RESULTS AND DISCUSSION

The relationship between short fiber content based on weight and either fiber or yarn traits, based on simple linear regression analysis, relatively varied among the studied 6 Egyptian cotton cultivars. This variation resulted due mainly to differences in the magnitude of the response of these dependent variables to the changes in the percentage short fiber content as the independent variable, not to the direction of the relationship as expressed by the fitted regression equation.

Generally, adopting to fit a first order linear regression model, to both fiber and yarn data of the different cultivars according to the two particular staple length groups used in this study, seemed satisfactory to establish these relationships. This model was mainly chosen to be fitted based on the data space applied in this study. Moreover, estimated model parameters, i.e. slope and intercept, were evaluated for statistical significance being different from zero. The amount of variation in the dependent variable explained by the independent variable being in the model (the coefficient of determination, R^2) was also taken into consideration.

Almost all fitted regression equations had negative estimated regression slopes (b_1) which mean a negative relationship among both fiber and yarn traits on one side and short fiber content in cotton cultivars on the other side. However, some fiber and yarn traits exhibited a positive relationship with short fiber content in all sampled cot-

Second, in Figures 2, 4, 8, and 9, the fitted regression lines took a 'megaphone'-like shape. In which, fitted lines were close at one end, yet this closeness tended to gradually expand at the other end. In Figures 4 and 9, lines took the 'outward' megaphone shape towards the high SFC; however, in Figures 2 and 8, lines followed the 'inward' shape towards the high SFC.

In the case of 'outward' shape, at relatively lower short fiber content, cultivars Giza 45 and Giza 88 were equally likely to maintain close UQL values of about 0.5 mm difference at 4% SFC, but cv. Giza 45 did not maintain this trivial magnitude in its UQL to that of Giza 88 at higher SFC (Fig. 4) since the difference expanded to reach almost 2.0 mm at 11% SFC.

Fiber uniformity ratio followed both directions only within the long staple cultivar category; first in case of cultivars Giza 85 and 86, lines followed an inward-like shape (Fig. 8), but in case of cultivars Giza 80 and 90 lines followed an outward-like one (Fig. 9). In the former case, the magnitude of the difference at both ends of the megaphone shape was trivial; however, the shape was, in the latter case, quite wide open as SFC increased up to 13% to make about a 4-point difference in uniformity ratio between the cultivars.

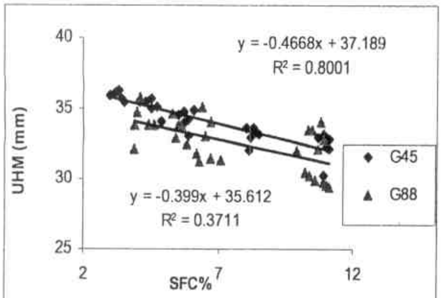

Fig. 1. Relationship between SFC and upper half mean (UHM) of G 45 and G88 cultivar.

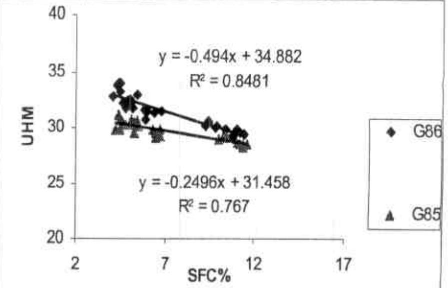

Fig. 2. Relationship between SFC and upper half mean (UHM) of G86 and G85 cultivar.

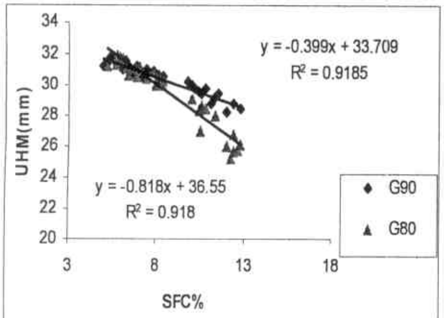

Fig. 3. Relatioship between SFC and upper half mean (UHM) of G90 and G 80 cultivar.

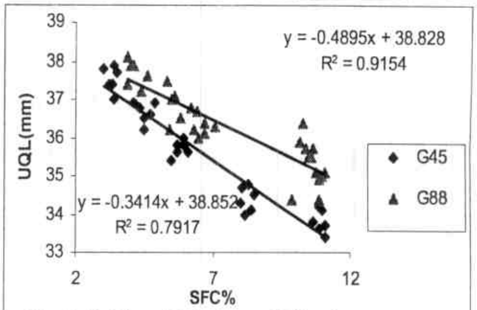

Fig. 4. Relationship between SFC and Upper Quartile length (UQL) of G 45 and G88 cultivar.

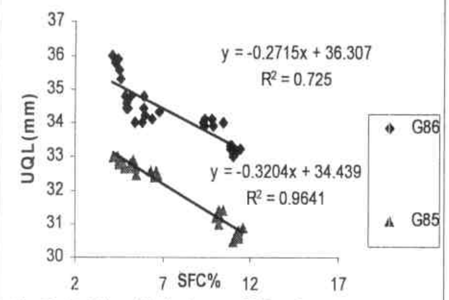

Fig. 5. Relationship between SFC and upper quartile length (UQL) of G86 and G85 cultivar.

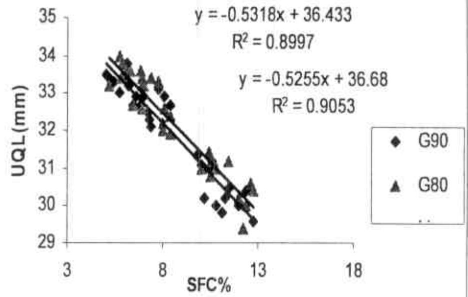

Fig. 6. Relationship between SFC and upper quartile length (UQL) of G90 and G 80 cultivar.

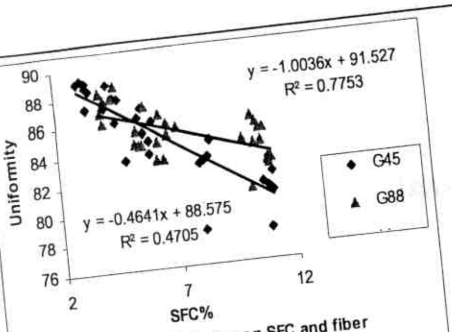

Fig. 7. Relationship between SFC and fiber uniformity ratio of G 45 and G88 cultivar.

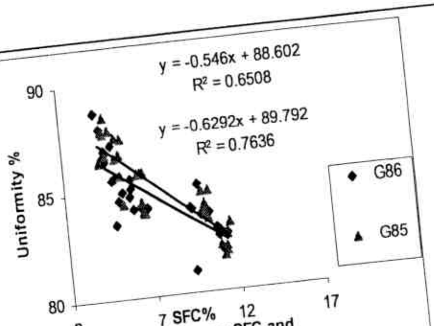

Fig. 8. Relationship between SFC and fiber uniformity ratio of G86 and G85 cultivar.

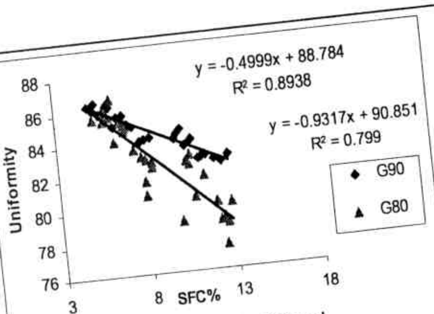

Fig. 9. Relationship between SFC and fiber uniformity ratio of G90 and G80 cultivar.

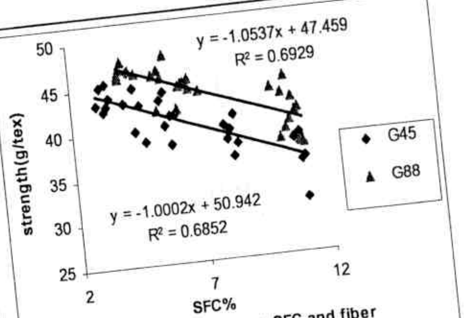

Fig. 10. Relationship between SFC and fiber strength of G45 and G88 cultivar.

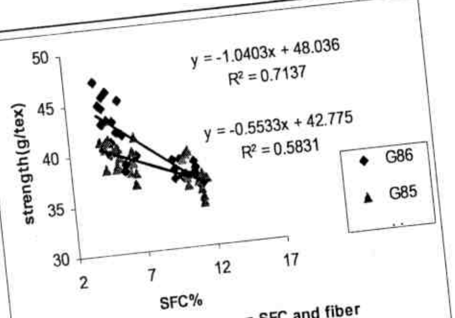

Fig. 11. Relationship between SFC and fiber strength of G86 and G85 cultivar.

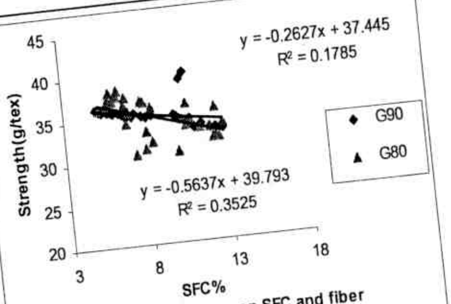

Fig. 12. Relationship between SFC and fiber strength of G90 and G80 cultivar.

Third, the fitted lines for each pair of cultivars reversed direction at some point of SFC. The first occurred in case of fiber uniformity ratio for cultivars Giza 45 and Giza 88 (Fig. 7); the second happened in case of upper half mean length for cultivars Giza 80 and Giza 90 (Fig. 3). In either case, the fitted regression lines reversed directions as short fiber content increased. The magnitude of fiber uniformity ratio gradually dropped more rapidly for Giza 45 than for Giza 88 as short fiber content increased. At about short fiber content of about 7%, fiber uniformity ratio started to decrease from about 86% to reach about 81% at short fiber content of 12% for Giza 45, but the ratio dropped to about 84% by reaching a short fiber content of 12% for Giza 88 (Fig. 7). In the second case, the upper half mean length of cv Giza 80 followed the pattern cv Giza 45 did earlier for fiber uniformity ratio. Since both cultivars, Giza 80 and Giza 90, had very close expected upper half mean length at low short fiber content <7%. However, as SFC increased up to 13%, UHML values started to reverse beyond SFC of 7% to make a difference of at least 3 mm between the two cultivar expected values (Fig. 3).

Based on the above, although in both cases there were sharp reductions in the fiber length trait of any of the studied cultivars as SFC increased, it is worthy to mention that for any of the studied fiber length parameters, differences among cultivars for any of which is likely to be more aggravated by high percentage SFC compared to those minor differences at low SFC. For any reason(s) that lead to cause the presence of higher SFC in cotton samples, cultivar fiber length traits seemed to be more likely to

Table 1. Parameter estimates for cultivar length characters by fitting a first-order linear regression model.

				Parameter Estimates				
Character[†]	Variable[‡]	Esti-mate	St. error	P>t	Variable	Estimate	St. error	P>t
			Giza 45				Giza 88	
UHM (mm)	B_0	37.1889	0.313632	0.0001	B_0	35.6116	0.783172	0.0001
	B_1	-0.4668	0.044097	0.0001	B_1	-0.3989	0.098161	0.0001
			Giza 86				Giza 85	
	B_0	34.8815	0.305076	0.0001	B_0	31.4581	0.208973	0.0001
	B_1	-0.4940	0.039506	0.0001	B_1	-0.2496	0.025998	0.0001
			Giza 90				Giza 80	
	B_0	33.7088	0.196226	0.0001	B_0	36.5501	0.420634	0.0001
	B_1	-0.3989	0.022457	0.0001	B_1	-0.8180	0.046198	0.0001
			Giza 45				Giza 88	
UQL (mm)	B_0	38.8278	0.200081	0.0001	B_0	38.8520	0.264046	0.0001
	B_1	-0.4895	0.028131	0.0001	B_1	-0.3414	0.033095	0.0001
			Giza 86				Giza 85	
	B_0	36.3069	0.244054	0.0001	B_0	34.4386	0.093897	0.0001
	B_1	-0.2715	0.031604	0.0001	B_1	-0.3203	0.011681	0.0001
			Giza 90				Giza 80	
	B_0	36.4326	0.293213	0.0001	B_0	36.6804	0.292485	0.0001
	B_1	-0.5318	0.033557	0.0001	B_1	-0.5255	0.032124	0.0001
			Giza 45				Giza 88	
UI (%)	B_0	91.5266	0.726200	0.0001	B_0	88.5748	0.742333	0.0001
	B_1	-1.0036	0.102105	0.0001	B_1	-0.4640	0.093042	0.0001
			Giza 86				Giza 85	
	B_0	88.6024	0.583706	0.0001	B_0	89.7923	0.531744	0.0001
	B_1	-0.5460	0.075588	0.0001	B_1	-0.6292	0.066153	0.0001
			Giza 90				Giza 80	
	B_0	88.7840	0.284554	0.0001	B_0	90.8505	0.804008	0.0001
	B_1	-0.4998	0.032566	0.0001	B_1	-0.9316	0.088305	0.0001

[†] UHM= upper half mean length, UQL= upper quartile length, and UI=uniformity index.

[‡] B_0= intercept, B_1= slope.

greatly vary even if these cultivars have in the average nearly equal staple length. On the other hand, if percentage SFC is being under control and is minimal, cultivars may be handled equally as far as fiber length traits are concerned.

First, the dependence of any studied trait on SFC, ignoring cultivar grades, was evaluated. Estimated parameters and their standard errors as well as their significance are shown in Table 1-4. For any particular length trait, both parameters were statistically different ($p < 0.01$). This indicates that SFC partially contributes to variation in the dependent variables, given that the intercept had been admitted and significantly contributed in the total variation.

All estimated slopes were negative and <1.0 (Figs. 1-9) and very different from zero ($p<0.05$) (Table 1). This indicates that SFC explains a great part of the total variation in the mean response fiber trait. They ranged from -0.2715 for cv. Giza 86 UQL (Fig. 5) to -0.6292 for UI (Fig. 8). Yet there were three exceptions where values approached -1.0. First for UHML (= -0.818) (Fig. 3). Second for fiber uniformity ratio of cv Giza 45 where the estimated slope was perfectly negative (= - 1.003) (Fig. 7), and third for UI (= -0.9317) (Fig. 9), both for cv Giza 80. These slopes represented the cases mentioned earlier in which fitted lines were intercrossed at some SFC point since the fitted slopes of the accompanied cultivar exhibited an estimated slope value nearly as half as much.

At any given value of the predictor variable, X, the expected mean of the response variable, Y, is influenced by both the fitted line slope and the intercept (Weisberg, 1980; Draper and Smith, 1981). The estimated fitted line intercepts (b_0) though statistically different from zero ($p<0.01$) (Tables 1-4), their estimated values did not differ much either between fitted lines of cultivars within the same staple length group or among groups (Figs. 1-9) for any particular length trait. The same result may be extended to the estimated line slopes of any of the three studies fiber length traits for any two cultivars within the same staple length group.

Therefore, predictions of length parameters, for these stable length-grouped cultivars based on SFC domain close to the present in the samples reported herein, may be to some extent taken as preliminary indicators in setting up future studies. This depends on the model being correct and does not suffer any lack of fit nor do data sets violate model basic assumptions.

In addition, there is, however, the major problem of the very high variation of the measured SFC (Cui et al., 2004; Heap, 2004) irrespective of the used instrument in measuring different length parameters. The length parameters and their variations, as Cui et al. (2004) reported, may vary to an extent due to sampling, sample preparations, sample size, principles of measurements, and calibration. These instruments varied to include HVI, AFIS, Suter-Webb Array, and Iso Tester. To confirm this high variations in length parameters, Knowlton (2002) reported that the reproducibility of short fiber index between HVI's averaged as low as 57%.

Among the ways to deal with high variations in length parameters especially in short fibers is to search for other length parameters with less tolerable variations that can characterize and predict SFC. The criteria for selecting alternative parameters to SFC, as Cui et al. (2004) suggest are: (i) be able to characterize short fiber well (having high correlation with SFC), (ii) have less variation than that of SFC, and (iii) be able to predict spinning performance and yarn quality as well as or better than SFC does.

Knowlton (1999) poses using 'longer' fiber parameters (UHML, UI) that have less variability to predict SFC. The perspective of Cui et al. (2004, 2004a), regarding the same issue though different, but it underlies the same basis. They suggest searching for other statistical parameters of 'shorter' fiber length distribution that also characterize the shorter fiber section. These parameters include "Lower Quartile Length" (LQL), and "Lower Half Mean Length" (LHML).

The LQL is the length that is exceeded by 75% of the fibers, by weight or by number, of the specimen. The LHML is the mean length by number of the shorter one-half (50%) by weight of the fibers. In addition, the values of SFC by weight defined by length limits of 0.3, 0.4, 0.6, and 0.7 inches ($SFC_{W\,0.3}$, $SFC_{W\,0.4}$, $SFC_{W\,0.6}$, and $SFC_{W\,0.7}$) were also estimated and compared with the commonly-used SFC defined by 0.5 inches ($SFC_{0.5}$). Cui et al. (2004a) further added that the value of short fiber content increases non-linearly as the limiting length increases. For instance, the difference between $SFC_{W\,0.3}$ and

$SFC_{W\,0.4}$ is 2.6%, while the difference is 6.1% between $SFC_{W\,0.6}$ and $SFC_{W\,0.7}$.

Cui et al. (2004, 2004a) based their conclusions on samples taken from a set of 21 bales of U.S Upland cotton in an American Textile Manufacturers Institute (ATMI) collected from 14 cotton cultivars grown in different locations in the U.S. Fiber length parameters were estimated on an AFIS based on using 5 replications and 5,000 fibers in each replication. They estimated both coefficients of variation, CV%, of various fiber length parameters and simple correlation coefficients, r, among them. They concluded that the CV of the short fiber content is about 6.8 times higher than that of UQL_W and UHML, while the CV of LHML is one third that of short fiber content. The CV of SFC decreased as the limiting length defining the short fiber content increases. Since mean CV% of SFC, defined by length limits from 0.3-0.7 inches, linearly decreased from 10.33 % to 8.05% as length limit increased from 0.3 inches to 0.7 inches, this confirms the difficulty of having a reliable estimate of SFC.

Regarding correlation, the short fiber content defined by 0.5 inches shows very high correlation coefficients with short fiber content defined by other lengths (r = 0.954 to 0.994). The LHML also shows a very strong negative correlation (-0.987) with short fiber content $SFC_{0.5}$. The uniformity index, UI, does contain significant amount of information about short fiber content (r = - 0.791) (Cui et al., 2004a). On the other hand, they indicated that the UHML and UQL_W seem to contain very little information on short fiber content (r = 0.072 and 0.028, respectively). They comment on this result: "This contradicts our general beliefs and needs to be further investigated." Unfortunately, concerning this contradicting result of the almost no contribution of both UHML and UQL in the variation in mean SFC, the authors do not offer in their paper any likely explanation. The contradiction, in their context, most likely implies that short fiber content is expected to some degree be negatively correlated to both length parameters.

By comparing spindle-harvested and stripper-harvested ultra narrow row cotton, McAlister III and Rogers (2005) found a difference of about +2.3 mm (28.19 mm vs. 25.91mm) in UHML and of about +2.45 % (80.75 vs. 78.33) in UI. The percentage SFC_W was caused to make a margin of about 75% difference (9.5% vs. 16.7 %) between the two treatments, respectively. Both UI and UHML were measured using HVI, and SFC_W using AFIS. They comment that since the fiber uniformity index is considered as a measure of the fiber length distribution in a sample, therefore a low UI value would indicate that there are more short fibers in a sample than in one with a high UI value for cottons of the same UHML. Their argument does not tell that UHML is not totally uncorrelated to SFC, but it does indicate how UI is quite more relatively informative about the SFC than does the UHML in a sample. Theoretically their conclusion makes sense; however, it is not tangible, for it is not clear from their data how they have arrived to this general conclusion since they have not carried out any statistical tests to confirm their conclusion.

The finding of Cui et al. (2004, 2004a) indicates that UI has the least variation among the studied length parameters and a high negative correlation with SFC. This may substantiate that of McAlister III and Rogers (2005) regarding their argument in favor of the very same length parameter.

The set of 'shorter length parameters' suggested by Cui et al. (2004, 2004a) –LQL_n, LQL_w, and UHML-- though having relatively high negative correlations with SFC compared to those between UI and SFC; yet the data show that these suggested length parameters' mean CVs are relatively higher than both of the UI's and of the longer length parameters' (UQL, UHML). The authors indicate that the SFC can be estimated with good accuracy based on LHML since a simple linear regression yielded R^2 of 0.97. They, therefore, concluded that based on LHML being, in addition, highly correlated to $SFC_{0.5}$, and less varied, it becomes a good candidate for characterizing short fibers of cotton.

To characterize SFC, the authors' argument they pose to choose LHML, among the other length parameters, was somewhat subjective. The LQL_w is one of the cotton fiber length parameters suggested by Cui et al. (2004, 2004a) that also characterize the short fiber portion. It has both lower variation (2.98%) and nearly equal negative correlation (r= -0.937) with $SFC_{0.5}$ as their data indicate. But, LQL_n, has nearly twice as much variation, (CV=5.09%) and comparatively quite wider range as those of either LHML or LQL_w. They do not report the coefficient of determination value, R^2, for predicting SFC from LQL_w as they did for LHML. These are the same criteria the authors base their choice of LHML on. In addition, the UI is greatly less varied than either character, but has comparatively lower simple correlation coefficient (r = - 0.807) by a negligible margin to $SFC_{0.5}$ as has been mentioned earlier. It is also about equally correlated to either LQL_w (r = 0.651) or LHML (r = 0.710).

In relating short fiber content to either fiber or yarn quality traits, Emam, Abdel-Fattah, and Mabrouk (1997) followed a different perspective. They artificially initiated different SFC using four 20%-80% carded and combed noil-added cotton samples in three Egyptian cotton cultivars. Short fiber content --ranged from as low as 8% to 35% over the three cultivars-- increases as the percentage noil is high in the four categories. Suter-Webb mean fiber UQL and mean length (ML) gradually decrease as percentage SFC increases in the sample. However, they report that fiber ML is more sensitive to high SFC than is UQL particularly in the extra-long staple cultivar, Giza 76. In addition, HVI fiber percentage uniformity ratio is also reduced as noil content is high. The Suter-Webb percentage fiber length CV increases from 32% to 48% averaged over cultivars as percentage noil increases.

It is true that different noil-blended cotton technique enables researcher to have a more wide range of percentage SFC than can be inherently found in a natural cotton sample. This, therefore, puts studying the relationship between this naturally narrow-ranged fiber trait mean and other traits in a more wide perspective. However, noil does not solely contain just short fibers; it contains other trash materials in different ratios. The post analysis of variance mean separation tool used by Emam et al. (1997) can not really refers the various effects on the response variable(s) to the effect of just one component of the noil, that is in this case the short fiber content. Since the effect(s), if present, of the other trash contents present in the noil are confounded with that of short fibers.

2. Fiber tensile and color-related traits

For each staple length-based cultivar category, Figures 10-21 show the relationship between SFC and two tensile-related traits: fiber strength (STR), and percentage fiber elongation (EL); two color-related traits: percentage reflectance (RD), in addition to yellowness degree (+B). These figures presented the first-order linear regression fitted lines for short fiber content vs. STR (Figs. 10-12), vs. EL (Figs. 13-15), vs. RD (Figs. 16-18), and vs. +B (Figs. 19-21).

In these two fiber trait groups, all dependent traits were negatively related to SFC (Figs. 10-18) except for yellowness degree (+B), which was positively related (Figs. 18-21). Both the intercept and the slope were extremely different from zero ($p<0.05$) (Table 2)

The R^2 values considerably varied across all traits. They, generally, ranged from as low as 18% and 35% for STR (Fig. 12) to as high as 92% for both percentage RD (Fig. 18) and yellowness degree (+B) (Fig. 21). These values were all associated with the Giza 90 and Giza 80 group.

Fiber strength had a perfect negative rate of change with SFC in case of both Giza 45 and Giza 88 (Fig. 10, Table 2) based on the value of the fitted line slope in either case (-1.00 vs. –1.05). In addition, both cultivars showed a nearly equal fitted intercepts (47.45 vs. 50.94 g tex^{-1}). Both cultivar mean fiber strength, therefore, were expected to be closely equally predicted at any particular mean SFC. Giza 86 fiber strength responded similarly as these two cultivars did (Fig. 11, Table 2); however, Giza 85's fiber strength response was half as much. For this differential in rate of response and the relatively lower fitted intercept of Giza 85's fiber strength, the expected mean responses were narrowed down as SFC getting higher (Fig. 11). The rate of fiber strength reduction of each of the other three cultivars --Giza 85, Giza 90, and Giza 80— was nearly half as much or less (Figs. 11 &12) relative to the other cultivar group's responses. The latter two cultivar SFCs did not explain much of the variation in the mean fiber strength. This was based on the low values of R^2 being 18% and 35% (Fig. 12).

The fore-mentioned results need to be commented on. Unlike the moderate contribution of SFC in explaining the total variation in mean fiber strength of four cultivars, causes of these latter two quite low R^2 values, in case of Giza 90 and Giza 80, need to be thoroughly investigated. Before trying to fit other regression models, it seems necessary to identify reason(s) that may contribute to better explore variations in fiber strength. A reason responsible for this poor fit might be due to high sampling variations either within and/or between collected samples of either cultivar. High variability is a common feature of short fiber content regardless of cultivar, yet this high variability is sample dependent to a very great extent. If the hypothesis for testing the equality of intercepts was not rejected, pooled data over Giza 45 and Giza 88, as well as over Giza 86, therefore, may of the noil, that is in this case the short fiber content. Since the effect(s), if present, of the other trash contents present in the noil are confounded with that of short fibers.

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Percentage fiber elongation response was not much different from fiber strength in its response to SFC present in various cultivars' samples (Figs. 13-15). However, SFC, in this case, was much better in explaining the total variation in fiber elongation compared to fiber strength since values of R^2 ranged from 44% to almost 88%. In addition both fitted regression parameters were nonzero ($p<0.05$) (Table 2) for all fitted lines across all cultivars.

Giza 45 and Giza 88 response pattern of fiber elongation to SFC was similar to that of fiber strength. Both intercepts and slopes were very close, this led to nearly parallel fitted lines. The fitted equations yielded, in case of cvs. Giza 90 and Giza 80, relatively higher values of the rates of change in percentage fiber elongation (-0.421 and -0.366) (Fig. 14) compared to those (-0.251 and -0.232) (Fig. 13) in case of the former two cultivars. Hence, the drop in fiber elongation is comparatively much greater for each unit increase in SFC of Giza 90 and Giza 80. The opposite yet was true in case of fiber strength reduction since the rate of drop was much greater in case of Giza 45 and Giza 88. Since fiber elongation is much related to fiber breakage when fibers experience stress during processing, it is much likely expected to find the rate of drop in these two associated fiber traits to vary less in response to the same unit increase in the predictor variable, i.e. SFC for the same cultivar.

On the contrary, in Emam et al.'s (1997) study, the three cultivars --Giza 76, Giza 75, Dandara-- did not show much differences ($p>0.05$) in either fiber strength or percentage fiber elongation among the five noil-added cotton samples. These within-cultivar non significant differences occurred no matter how these added noils have caused a diverse range of short fiber content in each cultivar. This induced SFC range is much wider than the inherent one used in my study. Also, since Giza 76 is being classified as an extra long staple, and both Giza 75 and Dandara as long staples, their fiber tensile traits all responded similarly to various combing wastes.

Cotton color can be described by degree of reflectance (RD) and degree of yellowness (+B). The range is between 40 to 85%, the latter value represents high degree of reflectance. The range of values for yellowness is 4 to 18 units, with 18 representing very yellow color (McAlister III and Rogers, 2005).

Reflectance degree is an indication of the degree of brightness or dullness of a cotton sample. Rainfall, and both insect and fungus infections, as well as contamination with soil or cotton plant leaf residues, are among the factors that may badly influence cotton color. Not only that but also excessive moisture and temperature during storage whether before or after ginning. When cotton color deteriorates due to one or more of the above factors, there is an increasing likelihood of a reduction in processing efficiency. With the onset of color deterioration, the efficiency of fibers to absorb and maintain dyes decreases.

Figures 16-21 present the relationship between reflectance degree and SFC. There was a sharp decline in reflectance degree as SFC went up to be about 2.5-point reduction for every one-point increase in SFC in case of cv. Giza 85 (Fig. 17). The RD of cv. Giza 88 (Fig. 16) and of cv. Giza 80 (Fig. 18) were similarly dropped by a rate of almost 2 points as SFC increased. The reflectance degree drop that occurred in case of cv. Giza 45 was comparatively the least as SFC gradually increases, since the estimated slope was about –1.36 (Fig. 16).

When fiber is shortened, then during the thickening phase, the same quantity of carbohydrate would spread over a shorter length and allow thicker daily rings. Always, short fiber cultivars are coarser when mature than long fiber cultivars. Even on one seed, the shorter fibers will be thicker (Hake et al., 1990). Based upon their argument, this extra thickening due to extra cellulose ring precipitation found in short fibers by nature may explain how reflectance decreases due to excess short fiber content in general regardless of cultivar.

However, short fibers also occur during handling processes starting from harvesting and ginning. So in cultivars of extra long fibers, and due to mishandling, short fibers are more likely to be found due to fiber breakage. So, trying to explain the decline in degree of reflectance as related to solely inherent short fiber content present in a cotton sample is somewhat questionable. Unless we assume that cotton lint has passed smoothly via all processes without any damage, and this is never happen in real life.

The degree of steepness of the dependence of degree of reflectance on short fibers of the studied cultivars, as shown in Figs. 16-18, can not be explained just upon the common composition of short fibers. Since there was no common trend can be deduced describing this relationship just based on the basic characteristics of either each individual cultivar or each staple length-based category. Some other factors might have affected each individual cultivar's content of short fiber, and hence each one's unique reflectance response has resulted.

Broken short fibers--which have resulted from mishandling during processing procedures--may be more likely affected by microbial degradation during improper storage than either naturally occurring short fibers or even full length fibers. As Hake et al. (1990) reported, grey and dark color develops on the fiber surface due to fungus feeding on this cotton lint. This microbial feeding develops a rough surface that slows air movement in the micronaire chamber, causing weathered cotton to suffer a micronaire reduction. The authors' discussion is originally concerned with various factors, which may cause cotton samples to record high and low micronaire readings. However, factors responsible for changes in fiber surface area and subsequently influence micronaire values may in addition be extended trying to explain the negative effect of short fibers on cotton color indicators.

Just one common feature all cultivars share regarding this linear relationship was the within each set of the three sets, both cultivars had very near mean reflectance at lower levels of short fibers. Yet, differences started to widen up as short fiber content increases. This was more pronounced with the Giza 85-Giza 86 set (Fig. 17).

Originally, Giza 45 is typically white as well as both Giza 85 and Giza 86, yet both Giza 88 and Giza 90 are creamy, while Giza 80 is dark creamy. Although various environmental conditions may cause cotton to become more yellow and gray especially with late harvesting (Duckett et al., 1999), McAlister III and Rogers (2005) further added that harvesting and ginning methods may also influence cotton color.

In trying to explain the dependence of cotton color on SFC based on the degree of reflectance, it is necessary to extend this one step further by examining the relationship between the degree of yellowness (+B) and SFC (Figs. 19-21 and Table 2). The mean cotton yellowness was positively influenced by the presence of more SFC in all studied cultivars ($p<0.0$) (Table 2). Both Giza 86 and 85 cultivars had almost matched fitted regression lines, for both cultivar showed nearly equal fitted intercept and slope values (Fig. 20). For cvs. Giza 90 and Giza 80, however, their fitted lines had near intercepts but there was about 2.5-unit difference in slopes (Fig. 21). In addition, the fitted lines reversed directions near a 9.0 % SFC. Giza 90 started to

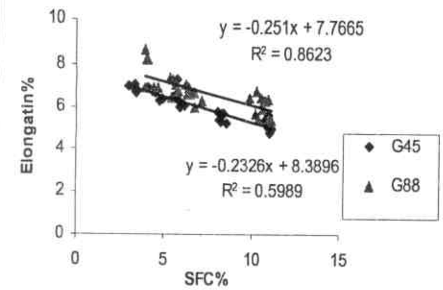

Fig. 13. Relationship between SFC and fiber elongation of G45 and G88 cultivar.

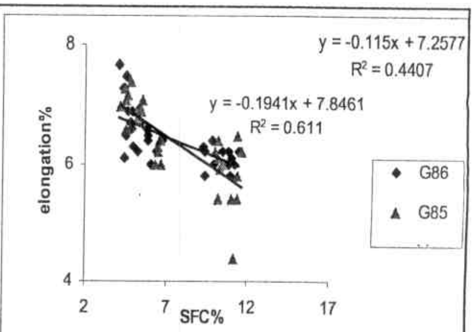

Fig. 14. Relationship between SFC and fiber elongation of G86 and G85 cultivar.

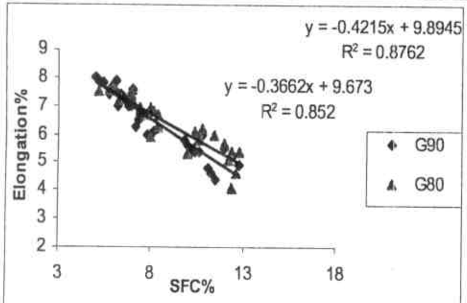

Fig. 15. Relatioship between SFC and fiber elongation of G90 and G80 cultivar.

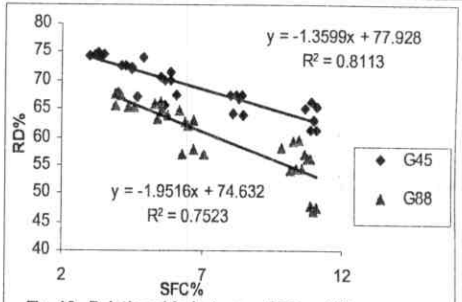

Fig. 16. Relationship between SFC and fiber reflectance (RD%) of G 45 and G 88 cultivar.

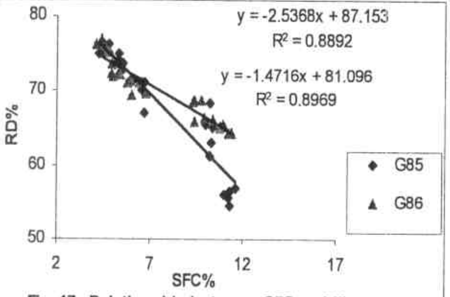

Fig. 17. Relationship between SFC and fiber reflectance (RD%) of G86 and G85 cultivar.

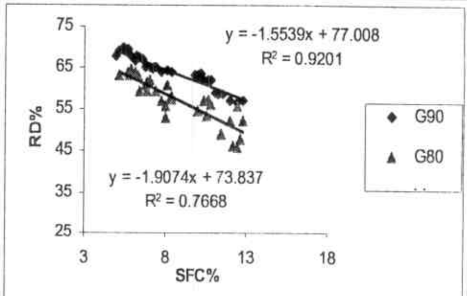

Fig. 18. Relationship between SFC and fiber reflectance (RD%) of G 90 and G 80 cultivar.

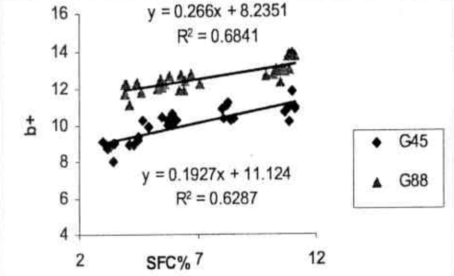

Fig. 19. Relationship between SFC and fiber yellwness degree (b+) of G 45 and G88 cultivar.

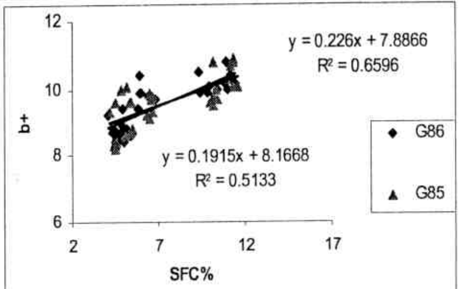

Fig. 20. Relationship between SFC and fiber yellowness degree (b+) of G86 and G85 cultivar.

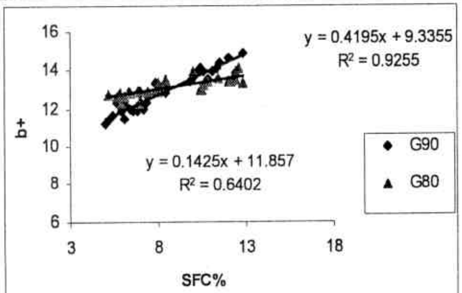

Fig. 21. Relationship between SFC and fiber yellowness degree (b+) of G90 and G80 cultivar.

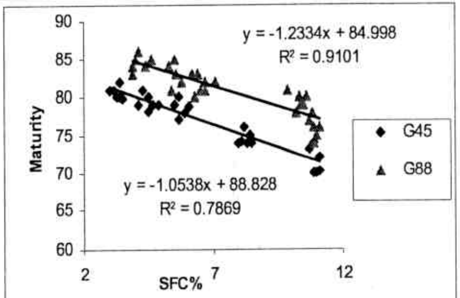

Fig. 22. Relationship between SFC and fiber maturity ratio of G 45 and G88 cultivar.

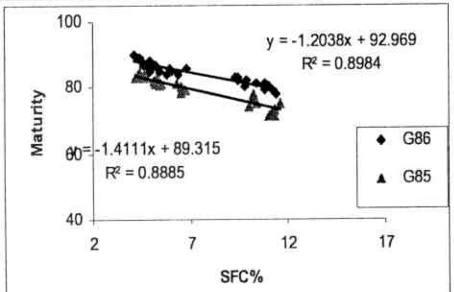

Fig. 23. Relationship between SFC and fiber maturity ratio of G86 and G85 cultivar

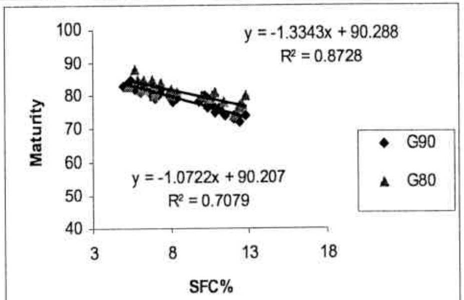

Fig. 24. Relationship between SFC and fiber maturity ratio of G90 and G 80 cultivar.

Table 2. Parameter estimates for cultivar fiber strength, percentages elongation and reflectance, and yelowness degree by fitting a first-order linear regression model.

Character[†]	Parameter Estimates							
	Variable[‡]	Estimate	St. error	P>t	Variable	Estimate	St. error	P>t
STR			Giza 45				Giza 88	
	B_0	47.4588	0.942920	0.0001	B_0	50.7679	1.071478	0.0001
	B_1	-1.0536	0.132576	0.0001	B_1	-0.9762	0.134297	0.0001
			Giza 86				Giza 85	
	B_0	48.0355	0.9615	0.0001	B_0	42.7754	0.710677	0.0001
	B_1	-1.0403	0.1245	0.0001	B_1	-0.5533	0.088414	0.0001
			Giza 90				Giza 80	
	B_0	37.4446	0.930705	0.0001	B_0	39.7925	1.314787	0.0001
	B_1	-0.2627	0.106516	0.0200	B_1	-0.5637	0.144404	0.0005
			Giza 45				Giza 88	
EL	B_0	7.7664	0.134786	0.0001	B_0	8.3896	0.286960	0.0001
	B_1	-0.2509	0.018951	0.0001	B_1	-0.2325	0.035967	0.0001
							Giza 85	
	B_0	7.2576	0.189003	0.0001	B_0	7.8460	0.235246	0.0001
	B_1	-0.1149	0.024475	0.0001	B_1	-0.1941	0.029266	0.0001
			Giza 90				Giza 80	
	B_0	9.8945	0.261641	0.0001	B_0	9.6730	0.262627	0.0001
	B_1	-0.4214	0.029944	0.0001	B_1	-0.3662	0.028844	0.0001
RD			Giza 45				Giza 88	
	B_0	77.9279	0.881417	0.0001	B_0	74.6322	1.688391	0.0001
	B_1	-1.3599	0.123928	0.0001	B_1	-1.9515	0.211620	0.0001
			Giza 86				Giza 85	
	B_0	81.0958	0.728283	0.0001	B_0	87.1533	1.360584	0.0001
	B_1	-1.4716	0.094310	0.0001	B_1	-2.5367	0.169267	0.0001
			Giza 90				Giza 80	
	B_0	77.0080	0.756313	0.0001	B_0	73.8373	1.810118	0.0001
	B_1	-1.5538	0.086557	0.0001	B_1	-1.9073	0.198807	0.0001
			Giza 45				Giza 88	
+B	B_0	8.2350	0.242935	0.0001	B_0	11.1236	0.223285	0.0001
	B_1	0.2659	0.034157	0.0001	B_1	0.1926	0.027986	0.0001
			Giza 86				Giza 85	
	B_0	7.8866	0.236946	0.0001	B_0	8.1668	0.283292	0.0001
	B_1	0.2260	0.030683	0.0001	B_1	0.1915	0.035243	0.0001
			Giza 90				Giza 80	
	B_0	9.3354	0.196522	0.0001	B_0	11.8566	0.183797	0.0001
	B_1	0.4194	0.022491	0.0001	B_1	0.1424	0.020186	0.0001

[†] STR= fiber strength, EL= percentage fiber elongation, RD= percentage reflectance, and +B= yellowness degree

[‡] B_0= intercept, B_1= slope.

record a relatively higher mean +B for more added SFC till reaching a 13% level. At lower levels near a 4.0% SFC, Giza 90 recorded a nearly equal drop in mean +B.

Based on the estimated values of the slope, both Giza 88 and Giza 80 fiber yellowness degree were the most affected by percentage short fiber compared to those of other cultivars. There was about 11% and 12% increase in degree of yellowness for the two cultivars, respectively, due to a unit increase in SFC (Table 2). This proves that SFC is an influential factor that partially contributes in determining the dark color of either one.

As short fiber content affects both fiber color parameters in cottons, these effects vary according to the extent to which other quality traits being directly or indirectly involved in shaping this relationship. This means that pairs of cotton fiber quality trait mutual relationship are not entirely isolated from the influential involvement of some other quality factors. Fiber micronaire, maturity, and fineness, as each influenced by short fiber content, are examples of such traits.

3. Fiber percentage maturity, micronaire value, and fiber fineness

Micronaire is used by textile manufacturers for determining the value of cotton for the yarns and fabrics for specific end products. The relationship between maturity and fineness is used in determining micronaire value. Micronaire is an indirect measure of cotton fiber gravimetric fineness (mass per unit length), and is influenced by both biological fineness and maturity. Micronaire is commonly used as an indicator of cotton fiber maturity, although care must be applied when doing this (McAlister III and Rogers, 2005).

Moreover, because micronaire is an indicator of gravimetric fineness, as they further added, and gravimetric fineness is influenced by both biological fineness and maturity, it is important to discuss these parameters. Maturity refers to the degree of secondary wall thickening in a cotton fiber. In cottons with normal maturity, the secondary wall constitutes about 90% of the fiber's total weight. Bradow and Bauer (1997) reported that severe weather can adversely influence the maturity of a cotton fiber, and immature cotton contributes to lower yarn strength, nep formation, and poor dye uptake.

The inter-relations among these three crucial cotton fiber characteristics need to be discussed not solely but in the light of the presence of a fourth characteristic—the percentage short fibers. In addition to the effect of processing the cotton fiber passes by on inducing more short fibers, the effect of the biotic and/or abiotic reasons can not be overlooked. Since percentage short fibers are cultivar-dependent, it, therefore, plays a key role in determining the micronaire value of any given cultivar.

Figures 22-30 show the response of percentage fiber maturity (MATP), micronaire value (MIC), and fiber fineness (MTEX) to

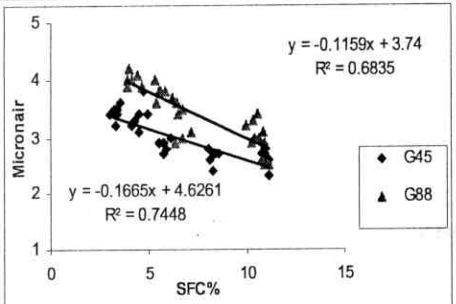

Fig. 25. Relationshipbetween SFC and micronair value of G45 and G 88 cultivar.

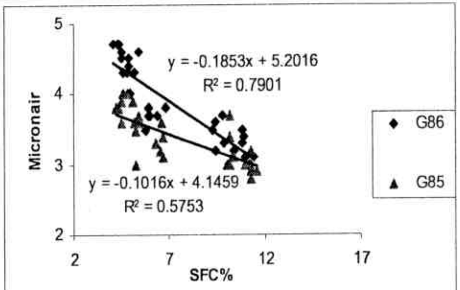

Fig. 26. Relationship between SFC and micronair value of 86 and G85 cultivar.

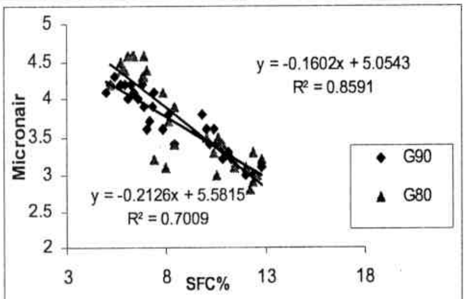

Fig. 27. Relationship between SFC and micronairvalue of G90 and G80 cultivar.

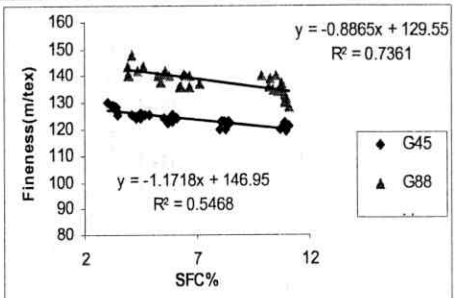

Fig. 28. Relationship between SFC and fiber fineness of G45 and G88 cultivar.

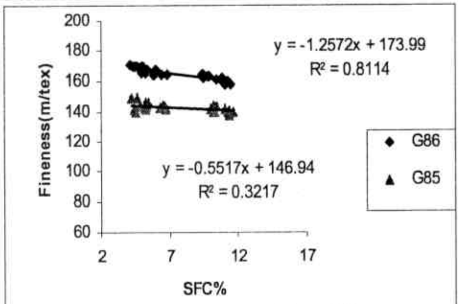

Fig. 29. Relationship between SFC and fiber fineness of G86 and G85 cultivar.

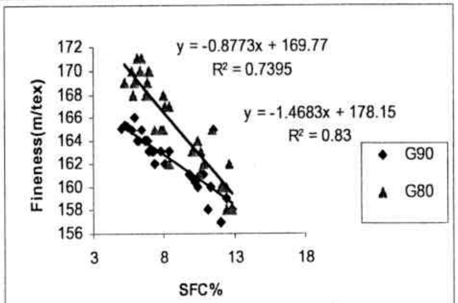

Fig. 30 Relationship between SFC and fiber fineness of G90 and G80 cultivar.

Table3. Parameter estimates for micronaire value, fineness, and maturity by fitting a first-order linear regression model.

Character[†]	Parameter Estimates							
	Variable[‡]	Esti-mate	St. error	P>t	Variable	Estimate	St. error	P>t
			Giza 45				Giza 88	
MIC	B_0	3.7399	0.105951	0.0001	B_0	4.6261	0.146950	0.0001
	B_1	-0.1158	0.014896	0.0001	B_1	-0.1665	0.018418	0.0001
			Giza 86				Giza 85	
	B_0	5.2015	0.139417	0.0001	B_0	4.1459	0.132621	0.0001
	B_1	-0.1853	0.018054	0.0001	B_1	-0.1016	0.016499	0.0001
			Giza 90				Giza 80	
	B_0	5.0543	0.107176	0.0001	B_0	5.5815	0.238895	0.0001
	B_1	-0.1602	0.012266	0.0001	B_1	-0.2125	0.026238	0.0001
			Giza 45				Giza 88.	
MTEX	B_0	129.5487	0.713531	0.0001	B_0	146.9492	1.608545	0.0001
	B_1	-0.8864	0.100323	0.0001	B_1	-1.1718	0.201612	0.0001
			Giza 86				Giza 85	
	B_0	173.9897	0.884597	0.0001	B_0	146.9429	1.216960	0.0001
	B_1	-1.2572	0.114553	0.0001	B_1	-0.5516	0.151399	0.0011
			Giza 90				Giza 80	
	B_0	178.1483	1.143392	0.0001	B_0	169.7677	0.859787	0.0001
	B_1	-1.4682	0.125580	0.0001	B_1	-0.8772	0.098400	0.0001
			Giza 45				Giza 88	
MATP	B_0	84.9979	0.521201	0.0001	B_0	88.8284	0.826947	0.0001
	B_1	-1.2334	0.073281	0.0001	B_1	-1.0538	0.103648	0.0001
			Giza 86				Giza 85	
	B_0	92.9686	0.590623	0.0001	B_0	89.3149	0.759307	0.0001
	B_1	-1.2037	0.076484	0.0001	B_1	-1.4110	0.094464	0.0001
			Giza 90				Giza 80	
	B_0	90.2881	0.841282	0.0001	B_0	90.2069	1.185232	0.0001
	B_1	-1.3343	0.096282	0.0001	B_1	-1.0722	0.130175	0.0001

[†] MIC= micronaire value, MTEX= fiber fineness, and MATP = percentage maturity.

[‡] B_0= intercept, B_1= slope.

SFC, and the first-order regression equations and the coefficient of determination (R^2) for each of the six cultivars. Each of the three cotton fiber traits, within any cultivar, was negatively associated with SFC. All fitted line estimated parameters were effective ($p<0.05$) (Table 3).

The R^2 values had an overall diverse range across the three traits and the six cultivars. For fiber maturity, values ranged from 70% to 91% (Figs. 22-24), 57%-86% for micronaire (Figs. 25-27), and from 32%-83% for fineness (Figs. 28-30%). All the fitted linear first-order regression models seemed of good fit except for fiber fineness of Giza 85 (Fig. 29) where the SFC explained only 32% of the total variation in mean fiber fineness. However, the estimated line slope was significant ($p=0.0011$) (Table 3).

Among the three fiber traits, and regardless of cultivars, MATP was generally the most affected by the presence of SFC. This was based upon the relative rate of drop in the mean MATP estimated by the line slope (Table 3). All six estimated slopes were > -1.00. On the other hand, the rate of reduction in MIC reading was relatively lower as SFC increases, since the rate of reduction ranged from about -0.101 to -0.185 (Table 3). This indicates that there were reductions in mean MIC of one-tenth to about 2-tenth unit for every 1% increase in SFC. For fiber fineness, MTEX, the rate of mean reduction was generally not far from unity (-0.886, -0.877) (Figs. 28&30), or even greater (-1.171, -1.257, and -1.468) (Figs, 28-30). The only deviant slope, -0.551, was that of Giza 85 (Fig. 29). Even the estimated intercept, 146.94 mtex, was also much less than the other cultivars'.

This finding suggests pooling data over cultivars, in case of either MATP or MIC, to fit the very same model that has been fitted for each cultivar. This can be done after different slopes and intercepts had been tested for equality. These procedures may be extended to all five cultivars in case of fiber MTEX ignoring Giza 85. For this cultivar, the fitted regression model needs further investigation.

The quite low R^2, which explains the total variation in Giza 85's fiber fineness by the presence of SFC, implies that the residual error sum of squares was high. Draper and Smith (1981) indicated that the residuals contain all available information on the way in which the fitted model fails to properly explain the observed variation in the dependent variable. Hence, the fitted model needs to be checked for lack of fit. If a prior estimate of σ^2 is available (this means an estimate obtained from previous experiments on the relation being studied). By an F test, the residual sum of squares is tested against this prior estimate to see if it is significant. If it does; therefore there is a lack of fit, and the model has to be reconsidered since it would be inadequate. Unfortunately, it is sometimes not easy for the researcher to access this information; therefore, he/she should plan for repeat runs when planning for the experiment. These replicates mean two or more measurements of the dependent variables at the same value of the independent one. These repeats can be used to obtain an estimate of σ^2.

If the model turns out to be correct in case of Giza 85, this low rate of reduction in Giza 85 MTEX in response to SFC should call researchers' attention for focusing on the nature of its SFC. This means that investigating factors that may have influenced short fiber development. Since it did not seem to negatively influence its MTEX to a considerable extent compared to those influences on other cultivars' MTEX as has been shown earlier. It is not enough in studies that depend on analyses of historical cotton samples to just collect data from different location and/or years; however, the history of the cotton samples, which have been collected for study, should be well known to the researcher. This would certainly help in trying to explain the data on a more wide perspective. Behery (1993) indicated how planting year, harvest number (first, second, or delayed), and gin lint cleaner all influence percentage short fibers. Delaying harvest negatively affected SFC. In addition, harvesting method is a key factor in determining SFC (McAlister III and Rogers, 2005)

The boost in percentage short fiber mainly comes from the growing conditions --harvesting, ginning--, and/or the spinning processes. Growing conditions affect the maturity of the fiber. Immature thin-walled fibers are more liable to breakage during harvesting, ginning and processing than mature thick-walled fibers. Growing conditions, such as water stress and disease, that cause immaturity, have an indirect impact on cotton fiber length distribution (Behery, 1993). Reduced maturity causes micronaire to get lower. However, one probable cause of a high micronaire reading is the presence of naturally-occurring shorter fibers on seeds as Hake et al. (1990) have argued. I think this does not contradict the more general consensus that short fibers are more likely immature, for the authors have discussed the issue of short fibers in a more general

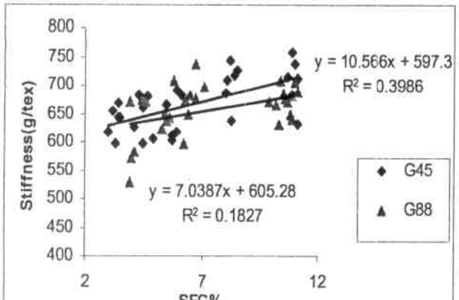

Fig. 31. Relationship between SFC and fiberstiffness of G45 and G88 cultivar.

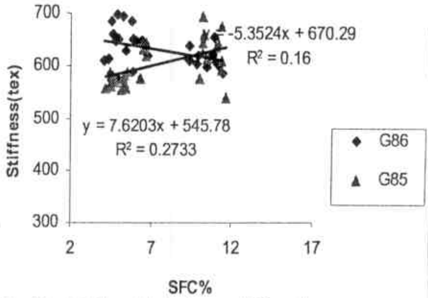

Fig. 32. Relationship between SFC and stiffness of G86 and G 85 cultivar.

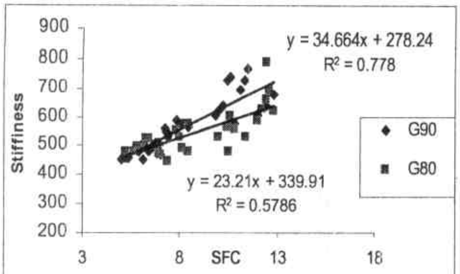

Fig. 33. Relationship between SFC and fiber stiffiness of G90 and G80 cultivar

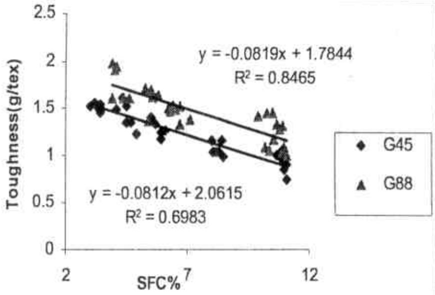

Fig. 34. Relationship between SFC and fibertoughness of G45 and G88 cultivar.

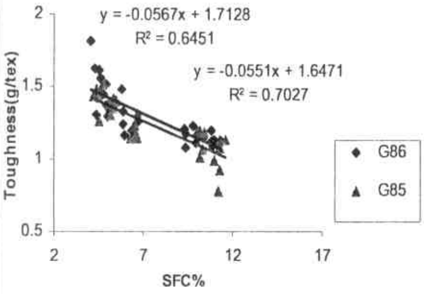

Fig. 35. Relationship between SFC and fiber toughness of G86 and G85 cultivar.

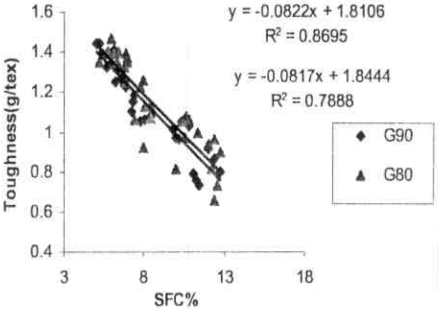

Fig. 36. Relationship between SFC and fiber toughness of G 90 and G 80 cultivar.

Table 4. Parameter estimates for fiber stiffness, and fiber toughness by fitting a first-order linear regression model.

Character[†]	Parameter Estimates							
	Variable[‡]	Esti-mate	St. error	P>t	Variable	Estimate	St. error	P>t
STIFF			Giza 45				Giza 88	
	B_0	597.3000	17.445213	0.0001	B_0	605.2822	22.446690	0.0001
	B_1	10.5659	2.452826	0.0002	B_1	7.0386	2.8 13429	0.0185
			Giza 86				Giza 85	
	B_0	670.2885	17.895620	0.0001	B_0	545.7788	18.877013	0.0001
	B_1	-5.3524	2.317438	0.0285	B_1	7.6203	2.348455	0.0030
			Giza 90				Giza 80	
	B_0	278.2370	30.573426	0.0001	B_0	339.9116	34.083780	0.0001
	B_1	34.6643	3.499033	0.0001	B_1	23.2103	3.743466	0.0001
TOUGH			Giza 45				Giza 88	
	B_0	1.7844	0.046865	0.0001	B_0	2.0615	0.080422	0.0001
	B_1	-0.0818	0.006589	0.0001	B_1	-0.0811	0.010079	0.0001
			Giza 86				Giza 85	
	B_0	1.7128	0.061372	0.0001	B_0	1.6471	0.054405	0.0001
	B_1	-0.0567	0.007947	0.0001	B_1	-0.0550	0.006768	0.0001
			Giza 90				Giza 80	
	B_0	1.8067	0.052278	0.0001	B_0	1.8443	0.072706	0.0001
	B_1	-0.0818	0.005983	0.0001	B_1	-0.0816	0.007985	0.0001

[†] STIFF= fiber stiffness, and TOUGH= fiber toughness.

[‡] B_0= intercept, B_1= slope.

context of the word rather than that of the definition. Consistently, they argued, short fiber cultivars are coarser and have higher mikes when mature than long fiber cultivars, and even on one single seed, the shorter fibers would be more thicker.

4. Fiber stiffness and toughness

Fiber stiffness (STIFF) (gf tex^{-1}) was positively related to short fiber content in all studied cultivars except in case of cv. Giza 86 (Figs. 31-33 & Table 4). Cotton fiber stiffness is the ratio between both fiber strength and percentage elongation (see Eq. 1). Four of the six regression equations generally indicated very poor fit since values of the coefficient of determination were all below 40% except for those of both Giza 90 and Giza 89 where values were 78% and 58%, respectively. Yet, all line slopes were significant ($p<0.05$) indicating how effective was the inclusion of SFC in the model to explain part of the total variation in mean fiber stiffness. These poor values of the coefficient of determination call for adopting other models so as to try to obtain much better fits. This depends on the pattern of the plot of the residuals against the fitted values of fiber stiffness, i.e. the dependent variable.

Stiffness, i.e. inelasticity present in cotton fibers increased, therefore, in response to high short fiber content. The nature of a short fiber regarding immaturity and the lack of sufficient cellulose ring precipitation in the secondary cell wall along with the expose to heat stress during harvest and ginning together make a short fiber is reasonably more inelastic than long mature fiber. Cultivars somewhat varied in their fibers being different in stiffness in response to short fiber content. The rates of increase --10.56 and 7.03, and 7.62-- in mean fiber stiffness of cvs. Giza 45 and Giza 88 and Giza 85, were much lower than those, 34.66 and 23.21, associated with cvs. Giza 90 and Giza 80, respectively (Table 4). This made both Giza 90 and Giza 80's fiber stiffness rate of increase became more faster when their short fibers had gone up. Both cultivars are usually grown in middle Egypt where relatively high temperature and low relative humidity usually prevail during the full growing season and during harvest; these conditions put fibers under conditions that increase short fiber content and cause reduction in elasticity.

On the other hand, the negative response of Giza 86's fiber stiffness to short fiber content was unexpected and needs further investigation. The estimated fitted line slope (-5.35)was, in absolute value, at least 12 points away from 7.03 that of the nearest fitted lines (Figs. 31-33). Moreover, this estimated slope was significant (p=0.0285). If the model is assumed to be correct; hence, both the quite big differential margin and the effective SFC contribution of this particular cultivar put forth a question mark about the presumption that short fibers always decrease fiber elasticity. However, this question mark should not be raised unless the same model is fit using more wide data range to see whether it still holds. On the other hand if the model turns out to suffer from a lack of fit, in this case some other models, perhaps a second-degree model, should be suggested and fit to the same data set in addition to an additional fit in case of more wide data range of the short fiber content.

Fiber inelasticity is interrelated to fiber toughness especially in their relation to short fiber content. The fiber's energy to rupture or its toughness (TOUGH) (gf tex^{-1}) showed, as most of fiber traits did, a negative relationship with SFC ($p<0.05$) (Figs. 34-36, and Table 4). All estimated slopes, for the six cultivars, were quite close -- 0.055-0.082-- and all were nonzero ($p<0.05$). Similarly, the estimated intercepts values made a narrow range between 1.65 and 2.06 gf tex^{-1}. The R^2 values ranged from 64%-87% indicating a reasonable fit.

Based on the above arguments, each of the magnitude of variation that characterizes any fiber quality trait, the degree of association of such a character with short fiber content, and the amount of variation in the mean response variable explained by the predictor variable are collectively considered key issues in candidate character(s) assessment based upon short fiber content. However, these selection-based criteria sometimes work in opposite direction as has been indicated above which makes selection based on either one somewhat a difficult task. Keeping in mind also that short fiber content whether treated as either a predictor or a response variable, is itself a highly variable character. This high variation present in the short fiber content by nature, due to various cotton crop management and fiber processing, makes predictions from this highly random variable depending on just a single predictor variable is insufficient and inconclusive.

To take account of that short fiber content relationship with various quality traits being possibly varied among different cotton grades, differences exerted by the five Egyptian cotton grades were considered in studying both fiber and yarn traits in my current study.

Within each cultivar, cotton grades showed differences in short fiber content and this contributed meaningfully to variation in the mean response cotton length parameter estimate. These meaningful contributions were evaluated based on the significance of parameter estimate ($p<0.05$) associated with the dummy variable, Z, which takes care of the difference between various cotton grades in the fitted linear regression equation. Tables 5-7 present only the significant Z parameter estimates for fiber traits within different cultivars.

Fiber traits vs. among-grade short fibers

In general, cotton 'grade' is mainly judged by the external appearance of the cotton and is determined basically on brightness of the fibers, by its more or less white color, by the presence of particles of the leaf or other extraneous substances. Evaluating colors, leaf and ginning preparation determine cotton grade. Higher-grade cottons provide better yarn appearance and reduced process waste. To maintain such ultimate goal, evaluation of various cotton grades on the basis of percentage short fiber present is required. This step should definitely be preceded by trying to predict various cotton quality parameters based on differential SFC in these grades, if present, since these quality traits are collectively expected to contribute to higher yarn quality.

In its relation with different fiber and yarn traits, short fiber content showed varying differentials among cotton grades for each individual trait of the studies 12 fiber traits within different sets of cultivars. There was no apparent general trend that describes these differentials whether they were based either on any cultivar set, i.e. staple length category, for any particular fiber trait or on any specific fiber trait set, i.e. length, tensile, etc., within any cultivar. However, there were high variations in SFC due to grade criterion for as low as one-cultivar set to as many as four-cultivar set to affect the total variation in the fiber trait, as a response variable, in the predicted regression equation (Tables 5-7).

In Tables 5-7, only the data that represent the resultant significant estimated coefficients (α_i) of the Z parameters ($p<0.05$) are shown along with the estimated intercept (b_0) and the slope (b_1) of the fitted regression line. The significance of some estimated α_i parameters implies that the use of dummy variables, which represents grades, was obviously worthwhile. These significant contributions indicated how short fiber content may considerably vary among grades, and as a result this would influence the prediction of related fiber traits.

Four dependent fiber traits were influenced by variations in SFC due to grade classification for at least three cultivars. First, within the length category, SFC differed ($p<0.05$) among some grades, of as many as four cultivars, to affect total variation in UQL (Table 5). This was the only cultivar group to contain all cultivars that represent the long staple category –cvs. Giza 86, Giza 85, Giza 90, and Giza 80. Due-to-grade variation in SFC was yet varied from cultivar to another in this group. Second, also, the UI of three cultivars, Giza 85, Giza 90, and Giza 80, was influenced by among-grade variations in SFC (Table 5). Third, within the fiber tensile group, percentage fiber elongation (EL) was affected by grade variations in SFC for three-cultivar group --Giza 45, Giza 85, and Giza 90 (Table 6). Fourth, in addition, percentage maturity (MATP) included three cultivars, Giza 88, Giza 85, and Giza 80, which due-to-grade variation in their SFC significantly influenced this trait (Table 7).

Among all the studied fiber predictor variables, it is worth noticing that the 'extra long staple' category, that contains both Giza 45 and Giza 88, was the least frequent cultivar category whose SFC was grade dependent. Grade influenced SFC of cv. Giza 88 in case of yellowness degree (+B), the micronaire value (MIC), and percentage maturity (MATP) (Table 5-7). Giza 45's SFC variation among grades occurred in case of percentage fiber (EL) and fiber toughness (TOUGH).

Surprisingly, for these two particular Giza 45 traits, all estimated α_i parameters were highly significant based on their resultant p values being all far <0.05 compared to any other trait for any other cultivar. In addition, both intercepts and slopes of the fitted lines were both nonzero ($p<0.01$) for the two respective traits. The statistical significance of both slopes in this case was unlike almost all those of the other fitted lines across all cultivars and traits ($p>0.05$) (Tables 5-7). However, the only exceptions were in cases of UI and RD of Giza 90 where $p=0.019$ and 0.0001, respectively. On the contrary, almost all intercepts across all cultivars and traits, contributed significantly to mean response variables.

Table 5. Linear regression and grade parameter estimates and their associated significant *p* values for predicting fiber upper half mean length, upper quartile length, and length uniformity index from short fiber content.

		Regression parameter estimates [‡]					
Trait [†]	Cultivar	b_0	b_1	α_1	α_2	α_3	α_4
UHML	Giza 80	28.65	-0.219	4.126	3.690	3.460	1.942
		0.0001	0.4414	0.0363	0.0268	0.0097	0.0024
UQL	Giza 86	35.72	-0.2305	0.9911	-0.0627	-0.0091	0.5131
		0.0001	0.1228	0.3132	0.9432	0.9899	0.0342
	Giza 85	63.310	0.8144	16.524	13.873	10.855	4.535
		0.0005	0.0566	0.0954	0.1118	0.1162	0.0107
	Giza 90	30.562	-0.0404	3.062	2.623	2.348	0.654
		0.0001	0.804	0.007	0.005	0.002	0.059
	Giza 80	27.710	0.1926	4.765	4.109	3.125	1.343
		0.0001	0.3902	0.0033	0.0027	0.0036	0.0065
UI	Giza 85	76.266	0.534	8.812	7.267	5.133	2.373
		0.0001	0.596	0.205	0.236	0.289	0.052
	Giza 90	87.107	-0.371	1.157	0.816	0.306	0.723
		0.0001	0.019	0.236	0.314	0.638	0.025
	Giza 80	73.531	0.449	9.748	7.969	5.056	3.250
		0.0001	0.428	0.014	0.017	0.050	0.008

[†] UHM=fiber upper half mean length, UQL=fiber upper quartile length, UI=length uniformity index.

[‡] Regression parameter estimate and associated p value.

The four estimated α_i parameters estimate differences in response levels among each of the first four grades and the 'reference grade', which is in this case the FF/GF grade (refer back to the 'design matrix' in the materials and methods section). For any response fiber trait, by substituting for the four sets of values for Z_1-Z_4, we obtain the five respective fitted regression equations for the five cotton grades. The five lines would be all parallel, i.e. have the same slope, but have different intercepts. This implies that the five grades would initially differ in the response fiber trait when SFC equals zero.

For example, the fitted linear regression equation of percentage elongation for Giza 45 was,

$$\hat{Y}_{G45EL} = 14.156 - 0.827X - 4.544Z_1 - 3.784Z_2 - 2.909Z_3 - 1.816Z_4$$

The estimates $a_1 = -4.544$, $a_2 = -3.784$, $a_3 = -2.909$, and $a_4 = -1.816$ estimated the differences in response levels between (i) G/FG and FF/GF; (ii) G and FF/GF; (iii) FGF/G and FF/GF; and (iv) GF/FGF and FF/GF, respectively. By substituting for the sets of values of Z_1-Z_4, the obtained fitted equations for the five grades were,

$$\hat{Y}_1 = 9.616 - 0.827X \text{, for G/FG}$$

$$\hat{Y}_2 = 10.372 - 0.827X \text{, for G}$$

$$\hat{Y}_3 = 11.251 - 0.827X \text{, for FGF/G}$$

$$\hat{Y}_4 = 12.340 - 0.827X \text{, for GF/FGF}$$

$$\hat{Y}_5 = 14.156 - 0.827X \text{, for FF/GF}$$

It appears from these five fitted equations that percentage EL, for the five grades, is equally negatively affected in response to any unit increase in SFC since all equations had the very same slope. However, general mean percentage EL seemed to be more affected by the contribution of the amount of inherent percentage fiber elongation present than did by that of the SFC by moving towards lower Giza 45 grades if SFC change rate kept constant. This was indicated by the decreasing order in estimated values of the line intercepts in the above five equations in the direction of the higher grades.

Unlike the case of Giza 45, neither Giza 85 nor Giza 90's percentage fiber EL similarly respond to SFC when grades are taken into consideration. In either cultivar, slope was positive and had a near-zero values ($p>0.05$). In addition, all estimated α_i values were generally positive (Table 6), and the values were in decreasing order. This means that differences in response levels gradually diminished as grades get closer in rank. Differences ($p<0.05$) existed for all grades against the reference grade in Giza 90, and so did all except for difference between Grade FGF/G and the reference grade in Giza 85. This indicated that grades differed in SFC magnitude as related to fiber EL. For Giza 90, the fitted linear regression equation of percentage elongation was,

$$\hat{Y}_{G90EL} = 4.519 + 0.0321X + 3.052Z_1 + 2.467Z_2 + 1.533Z_3 + 0.749Z_4$$

Similarly, by substituting for the sets of values of Z_1-Z_4, the obtained fitted equations for the five grades were,

$$\hat{Y}_1 = 7.211 + 0.0321X \text{, for G/FG}$$

$$\hat{Y}_2 = 7.986 + 0.0321X \text{, for G}$$

$$\hat{Y}_3 = 6.052 + 0.0321X \text{, for FGF/G}$$

$$\hat{Y}_4 = 5.268 + 00321X \text{, for GF/FGF}$$

$$\hat{Y}_5 = 4.519 + 0.0321X \text{, for FF/G}$$

The positive slopes of these fitted lines of Giza 90, as well as those expected of Giza 85, indicated that SFC is positively correlated to percentage elongation regardless of the grade. Yet, these lines differed in the intercepts in an increasing order towards high-rank grades. This positive relationship contradicted what has been theoretically believed that the more cotton short fibers present in a sample the less the chance of its showing more fiber elongation under stress. This 'unexpected' relationship needs further investigation using more wide range of percentage short fibers in the samples and bigger sample sizes (sampling units and/or replicates) depending on the magnitude of variation to see if this kind of relationship still exists or another one develops. This further inspection is still proper despite that this positive slope was non significant for both cultivars ($p>0.05$), i.e. not far from zero (Table 6).

To see whether this positive relationship is unique to Giza 90, I checked the relationship for cv. Giza 80. This cultivar belongs to the same 'long staple' group and grows in the same geographical region of Egypt. Although the estimated α_i parameters were all ineffective ($p>0.05$) in explaining the total variation in percentage elongation, yet all were positive too as in the case of Giza 90. Hence, both cultivars follow the same pattern that relates SFC to percentage EL for different grades, and both intercepts were quite equal (0.032 and -0.034) with nearly equal p values (0.800 and 0.873). However, Giza 80's SFC is still negatively correlated to percentage EL unlike Giza 90's.

Yarn traits vs. short fiber content

Spinners are more concerned with the harm short fibers may cause to the spinning industry. The more short fiber contents in cotton, the less efficient both the yarn processing and the product quality and later on the greater losses in textile quality (Thibodeaux et al., 2008). Under the Egyptian conditions, cotton is usually hand picked and therefore it does not require extra lint cleaning as that required for the machine-picked U.S. cotton. The latter procedure can lead to fiber damage and the creation of broken short fiber fragments (Behery, 1993). Short fiber content has an impact not only on fiber traits but also on spin yarn quality measurements. Yarn quality is one crucial step to successful textile product marketing.

Lea product (LP), yarn strength (YSTRNTH), and yarn regularity or evenness (YCV) fitted regression equations and the associated coefficients of determinations are shown in Figs. 37-45. Parameter estimates, standard error estimates, and p values are shown in Table 8. Like wise those of each of yarn elongation (YEL), yarn neps 200 (YNPS), and yarn hairiness (YHNSS) are presented in Figs. 46-54 and Table 9.

The estimated parameters of the fitted regression equations of only yarn traits LP, YCV, and YNPS each on SFC were all significant ($p<0.05$) for each cultivar (Tables 8&9). Particularly for these three yarn traits, values of percentage variation (R^2) explained by SFC were moderate to high depending on the cultivar. For the other studied three traits, YSTRTH (Table 8), YEL, and YHNSS (Table 9), estimated line slopes were only significant ($p<0.05$) for at least three cultivars. Variations in mean YSTRTH were fairly to moderately explained by SFC; however, values of R^2 were generally poor for YEL and YHNSS.

Among all the studied cultivars, only Giza 86 and Giza 85's short fibers failed to explain ($p>0.05$) YSTRTH (Table 8). Mean YEL of the very same two cultivars, as well as that of Giza 45 did not respond either (Table 9). Also, the SFC of both Giza 90 and Giza 80 similarly did for YHNSS (Table 9). It seems that neither of these specific three yarn traits of these cultivars, which belong to the 'long-staple lint' category, significantly responds to short fiber content. Nevertheless, they responded the same way the cultivars of the 'extra-long staple lint' category did for the other three studied yarn traits. The role the presence of short fibers played in determining some of the very crucial yarn properties can not be overlooked.

From a pool of 23 potential predictors from the AFIS, HVI, and SW, Thibodeaux et al. (2008) develop regression models relating seven yarn properties --elongation, endsdown, irregularity, neps, thicks, thins, and yarn strength. In five of the seven models the short fiber content variable was the most important regressor. Despite the importance of lea product, its relationship to SFC was not among the variable-related yarn property list in Thibodeaux et al.'s (2008) study. The reason for this might have been due to the inclusion of more specific yarn traits, for it is not considered a direct yarn property. They have emphasized, however, yarn strength.

Lea product or strength was strongly influenced by the short fiber content (Table 8). This trait is strongly correlated to single yarn strength. Single yarn strength is predicted well (R^2=0.948) from HVI fiber strength, HVI micronaire value, and SW short fiber content (Thibodeaux et al., 2008). Even when SW short fiber content is replaced by HVI uniformity %, a close regression equation has resulted since they consider HVI uniformity % acts as a surrogate for SW short fiber content since they are highly correlated (r=-0.95). Both HVI strength and HVI uniformity % are significant in the model, they commented, because both are strongly correlated with yarn strength (r=0.96 and 0.82, respectively). But HVI micronaire alone shows poor correlation with yarn strength (r = -0.077) yet it is an effective predictor (p=0.0001) of yarn strength in linear combinations with the other two fiber traits.

The last remark by Thibodeaux et al. (2008) is not surprising. A predictor variable has a low correlation with the response does not necessarily exclude it being a good predictor when fitting a certain regression model. In multiple regression analysis the inclusion of the predictors does not depend on just the pairwise Peasron's simple correlation coefficients between the predictors and the response variable; yet it does on the magnitude of the partial correlation, $r_{yx/xj}$, the partial correlation values in the partial correlation matrix (Steele and Torrie, 1980; and Draper and Smith, 1981).

Yarn strength of four cultivars was significantly predicted from short fibers (Table 8). HVI yarn strength is highly correlated with SW short fibers ($r = -0.794$) (Thibodeaux et al., 2008). In the same study, both HVI strength and yarn strength were correlated well ($r = 0.959$). Fiber strength is very influential for predicting yarn strength even with other fiber quality measures. Hequet (1999) suggested a measure he called 'standard fineness'. It is the ratio AFIS fineness/AFIS maturity. This measure was found to be a good predictor of yarn strength for ring spun yarn. Together with HVI strength, they predicted well ($R^2 = 0.925$) yarn strength.

Percentage yarn irregularity (YCV) was the second yarn trait that was overwhelmingly predicted ($p<0.05$) from short fiber content for all studied cultivars. The coefficients of variation greatly varied among cultivars (Figs. 43-45). Of the total variations in YCV short fibers only explained as low as 45% for both Giza 86 and Giza 85 (Fig. 44), and as high as 94% for Giza 80 (Fig. 45). Percentage unevenness of Giza 45 was the most affected since its CV% increased with at a rate of 3.19 % for every 1% increase in SFC (Fig. 43). The least affected was Giza 88's CV% at a rate of 0.54%. This big marginal difference occurred between two cultivars belong to the same lint-length group. This lead to the gap between the two cultivars' YCV got wider as SFC reached high values. This gap occurred within the two cultivars of the other two sets yet it was comparatively minimal.

The 'best' model for YCV, as Thibodeaux et al., 2008 has called, is the one with AFIS fineness and SF SFC with an R^2=0.87. The YCV has a correlation coefficient of 0.897 with SFC and of 0.162 with AFIS fineness. The latter correlation coefficient value indicates a very weak linear relationship between the two variables. Yet, both predictors are reported to be very highly significant (p=0.001, and p=0.000, respectively). Moreover, the Pearson's r value between YCV and AFIS fineness though positive, its estimated regression parameter turns out to be negative, -0.054, in the presence of SW SFC in the regression equation.. The authors obtain another regression equation for YCV by replacing AFIS fineness by HVI micronaire and SW SFC by HVI SFC giving R^2 = 0.843.

One interesting result Thibodeaux et al. (2008) have come to that the pairs of models for the square root of both yarn thicks and thins, and yarn irregularity CV use the same sets of predictors (AFIS fineness and SW SFC or HVI micronaire and HVI uniformity) and have similar R^2 values. In the models with AFIS fineness and SW SFC as predictors, SW SFC is relatively more important. Likewise, HVI uniformity is relatively more important in the models with HVE micronaire and HVI uniformity. The authors do not report on what criteria they have determined the relative importance of a predictor variable. However, this relative importance may have been decided based upon the magnitude of the calculated 't' statistic value as well as of the reported 'p' value of the test statistic.

The third yarn trait that was satisfactorily predicted ($p<0.05$) from short fiber content, across all studied cultivars, was yarn nep count (YNPS) (Figs. 49-51 and Table 9). The six regression equations had values of the coefficient of determinations between 64% and 95%. In addition, all the fitted regression equation parameters were different from zero ($p<0.05$) except for the estimated intercept, in case of cv. Giza 90, with a $p= 0.7173$ (Table10).

The two predicted regression lines of Giza 45 and Giza 88 (Fig. 49) similarly tracked the same pattern of the two cultivars' CV predictive ones (Fig. 43). The two cultivars' nep count were reversed, at 4% SFC to, reach maximum at extreme ends of SFC. There was about a 3.7-fold consistent difference in the estimated values of both intercepts (236.52 vs. 64.26) and slopes (93.74 vs. 25.28) in favor of Giza 45. The fitted lines of both Giza 86 and Giza 85 reversed directions too --with a noticeable difference in both estimated line parameters--but at somewhat higher SFC of about 6% (Fig. 50). For Giza 90 and Giza 80, their yarns tended to make a little more marginal difference by reaching higher SFC relative to their nep formation at lower SFC (Fig.51) since there was > 7-fold difference in line estimated intercepts in favor of Giza 80 and a 10-point slope difference (Table 9). The big difference, therefore, in the two cultivars Giza 90 and Giza 80 expected mean nep counts at an specific SFC was then controlled more effectively by the initial mean nep count.

Hence, the resultant neps 200 of some cotton cultivars are therefore expected not to be relatively consistent in response to extremely varying the short fiber content range. Moreover, the apparent

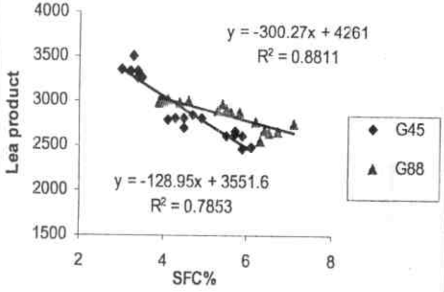

Fig. 37. Relationship between SFC and lea product of G45 and G88 cultivar.

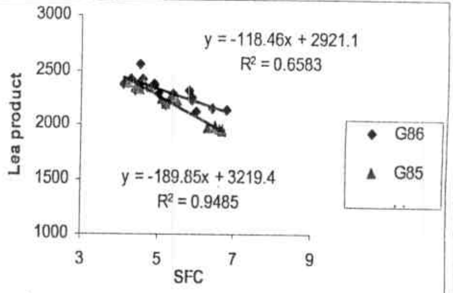

Fig. 38. Relationship between SFC and lea product of G86 and G85 cultivar.

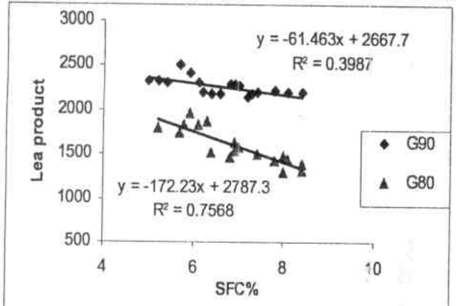

Fig. 39. Relationship between SFC and lea product of G90 and G80 cultivar.

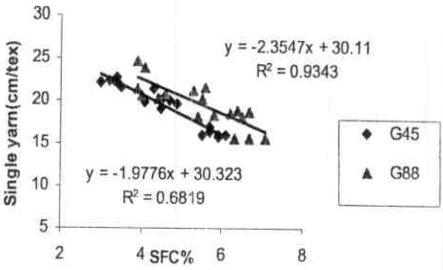

Fig. 40. Relationship between SFC and single yarn strength of G 45 and G 88 cultivar.

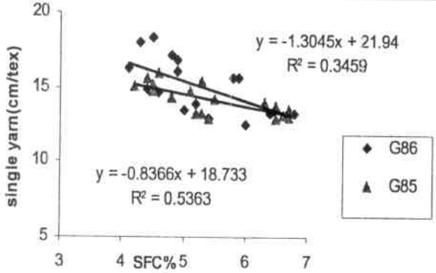

Fig. 41. Relationship between SFC and single yarn strength of G 86 and G85 Cultivar.

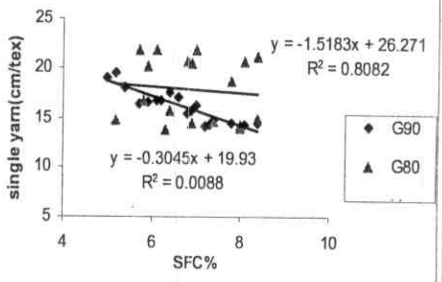

Fig. (42). Relationship between SFC and single yarn strength of G 90 and G 80 cultivar.

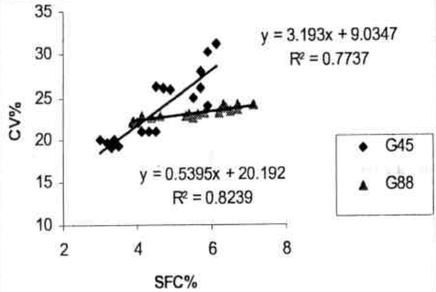

Fig. 43. Relationship between SFC and evenness (CV%) of G 45 and G 88 cultivar.

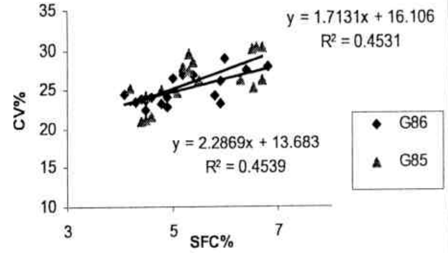

Fig. 44. Relationship between SFC and evenness (CV%) of G 86 and G 85 cultivar.

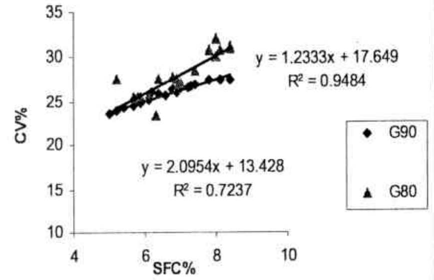

Fig. 45. Relationship between SFC and evenness (CV%)of G90 and G80 cultivar.

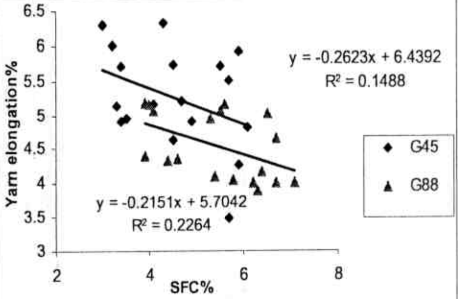

Fig. 46. Relationship between SFC and yarn elongation of G45 and G88 cultivar.

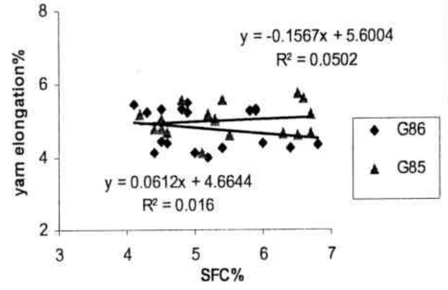

Fig. 47. Relationship between SFC and yarn elongation of G86 and G 85 cultivar.

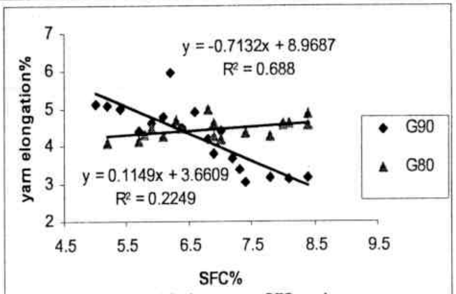

Fig. 48. Relationship between SFC and yarn elongation of G 90 and G80 cultivar.

Table 8. Parameter estimates for cultivar lea product, yarn strength, and evenness by fitting a first-order linear regression model.

Character[†]	*Parameter Estimates*							
	Variable[††]	Estimate	St. error	P>t	Variable	Estimate	St. error	P>t
			Giza 45				Giza 88	
LP	B_0	4260.95	128.264	0.0001	B_0	3551.60	93.841	0.0001
	B_1	-300.27	27.574	0.0001	B_1	-128.95	16.857	0.0001
			Giza 86				Giza 85	
	B_0	2921.06	111.889	0.0001	B_0	3219.39	6.990	0.0001
	B_1	-118.46	21.335	0.0001	B_1	-189.84	11.055	0.0001
			Giza 90				Giza 80	
	B_0	2667.70	126.467	0.0001	B_0	2787.26	171.028	0.0001
	B_1	-61.46	18.871	0.0049	B_1	-172.22	24.405	0.0001
			Giza 45				Giza 88	
YSTRNTH	B_0	3.01	0.726	0.0001	B_0	30.32	1.879	0.0001
	B_1	-2.35	0.156	0.0001	B_1	-1.97	0.337	0.0001
			Giza 86				Giza 85	
	B_0	25.47	5.126	0.0001	B_0	20.04	2.416	0.0001
	B_1	-1.47	0.977	0.1506	B_1	-0.89	0.437	0.0581
			Giza 90				Giza 80	
	B_0	20.08	0.852	0.0001	B_0	25.31	1.754	0.0001
	B_1	-0.89	0.127	0.0001	B_1	-1.31	0.250	0.0001
			Giza 45				Giza 88	
YCV	B_0	9.03	2.008	0.0004	B_0	20.19	0.347	0.0001
	B_1	3.19	0.431	0.0001	B_1	0.540	0.062	0.0001
			Giza 86				Giza 85	
	B_0	16.10	2.467	0.0001	B_0	13.61	3.458	0.0012
	B_1	1.71	0.470	0.0022	B_1	2.30	0.626	0.0021
			Giza 90				Giza 80	
	B_0	17.64	0.481	0.0001	B_0	13.42	2.271	0.0001
	B_1	1.23	0.071	0.0001	B_1	2.09	0.323	0.0001

[†] LP=lea product, YSTRNTH= yarn strength (cNtex^{-1}), YCV=yarn evenness %.

[††] B_0= intercept, B_1= slope.

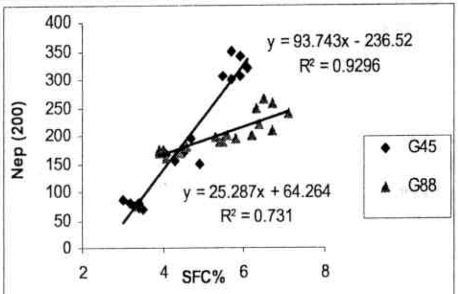

Fig. 49. Relationship between SFC and nep (200) of G 45 and G 88 cultivar.

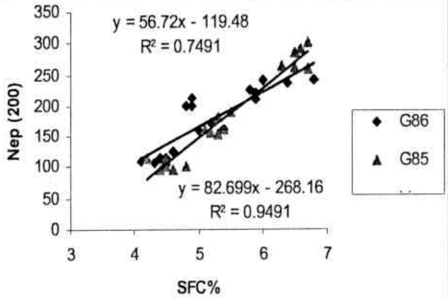

Fig. 50. Relationship between SFC and nep (200) of G 86 and G 85 cultivar.

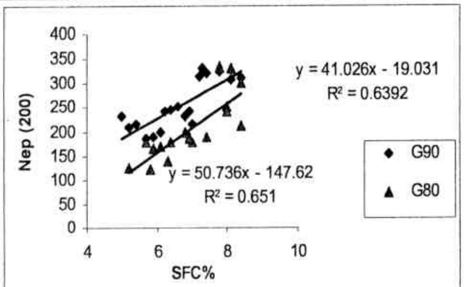

Fig. 51. Relationship between SFC and neps 200% of G 90 and G 80 cultivar.

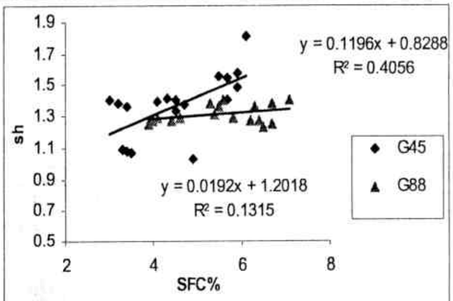

Fig. 52. Relationship between SFC and hairiness (sh) of G45 and G88 cultivar.

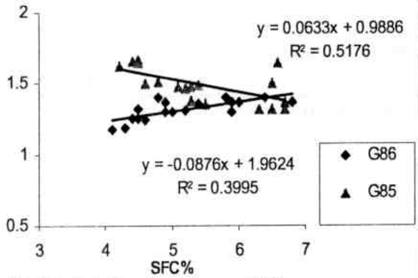

Fig. 53. Relationship between SFC and hairiness(sh) of G 86 and G 85 cultivar.

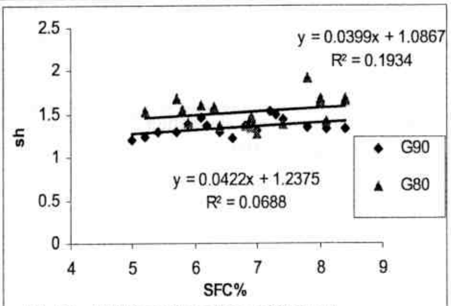

Fig. 54. Relationship between SFC and hairiness(sh) of G 90 and G 80 cultivar.

Table 9. Parameter estimates for cultivar yarn elongation, neps, and hairiness characters by fitting a first-order linear regression model.

Character[†]	*Parameter Estimates*							
	Variable[††]	Estimate	St. error	P>t	Variable	Estimate	St. error	P>t
			Giza 45				Giza 88	
YEL	B_0	6.43	0.729	0.0001	B_0	5.70	0.553	0.0001
	B_1	-0.26	0.156	0.1138	B_1	-0.21	0.099	0.0459
			Giza 86				Giza 85	
	B_0	5.60	0.893	0.0001	B_0	4.66	0.661	0.0001
	B_1	-0.15	0.170	0.3716	B_1	0.06	0.119	0.6171
			Giza 90				Giza 80	
	B_0	8.96	0.804	0.0001	B_0	3.66	0.374	0.0001
	B_1	-0.71	0.120	0.0001	B_1	0.11	0.053	0.0468
			Giza 45				Giza 88	
YNPS	B_0	-236.52	30.009	0.0001	B_0	64.26	21.348	0.0083
	B_1	93.74	6.451	0.0001	B_1	25.28	3.834	0.0001
			Giza 86				Giza 85	
	B_0	-119.48	43.041	0.0135	B_0	-264.92	25.069	0.0001
	B_1	56.72	8.207	0.0001	B_1	82.20	4.544	0.0001
			Giza 90				Giza 80	
	B_0	-19.03	51.646	0.7173	B_0	-147.61	65.179	0.0378
	B_1	41.02	7.706	0.0001	B_1	50.73	9.287	0.0001
			Giza 45				Giza 88	
YHNSS	B_0	0.82	0.168	0.0002	B_0	1.20	0.068	0.0001
	B_1	0.11	0.036	0.0045	B_1	0.01	0.012	0.1392
			Giza 86				Giza 85	
	B_0	0.98	0.080	0.0001	B_0	1.96	0.148	0.0001
	B_1	0.06	0.015	0.0008	B_1	-0.08	0.026	0.0049
			Giza 90				Giza 80	
	B_0	1.08	0.136	0.0001	B_0	1.23	0.272	0.0003
	B_1	0.03	0.020	0.0678	B_1	0.04	0.038	0.2930

[†] YEL=percentage yarn elongation %, YNPS=yarn neps 200 m, and YHNSS=yarn hairiness.

[††] B_0= intercept, B_1= slope.

similarity in the pattern of some cultivars' response of either yarn CV or neps count to short fiber content indicated a connection existed between the two important yarn variables in their relations to short fiber content. The more yarn evenness or regularity the less the chance of getting more neps along yarn length as short fiber content decreased.

Yarn neps are collection of one or more fibers occurring in a tangled and unorganized mass and are mainly composed of immature fibers (McAlister and Rogers, 2005). Low mike cotton can be fine fiber but usually is immature fiber. Low mike cotton is also more likely to form neps in the ginning and yarn manufacturing processes (Hake et al., 1990)

.

However, McAlister and Rogers (2005) obtained similar maturity tests for the two studied cottons. AFIS results indicate that one cotton has a higher nep count than the other. They decide that this trend is consistent with the fineness measurement since the more finer cotton is the one that makes more neps. They refer this to that fine fiber tends to be less rigid, and easily tangled into a nep.

Although Thibodeaux et al. (2008) expected that nep count to be more by increasing short fiber content, it was surprising to them to find that increased HVI UHM length is associated with more neps. Relatively, short fiber content is the most important of the three predictors – HVI UHM, HVI MIC, and AFIS SFC—in the nep count predictive equation. All three predictors positively contribute to nep count based on their estimated regression coefficients. Equivalently, they obtain a good regression equation when HVI UNIF is substituted for AFIS SFC.

High mikes are therefore as effective as low mikes in influencing yarn nep count. This result does not by any means contradict what Hake et al. (1990) conclude about the relation between low mike and the incidence of more nep count, but it add extra information to what has been expected. The authors have argued, high mike results from less fineness and high maturity, in addition to small ratio of surface area to weight. Yet, nep count is not affected by none of fiber length parameters measured by AFIS, HVI, and SW and neither does yarn elongation to break, YEL (Thibodeaux et al., 2008).

The contribution of short fibers in explaining part of the total variation in YEL was quite poor cultivarwise (Figs. 46-48, Table 9). In addition to the all six fiber length parameters low association with YEL, Thibodeaux et al. (2008) find that among the seven studied yarn properties in relation to short fiber content, YEL is not well predicted for by this fiber predictor either. Both variables have an estimated non significant Peasrson's r of –0.366. However, YEL is best estimated by HVI strength, HVI mike, and HVI uniformity with a poor R^2=0.37. These three fiber traits are the same to predict YSTRTH but with a positive coefficient sign of HVI STRTH. The other two predictors contribute negatively and positively, respectively, in either predictive equations.

Yarn hairiness was not better predicted for either (Figs. 52-54, Table 9). Only the predictive equations of Giza 45, Giza 90, and Giza

80 had values of R^2 ranged from about 40% to 52%, and all estimated parameters were significant ($p<0.05$) (Table 9). Short fiber content can be a cause of the higher amount of shorter hair lengths in the yarn (McAlister and Rogers, 2005). There is a strong correlation ($R^2=0.977$ with $p<0.05$) between short fiber and total hairs at the 1, 2, and 3 mm lengths. On ring spun yarns (both 36s and 50s English count NE) for Upland cotton, Hequet (1999) found also that significant correlations exist between AFIS short fiber by weight any yarn hairiness. Chanseleme et al. (1997) also utilized AFIS fiber data on both ring and rotor yarns (20 tex). Short fiber content by weight correlates significantly with hairiness.

Yarn traits vs. among-grade short fibers

The query, that is concerned with the extent to which cotton grade likely differentials in short fiber content may contribute to partially explain the expected mean of any yarn trait, still needs to be fully addressed. The spinners are more concerned about this relationship. Generally, the presence of non trivial difference in percentage short fibers in cotton, as Thibodeaux et al. (2008) indicated, may result in severe reduction in the efficiencies of both yarn and textile processes and product qualities. If cotton grades happen to differ in short fiber content, this would eventually lead to more problems during cotton spinning. Of the six yarn traits I addressed in this study, four traits showed differences in their response due to apparent variations among at least two of the three studied grades of some cultivars in short fiber content (Table 10). Giza 45 grade differentials in SFC were effective in predicting three of the four traits: LP, YSTRTH, and

Table 10. Linear regression and grade parameter estimates and their associated significant *p* values for predicting lea product, yarn strength, elongation, and hairiness from short fiber content.

Trait †	Cultivar	Regression parameter estimates ‡			
		b_0	b_1	α_1	α_2
LP	Giza 45	3172.69	-134.48	514.61	87.50
		0.0001	0.2335	0.0307	0.4676
	Giza 88	2757.42	-15.47	311.81	209.77
		0.0001	0.7490	0.0222	0.0023
	Giza 85	2069.03	-16.26	363.32	249.66
		0.0001	0.6986	0.0008	0.0004
	Giza 90	1705.65	62.05	313.84	110.36
		0.0001	0.0862	0.0014	0.0342
YSTRTH	Giza 45	20.90	-0.81	3.98	2.74
		0.0001	0.1898	0.0200	0.0052
	Giza 86	72.09	-8.93	-14.59	-9.11
		0.0002	0.0016	0.0038	0.0071
	Giza 80	11.67	0.33	4.11	2.45
		0.0805	0.6669	0.0405	0.0383
YEL	Giza 86	13.42	-1.40	-2.42	-1.61
		0.0001	0.0042	0.0064	0.0077
HNSS	Giza 45	2.78	-0.21	-0.86	-0.51
		0.0120	0.2244	0.0622	0.0438
	Giza 80	2.01	-0.04	-0.20	-0.34
		0.0179	0.6503	0.3740	0.0193

† LP =lea product, YSTRTH=yarn strength (cNtex^{-1}), YEL=yarn elongation %, YHNSS=yarn hairiness.

†† B_0= intercept, B_1= slope, α_1=difference between Grades G and FGF/G, α_2= difference between Grades G/FG and FGF/G.

HNSS. Giza 80 also shared Giza 45 in both YSTRTH and HNSS, in addition to Giza 86 in both YSTRTH and YEL.

Both Giza 86 YSTRTH and YEL predictive equations were the only ones to have all their estimated parameters significantly participated in explaining the total variation in the response ($p<0.01$) (Table 10). By taking care of grades in the regression model, there has been an improvement to the contribution of short fiber content to mean YSTRTH. The p value was > 0.05 (Table 8) and became 0.0016 (Table 10). Likewise, for YEL, the p value also improved from 0.3716 (Table 9) to 0.0042 (Table 10) by the inclusion of the grade in the regression model.

On one hand, these yarn trait predictive equations depended upon a relatively small data set ($n=18$), therefore predictions are not reliable enough due to the loss of precision. In future experiments, inference should be made based upon prediction equations using larger data set to contain a diverse population of short fiber content. This certainly requires extending more the population of cultivars to maintain such wide range of short fibers. On the other hand, despite that the purpose of developing these regression equations were not for using as a tool for prediction purposes, however they were to threw light on how cotton grade may significantly participate in explaining the total response variation. Within each of the four yarn traits (Table 10), there was at least one cultivar yarn trait that was highly affected by differences among at least two cotton grades. Grade effect did appear to be influential for all cultivar(s); however, generally it did not for some yarn traits.

be influenced by the roller setting and the amount of draft. This setting corresponds to the fiber length attained by 1% of the fibers, i.e. theoretically 1% of the fibers are gripped on both sides of the roller pairs.

If distance between these drafting rolls is controlled to allow fibers to get through based on the assumption that grades are different in short fiber content and in real life they are not, i.e. committing a type I error, hence this would cause much less imperfections. Therefore raising the α level would eventually lead to reduce the β level and this give more chance to reject the null hypothesis.