Cotton Ginning Parameters - A Review

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Abstract— Scholars in field of ginning of cotton have carried out exhaustive studies on various parameters like moisture content, staple length, trash content, selection of ginning machine, energy consumption etc. The works carried out by various researchers appear to be extensive but lacks interconnection between them. In this paper a comprehensive review of work of different researcher are carried out on the basis of various ginning parameter. It is observed that various researcher are having different opinion about optimum parameter settings. This leads to need of extensive study of setting some standard optimum parameter for ginning industry.

Key words: Cotton ginning, Staple length, Trash, Moisture content, Parameter cotton ginning

I. Introduction

Raw cotton is a natural fiber, raw cotton contains both lint and non-lint material. The cotton fiber is called lint, and all other foreign matter in cotton is called non-lint material or trash. Seed cotton refers to the harvested cotton that is hauled to the gin plant for processing.. The roller ginning process for cotton was invented by Fones McCarthy in 1840 process mechanically separates cotton fibers from seeds by means of one or more rollers to which fibers adhere while the seeds are struck off or pulled loose. Fig. 01 shows the working principle of the roller ginning process. [1]. Ginning is an important operation within the overall cotton production system. Ginning is a process where cotton seed and foreign matter (trash) are removed from the lint [3]. India ranks first in area under cotton cultivation (9.0 million hectares) and is the second largest producer of cotton fiber in the world producing 4.59 million tons during 2006-07, Ginning is the process by which seed cotton is separated into lint (fibers) and seed and machine used for its separation is called as gin. Thus ginning is the first engineering activity that cotton undergoes on its way from cotton field to textile mills.

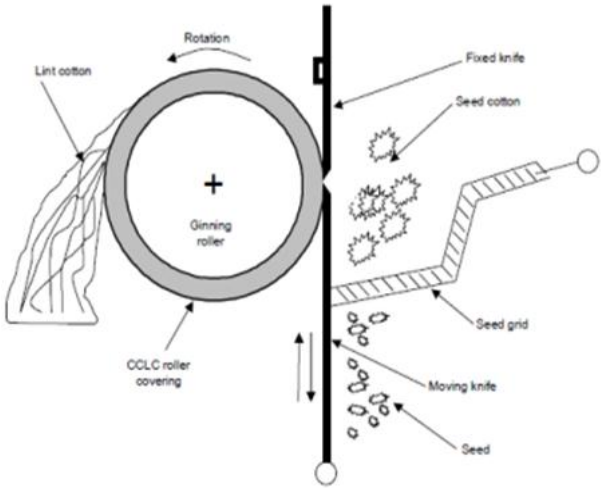

Fig. 1: working principle of cotton roller Ginning [2]

There are mainly three types of gin viz; (i) Saw gin (ii) Rotobar gins (iii) Double roller gin. In India, mostly roller gins are used for commercial ginning. About 50,000 double roller (DR) gins are operating in India for ginning and producing 5.1 million tones of fibers (90 % of total cotton lint production) on DR gin in year 2006-2007. Further only 10 % of seed cotton is ginned on saw gins particularly in northern part of India and since last five years the saw gins are being replaced by the roller gins

II. Objective

The sole purpose of this work is to consolidate various work carried out by different researchers in cotton ginning industry and put comprehensive comparison of various researchers. This outline objective is summarized, as below:

1) To find out the different opinion of researcher on same parameter of cottoning ginning.
2) To preserve the comprehensive analysis of cotton ginning parameter.
3) To find out parameter of cotton ginning which is less researched.

III. Ginning processes

A. *Saw Gins:*

Saw Gins are normally usable for upland cotton and not suitable for extra-long cotton. Moreover, each machine is of very high capacity hence in case of lower capacity requirement no adjustment is possible. Further, this gin generates higher neps and cuts the length of fibre. There has not been any improvement in these parameters by the recent advances only ginning speed has improved; hence comparative user friendliness has not improved in saw gin [5].

B. *Rotobar Gins:*

Rotobar Gins are usable for long and extra-long staple cotton and not usable for short staple cotton. Further, unginned cotton goes with seed which can only be partially recovered. This also causes significant seed cuts, since the recent advances have not improved upon these parameters and focused only on higher outturn there is no enhancement in user friendliness. [5].

C. *Double Roller Gin:*

This gin is usable for any variety of cotton i.e. short, long or extra-long staple by simple adjustments of settings and retains maximum fibre length as well as natural fibre parameters. This ginning machine can be used for all type of capacity requirements i.e. small, medium, and large. The machine being very simple it can be used in rural atmosphere hence can provide a local solution to group of farmers for value addition in cotton. Since the recent advances have improved productivity as well as controlled

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the vibrations, thereby reducing the maintenance has improved user friendliness. [5].

IV. PARAMETER OF COTTON GINNING

A. Moisture Contain:

Moisture content is the percentage of water vapour (which is we called moisture) present with cotton lint either before ginning or after ginning. While considering the quality of cotton lint, moisture content is being an important parameter, which is ultimately responsible for increase or decrease in ginning rate and quality of cotton. Moisture levels in cotton are very important for successful ginning, as if moisture is too high while ginning it forms small lumpy balls called neps. On other hand, if it is too dry, the fiber breaks or can cause static electricity. For efficient operation of cleaning and drying systems it becomes necessary to consider the proper moisture content in seed cotton.

Study	Moisture Content (%)
Anthony (1990) [11]	4.1 - 8.4
Anthony (1996) [12]	3.4 - 6.6
Hughs and Price (1998) [13]	3.1 - 6.2
Byler (2003) [14]	4.7 - 5.8
Byler (2005) [15]	4.6 - 6.1
Boykin (2005) [16]	4.2 - 5.5
m.k.sharma [2]	8%
G.Estur and Nicholas [8]	5-6%
P.Kumar,G.patil and V.patil [4]	5-5.4%

Table 1: Moisture Contents

As excessive moisture results in high trash content, thus cleaning process is ultimately depends on moisture percentage, being an important factor in ginning process. If moisture is too low water is added by means of humidification process. If it is too high the cotton is heated up in order to dry it out by using dryer. [2] Recommends that except for certain areas, moisture level up to 8 % is acceptable unless intentionally added by farmers or intermediaries. Due to which it gives better cleaning efficiency and some trash if get mixed clean. As water is added by various people, ginning factory must be fixed the percentage level of moisture, depending upon the local condition. [8] Recommends that for efficient gin, cleaning cotton operation and to preserve the intrinsic fiber quality the moisture percentage must be ranges from 6.5 to 8 % for upland cotton and 5 to 6 % for pima cotton .the cotton that too moist doesn't separate into locks but remains in wads which can choke ginning process. [4] Suggested that 7% moisture content serves best not only for lower electrical consumption but also for maximum ginning rate. The moisture content is important factor that helps to determine the quality of ginned fiber. The seed cotton with high moisture content does not clean well and lends itself to the rest of ginning processes. Also he stated that for removing more trash drying is good but over drying will affects to the fiber length and strength called as mic., Suggested that it was observed that the optimum range of fiber moisture content for roller ginning and lint cleaning was found to be from 5 to 6 percent. The maximum ginning rates were obtained in the 5 to 5.4 percent range of fiber moisture content [4].

B. Trash Content:

The primary objective of a commercial gin is to separate cotton fiber from the cottonseeds. However, prior to the separation of the cotton fibers from seeds, all non-lint material associated with the seed cotton needs to be extracted to obtain quality lint. This non lint material called as trash. It consists of bark, stick, leaf, pepper trash, grass, hulls, seed coat fragments, and motes left behind in the lint shown in Fig.02. As the name suggests, bark is the outer covering of sticks and is rather stringy in appearance and not easy to separate from the fibrous lint material. Pepper trash refers to small broken or crushed pieces of leaf; hulls are the outer coverings of the cotton ball. Immature cottonseeds are referred to as motes.

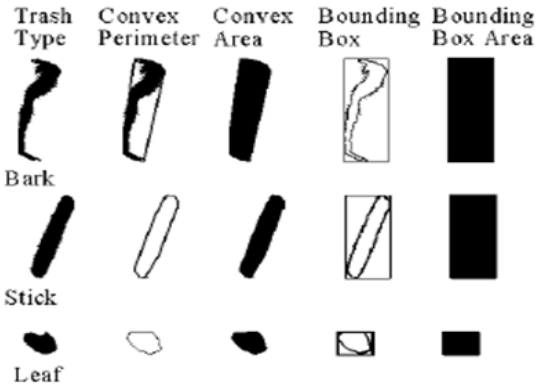
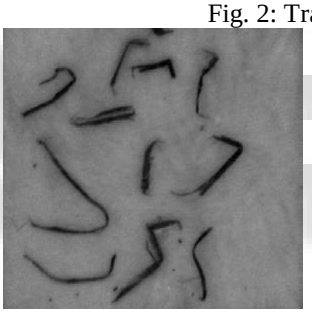
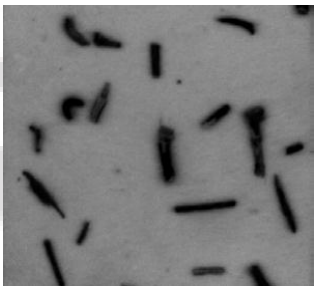


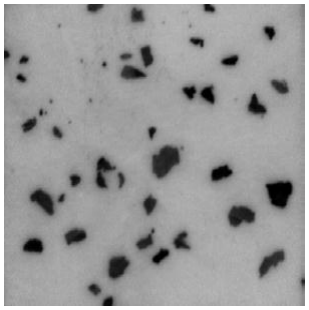
Fig. 2: Trash contents



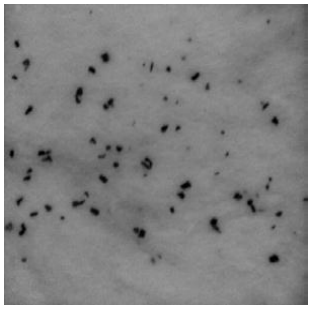
A .Bark trash type.



B. Stick trash type



C. Leaf trash type.



D. Pepper trash types.

Table 2: Macro structure of Trash contents

Trash content is ultimately related to the harvesting of seed cotton. There are two types of harvesting equipments; one is the spindle picker and cotton stripper. In spite of harvesting equipment, large quantity of trash obtains in stripper harvesting as compared to picker harvesting. Trash Content is defined as the ratio of the total trash area to the image area, the trash area is measured using trash meters. Trash meters count the number of pixels identified as trash based on a certain threshold criteria for a known area of the cotton sample. Selection of ginning technology is ultimately depends upon percentage of trash content. As compared to machine harvesting trash content in handpicked

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is minimum [03]. Stated that trashy cotton requires extensive machines. DR machines remove less trash content as compared to saw ginning. Usually 75% -85% trash of total trash content is necessary to be removed from seed cotton. Strippers collect up to six times more leaves, burs, sticks and trash than the spindle picker machines [8]. This higher ratio of trash to lint requires additional equipment for cleaning and trash extraction. Stripper harvested cotton may produce 1000 pounds of trash per 500 pounds bale of lint , compare to 150 pounds of trash per 500 pounds bale from spindle picking [9]. The nutritive quality of gin trash varies depending on the variety of cotton, the region grown, and the type of harvest method used. The ash content is the most variable component of gin trash and may be very high in areas with sandy soils or in stripper-harvested areas [6].

C. Staple Length:

Staple length is the measure of length of cotton fiber it is the genetic property. It is an important attribute of fiber. Three length properties are important: (1) staple length or the average length of the longer half of the fiber; (2) the percentage by weight of the fibers shorter than half an inch, referred to as short fiber Content (SFC); and (3) length uniformity index (UI) or the average fiber length as a percentage of staple length. When the cotton is taken from the farms or when it is stored as raw cotton it has maximum staple length, there after due to some mechanical processes carried out on raw cotton results in decreased length of fiber. It is not possible to increase the natural staple length of seed cotton in our aspect, but we can reduce the effect of machining processes which is being made on fiber length during ginning and other cleaning operations. The staple length of cotton is not affected by increasing the roller speed and the indicated differences in grade steps were insignificant. For every cotton industry it becomes necessary to focus more on this factor because it relates much with the profitability of company. As price of the product (cotton bales) is directly proportional to the staple length. Unneeded cleaning has other disadvantages it reduces staple length and it causes the creation of short fiber and neps, which are especially detrimental in the spinning process. The staple length of modern cotton varieties is the result of years of breeding, and is not something that the ginner can produce. But the ginner must know how to protect length and avoid creating short fiber. As a general rule, do only the cleaning and drying necessary to achieve the desired leaf grade. Each lint cleaner reduces staple by up to 1/32 of an inch and this is worsened if excessive drying has weakened the fiber. Ginning processing at lower moisture content resulted in better cleaning efficiency and higher reflectance. Fiber length uniformity ratio and 2.5% span length before and after lint cleaning were adversely affected by ginning at the lower moisture content. Before lint cleaning, the 2.5% span length was reduced from28.7 mm to 28.4 mm (1.13 to 1.12 in), and after lint cleaning it was reduced from 28.4 mm to 27.9 mm. Hand ginning we can get maximum fiber length. However mechanically process the same in a ginning factory in bulk quantity after high volume harvesting we get lower fiber length [3]. studied the ginning performance by varying the crank and roller speeds on Pima and SXP varieties, It was further observed that by increasing the speed of the roller from 110 to 150 (36 %) revolutions per minute, the amount of lint ginned per hour was stepped up from 18.8 to 22.5 kg (i.e. 41.5 to 49.5 pounds) (19%). The staple length of cotton was not affected by increasing the roller speed and the indicated differences in grade steps were insignificant.

D. Selection of Machine in Ginning:

Mainly this factor refers to the heart of the ginning process i.e. the machine which actually separates the seeds and cotton lint from seed cotton. Selection of the machine mainly depends upon the quality of the cotton. Most of the ginners were unaware of selection criteria of ginning technologies and used to purchase the ginning machinery led by the information available in their area and other factors such as financing and government to government country relations were the guiding factor rather than suitability of ginning technology for their cotton. Now the ginners have started understanding the role of cotton fibre parameters such as length, micronaire, strength, trash content etc in the selection of suitable ginning technologies and now prefer to buy the ginning machines based on suitability of technology to fibre in their area. This trend is increasing day by day such as the Benin which up till now uses only Saw Gins are willing to go for Double Roller Gins as early as possible due to its suitability for the cotton to be ginned in the country.

[2] It is better to higher saw ginning machining for short medium staple length up to 28 mm, higher trash content, and machined picked cotton. Single roller ginning is most suitable for medium, long and extra long staple length, low trash content and hand picked cotton having fuzzy seeds. But it requires additional cleaning equipments. Double roller ginning is suitable for all types of cotton, handpicked with low trash content and having black seeds. Rotobar ginning is used in overall world mainly for pima cotton in USA, black seed cotton, having long and extra long staple length .it is suitable for machined picked cotton but not good for fuzzy seed cotton [3]. Selection of machine on such criteria preserves the best natural fiber qualities. The roller gin is used on high quality, fine fibred, extra-long staple cottons because of its tendencies to maintain fibre length and low neps levels as opposed to the adverse effects on these characteristics by the saw gins [4]. [8] Recommends that Roller ginning is a slower and more labour intensive process than saw ginning, but it preserves better the quality of the lint. Roller gin is the only technology used for extra long staple irrigated cotton (Gossypium barbadense), as saw gins would result in fiber breakage. An estimated 79% of the production of upland cottons is roller ginned in India. A simple gin machine sequence is required to gin clean cotton. Trashy cotton requires a more extensive machine sequence. Roller ginning is less efficient than saw ginning in processing trashy and immature hand-picked seed cotton.

E. Energy Consumption:

The ginning rate and energy consumption are dependent on the roller speed, beater oscillations, moisture content and staple length of cotton. The maximum average energy consumption by the gin stand was associated with low fiber moisture contents. Energy consumption increased substantially with fiber moisture content above 7 percent. Further they stated that Double roller gins are commonly

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used in India for ginning seed cotton. International Textile Manufacturers Federation's survey 2005 reported that degree of grease and oil contamination in cotton lint is serious in India. Study revealed that the source of this contamination is the gearbox (power transmission system) of double roller gin as it is filled with grease/oil measuring about 20 kg. Prototype double roller gin has been designed and developed with new power transmission system which minimizes the use of oil and grease to a great extent [4]. It is found that after studied or reviewed the effect of roller speed and moisture content on ginning rate, lint quality and electric energy consumption in double roller gins. This study revealed that highest roller speed of 120 RPM coupled with 8% moisture content of seed cotton showed highest ginning rate with maximum saving in electric energy. Further, highest ginning rate and maximum energy saving were observed for higher staple length of fiber as compared to lower staple length of fibers. Suggested that for removing the extra moisture, the drying method is used. It has several disadvantages like contamination of products, no control over drying process, undesirable changes in quality of products and long drying time, to overcome these disadvantages open sun drying should be replaced with industrial dryers [10].

V. CONCLUSION

Exhaustive literature survey carried out on various parameters of cotton ginning. In this paper we conclude that there is variation in recommendation for each parameter of cotton ginning. The reason for this variation in parameters is because of variation in cotton quality, location, environmental condition etc. The ginning process is dependent on various local parameters and hence, study for at one location may not be suite for another location. Thus location wise study for ginning parameter is needed to carry out. Subsequently the proper improvement should be suggested in designing of productive, efficient ginning technology. To achieve this efficiency standardization of these parameters becomes necessary. May be such standardization globally, for cotton parameters is not possible as cotton quality changes with the changing regions. But even there is scope to set a particular standard for particular region. Indirectly this will result in minimizing the loss of country.

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