

1 Original research paper

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3 **Ginning efficiency and fiber quality properties of cotton as affected by roller**  
4 **gin stand feeding methods and seed cotton grade**

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10 **ABSTRACT:**

**Aims:** Attaining the highest ginning efficiency process and fiber quality properties of Egyptian cotton cultivar 'Giza 88' during feeding methods of roller gin stand is the ultimate objective of the community of cotton field industry for local uses, but the productivity of the three feeding methods of conventional roller gin stand used in ginning process still limited.

Therefore, the aim of this investigation is to overcome this obstacle.

**Study design:** This investigation was conducted in a completely randomized design with three replicates and analyzed as a factorial experiment.

**Place and Duration of Study:** Plant Production Department, the Faculty of Agriculture (Saba Basha), Alexandria University, Egypt during 2017.

**Methods:** Four seed cotton grades; namely, Good to Fully Good (G/FG), Good + ¼ (G + ¼), Good (G) and Good -¼ (G - ¼) belonging to 'Giza 88' cotton cultivar were used in this work. The extra-long staple Egyptian cotton variety with the pedigree and origin of cotton Giza 88 (Giza 77 x Giza 45 B) was used. This work was carried out in 2017. About half cantar (1 cantar = 157.5 kg) of each seed cotton grade as a bulk sample was thoroughly mixed and checked and reclassified by a committee of three expert classers belong to the Cotton Arbitration for Testing General Organization (CATGO), in the gin plan.

**Results:**

The obtained results indicated that the gin stand's hand feeding method (control treatment); results in significant ( $p \leq 0.05$ ) increases the highest mean values of the gin stand capacity (0.97 kg lint/inch/hr), lint percentage (36.59%) and lint grade code (27.33) and the lowest mean value of the ginning time (1.42 hr/cantar). Meanwhile, the belt (2 rows) as a mechanical feeding method; gave rise to the lowest mean value of gin stand capacity (0.89 kg lint/inch/hr.). The differences in fiber length parameters (Upper half mean length and short fiber index), fiber elongation percentage, micronaire reading, yellowness degree (+b) were not significantly ( $p \geq 0.05$ ) affected. The highest seed cotton grade (Good / Fully Good) gave the better lint cotton grade and the best fiber properties tested by HVI instrument of 'Giza 88' cotton cultivar.

**Conclusion:**

- The hand feeding method of seed cotton to the gin stand surpassed all studied feeding methods in gin stand productivity, lint percentage and the most H.V.I. fiber properties are better classer grade. Though, this method is recommended to be used specially with the high levels of the extra-long cottons.
- Cylinder feeding method ranked first in order among studied mechanical method and it could be recommended for ginning medium and low seed cotton level.
- Belt (2 rows) is the preferred feeding method regardless of gin stand productivity.

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12 *Keywords:* seed cotton grade, feeding method, fiber quality.

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14 **1. INTRODUCTION**

15 Historically, ginning is the process in which seed cotton is subjected to separation of fibers  
16 from the seed with conserving its quality characteristics [1]. The roller gin stand was designed  
17 by Fones McCarthy in 1840. Ginning efficiency usually evaluated as gin stand capacity,  
18 ginning time and ginning out-turn. Generally, the gin stand capacity is influenced by several  
19 factors such as gin stand speed and adjustments, feeding method, cotton variety grade,  
20 besides its moisture content. Also, the feeder of gin stand regulates the flow of seed cotton

21 provided to ginning system according to rate preset by ginner, beside fluffing and cleaning of  
22 the fed seed cotton. Historically, the first method for feeding gin stand with seed cotton by  
23 using hands was designed by Eli Whitney. In Egypt, the hand feeding remains in use beside  
24 two more mechanical feeding methods as the cylinder and belt. The rate of cleaning, fluffing  
25 and regulating the flow of seed cotton to the ginning zone greatly varied from one method to  
26 another, in addition to the lack of uniformity of seed cotton locks distribution along the ginning  
27 roller. On the other hand, some cotton dealers believe that the mechanical feeders in general  
28 have a deleterious effect on ginning efficiency and fiber quality.

29 In 1902 Chessman used a small drum as cleaning feeder to regulate the flow of seed  
30 cotton. In 1917 Murray Company invented a draper or a spiked belt as a feeder, a drum type  
31 feeder, and saw gin stand, which was usually located between the ginning roller and the  
32 overhead cleaning feeder to provide more uniformity and slower feeding at the working zones.  
33 The feeder was used at this time with modern roller gin stands. It was a type known as  
34 cleaner extractor, it was regulate the feeding the roller gins with suitable amount of seed  
35 cotton [2]. The seed cotton feeding rate to the gin stand, significantly ( $p \leq 0.05$ ) affected the  
36 ginning efficiency (ginning capacity and ginning time), lint grade, non-lint content and lint  
37 colour (Rd% and +b). As the feeding rate increased; the amount of seed cotton increased in  
38 ginning point, while the extractor of tight locks worked as an opener for the seed cotton before  
39 ginning in process. Ginning efficiency increased or decreased owing to the level of feeding  
40 rate and the position of the extractor [3]. Feeding rates of seed cotton to roller gin stand,  
41 significantly ( $p \leq 0.05$ ) affected gin stand capacity, ginning time, non-lint content, but  
42 insignificantly affected lint colour ( Rd% and +b) [4]. An extractor feeder led to lint separation  
43 from seeds consistently at higher given feed rate. The obtained results showed that the  
44 performance and capacity of the cage gin can be increased by improving the separation and  
45 distribution of seed cotton on the surface of the roller [5]. Likewise, feeding the gin stand with  
46 seed cotton by hand exhibited the highest gin stand capacity (32.76, 38.8 and 38.9 kg/in/hr.)  
47 for the belt, cylinder and hand feeding methods, respectively [6]. A new designed extractor-  
48 feeder machine was built to replace both the inefficient belt and cylinder methods that are in  
49 use in feeding the gin stand with seed cotton. The obtained results also show that fixing the  
50 speed of the extractor feeder at 0.7 rpm, resulted in an increase in the gin stand capacity ca.  
51 38.5% higher than using hand, and by about 35% and 27% for cylinder and belt methods,  
52 consecutively [7]. Furthermore, the seed cotton hand feeding method to the gin stand,  
53 surpassed all studied feeding methods in gin stand productivity, ginning out-turn, length  
54 uniformity be better classer grade [8]. Gin stand capacity (kg/inch/hr) was increased by  
55 increasing the seed cotton grade, while, the ginning time varied within the same variety using  
56 different grades. This could be explained on the basis that each cotton variety has unique  
57 characteristics in terms of staple length, lock size, seed weigh and also the attachment force  
58 of the fibers to seeds [9]. Fiber length parameters considerably depending on the used grade  
59 of cotton cultivar [10].

60 The present research was conducted aiming to investigate the effect of feeding  
61 method of conventional roller gin stand and seed cotton grade on ginning efficiency, lint  
62 grades and fiber properties of the Egyptian extra-long staple cotton variety 'Giza 88'.  
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## 2. MATERIAL AND METHODS

This investigation was carried out in the Plant Production Department, the Faculty of Agriculture (Saba Basha), Alexandria University, Egypt to overcome the research statement. Two independent variables were under investigation as 1) three feeding methods were used in this research as follows: hand feeding (control), cylinder feeding and belt feeding (2 rows) of tooth spicks, and 2) four seed cotton grades; namely, Good to Fully Good (G/FG), Good + ¼ (G + ¼), Good (G) and Good - ¼ (G - ¼) belonging to 'Giza 88' cotton cultivar during the season of 2017. It is an extra-long staple Egyptian cotton variety and its pedigree and origin of cotton Giza 88 (Giza 77 x Giza 45 B). About half cantar (1 cantar = 157.5 kg) of each seed cotton grade as a bulk sample was, thoroughly, mixed and checked or reclassified by a committee of three expert classers belong to the Cotton Arbitration for Testing General Organization (CATGO), in the gin plant. The studied samples were attained from the Arabia Ginning Company, Damanhour, of the commercial cotton received from Shubrakhit region, El-Beheira Governorate, during 2017 season. The bulk sample (27 kg) of each seed cotton grade was divided into nine sub- samples (3 kg/replicate), representing the various combinations of both variables (Twelve treatments representing four seed cotton grades and three feeding methods). The studied sub-samples were ginned using the conventional single roller gin stand [a roll covered with natural leather (McCarthy roller gin)] with the adjustments required for the each grade in the same gin plant.

Studied characteristics

The independent variable was represented by the following parameters:

1. Ginning efficiency parameters:

These parameters were calculated according to the following equations, proposed by [11]:

1.1. Gin stand capacity (G.S.C.) expressed as the lint weight (kg) per inch per hour, as follows:

$$\text{Gin stand capacity (G.S.C.)} = \frac{60 \times \text{weight of ginned lint (kg)}}{\text{Time (min)} \times \text{Length of roller (inch)}} = (\text{kg lint /inch/hr})$$

(Length of roller = 40 inch of the McCarthy roller gin stand)

1.2. Ginning time (G.T.) was determined according the following equation:

$$\text{Ginning time (G.T.)} = \frac{\text{Ginning time (minute)} \times 157.5}{\text{Seed cotton weight (kg)} \times 60} = (\text{h/cantar})$$

(1 metric seed-cotton cantar = 157.5 kilograms)

1.3. Lint percentage (%): was expressed as a percentage, and determined according the following equation:

$$\text{Lint percentage (L.P.)} = \frac{\text{Lint cotton weight (kg)}}{\text{Seed cotton weight (kg)}} \times 100 = \%$$

1.4. Seed index: The average weight of 100 seeds (g) was determined for each replicate.

1.5. Lint grade: The ginned lint of each sample was determined by a three expert classers, at (CATGO), Alexandria. For statistical analysis, the grades were converted to code numbers [12] as shown in the following Table (1).

Table (1): Lint cotton grades, their abbreviation and their codes.

Grade	Abbreviation	Code
Extra	Extra	41
Fully good/Extra	FG/Extra	37
Fully good	FG	33
Good/fully good	G/FG	29
Good	G	25
Fully good fair/good	FGF/G	21
Fully good fair	FGF	17
Good fair/fully good fair	GF/FGF	13
Good fair	GF	9
Fully fair/good fair	FF/GF	5
Fully fair	FF	1

Each 1/8 grade is represented by one mark.

3. Determination of fiber properties using H.V.I. instrument:

Representative sample of lint cotton (about 200 grams) was drawn for determining

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118 the fiber properties. The High Volume Instrument (HVI) Spectrum II system was used to  
 119 determine the fiber properties at the Laboratories of Cotton Arbitration for Testing General  
 120 Organization (C.A.T.G.O.), Alexandria, Egypt.

121 All samples were opened and left for 24 hours at least under the standard conditions  
 122 of  $65 \pm 2\%$  relative humidity and  $21 \pm 1^\circ\text{C}$  temperature before being tested, and the following  
 123 properties were determined:

124 3.1. Fiber upper half mean length (U.H.M.L.; mm.).

125 3.2. Length uniformity index (%).

126 3.3. Short fiber index (%).

127 3.4. Fiber bundle strength (g/tex).

128 3.5. Fiber elongation (%).

129 3.6. Micronaire value.

130 3.7. Maturity index (%).

131 3.8. Fiber brightness or reflectance degree (Rd %).

132 3.9. Chroma or degree of yellowness (+b).

133 3.10. Trash area (%).

134 3.11. Trash count.

135 3.12. Spinning consistency index (SCI).

136 4. Statistical procedures

137 This investigation was conducted in a completely randomized design with three  
 138 replicates and analyzed as a factorial experiment according to the procedure of [13]. The  
 139 mean values were computed using the CoStat 6.311 (1998-2005) [14] as a statistical  
 140 program, to test significant differences among treatments using the least significant difference  
 141 (L.S.D.) at 0.05 level of probability.

142 **RESULTS AND DISCUSSION**

143 1. Ginning efficiency parameters:

144 Results presented in Table (2) show the mean values of the ginning efficiency  
 145 parameters, ie. gin stand capacity, ginning time, Lint percentage (%), seed index and lint  
 146 grade code for the cotton cultivar 'Giza 88'.

147 The attained results indicated that feeding methods treatments affected significantly  
 148 ( $p \leq 0.05$ ) the gin stand capacity, ginning time, Lint percentage (%) and lint grade code.  
 149 Whereas, the differences in seed index were insignificant due to the feeding methods, effect.

150 It is obvious that the hand method (control treatment) possessed the highest mean  
 151 values of the gin stand capacity (G.S.C.), lint percentage, seed index and lint grade code and  
 152 the lowest mean value of the ginning time (G.T.). Meanwhile, the belt (2 rows) mechanical  
 153 feeding method; gave the lowest mean values gin stand capacity (G.S.C.), Lint percentage,  
 154 seed index and lint grade code, and the highest mean value of ginning time. It could be  
 155 proposed that the gin stand capacity increases and the ginning time decreases proportionally  
 156 as the increase in delivery of cotton locks to the ginning zone in case of the hand feeding  
 157 method. These results are in accordance with those obtained by [6, 8] they noticed that the  
 158 feeding rates of seed cotton to roller gin stand significantly affected ginning efficiency (ginning  
 159 stand capacity and ginning time).

160 Table (2). Mean values of the ginning efficiency parameters of Giza 88 cotton variety as affected by  
 161 the feeding method, seed cotton grade and their interaction during season of 2017.

Characters Treatments	Gin stand capacity (kg lint/inch/hr.)	Ginning time (hr./cantar)	Lint (%)	Seed index (g)	Lint grade code
<b>Feeding method (A)</b>					
Hand	0.97 a	1.42 b	36.59 a	9.19 a	27.33 a
Cylinder	0.94 b	1.49 ab	36.36 a	8.90 a	26.83 b
Belt (2 rows)	0.89 c	1.55 a	35.89 b	8.89 a	26.66 b
L.S.D. <sub>0.05</sub>	0.027	0.076	0.411	0.372	0.397
<b>Seed cotton grade (B)</b>					
Good / Fully Good	1.03 a	1.38 c	37.33 a	10.48 a	29.00 a
Good + ¼	0.97 b	1.46 bc	37.08 a	9.99 b	28.33 b
Good	0.89 c	1.52 ab	35.98 b	8.98 c	26.33 c
Good - ¼	0.84 d	1.57 a	34.73 c	6.52 d	24.11 d
L.S.D. <sub>0.05</sub>	0.032	0.088	0.474	0.430	0.458
<b>Interaction</b>					

A × B	Ns	ns	**	*	ns
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162 Means designated by the same letter within each column are not significantly different.

163 \* Significant at 0.05 level of probability. \*\*: Significant at 0.01 level of probability.

164 NS. : Not significant.

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166 In terms of the main effect of seed cotton grade, results outlined in the same Table,  
167 reveal that all studied ginning efficiency parameters were significantly ( $p \leq 0.05$ ) affected by  
168 seed cotton grade. It is obvious that the highest seed cotton grade (Good to Fully Good  
169 (G/FG)); brought about the lowest mean values of the ginning time and the highest mean  
170 values for the rest of the studied ginning efficiency parameters. This result might be because  
171 the highest seed cotton grade usually contains the highest proportion of the big fluffy cotton  
172 locks, and the lowest proportion of foreign matters or trash content and tight locks. In this  
173 connection, [8, 15] reported that the highest seed cotton grade, gave rise to the highest  
174 ginning out-turn (%) and gin stand capacity and the lowest value of the ginning time.

175 Results tabulated in Table (2) declare that the interaction between the two studied  
176 factors, i.e. feeding methods and seed cotton grades (A×B) was significant ( $p \leq 0.05$ ) for lint  
177 percentage and seed index of the cotton cultivar 'Giza 88'. Mean values of the same traits are  
178 presented in Table (3). It is obvious that the hand feeding method of the highest seed cotton  
179 grade (G/FG) records the highest mean value of lint percentage. Otherwise, the lowest mean  
180 value of the same trait was recorded from the Belt (2 rows) mechanical feeding method with  
181 seed cotton grade (G - ¼).

182 Regarding the seed index, the highest mean value was reached by the cylinder  
183 feeding method with the highest seed cotton grade (G /FG) and the Belt (2 rows) mechanical  
184 feeding method with the same seed cotton grade (G /FG). On the other hand, the lowest  
185 mean value of the same trait was obtained using the cylinder feeding method with the lowest  
186 seed cotton grade (G - ¼) and the Belt (2 rows) mechanical feeding method with the same  
187 seed cotton grade (G - ¼).

188

189 Table (3). The interaction between feeding method and seed cotton grade (A × B) for the  
190 lint percentage (%) and seed index (g) of 'Giza 88' during season of 2017.

Variables		Lint percentage (%)	Seed index (g)
Feeding method (A)	Seed cotton grade (B)		
Hand	G / FG	37.36	10.29
	Good + ¼	37.15	9.99
	Good	36.01	9.00
	Good - ¼	35.86	7.50
Cylinder	G / FG	37.33	10.58
	Good + ¼	37.16	9.99
	Good	36	8.99
	Good - ¼	34.98	6.04
Belt (2 rows)	G / FG	37.32	10.58
	Good + ¼	36.93	9.99
	Good	35.95	8.96
	Good - ¼	33.36	6.04
L.S.D. <sub>(0.05)</sub>		0.822	0.744

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### 192 3. Fiber properties tested by H.V.I. instrument:

193 In general the results outlined in Table (4) indicated that the effect of the feeding  
194 method treatments had a highly significant ( $p \leq 0.01$ ) on spinning consistency index (SCI),  
195 maturity index, length uniformity index (U.I.), the fiber bundle strength, fiber reflectance  
196 degree (Rd %) and the differences in trash count, and trash area. Whereas, the differences in  
197 micronaire value, fiber length parameters, upper half mean length (U.H.M.L.), and short fiber  
198 index (SFI), fiber elongation percentage, micronaire reading and yellowness degree (+b)  
199 were not significantly affected, due to the feeding method effect.

200 Hand feeding method exhibited the highest mean values for the spinning consistency  
201 index (SCI), maturity index, length uniformity index (U.I.), the fiber bundle strength, fiber  
202 reflectance degree (Rd %) and the lowest mean values of trash count and trash area, as

203 shown in Table (4), while the lowest mean values of the same traits and the highest mean  
204 value of trash count were possessed by using the Belt (2 rows) mechanical feeding method.  
205 Meanwhile, the lowest mean value of the trash area was recorded by cylinder feeding method  
206 to the gin stand. These results could be attributed to the little chance for the tight locks to be  
207 hanged and ginned, besides the lower rate of flow of seed cotton to the ginning zone in case  
208 of the Belt (2 rows) mechanical feeding method.

209 These results are in agreement with the findings of [7, 8]. They reported that the fiber  
210 length parameters as upper half mean length (U.H.M.L.) and short fiber index (SFI), were  
211 insignificantly affected by the seed cotton feeding method to the gin stand. In the same time  
212 the attained results disagree with those of [3], who indicated that the length parameters were  
213 significantly affected by the different levels of feeding rates.

214 All studied fiber properties tested by H.V.I. instrument were significantly ( $p \leq 0.05$ )  
215 affected by the seed cotton grade, as presented in Table (4).

216 The highest mean values of spinning consistency index (SCI), maturity index,  
217 length uniformity index (U.I.), upper half mean length (U.H.M.L.), the fiber bundle strength,  
218 fiber elongation percentage, fiber reflectance degree (Rd %) and the lowest mean values of  
219 four characters short fiber index (SFI), trash count, trash area and yellowness degree (+b)  
220 were reached by the highest seed cotton grade Good / Fully Good (G/FG). On the other  
221 exhumed, the highest mean value of the micronaire reading was recorded by the seed cotton  
222 grade Good +  $\frac{1}{4}$  (G +  $\frac{1}{4}$ ). Fiber properties tested by H.V.I. instrument of 'Giza 88' cotton  
223 cultivar, except short fiber index (SFI), trash count, trash area and yellowness degree (+b)  
224 correspondingly decreased as the seed cotton grade decreased. These results were in  
225 harmony with those obtained by [8,15]. They claimed that the H.V.I. fiber properties are in  
226 relation with the grade and the high content of mature locks and fibers and low content of  
227 trash (non-lint content) and short fibers of the highest seed cotton levels gave the better lint  
228 cotton grades.

229 Likewise, results of Table (4) refer that the interaction (A  $\times$  B) of both variables under  
230 the study i.e. feeding method (A) and seed cotton grade (B) affected insignificantly all studied  
231 H.V.I. fiber properties.

232 Table (4). Mean values of the H.V.I fiber properties of 'Giza 88' as affected by feeding  
 233 methods and seed cotton levels during season of 2017.

Characters Treatments	SCI	UHML (mm)	Unifo- rmy index (%)	Short fiber index (%)	Fiber strength (g/tex)	Fiber elon- gation (%)	Maturity index (%)	Micro- naire reading	Rd (%)	+ b	Trash count	Trash Area (%)
Hand	218.50 a	35.04 a	88.42 a	5.54 a	46.07 a	3.72 a	0.87 a	4.00 a	70.14 a	11.61 a	35.08 b	0.49 b
Cylinder	204.75 b	35.27 a	86.09 b	5.58 a	40.27 b	3.64 a	0.85 b	3.97 a	67.98 b	11.51 a	87.08 a	1.04 a
Belt (2 rows)	202.25 b	35.01 a	86.31 b	5.55 a	38.94 b	3.58 a	0.84 b	3.94 a	67.31 c	11.47 a	87.41 a	1.00 a
L.S.D. <sub>0.05</sub>	9.844	ns	1.073	ns	2.292	ns	0.008	ns	0.626	ns	8.857	0.164
Good / Fully Good	219.88 a	35.58 a	88.65 a	5.38 c	45.66 a	3.82 a	0.87 a	4.25 a	70.08 a	11.33 b	39.22 d	0.43 c
Good + ¼	212.77 ab	35.48 a	88.10 a	5.40 c	41.03 b	3.74 a	0.87 a	4.30 a	69.02 b	11.47 ab	58.88 c	0.78 b
Good	204.44 bc	35.10 b	86.78 b	5.58 b	40.08 b	3.63 a	0.84 b	3.88 b	68.47 b	11.63 ab	72.66 b	1.03 a
Good - ¼	196.88 c	34.26 c	85.31 c	5.85 a	40.26 c	3.40 b	0.83 b	3.44 c	66.33 c	11.70 a	108.66 a	1.13 a
L.S.D. <sub>0.05</sub>	11.367	0.369	1.239	0.103	2.646	0.179	0.009	0.113	0.723	0.256	10.227	0.189
A × B	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

234 Means designated by the same letter within each column are not significantly different

235 Ns: Not significant. UHML: Upper Half Mean Length.

236 SCI: Spinning consistency index

237

238 **Conclusion**

239 - The hand feeding method of seed cotton to the gin stand surpassed all studied feeding  
 240 methods in gin stand productivity, lint percentage and the most H.V.I. fiber properties **is the**  
 241 **best classer grade**. Though, this method is recommended to be used specially with the high  
 242 levels of the extra-long cottons.

243 - Cylinder feeding method ranked first in order among studied mechanical method and it  
 244 could be recommended for ginning medium and low seed cotton level.

245 - Belt (2 rows) is **the** preferred feeding method regardless **of** gin stand productivity.

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