


COTTON TRASH CONTENT AND CLEANABILITY IN RELATION TO FIBER QUALITY

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ABSTRACT

The present study was carried out to evaluate the effect of trash content and cotton cleaning and find out the behavior of the Egyptian cotton fiber properties in two stages of cleaning at Cotton Research Institute, Egypt. The used Egyptian cotton varieties were taken from product and marketing season of 2024 such as Giza 92, Giza 96, Giza 97 and Giza 98. There was lint cotton grade for each variety; Good/Fully Good for Giza 92 and Giza 97, Fully Good for Giza 96 and Giza 98 and both of Good and Fully Good Fair for all the studied cotton varieties. Measuring trash components and physical fiber properties; there were obvious effect for the presence of trash and cleaning stages for all cotton fiber properties; upper half mean length, micronaire, maturity, fiber strength and degree of yellowness. The most effect of trash was on reflectance percentage. From trash components; non-lint, fiber fragment and dust, both of cleanability and degree of cleaning were calculated for all cotton varieties. No obvious trend of cleanability and degree of cleaning was appeared for G 92, G 96 and G 97. Meanwhile; G 98 as a shorter Egyptian cotton variety gave the highest value of cleanability.

Keywords: Egyptian cotton, trash, fiber properties, cleaning stages, cleanability, degree of cleaning.

1. INTRODUCTION

Egyptian cotton is considered a well- established reputation as one of the finest cottons in the world. In addition to Egyptian cotton is known for its superior softness, strength and durability. Generally; Cotton is well known by its reputation in high quality product compared to synthetic fibers. Cotton fiber quality can be affected by a variety of factors, such as cotton cultivar, growing

environmental, farming practices, harvesting methods and ginning procedures, hence many research tries to cover all stages for cotton supply chain from farm to end-product; Dugger *et al.* (1996), Liu *et al.* (2019), Habib-A-Rasul *et al.* (2020), Hussain *et al.* (2022) and Scarpin *et al.* (2025). In addition to cotton fiber properties are influenced by all cotton previous processes till lint appearance to be measured as elaborated by Mona Shalaby (2023 and 2024) and Phuong and Tan (2024).

In general, trash or impurities are all foreign matter other than cotton whether affects seed or lint. Meanwhile, trash in lint refers to non-fiber particles such as leaf, seed coat, bark, dust and other foreign matters. The methods that have been used for assessing trash content in cotton may be divided into two basic groups: geometric and gravimetric. The geometric methods estimate the trash portion in a sample according to sizes of particles, while gravimetric method evaluate trash content by trash weight, as shown with both of Xu and Ting (1996) and Alisherova (2024). All details of trash characterization can be located by scanning the image, and a number of characteristics as size, shape, color and density which the presence of trash particles can be seen darker as were elaborated and plotted by Taylor (1990 a and b), Williams and Schleth (1993) and Xu and Ting (1996). Many machines developed, modified and used in commercial textile mills to improve the efficiency of clean and open raw cotton and produce good quality yarn as detected and elaborated by Chiu and Chiou (1998). Several cotton fiber instruments aim at these concepts such as Cotton Classifying System (CCS) and Tomsic Fiber Tester (TFT) which are herein Egyptian & International Cotton Classification Center (EICCC) at Cotton Research Institute (CRI), Egypt. (ITMF- ICCTM; 2020).

Practically, trash plays an important role in Egyptian cotton grading, especially the presence of trash increases, the cotton quality decreases. Cotton contains an appreciable amount of dirt due to field conditions, picking and ginning such as seed cotton neps, fiber fragment, leaf and pods. In general, in good qualities the trash proportion possibly around 1% meanwhile in low quality the percentage may be more than 15%; Basu (1998).

Trash content in cotton is a strong consideration in cotton grading system which is affects all other cotton fiber properties such as short fiber content which was extracted by Cui *et al.* (2003 and 2008) and John *et al.* (2003). All extraneous matters such as parts and particles of the cotton plant after ginning process except fibers is often included in grading physical standards boxes of cotton producing countries such as in Cotton Grading Department (CGD), Cotton Research Institute (CRI), Agricultural Research Center (ARC), Egypt, which these standard cotton boxes are provided and approved from Cotton Attribution Testing Generally Organization (CATGO) At Alexandria, Egypt.

The information could be useful to improve the profitability for cotton growers, ginners and spinner alike.

Trash content usually minimum for cotton picked manual compared to mechanical cotton harvested; Mishra *et al.* (2017 and 2018), Islam *et al.* (2019), Mishra *et al.* (2021 and 2023), and Jumaniyazov *et al.* (2024).

Moreover, trash measurements provide the gin with valuable information to make process control decisions to optimize the balance between trash removal and fiber quality. In general gins are often forced to over clean the cotton to achieve a high cotton grade and higher price being paid for the cotton lint, and therefore a better return for the grower. Any trash remaining in ginning cotton is a waste product to the mill and must be removed during mill processing; Davidonis and Johnson (1999) and Li *et al.* (2012).

In spinning, trash influences yarn quality with respect to defects as well as lower spinning efficiencies and the number of yarn end breaks. Higher trash content also affects the cost of the raw cotton bale material to the mill. Mills purchase cotton bales based on total bale weight, which includes both fiber and trash which, increasing in trash proportion take a wide range of losing and detriment regardless other reasons in mill defects. All other details of cleanability improving on fabrics was explained by Jackowski *et al.* (2002), Calvimontes and Dutschk (2012), Armijo *et al.* (2009), Usharani, (2015) and Mishra *et al.* (2018).

Cleanability was determined in terms of cost saving where fiber material with low trash content is usually more expensive than material with higher trash content, knowing the cleanability of the fiber material permits significant cost saving. In addition to interpretations of cleaning systems as discussed by Mangialardi (1992) and Halimi *et al.* (2008).

Cleanability was called by Bennett and Misra (1997) and Calvimontes and Dutschk (2012); as an optimum trade-off between reduction of foreign matter on one hand, and the necessary mechanical damage which must be imposed upon the cotton to achieve a desired level of cleaning. In addition, Bennett and Misra (1997), Armijo *et al.* (2009) and Wanjura *et al.* (2011) showed all interpretation of a field cleaner should be used as a first step of cleaning to get the least cost cleaning configuration across the harvesting, ginning, and textile mill stages. Besides of founding that field cleaning did not affect the quality parameters measured in cotton classification.

There are several degrees of cleaning with various factors affect the efficiency of cleaning like fiber loss, fiber rupture, neps generation, machine settings, fiber properties and environmental conditions. Any loss means loss of money for raw cotton purchasing, total manufacturing cost or yarn industry. All details were discussed by Islam *et al.* (2019), Alisherova (2024) and Jumaniyazov *et al.* (2024).

After any cotton treatment as cleaning stages; determining the technological value of cotton fiber is essential in science textile fields. The quality of final yarn is largely influenced by all cotton fiber properties in different percentages according to Lord (1961), Murthy and Samanta (2000) and Mona Shalaby (2024). Practically, using any technological quantification index such as fiber quality index would provide briefed and informative data of overall quality attributes of each cotton variety which is crucial for industrial process.

The target of the research is to clarify the effect of trash content and cotton cleanability through two cleaning stages on cotton fiber properties of Egyptian cotton across grades.

2. MATERIALS AND METHODS

The present investigation was carried out at Egyptian & International Cotton Classification Center (EICCC), Cotton Research Institute (CRI), Agricultural Research Center (ARC), Giza, Egypt. The used Egyptian cotton varieties were taken from product and marketing season of 2024; extra strength Giza 92 (G 92), extra-long Giza 96 (G 96), super Giza-Delta long staple variety Giza 97 (G97) and Upper long staple variety Giza 98 (G 98).

For each cotton variety presented three grades; G 92 with grades Good/Fully Good (G/FG), Good (G) and Fully Good Fair (FGF), G 96 with grades Fully Good (FG), Good (G) and Fully Good Fair (FGF), G 97 with grades Good/Fully Good (G/FG), Good (G) and Fully Good Fair (FGF) and G 98 with grades Fully Good (FG), Good (G) and Fully Good Fair (FGF).

All samples have been tested and cleaned for two stages according to cotton Classifying System instrument (CCS) which stands for medium volume instrument (MVI). Fiber measurements were taken before and after cleaning stages. In this study; a detailed investigation was conducted to evaluate the effect of the two cleaning times on fiber properties and cleanability of Egyptian cotton. CCS has several modules for cotton lint properties as follows:

1. Fibrotest for length-strength measurements such as Upper Half Mean Length (UHML) and Fiber Strength (FS).
2. Wira for maturity-fineness measurements such as Micronaire value (Mic) and Maturity Ratio (MR).
3. Opotest for color measurements such as Reflectance Percentage (Rd) and Degree of Yellowness (+b).
4. NTDA3 for trash components such as Trash (T), Fiber Fragment (FF) and Dust (D).

In terms of ambient conditions; proper cleaning for the laboratory and CCS instrument, used GS Air Technology System; Unflair™ (2023) for standard temperature 21 ± 2^0 and $65\pm 2\%$ humidity and sufficient quantity of samples according to CCS instrument modules be as recommended.

An index of technological value of cotton was determined by Fiber Quality Index (FQI) which expresses by cotton fiber properties as follows; Upper Half Mean Length (UHML), Uniformity Index (UI), Fiber Strength (FS) and Micronaire Value (Mic); (Murthy and Samanta (2000)) and (El-Messiry and Abd- Ellatif (2013)).

$$FQI = \frac{UHML \times UI \times fs}{Mic}$$

According to the trash components; cleanability and degree of cleaning were derived as follow:

$$\text{Cleanability (C)} = T_1 / (T_1 + T_2) * 100$$

$$\text{Degree of Cleaning (DC)} = T_2 / T_1 * 100$$

Where:

T₁ represents percentage of impurities at the input raw cotton.

T₂ represents percentage of eliminate impurities.

According to Uster (2001) and (2022); the degree of cleaning can be classified as shown in Table 1.

Table 1: Classification of degree of cleaning (%) of raw cotton

Class	Interpretation
> 40%	Very good
30% - 40%	Good
20% - 30%	Average
10% - 20%	Bad
< 10%	Very bad

Descriptive statistics analyses were calculated according to Steel and Torrie (1980).

Regression analysis and curve estimation regression are supervised machine learning which consists of the prediction of predicted variable from a set of continuous independent predictor variables. The main comparable parameter are Coefficient of Determination (R²) and Standard Error (SE). R² is for measuring how well the statistical model is fit for the studied cotton fiber attributes. Thus, R² is a number between 0 and 1; herein; R² = 1 indicates that the fitted model explains perfectly all variability between cleaning stages and other cotton fiber properties. Meanwhile, R² = 0 indicates no relations, this means that the straight-line model is constant

between cleaning stages and other cotton fiber properties. According to Draper and Smith (1966) and Mason *et al.* (2003).

SPSS (2012) and Excel (2007) was used for statistical analyses.

3. RESULTS

Descriptive statistics used to describe characteristic of Egyptian cotton fiber data of Giza 92 (G 92), Giza 96 (G 96), Giza 97 (G 97) and Giza 98 (G 98). Such as minimum, maximum, mean (where the center lies) and standard deviation (how the data vary about the mean).

All cotton fiber properties influence with each other. Moreover, trash affect all cotton fiber properties in different degrees, there are obvious effects for properties more or less than others. Tables 2, 3, 4 and 5 showed mean values of cotton fiber properties; Upper Half Mean Length (UHML), Micronaire Value (Mic), Maturity Ratio (MR), Fiber Strength (FS), Reflectance Percentage (Rd) and Degree of Yellowness (+b) with and without cleaning of trash (first (S1) and second cleaning (S2) stages).

Table 2: Descriptive statistics for fiber quality properties of G/FG, G and FGF in G 92

Grade	Cotton	Statistics	UHML	Mic	MR	FS	Rd	+b	FQI
G/FG	Raw	Mean	33.32	3.58	91.12	48.44	76.39	9.40	16504
		SD	1.18	0.165	4.04	11.60	0.603	0.377	2092
		Min.	31.80	3.20	90.60	47.90	75.21	8.99	14661
		Max.	34.60	3.66	94.80	48.99	76.98	9.74	20430
	S1	Mean	33.30	3.54	89.63	47.59	80.49	9.40	13970
		SD	0.548	0.035	0.872	5.07	1.12	0.212	4769
		Min.	32.70	3.02	88.20	46.80	78.67	9.23	8319
		Max.	34.20	3.91	90.60	47.99	82.17	9.74	20462
	S2	Mean	32.47	3.50	88.23	47.01	80.91	9.80	7844
		SD	0.582	0.092	1.69	6.22	0.619	0.212	1599
		Min.	31.60	3.49	87.30	46.90	80.15	9.63	5492
		Max.	33.20	3.78	88.29	47.70	81.50	10.14	9684
G	Raw	Mean	31.93	3.43	89.44	47.38	73.73	8.67	14532
		SD	1.43	0.168	1.90	4.55	1.37	0.478	2330
		Min.	28.80	3.35	86.30	45.90	72.06	8.04	10631
		Max.	33.20	3.83	90.90	48.90	75.25	9.30	17106
	S1	Mean	30.77	3.40	88.40	46.50	78.09	9.62	8712
		SD	0.646	0.030	1.47	8.12	1.18	0.161	1728
		Min.	29.40	3.25	87.00	45.60	76.61	9.35	7147
		Max.	31.20	3.46	91.70	48.70	80.15	9.86	12078
	S2	Mean	30.38	3.39	86.55	44.22	79.14	10.29	8484
		SD	0.383	0.111	2.12	3.54	0.272	0.265	2066

		Min.	30.30	3.30	85.30	43.60	78.69	9.97	6178
		Max.	31.20	4.00	89.20	48.80	79.55	10.51	12173
FGF	Raw	Mean	30.60	3.24	86.32	45.55	67.03	8.20	9986
		SD	1.34	0.231	3.90	8.27	1.57	0.145	1198
		Min.	29.50	3.10	85.40	42.10	65.01	8.05	8945
		Max.	33.30	3.79	88.30	49.80	69.06	8.34	12147
	S1	Mean	29.67	3.20	85.63	44.15	74.39	10.37	9860
		SD	0.163	0.089	3.04	2.77	0.461	0.251	2624
		Min.	29.50	3.00	84.90	42.80	73.67	9.99	7854
		Max.	29.90	3.66	88.20	48.50	75.00	10.58	15027
	S2	Mean	29.60	3.17	84.99	43.95	76.86	9.96	5958
		SD	0.405	0.076	1.23	4.17	0.351	0.167	513
		Min.	29.00	3.00	83.40	41.50	76.72	9.62	5448
		Max.	30.10	3.89	87.70	49.90	77.58	10.03	6889

UHML values decreased from raw cotton to first and second cleaning stages. In addition to decreasing from the highest grade to the lowest grade for each variety as seen in Fig 1. The same trend of results was shown by Armijo *et al.* 2019, Mishra *et al.* 2018 and Usharani *et al.* 2015 and Mishra *et al.* 2023.

Micronaire value (Mic) gave the highest value for raw cotton followed by the first cleaning stage (S1) and finally the second cleaning stage (S2). This geometrically due to that the more cleaning decrease the presence of trash parts between fibers, thus the spaces through fiber decreasing. So, the specific surface area increasing then resulting in low air flow, hence low micronaire value. The same findings were stated by Hussein *et al.* (2014 and 2015).

Maturity Ratio (MR) decreased from high to low grade and from raw cotton to the two cleaning stages.

Fiber strength (FS) decreased from the highest to the lowest grades, meanwhile there was a fluctuation within each grade from raw cotton to the two cleaning stages (S1 and S2) in G 92, G 96, G 97 and G 98.

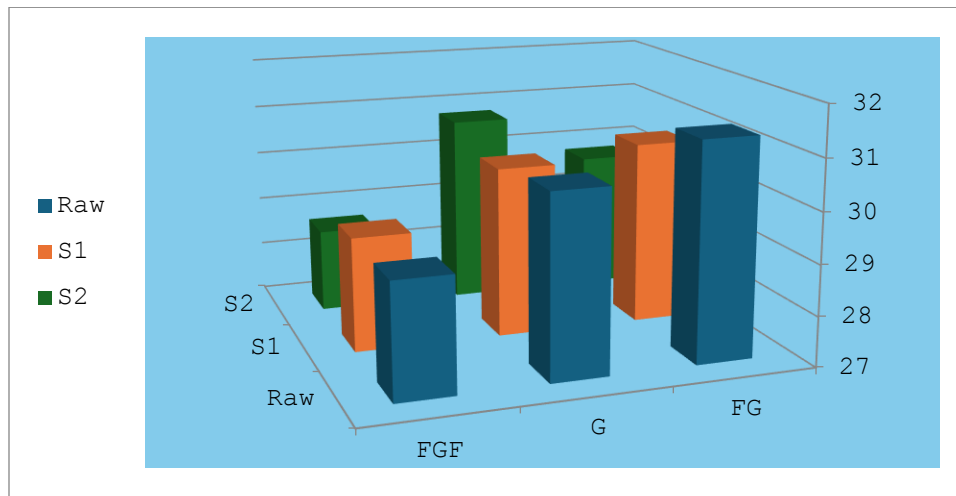


Fig. 1: Means values of UHML for G 29 with FG, G and FGF in Raw, S 1 and S2 cleaning stages

Table 3: Descriptive statistics for fiber quality properties of FG, G and FGF in Giza 96

Grade	Cotton	Statistics	UHML	Mic	MR	FS	Rd	+b	FQI
FG	Raw	Mean	36.77	4.00	93.42	47.00	75.24	10.10	20099
		SD	1.31	0.324	6.47	1.69	0.904	0.255	1821
		Min.	35.00	3.90	92.20	45.99	74.13	9.89	17016
		Max.	38.20	4.44	94.20	47.11	76.15	10.41	22591
	S1	Mean	36.00	3.99	92.41	46.93	78.91	9.59	18732
		SD	1.23	0.168	1.42	3.94	0.816	0.256	2419
		Min.	34.40	3.91	91.60	45.10	75.75	9.37	15440
		Max.	37.40	4.54	92.99	46.99	79.65	9.89	21556
	S2	Mean	35.17	3.92	92.00	46.21	80.12	9.72	14204
		SD	1.44	0.071	2.65	4.10	0.727	0.268	804
		Min.	33.20	3.89	91.30	45.10	79.09	9.37	13351
		Max.	37.70	4.43	93.20	47.30	81.30	9.89	15284
G	Raw	Mean	32.93	3.99	90.58	45.96	70.74	8.83	18732
		SD	1.78	0.197	1.84	5.57	1.68	0.382	2419
		Min.	29.60	3.83	90.21	42.70	69.63	8.29	15440
		Max.	34.50	4.30	92.70	46.20	72.70	9.33	21556
	S1	Mean	32.57	3.87	89.11	45.22	72.92	7.71	14204
		SD	1.25	0.163	1.23	2.53	0.536	3.78	804
		Min.	30.90	3.43	88.80	41.50	70.27	7.00	13351
		Max.	34.10	3.77	90.80	46.30	74.58	9.56	15284
	S2	Mean	29.30	3.84	88.58	44.88	74.47	9.98	13053
		SD	0.978	0.056	1.69	3.76	0.806	0.223	2442
		Min.	27.60	3.59	86.10	40.90	74.00	9.86	9895
		Max.	31.50	4.10	91.50	45.50	78.50	9.50	15000

		Max.	30.40	3.74	91.10	46.80	78.27	10.43	16979
FGF	Raw	Mean	32.56	3.87	86.18	39.28	63.34	9.23	8663
		SD	1.10	0.292	4.58	1.64	1.81	0.412	777
		Min.	31.00	3.00	85.40	27.10	60.61	8.53	7997
		Max.	34.00	3.98	88.70	40.70	66.06	9.62	10090
	S1	Mean	32.40	3.82	85.17	38.50	65.13	10.31	7627
		SD	0.637	0.055	1.54	1.87	0.723	0.306	1183
		Min.	31.40	3.03	82.30	31.90	61.47	10.14	6656
		Max.	33.10	4.79	86.50	41.10	66.24	10.90	9481
	S2	Mean	31.60	3.79	84.38	37.70	66.43	10.48	6998
		SD	0.60	0.063	1.78	5.02	0.639	0.322	1360
		Min.	30.90	3.21	82.10	35.40	60.34	10.14	5103
		Max.	32.30	4.56	86.10	41.50	69.24	10.94	8631

Reflectance Percentage (Rd) decreased from the highest grade to the lowest grade and increased from raw cotton to the cleaning stages (S1 and S2) for each grade of G 92, G 96, G 97 and G 98 and the effect were in an obvious degree as seen in Fig. 2.

Table 4: Descriptive statistics for fiber quality properties of G/FG, G and FGF in G 97

Grade	Cotton	Statistics	UHML	Mic	MR	FS	Rd	+b	FQI
G/FG	Raw	Mean	34.07	4.14	95.97	45.98	78.13	9.69	11815
		SD	0.933	0.178	2.23	22.04	0.52	0.118	957
		Min.	32.60	4.01	94.40	40.20	77.55	9.64	10574
		Max.	35.40	4.49	96.11	49.20	78.85	9.93	12897
	S1	Mean	31.75	4.13	94.60	44.93	78.69	9.69	10502
		SD	1.17	0.156	1.69	8.62	0.509	0.343	1010
		Min.	30.60	3.92	89.90	41.00	78.00	9.05	9227
		Max.	33.3	4.33	95.80	46.30	79.25	9.93	11999
	S2	Mean	31.50	4.14	92.30	43.62	80.26	10.01	6361
		SD	0.751	0.131	2.13	9.84	0.454	0.217	925
		Min.	31.50	3.98	89.00	42.30	79.71	9.64	5128
		Max.	33.50	4.26	94.40	45.90	81.01	10.18	7537
G	Raw	Mean	32.97	4.00	93.73	43.12	68.59	10	10606
		SD	1.08	0.332	4.23	3.28	1.18	0.536	2892
		Min.	27.90	3.92	91.70	40.10	67.45	9.14	6390
		Max.	33.00	4.79	95.70	48.40	70.63	10.44	14811
	S1	Mean	30.80	3.61	93.20	42.43	73.22	10.96	10566
		SD	0.756	0.236	3.35	5.37	0.914	0.168	1323
		Min.	29.80	3.33	91.30	41.20	71.96	10.68	8858
		Max.	31.70	3.93	94.10	44.80	74.63	11.21	12124
	S2	Mean	30.72	3.55	92.00	41.70	75.52	11.05	10508
		SD	1.79	0.191	2.21	3.61	0.88	0.22	1665

		Min.	26.90	3.31	91.10	41.00	74.63	10.68	7425
		Max.	32.10	3.75	92.00	42.70	86.83	11.26	12082
FGF	Raw	Mean	31.53	3.95	90.78	41.42	66.78	9.44	10114
		SD	0.810	0.275	4.87	4.05	1.67	0.316	1916
		Min.	30.30	3.60	88.20	38.40	64.73	8.68	7213
		Max.	32.70	4.27	94.10	46.80	68.37	10.45	12409
	S1	Mean	30.99	3.49	89.90	41.78	71.88	9.89	8938
		SD	0.479	0.143	2.09	2.89	1.04	0.216	1815
		Min.	29.70	3.26	87.90	40.40	70.17	8.98	6570
		Max.	31.00	3.68	93.40	43.50	73.70	9.56	11274
	S2	Mean	30.40	3.43	87.23	40.37	72.78	9.37	7646
		SD	1.14	0.052	89.06	2.81	0.988	0.299	632
		Min.	27.00	3.37	87.40	39.10	71.50	8.98	6694
		Max.	30.78	3.50	90.40	41.20	74.16	12.56	8373

Degree of Yellowness (+b) did not exhibit any differences between lint grades nor cleaning stages for all cotton varieties. All in all; the differences of cotton fiber quality properties due to cleaning were a little bit obvious between raw cotton and the next cleaning stages. Whereas, the differences between the first cleaning stage and the second one are very small and vice versa for Rd.

In terms of combination of cotton fiber attributes data allowed to predict quite accurately calculated technological value such as Fiber Quality Index (FQI) which was calculated for each grade of each variety. Fiber quality Index (FQI) is a useful tool for textile industry which relates fiber parameters based on the used cotton fiber device results.

Almost the same trend of results was obtained as; decreasing from high to low grades for each variety and the same trend from raw cotton to the two cleaning stages. All quantification technological values are useful for predicting usefulness of cotton fibers for subsequences industrial process. That is to be assuring with; fiber quality index would provide briefed and informative data of overall quality attributes of each cotton variety which is crucial for industrial process by correcting gear on certain machining such as the card, drawing frame and spinning frame in spinning process.

Table 5: Descriptive statistics for fiber quality properties of FG, G and FGF in G 98

Grade	Cotton	Grade	Statistics	UHM	Mic	MR	FS	Rd	+b	FQI
FG	Raw	FG	Mean	31.32	4.20	91.71	38.42	67.97	12.49	19016
			SD	0.919	0.180	2.94	2.22	0.457	0.354	8388
			Min.	30.50	3.79	88.10	29.10	67.41	11.99	12921
			Max.	33.00	4.58	94.30	40.21	68.72	2.80	35363
	S1		Mean	30.65	4.18	90.32	38.10	71.16	12.65	10220
			SD	0.489	0.153	1.49	2.13	0.356	0.228	2681
			Min.	30.00	4.40	89.10	37.30	70.95	12.40	7718
			Max.	31.20	4.68	91.50	39.90	71.81	12.91	15193
	S2		Mean	29.77	4.12	89.72	37.23	72.03	12.18	9606
			SD	0.151	0.101	2.29	3.38	0.461	0.284	3243
			Min.	29.50	4.11	88.50	37.20	71.35	11.84	4713
			Max.	29.90	4.13	90.60	39.69	72.66	12.63	14568
G	Raw	G	Mean	30.60	3.99	89.52	37.38	63.73	8.67	11209
			SD	1.43	0.168	1.90	4.55	1.37	0.478	3473
			Min.	28.80	3.35	80.60	24.90	60.06	8.04	6980
			Max.	33.20	4.25	90.90	38.90	70.25	9.30	16598
	S1		Mean	30.38	3.97	88.40	36.50	70.09	9.62	8470
			SD	0.646	0.032	1.47	8.12	1.18	0.162	2018
			Min.	29.40	3.87	85.00	30.60	66.61	9.35	7090
			Max.	31.20	4.00	90.70	32.70	71.15	9.86	12419
	S2		Mean	30.77	3.95	88.00	35.22	75.14	10.29	8251
			SD	0.383	0.111	2.12	3.55	0.272	0.265	2106
			Min.	30.30	3.88	86.30	34.60	71.69	9.97	5919
			Max.	31.20	4.00	89.20	35.80	79.55	10.51	12097
FGF	Raw	FGF	Mean	29.27	3.78	88.99	36.18	59.97	10.81	1880
			SD	1.19	0.241	3.21	3.19	2.37	0.374	387
			Min.	27.90	3.59	80.70	29.30	56.50	10.26	1445
			Max.	31.00	4.18	89.00	38.50	63.56	11.26	2453
	S1		Mean	29.27	3.75	88.11	36.80	66.56	12.08	1819
			SD	0.635	0.159	2.17	1.29	0.793	0.259	384
			Min.	28.20	3.69	83.60	34.10	65.87	11.79	1497
			Max.	29.90	4.00	89.00	37.60	67.61	12.37	2404
	S2		Mean	28.66	3.68	87.25	33.17	67.51	12.72	1784
			SD	0.849	0.141	2.06	9.53	0.787	0.276	220
			Min.	28.40	3.50	84.80	32.50	66.64	12.19	1583
			Max.	29.40	3.99	88.20	34.80	68.40	13.02	2168

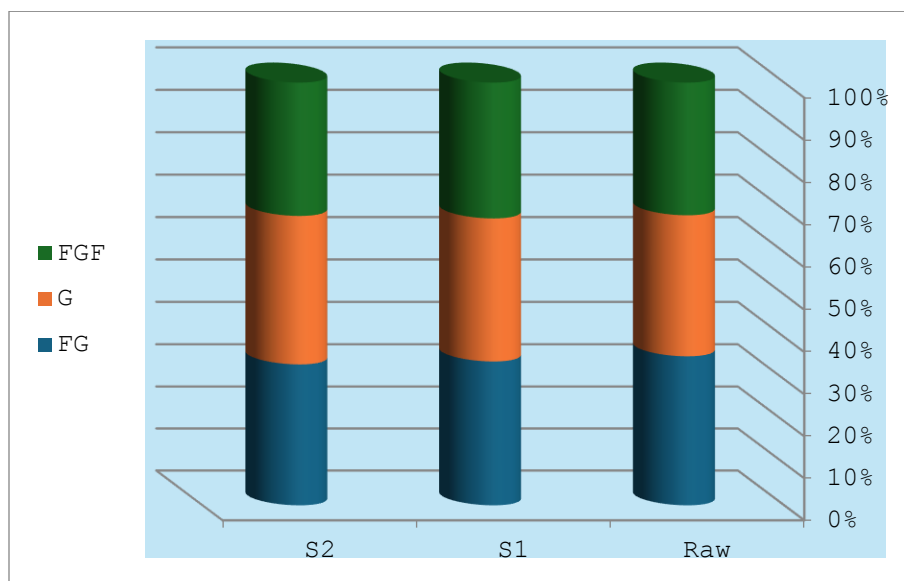


Fig. 2: Means values of Rd for G 29 with FG, G and FGF in Raw, S1 and S2 cleaning stages

It is obvious that cotton contains various kinds of trash for all grades which degraded low grades compared to high grades, in terms of using gravimetric methods such as in CCS instrument; from that, it is to measure dust, fiber fragment and trash to get total trash then to be able to calculate both of degree of cleaning and cleanability as seen in Table 6. Trash; dust, fiber fragment and total trash showed significant differences between lint cotton grades of each variety. There were clear trends for cleanability by almost increasing from first (S1) to second (S2) cleaning stages. On the other hand; degree of cleaning decreased from the first (S1) to second (S2) cleaning stages. Almost the same trend of results was established for Egyptian cotton grades by Hussein *et al.* (2014).

According to Uster (2001) degree of cleaning is more than 40% indicates very good degree of cleaning for all subsequences cotton manufacture as seen for G 98 gave the highest value of cleanability as 64.70, 69.77- 67.59, 70.14- 70.99 and 71.43% in raw cotton, first cleaning and second cleaning stages inside grades, fully Good, Good and Fully Good Fair, respectively. In addition to G 98 gave highest values of degree of cleaning as 40% and more than 40%. It may due to that G 98 is shorter than other rest varieties so it is be easier in cleaning. It is mostly because the entanglement of impurities with shorter fibers is less than the longest fibers.

Then; no obvious trend of cleanability and degree of cleaning was appeared for G 92, G 96 and G 97. Meanwhile; G 98 as a shorter Egyptian cotton variety gave the highest value of them. Moreover; In the first cleaning stage; the amounts of impurities cotton were greatly reduced, meanwhile in the second cleaning stage there were slightly different, so improvement of cleanability seems to be low. On the other hand, degree of cleaning decreased after the first cleaning stage.

Any differences in results are regarded to the measured sample, personal performing the measurements, the used instrument, ambient atmospheric for the measured sample and any unexpected actions.

Regression models are often applied to the prediction of continuous values. Where linear regression is used to establish linear relations between variables. Meanwhile, when linear regression is not proper for describing the relations between variables. It is the way for other regression models (Polynomials) to cover these relations by using other curve estimation regression models such as quadratic and cubic regressions.

Regardless to the whole coefficients of all regression models (polynomials). Where polynomials are one of the significant concepts of mathematics where determines the maximum number of solutions. The main target is to get basic information about cotton fiber quality indicators by using coefficient of determination (R^2) which is the proportion of variance in the dependent variables (cotton fiber properties) with independent variable (trash and cleaning stages), and Standard Error (SE) for each model in each grade variety as were presented in Tables 7, 8, 9 and 10.

A linear polynomial is a degree one where the highest exponent of the variable is one. Meanwhile quadratic and cubic polynomials are degrees two and three, respectively. The comparison among them in the best is higher R^2 and lower SE as seen with Chicoo *et al.* (2021). The coefficient of determination (R^2) is for measuring how well the statistical model is fit; if it is close to 1 so it is better than other close to 0.

Generally, quadratic and cubic estimators are more often better than linear estimation. Almost cotton fiber properties gave the same trend as seen in Tables 7,8, 9 and 10 and Fig. 3. It due to when the relationship between variables is not linear, meaning a straight line doesn't adequately represent the data (cotton fiber properties with cleaning stages across grades). Quadratic models (parabolas) and cubic models (curves with two humps) can capture curves and trends that linear models (straight lines) miss, providing a more accurate representation of the underlying relation and potentially leading to better predictions. All the same trend and details were illustrated by Ayub and Furukawa (2024).

Meanwhile, many observations are far from the line of best fit model's predictions as seen in Table 9 and Fig. 4 for G 97; UHML for linear, quadratic and cubic curve estimation for FGF (congruence between linear, quadratic and cubic estimation) and that may due to the lowest grade is known by deterioration of fiber properties compared to other higher grades.

In G 92; FS had the same value of R^2 (32.2 %) and the same SE (5.751) for total grades in linear, quadratic and cubic curve estimates as seen in Table 7 and Fig. 5. Meanwhile, Rd results were

higher and equal values for quadratic and cubic regressions compared to linear curve estimation for G/FG grade as seen in Table 7 and Fig. 6.

All in all; any cleaning processes can be affected all cotton fiber properties and both of quadratic and cubic curve estimations were more effective than using linear model. Nearly the same trend of results was covered by Wanjura *et al.* (2011).

Table 6: Mean values of trash components and degree of cleaning and cleanability of G 92, G 96, G 97 and G 98 cotton varieties

Varieties	Grade	Cleaning stages	T	FF	D	TT	C	DC
G 92	G/FG	Raw	1	0.17	0.16	1.33	-	
		S1	0.4	0.008	0.008	0.42	76.17	40.0
		S2	0.1	0.001	0.001	0.10	80.31	24.52
	G	Raw	1.9	0.32	0.31	2.53	-	
		S1	0.70	0.10	0.10	0.9	73.58	31.62
		S2	0.30	0.002	0.005	0.31	74.57	38.38
	FGF	Raw	4.5	0.25	0.24	4.99	-	
		S1	1.7	0.15	0.15	2.0	71.39	40.08
		S2	0.8	0.001	0.001	0.80	71.38	40.10
G 96	FG	Raw	1.2	0.24	0.2	1.64	-	
		S1	0.6	0.14	0.14	0.88	65.08	53.66
		S2	0.3	0.009	0.009	0.318	73.46	36.14
	G	Raw	3.4	0.44	0.44	4.28	-	
		S1	1.99	0.19	0.18	2.36	64.45	55.14
		S2	0.7	0.01	0.01	0.72	76.62	30.51
	FGF	Raw	6.2	0.6	0.6	7.4	-	
		S1	3.5	0.3	0.2	4.00	64.91	54.05
		S2	1.8	0.01	0.01	1.82	68.73	45.51
G 97	G/FG	Raw	1.5	0.41	0.41	2.32	-	
		S1	0.4	0.21	0.21	0.82	73.89	35.34
		S2	0.1	0.01	0.01	0.12	87.23	14.63
	G	Raw	4.2	0.71	0.71	5.62	-	
		S1	1.91	0.42	0.42	2.33	70.69	41.46
		S2	0.3	0.09	0.09	0.48	82.92	20.60
	FGF	Raw	6.6	1	1	8.6	-	
		S1	4.7	0.6	0.6	5.9	66.15	51.16
		S2	1.1	0.07	0.07	1.24	78.01	28.18
FG	Raw	1.2	0.5	0.5	2.2	-		
	S1	1	0.1	0.1	1.2	64.70	54.55	
	S2	0.5	0.01	0.01	0.52	69.77	43.33	

G 98	G	Raw	5.1	1.1	1.1	7.3	-	
		S1	2.5	0.5	0.5	3.5	67.59	47.95
		S2	1.4	0.05	0.04	1.49	70.14	42.57
	FGF	Raw	8.3	1.6	1.6	11.5	-	
		S1	3.9	0.4	0.4	4.7	70.99	40.87
		S2	1.7	0.09	0.09	1.88	71.43	40.00

Where cleaning stages; raw refers to cotton without cleaning, 1 refers to first cleaning stage and 2 refers to second cleaning stage.

Table 7: Models summary of regression curve estimations of G 92

Grades	Curve estimation	Parameters	UHM	Mic	MR	FS	Rd	+b
Total Grades	Linear	R ²	16.7	24.6	95.1	32.2	76.0	82.2
		SE	0.823	0.359	0.032	5.751	1.315	0.326
	Quadratic	R ²	21.8	30.58	98.3	32.2	85.5	83.1
		SE	0.824	0.255	0.019	5.751	1.055	0.329
	Cubic	R ²	21.8	30.58	98.3	32.2	85.5	83.1
		SE	0.824	0.255	0.19	5.751	1.055	0.329
G/FG	Linear	R ²	22.5	46.2	95.1	41.4	82.6	64.3
		SE	1.287	0.167	0.032	4.697	1.137	0.407
	Quadratic	R ²	22.5	58.9	98.3	57.2	84.2	75.3
		SE	1.329	0.151	0.019	4.146	1.121	0.350
	Cubic	R ²	22.5	58.9	98.3	57.2	84.2	75.3
		SE	1.329	0.151	0.019	4.146	1.121	0.350
G	Linear	R ²	14.6	37.9	83.1	35.7	78.6	24.0
		SE	0.837	0.179	0.065	3.819	0.875	0.298
	Quadratic	R ²	24.4	42.2	96.8	51.4	82.4	45.7
		SE	0.814	0.176	0.029	3.427	0.819	0.260
	Cubic	R ²	24.4	42.2	96.8	51.4	82.4	45.7
		SE	0.814	0.176	0.029	3.427	0.819	0.260
FGF	Linear	R ²	8.9	36.5	68.0	21.1	71.8	4.5
		SE	1.336	0.208	0.084	4.172	2.197	2.291
	Quadratic	R ²	18.1	36.5	89.6	44.8	92.3	17.4
		SE	1.309	0.215	0.050	3.237	1.185	2.201
	Cubic	R ²	18.1	36.5	89.6	44.8	92.3	17.4
		SE	1.309	0.215	0.050	3.237	1.185	2.201

4. CONCLUSION

Trash is one of the major factors of cotton grading. The more presence trash, the less of cotton grade (low grade) and the less trash, the more cotton grade (high grade). Therefore; from stage to stage of cleaning give clear results for trash and as much that all studied properties. Trash affects all cotton fiber properties in different degrees for; upper half mean length, micronaire value,

maturity ratio, fiber strength and degree of yellowness. Meanwhile reflectance percentage had the most obvious effect from trash and the two cleaning stages. It is essential to calculate both of cleanability and degree of cleaning to give a vision about a target sample to industrial process. Then; The main target of cotton lint cleaning is to reduce trash components to an acceptable level with minimal fiber damage in its cotton fiber properties to get proper price for marketing, mixing or blending process and spinnability. To get an acceptable references prediction for cotton industry by using any technological indices to predict a calculated value to be the main comparison for a product manufacturing which is this depended on the market requirement. All that to avoid serious ramifications which are done in industrial processes.

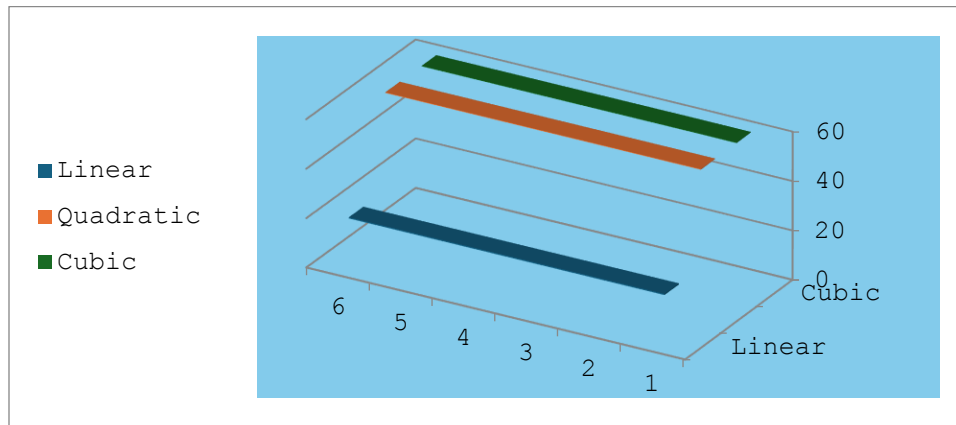


Fig. 3: The superiority of quadratic and cubic models compared to linear model curve estimation

Table 8: Models’ summary of regression curve estimations of G 96

Grades	Curve estimation	Parameters	UHM	Mic	MR	FS	Rd	+b
Total Grades	Linear	R ²	0.9	30.56	67.9	0.7	18.2	3.7
		SE	2.041	0.296	0.090	6.999	5.193	1.435
	Quadratic	R ²	1.0	35.89	68.0	1.7	19.4	6.6
		SE	2.021	0.199	0.090	6.793	5.007	1.427
	Cubic	R ²	1.0	35.89	68.0	1.7	19.4	6.6
		SE	2.021	0.199	0.090	6.793	5.007	1.427
G/FG	Linear	R ²	54.9	42.85	95.1	64.9	97.1	41.4
		SE	2.828	0.193	0.032	2.828	1.410	0.298
	Quadratic	R ²	60.9	45.33	98.3	68.4	98.7	45.7
		SE	1.111	0.155	0.019	2.773	1.202	0.260
	Cubic	R ²	60.9	45.33	98.3	68.4	98.7	45.7
		SE	1.111	0.155	0.019	2.773	1.202	0.260
	Linear	R ²	22.5	34.21	68.0	41.4	82.6	13.9

G	Quadratic	SE	1.329	0.166	0.084	4.697	1.137	0.529
		R²	22.5	38.87	89.6	57.2	84.2	67.7
	Cubic	SE	1.329	0.147	0.050	4.146	1.121	0.335
		R²	22.5	38.87	89.6	57.2	84.2	67.7
FGF	Linear	R²	8.9	11.25	55.42	35.7	78.6	4.5
		SE	1.336	0.239	0.365	3.819	0.875	2.291
	Quadratic	R²	18.1	15.42	61.56	51.4	82.4	17.4
		SE	1.309	0.188	0.266	3.427	0.819	2.201
	Cubic	R²	18.1	15.42	61.56	51.4	82.4	17.4
		SE	1.309	0.188	0.266	3.427	0.819	2.201

Table 9: Models summary of regression curve estimations of G 97

Grades	Curve estimation	Parameters	UHM	Mic	MR	FS	Rd	+b
Total Grades	Linear	R²	8.7	24.1	72.6	6.1	37.1	32.5
		SE	0.971	0.260	0.064	4.860	2.849	0.610
	Quadratic	R²	9.8	32.4	85.7	8.2	40.4	42.8
		SE	0.082	0.248	0.047	4.854	0.248	0.567
	Cubic	R²	9.8	32.4	85.7	8.2	40.4	42.8
		SE	0.082	0.248	0.047	4.854	0.248	0.567
G/FG	Linear	R²	56.3	54.3	88.9	24.5	85.8	85.7
		SE	0.591	0.161	0.049	1.077	0.713	0.337
	Quadratic	R²	56.7	63.7	95.9	34.2	95.2	88.8
		SE	0.508	0.149	0.030	0.855	0.427	0.307
	Cubic	R²	56.7	63.7	95.9	34.2	95.2	88.8
		SE	0.508	0.149	0.030	0.855	0.427	0.307
G	Linear	R²	9.8	44.7	79.5	1.8	72.0	59.1
		SE	0.831	0.231	0.159	2.578	2.034	0.525
	Quadratic	R²	9.8	66.2	91.6	3.8	85.4	86.8
		SE	0.859	0.186	0.055	2.636	1.517	0.308
	Cubic	R²	9.8	66.2	91.6	3.8	85.4	86.8
		SE	0.859	0.186	0.055	2.636	1.517	0.308
FGF	Linear	R²	0	15.7	65.6	0	65.4	14.8
		SE	0.920	0.172	0.055	4.908	1.321	0.324
	Quadratic	R²	0	23.2	90.9	0.4	85.5	34.4
		SE	0.920	0.170	0.029	5.059	0.885	0.293
	Cubic	R²	0	23.2	90.9	0.4	85.5	34.4
		SE	0.920	0.170	0.029	5.059	0.885	0.293

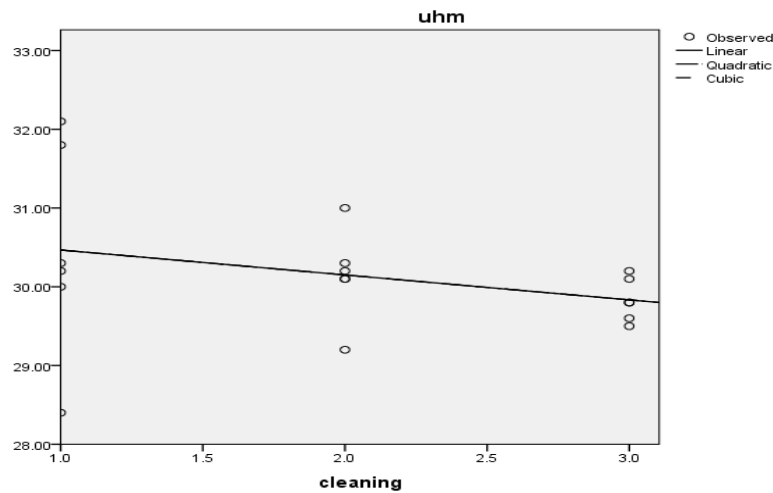


Fig. 4: The same curve estimations values ($R^2 = 0$) in UHML in G 97 for FGF grade

Table 10: Models summary of regression curve estimations of G 98

Grades	Curve estimation	Parameters	UHM	Mic	MR	FS	Rd	+b
Total Grades	Linear	R ²	13.1	21.6	65.2	5.3	21.6	65.2
		SE	1.864	0.328	0.089	11.622	0.328	0.089
	Quadratic	R ²	13.3	26.3	83.1	6.6	26.3	83.1
		SE	1.780	0.321	0.062	11.11	0.321	0.062
	Cubic	R ²	13.3	26.3	83.1	6.6	26.3	83.1
		SE	1.780	0.321	0.062	11.11	0.321	0.062
G/FG	Linear	R ²	72.8	55.5	76.6	20.4	80.60	76.6
		SE	0.830	0.202	0.075	15.709	0.202	0.075
	Quadratic	R ²	73.0	66.0	98.1	33.8	84.66	98.1
		SE	0.814	0.182	0.032	14.801	0.182	0.032
	Cubic	R ²	73.0	66.0	98.1	33.8	84.66	98.1
		SE	0.814	0.182	0.032	14.801	0.182	0.032
G	Linear	R ²	23.9	52.9	75.4	2.0	75.12	75.4
		SE	1.211	0.292	0.073	4.419	0.292	0.073
	Quadratic	R ²	54.4	65.1	97.3	16.0	79.55	97.3
		SE	0.968	0.260	0.025	4.186	0.260	0.025
	Cubic	R ²	54.4	65.1	97.3	16.0	79.55	97.3
		SE	0.968	0.260	0.025	4.186	0.260	0.025
FGF	Linear	R ²	0.7	0	73.0	1.9	73.24	73.0
		SE	0.139	0.151	0.069	3.228	0.151	0.069
	Quadratic	R ²	13.9	0.1	93.7	3.8	76.85	93.7
		SE	1.281	0.146	0.034	3.002	0.144	0.034
	Cubic	R ²	13.9	0.1	93.7	3.8	76.58	93.7
		SE	1.281	0.146	0.034	3.002	0.144	0.034

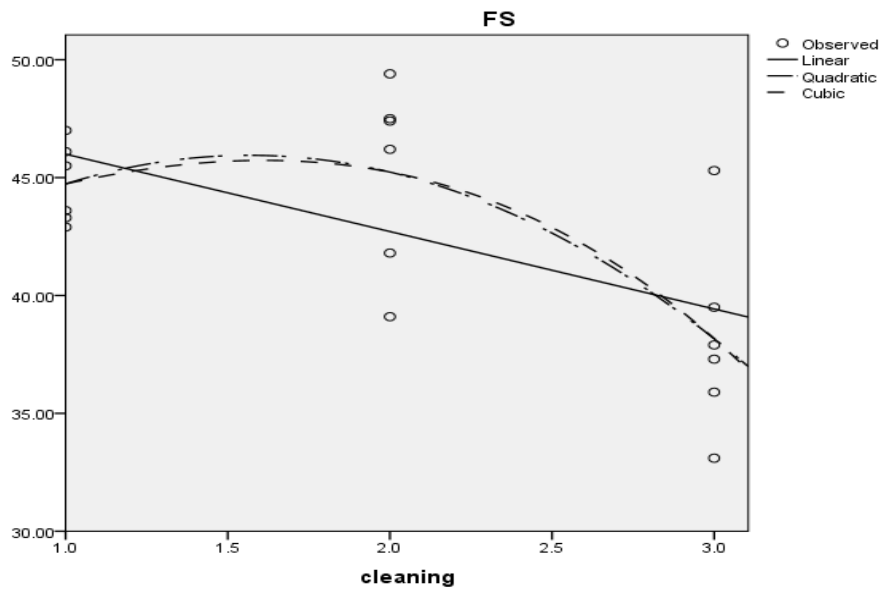


Fig. 5: The same value of (R²) and (SE) for curve estimation in strength for G 92 for total grade

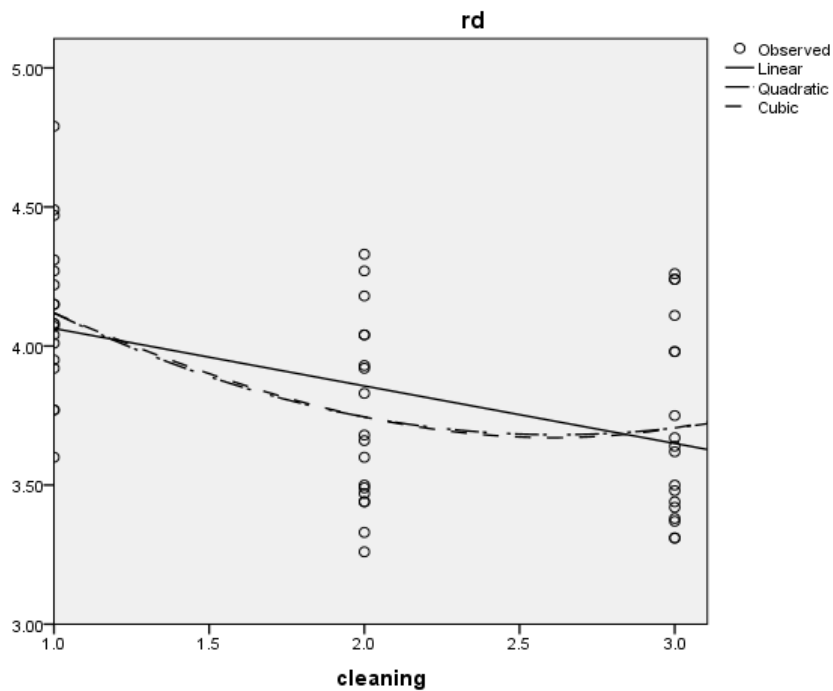


Fig. 6: The same value (R²) of quadratic and cubic curve estimations

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