- 4	12	6	3		17	12
- 5	4	3	2		7	5
- 6	2	1	1		3	1
- 7	1				4	1
- 8	1				4	1
- 9					1	1
-10					2	
-11					1	
-12					1	
Average	0	0	0	0	0	0
St.Dev.	2.0986	1.6112	1.5492	.9592	2.9346	2.0630
Max.Ord.	95.05	123.80	128.76	207.96	67.97	96.69
Total	500	500	500	500	500	500
Control Limit*	3.82	2.93	2.82	1.75	5.35	3.76
Control Limit**	2.70	2.08	2.00	1.24	3.78	2.66

* Control limit average of two tests - control limit is plus or minus.

**Control limit average of four tests - control limit is plus or minus.

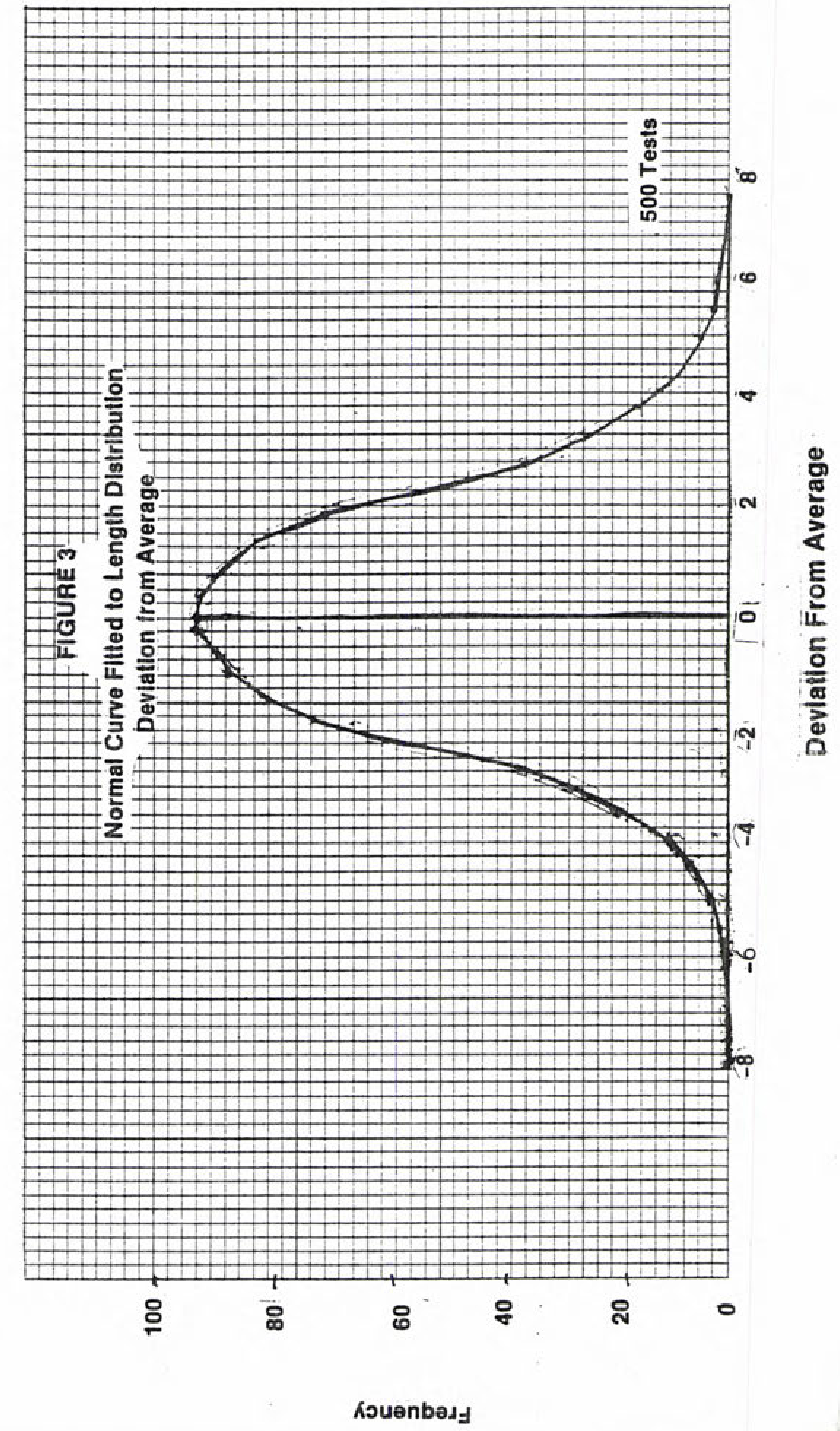


FIGURE 3
Normal Curve Fitted to Length Distribution
Deviation from Average
500 Tests
Frequency
100
80
60
40
20
0
Deviation From Average
-8
-6
-4
-2
0
2
4
6
8

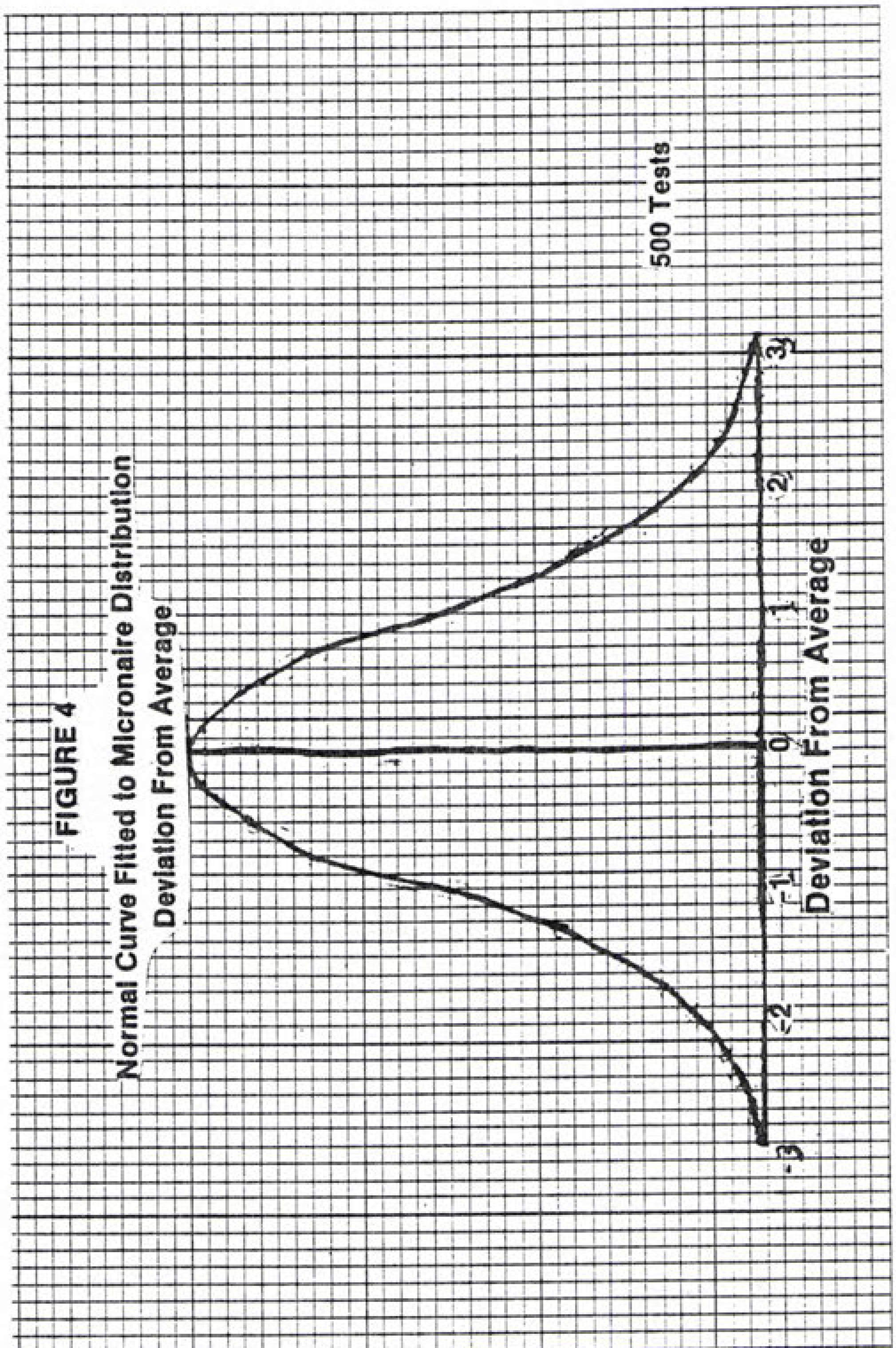


FIGURE 4
Normal Curve Fitted to Micronaire Distribution
Deviation From Average
500 Tests
Frequency
250
200
150
100
50
0
-3
-2
-1
0
1
2
3
Deviation From Average

Table 6
The Variation About The Average To Be Expected
In A Normal Bale Of Cotton Length Only

Deviation From Average*	Frequency
-8	1
-7	1
-6	2
-5	4
-4	12
-3	30
-2	67
-1	86
0	94
1	86
2	67
3	30
4	12
5	4
6	2
7	1
8	1
Total	500
Standard deviation	2.10
Maximum ordinate	95.05
Control limit average two tests	± 3.82
Control limit average four tests	± 2.70

TABLE 7

Given 50 Tests On A Bale Of Cotton The Possible Combinations Of Two Tests Are 1225. The Actual And Theoretical Combinations Are As Shown Below

Length In Inches	Actual Frequency	Theoretical Frequency
.9925	6	9.84
1.0025	66	61.27
1.0125	223	206.69
1.0225	348	366.50
1.0325	345	348.15
1.0425	174	177.18
1.0525	60	48.31
1.0625	3	7.06
Total	1225	1225.00
Standard deviation		.0126
Coefficient of variation		1.23
Chi^2		3.36
Chi^2 required at 95		1.15
Chi^2 required at 50		4.35
Average		1.0267

Table 8
Analysis Of Variance Two Classification
Data Are For Fiber Length

Variance Source	Degrees Freedom	Variance		Variance Ratio F	
		Bale 1	Bale 2	Bale 1	Bale 2
Test per position	4	12.32	53.48	1.55	2.93
Positions	9	29.52	114.88	1.66	2.80
Residual	36	71.28	164.12		
Total	49	113.12	232.48		

TABLE 9

Average Fiber Data — Instrument — For 18 Spinning Tests Open End

Fiber Property	Unit	Average*	St. Dev.	Coef. Var. Per Cent
Length	32's Inch	31.17	.83	2.66
Micronaire	1.00	41.72**	2.96	7.09
Length Uniformity	Per Cent	76.39	1.53	2.00
Fiber Strength	GPT	21.83	1.46	6.69
Leaf	1	4.33	.94	21.71
White Color	1	35.50	8.98	25.30
Yellow Color	1	48.22	7.56	15.68
8's Open End	CSP***	1945	116	5.96

*Average fiber property for 18 spinning tests.

**Micronaire value x 10.

***CSP or yarn strength x yarn number.

Source of data: Cotton Fiber and Processing Test Results—Crop 1980, Report No. 12—U. S. Department of Agriculture.

TABLE 10

Relationship Between Fiber Properties And Yarn Strength For 18 Tests*

Dependent Variable	Length	Unif.	Mic.	Str.	Leaf	White	Yellow	Coef. Cor.	Expl. Var.	Error Est.
Yarn Strength	46.23							.36	13.3	114.7
Yarn Strength	47.47	7.61						.39	15.5	116.9
Yarn Strength	29.99	12.39	-21.40					.65	42.3	100.0
Yarn Strength	.01	- 4.23	-10.62	57.02				.84	71.0	73.6
Yarn Strength	- 6.52	- 7.11	-11.48	60.54	-70.04			.87	75.5	70.4
Yarn Strength	12.77	- 5.93	- 9.44	45.68	-21.07	-4.82		.92	84.4	58.6
Yarn Strength**	15.95	- 4.94	- 9.90	44.09	-23.11	-4.41	-1.02	.92	84.7	61.0

*Source basic data USDA Report No. 12 crop of 1980. Open end yarn 8/1.

**Constant 1582.16

These data show how the importance of the various fiber properties change as others are brought into the equation. They also show there is a correlation between the various fiber properties. There is evidence of collinearity as well as synergistic effects. These must be taken into account.

TABLE 11

Relative Importance Of Fiber Properties Associated With Yarn Strength 8/1*

Fiber Property	Beta Coefficient
Length	.11
Micronaire	-.25
Uniformity	-.07
Strength	.55
Leaf	-.19
White	-.34
Yellow	-.07

*Remember the beta's shown apply only to results for the 18 tests used in this example. Data from Report No. 12—USDA Crop of 1980.

Table 12
Actual Yarn Strength Values Compared With Yarn Strength Estimated From Fiber Properties

Test No.	Strength Test	Estimated Strength	Difference
1	1832	1924	92
2	1928	1975	47
3	2088	2095	7
4	1976	1946	-30
5	1968	1979	11
6	1936	1905	-31
7	1904	1908	4
8	1818	1830	14
9	2072	2004	-68
10	1960	1958	- 2
11	1960	1923	-37
12	1840	1894	54
13	2040	2119	79
14	1976	1955	-21
15	1824	1843	19
16	2256	2185	-71
17	1888	1854	-34
18	1752	1711	-41
Average	1945	1945	00
Standard dev.	116	108	45

TABLE 13

Example Of Mix Data Report

Bale No.	HPR	Fiber Property Length	Mic.	Unif.	Strg.	Leaf	White	Yellow	Est. CSP
35	5	33	32	80	25	4	24	37	2263
89	5	32	30	80	25	4	23	43	2265
73	2	31	31	79	27	3	33	43	2311
45	4	32	31	82	24	3	23	45	2222
37	1	33	31	79	24	3	29	43	2174

*Micronaire value x 10.

TABLE 14

Fiber Properties And Estimated Yarn Strength For Blend 1

Bale No.	Length	Mic.	Unif.	Fiber Prop. Str.	Fiber Prop. Leaf	White	Yellow	Est. CSP
14	32	32	80	24	4	29	45	2172
58	33	31	77	26	4	22	36	2341
37	33	31	79	24	3	29	43	2174
80	31	31	78	27	4	25	38	2333
61	32	32	80	25	4	22	38	2254
Average	32.0	31.4	78.8	25.2	3.8	25.4	40.0	2255
St. Dev.	.7483	.4899	1.1662	1.1662	.4000	3.1369	3.4059	73.3905

Table 15

Fiber Properties And Estimated Yarn Strength Blend 2

Bale No.	Fiber Property Length	Mic.	Unif.	Str.	Leaf	White	Yellow	Estimated CSP
23	30	32	80	25	4	28	42	2192
19	32	30	78	26	4	23	36	2326
755	32	32	80	24	3	27	50	2199
73	31	31	79	27	3	33	43	2311
99	32	32	80	25	4	23	42	2246
Average	31.4	31.4	79.4	25.4	3.6	26.8	42.6	2255
St. Dev.	.8000	.8000	.8000	1.0198	.4899	3.7094	4.4542	55.4307

Table 16

Fiber Properties And Estimated Yarn Strength Blend 3

Bale No.	Fiber Property Length	Mic.	Unif.	Str.	Leaf	White	Yellow	Estimated CSP
573	33	32	79	24	4	26	43	2209
82	31	31	79	25	3	14	40	2301
38	33	32	80	24	4	24	41	2215
55	34	31	81	25	4	19	39	2304
21	31	31	78	24	3	22	47	2229
Average	32.4	31.4	79.4	24.4	3.6	21.0	42.0	2253
St. Dev.	1.2000	.4899	1.0198	.4899	.4899	4.1952	2.8284	44.2836

Table 17

Fiber Properties And Estimated Yarn Strength Blend 4

Bale No.	Fiber Property Length	Mic.	Unif.	Str.	Leaf	White	Yellow	Estimated CSP
01	30	32	80	25	3	35	50	2220
78	32	32	78	25	4	14	36	2302
45	32	31	82	24	3	23	45	2222
92	33	30	80	25	3	23	53	2294
26	31	31	81	25	5	16	39	2246
Average	31.6	31.2	80.2	24.8	3.6	20.2	44.6	2257
St. Dev.	1.0198	.7483	1.3266	.4000	.8000	4.3543	6.4062	34.9537

Table 18

Fiber Properties And Estimated Yarn Strength Blend 5

Bale No.	Length	Mic.	Unif.	Fiber Property Str.	Leaf	White	Yellow	Estimated CSP
66	32	31	79	25	4	30	43	2229
35	33	32	80	25	4	24	37	2263
67	30	32	79	26	4	24	37	2264
51	32	32	77	25	4	23	43	2260
89	32	30	80	25	4	23	43	2265
Average	31.8	31.4	79.0	25.2	4.0	24.8	40.6	2256
St. Dev.	.9798	.8000	1.0954	.4000	.0000	2.6382	2.9394	13.7026

Table 19

Average Fiber Property And Estimated Yarn Strength For Blend Designated

Part A

Blend No.	Length	Mic.	Unif.	Str.	Leaf	White	Yellow	Estimated CSP
	Fiber Property							
1	32.0	31.4	78.8	25.2	3.8	25.4	40.0	2255
2	31.4	31.4	79.4	25.4	3.6	26.8	42.6	2255
3	32.4	31.4	79.4	24.4	3.6	21.0	42.0	2253
4	31.6	31.2	80.2	24.8	3.6	20.2	44.6	2257
5	31.8	31.4	79.0	25.2	4.0	24.8	40.6	2256

Part B
Standard Deviation

Blend No.	Length	Mic.	Unif.	Str.	Leaf	White	Yellow	Estimated CSP
	Fiber Property							
1	.7483	.4899	1.1662	1.1662	.4000	3.1369	3.4059	73.3905
2	.8000	.8000	.8000	1.0198	.4899	3.7094	4.4542	55.4307
3	1.2000	.4899	1.0198	.4899	.4899	4.1952	2.8284	44.2836
4	1.0198	.7483	1.3266	.4000	.8000	4.3543	6.4062	34.9537
5	.9798	.8000	1.0954	.4000	.0000	2.6382	2.9394	13.7026

TABLE 20

Example Of How Fiber Properties Compensate As Contributors To Yarn Strength

Fiber Property	Regression Value	Fiber Units Blend A	Fiber Units Blend B	Dif.	Extension* Blend A	Extension* Blend B
Length	15.95	30	34	+4	478.50	542.30
Uniformity	- 4.94	78	77	-1	- 385.32	- 380.38
Micronaire	- 9.90	38**	37**	-1	- 376.20	- 366.30
Strength	44.09	26	24	-2	1146.34	1058.16
Leaf	-23.11	4	4	0	- 92.44	- 92.44
White	- 4.41	25	23	-2	- 110.25	- 101.43
Yellow	- 1.02	45	45	0	- 45.90	- 45.90
Constant	1582.16	1	1		1582.16	1582.16
Total					2197	2196

*Extension = Regression value X fiber units.

**Micronaire value X 10.

Table 21

Direct And Indirect Contribution Of The Various Fiber Properties To The Explained Variance Yarn Strength

Source	Fiber Property	Contribution To* Explained Variance
Direct	Length	1.53
Direct	Strength	32.36
Direct	Micronaire	2.16
Direct	Uniformity	1.97
Direct	Leaf	.09
Direct	White	8.34
Direct	Yellow	6.17
Total		52.62
Indirect	Length & Strength	5.59
Indirect	Length & Micronaire	1.02
Indirect	Length & Uniformity	1.50
Indirect	Length & Leaf	.23
Indirect	Length & White	2.50
Indirect	Length & Yellow	- 1.87
Indirect	Strength & Micronaire	5.57
Indirect	Strength & Uniformity	6.38
Indirect	Strength & Leaf	.80
Indirect	Strength & White	8.92
Indirect	Strength & Yellow	- 8.80
Indirect	Micronaire & Uniformity	1.31
Indirect	Micronaire & Leaf	1.95
Indirect	Micronaire & White	2.60
Indirect	Micronaire & Yellow	- 2.98
Indirect	Uniformity & Leaf	.23
Indirect	Uniformity & White	2.90
Indirect	Uniformity & Yellow	- 2.31
Indirect	Leaf & White	.53
Indirect	Leaf & Yellow	- .28
Indirect	White & Yellow	- 6.13
Indirect Total	Length	8.98
Indirect Total	Strength	18.46
Indirect Total	Micronaire	7.71
Indirect Total	Uniformity	10.02
Indirect Total	Leaf	1.70
Indirect Total	White	11.31
Indirect Total	Yellow	- 22.38
Total		35.80
Net Effect	Length	10.51
Net Effect	Strength	50.82
Net Effect	Micronaire	9.87
Net Effect	Uniformity	11.99
Net Effect	Leaf	1.79
Net Effect	White	19.65
Net Effect	Yellow	- 16.21
Total Explained Variance		88.42
Coefficient Of Multiple Correlation		.94

TABLE 22

Directed And Indirect Contribution Of The Various Fiber Properties To The Explained Variance — Yarn Strength

Fiber Property	Source Of Variance Direct %	Indirect %	Total %
Length	1.53	8.98	10.51
Strength	32.36	18.46	50.82
Micronaire	2.16	7.71	9.87
Uniformity	1.97	10.02	11.99
Leaf	.09	1.70	1.79
White	8.34	11.31	19.65
Yellow	6.17	-22.38	-16.21
Total	52.62	35.80	88.42

TABLE 23

Comparison Of Duplicate Tests* For Length Made On The Same Cotton By Classer And Instrument

Classer Number	Explained Variance Per Cent	Instrument Number	Explained Variance Per Cent
1	65	1	88
2	31	2	79
3	9	3	84
4	54	4	91
5	63	5	81
Average	44	Average	85
Standard deviation	21.43		4.41
Coefficient variation	48.70		5.21

*Second test made one month after first test.

TABLE 24

Explained Variance Associated Yarn Strength When Classer And Instrument Data Are Related To Yarn Strength

Source Of Data*	Explained Variance
Instrument	86%
Classer	56%
Instrument advantage	30%

THE DEAD HAND OF THE PAST

1. WE WERE TOLD WE COULD NOT MAKE ACCEPTABLE DENIM FOR LEVI-STRAUSS & CO. FROM HIGH PLAINS COTTON.

2. WE WERE TOLD THE COTTON WOULD HAVE TO BE SELECTED BY A CLASSER.

3. WE WERE TOLD WE COULD NOT USE INSTRUMENT MEASUREMENTS TO SELECT COTTON FOR THE MILL.

4 WE WERE TOLD WE COULD NOT SELECT THE MIXES USING A COMPUTER.

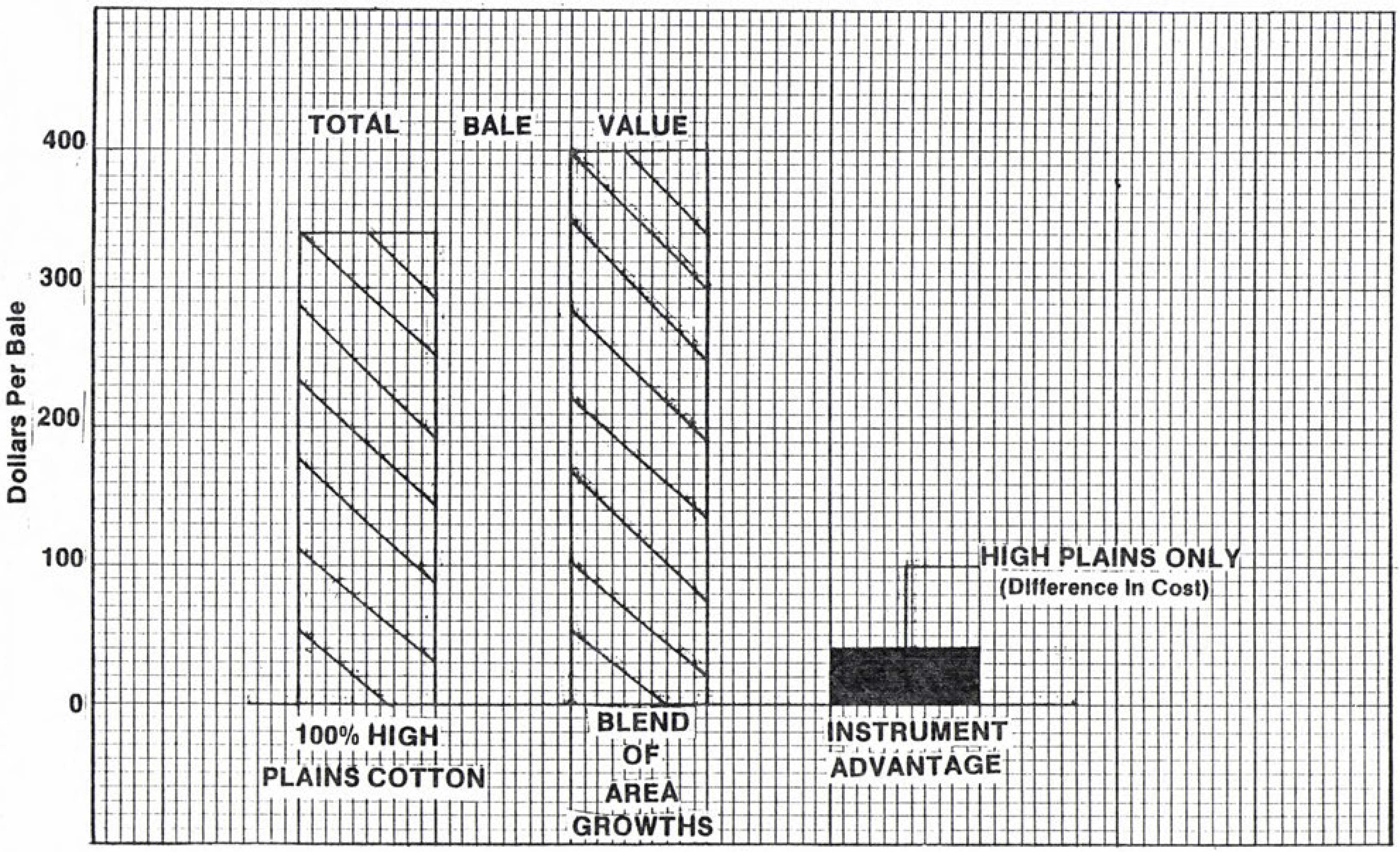
5. WE WERE TOLD WE COULD NOT MAKE SATISFACTORY WARP YARN WITH OPEN-END EQUIPMENT.

6. WE HAVE DONE THESE THINGS AND MORE.

7. THERE ARE 1,000 EXCUSES WHY A NEW TECHNIQUE WILL NOT WORK FOR A SINGLE REASON WHY IT WILL.

FIGURE 5

Advantage of Using High Plains Cotton Over Blends of All Growths



LANDED MILL PRICES GROUP 201 MILL POINTS USDA DATA