

# Optimization and Performance Evaluation of Feeder for Ginning Machine: A Review

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**Abstract** - Cotton fibers must be separated from the seed (ginned) before they can be used to manufacture textile goods. The first machine to gin cotton was the “Churka” gin was the most efficient when handling naked seeded varieties with loosely attached fibers. Early American settlers found that the fuzzy seeded varieties that yielded best in this country were difficult to gin on a roller gin. Consequently, the fiber was generally pulled from the seed by hand until Eli Whitney patented his gin in 1794.

The primary function of a feeder is to feed seed cotton uniformly to the gin stand at controllable rates. Seed cotton cleaning is a secondary function. Feed rollers, located at the top of the extractor feeder and directly under the distributor hopper, control the feed rate of seed cotton to the gin stand. The feed roller is powered by variable speed motors controlled manually or automatically by various interlocking systems with the gin stand. Irregular feeding of lint through the feeder to ginning machine, it decreases the production rate of seed and fiber. It also affects the quality of the fiber and seed. To overcome these errors, different analysis method will used .

The function of the gin is to separate lint from gin to create two marketable products, fiber and seed. The gin must also be equipped to remove foreign matter, control moisture and remove other contaminants that significantly reduce the value of the bale. The gin’s customer is the grower, the one who pays in one way or another to have the cotton ginned. It is the ginner’s responsibility to maximize the revenue from every module of cotton.

**Keywords:** Ginning machine, feeder, cotton seed separation, production

## 1. INTRODUCTION

A cotton gin is a machine that quickly and easily separates cotton fibers from their seeds, allowing for much greater productivity than manual cotton separation. The fibers are processed into clothing or other cotton goods, and any undamaged seeds may be used to grow more cotton or to produce cotton seed oil and meal.

Gin machinery operates more efficiently when the cotton flow rate is constant. In early gins the flow rate was often erratic because of the variable work rate of the person unloading the wagon. The feed control will develop to solve this problem by providing an even flow of cotton to the gin’s cleaning and drying system. The module feeder

also performs a similar function and may be used to feed seed cotton directly from a module into the gin.

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Capacity of modern gin can process up to the 15 tons of cotton per hour Earlier single roller is used between 12th and 14th centuries dual roller gin appeared in India and china In India this mechanical device was in some areas driven by water power .The model consist of wooden cylinder surrounded by rows of slender spikes

During the last decade in the world more particularly in the India as the cotton sector is progressing with high speed, significant technological advancement have taken place to improve the fundamentals of ginning to increase the outturn and to preserve the intrinsic quality of fiber obtaining the maximum length of fiber without breakage of seed, producing lint free of trash and contaminants at the lowest cost per unit ginned.

## Product of cotton seed separation machine

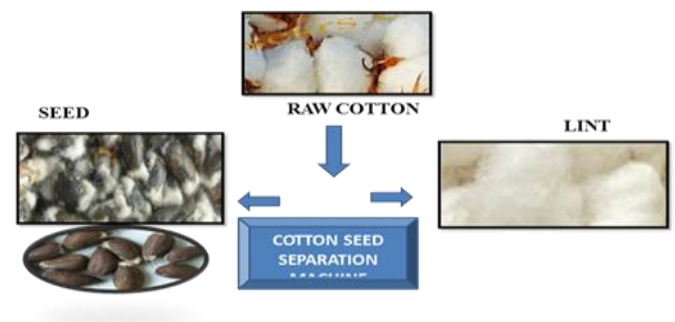


Fig. 1. Cotton Seed Separation Machine

In India, the present ginnery can be categorized into three major groups:

a) Conventional Ginnery - In conventional ginnery, ginning, pressing or both operations are carried out but the handling of seed cotton, lint, cottonseed and bales are done manually.

b) Semi-automatic Ginnery - This is a composite unit where all the unit operations of material handling except

- 1) Unloading and heap making of seed cotton
- 2) Feeding of seed cotton to the gins from central platform
- 3) Feeding of lint to press box and handling of bales in the press house are done automatically.

c) Automatic Ginnery - It is either a composite unit or an integrated unit, where all

the unit operations are done automatically except

- 1) Seed cotton unloading and heap making
- 2) Feeding to suction system and
- 3) Unloading of bales.

#### Feeding Mechanism

The conventional feeding mechanism for feeding cotton to cleaning, extracting and ginning machines, consists of a pair of fluted rollers geared together, and driven so that the upper portions of the rollers rotate toward each other to compress a body of cotton contained in a hopper above the rollers, the compressed or compacted mass being drawn through between the rollers and picked off beneath by a picker roller rotating at a much higher speed than the feeding rollers.

The difficulty in the use of such mechanism, so far as trapping out foreign matter is concerned, is that by reason of the bulky nature of seed cotton with its foreign matter distributed from wagons to the various hoppers above the cleaning and ginning machines it is necessary to have the hoppers no less than ten or twelve inches in width, and with a heavy mass of cotton of such thickness, the feeding rollers must be spaced apart far enough to avoid excessive squeezing or compressing in pulling the body of cotton between the rollers and delivering, it to the picker roller beneath, and the space between the feeding rollers necessary to facilitate handling the heavy, thick mass of cotton, is wide enough to permit large foreign substances to go through with the body of cotton, and to be delivered by the picker roller into the machinery below. To avoid this difficulty, and to trap any large foreign bodies or articles, while at the same time, not interfering with the free and continuous feeding of the seed cotton to the machinery below, I have provided two sets of feeding rollers, one above and the other below a relatively small picker roller. The upper pair of fluted rollers is spaced far enough apart to permit feeding through the thick body of cotton extending across the full width of the hopper and without having

to compress the cotton excessively. The lower pair of fluted rollers are comparatively close together, and would obviously choke or look if required to compress a thick body of cotton. Such action, so far as the cotton is concerned.

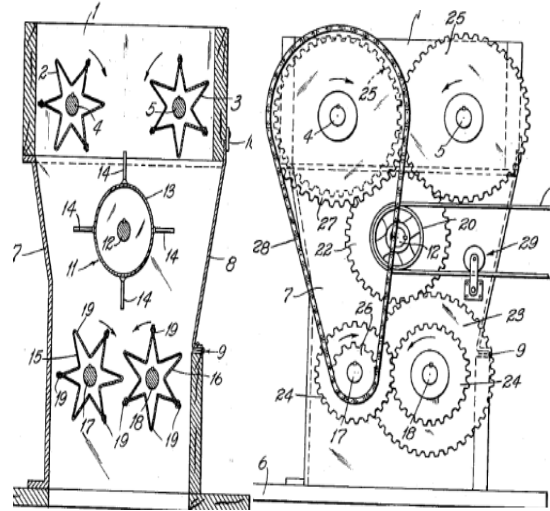


Figure 2: Cotton feeding mechanism

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- 2) Feeding to suction system and
- 3) Unloading of bales.

The primary function of an extractor-feeder is to feed seed cotton uniformly to the gin stand at controllable rates. Seed cotton cleaning is a secondary function. Feed rollers, located at the top of the extractor-feeder and directly under the distributor hopper, control the feed rate of seed cotton to the gin stand. These feed rollers are powered by variable-speed motors controlled manually or automatically by various interlocking systems with the gin stand.

## Types of Feeder

1. Auto feeder
2. Manual feeder

### Automatic feed control:

Gin machinery operate more efficiently when cotton flow rate is constant. In early gins the flow rate was often erratic because of variable flow rate of the operating the unloading system. The automatic feed control was developed to solve this problem by providing an even flow of cotton to the gin cleaning and drying system. A mechanical module feeder also perform a similar function and may be used to feed seed cotton directly from module.

### Extractor feeder:

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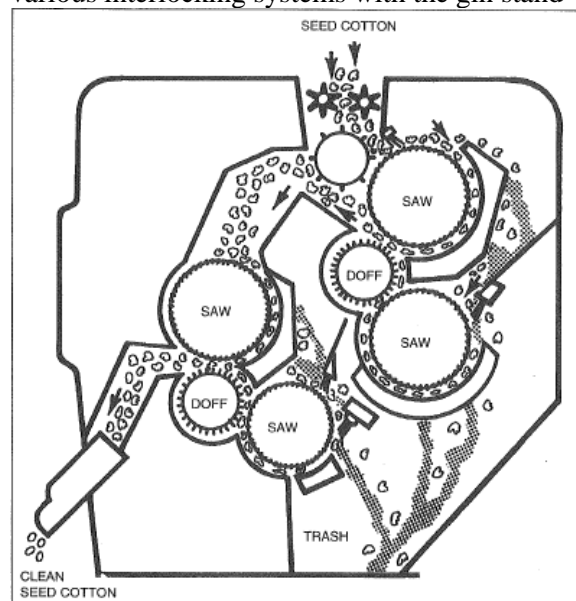


Figure 3: The Extractor Feeder

### Roller Gin:

The first mechanical gin (churka) was a roller gin consisting of two rollers (one metal, one hardwood) less than one inch in diameter, turned together by means of a hand crank. In 1840, Fones McCarthy invented a more efficient roller gin which consisted of a single leather ginning roller, a stationary knife, and a reciprocating knife which pulled the seed from the lint as the lint was held by the roller and stationary

knife. Although the McCarthy gin was a major improvement over the Churka type gin, machine vibration due to the reciprocating knife along with maintenance problem prohibited high ginning rates.

In the late 1950s and early 1960s, a rotary knife roller gin was developed by the USDA Southwestern Cotton Ginning Research Laboratory, gin manufactures, and private gineries. The ginning roller and stationary knife were retained from the McCarthy gin while a rotary knife replaced the reciprocating knife, eliminating the lot time of the backstroke of the reciprocating knife and reducing the vibration. The rotary knife allowed increased ginning rates and is currently the only roller type gin use in the United States. A typical rotary knife roller gin stand is shown in figure 3.

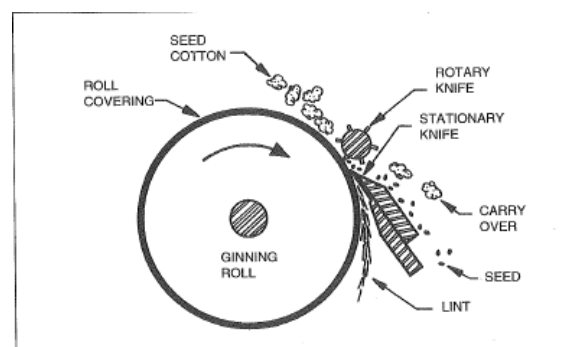


Figure 4: A modern roller gin stand

### Technological development in feeding system of roller ginning

The Double Roller Ginning Technology is least known in the countries like U.S.A., China, Brazil and Uzbekistan etc. as in the earlier days double roller ginning technology was treated to be manpower oriented low capacity cotton ginning. Most of the factories working on this technology in India were manually operated and each double roller ginning machine required one workman to feed and stir the cotton at the time of ginning, which was making it labour oriented. Thus, despite having various advantages this technology was not adopted by the countries where large volumes were required to be processed with lowest manpower. However, during the last 10 years scenario has totally changed due to fast developments in this ginning technology and it has helped various countries in Asia and East Africa particularly India to write a success story in the field of cotton ginning and obtained competitive edge in the cotton sector.

In the year 2000, Government of India launched a mission called 'Technology Mission on Cotton' to increase the cotton production and to improve the processing of cotton which has given a boost to cotton sector in India. The major cotton ginning machinery

manufacturing companies in India together with leading cotton technology research institutes, such as “Central Institute for Research on Cotton Technology” Indian Council of Agricultural Research, Government of India took up a challenge to produce the cotton ginning machinery to process the cotton in large volumes in a gentle way to preserve the inherent properties of cotton involving lowest manpower similar to manpower requirement of saw ginning factories and at the lowest cost per unit of production. Various scientists, designers and researchers from leading manufacturing companies and research institutes designed various layouts & machineries to achieve the target of optimization of fiber properties with lowest cost. The major changes occurred in feeding system during this period are listed below:

**Automization of Cotton Feeding Process:** The manual feeding of seed cotton into the Double Roller Ginning Machines were replaced by well-designed suitable capacity, electrical power efficient pneumatic suction systems to pull the cotton from length up to 750 feet with multiple points. This has resulted in reduction of a substantial number of manpower and dependent inefficiencies due to erratic working / non-availability of manpower. Moreover, regular supply of seed cotton has resulted in uniform and sufficient feeding to Double Roller Gins thereby increasing productivity.

**Online Precleaning:** Single or multi stage inclined as well as horizontal pre-cleaners were designed and put to use online without any involvement of manpower depending upon cleaning requirement for hand-picked or machine picked seed cotton, which has helped to reduce the trash contents and Double Roller Gin Machine maintenance requirements.

**Automatic Individual Gin Feeding Systems:** Sensor based individual Gin feeding auto regulators and Overhead Distribution Conveyors over a series of Double Roller Gins in one row and parallel rows has eliminated complete requirement of manpower for feeding each gin and ensured continuous and controlled feeding as per requirement of gin which has helped higher production and reduction of manpower requirement greatly.

iv. Use of Improved Auto Feeder / Lattice Feeder on Double Roller Gin: Earlier each gin was required to be continuously fed and cotton was to be stirred to avoid chocking of beater area.

Now improved Auto Feeder / Lattice Feeder provides a reservoir for about 10 minutes feeding to each gin

and level sensors signals refeeding as soon as cotton level in the feeder goes below minimum level hence continuous feeding of cotton is ensured while the rotating lattice spikes removes excess material as well as stirs the cotton in the beater area, thus manual involvement is fully eliminated. As per paper “Performance evaluation of Lattice Feeder for Double Roller Gin” published in journal of The Indian Society for Cotton Improvement – Volume 28, December 2003 (03) “The Lattice Feeder assists in continuous feeding and even distribution of seed cotton to Gin” “Use of Lattice Feeder led to an average increase in Ginning output of 7%”

v. Improved Higher Capacity Double Roller Gins: Earlier Double Roller Gins used to be 40” width which have been increased gradually to 54” width without any change in electrical power requirement of 5 HP (3.7 KW) per double roller gin and many changes were made in eccentricity of the beater to improve the setting parameters to suit various varieties of cotton. Moreover, a device called “Sail Feeder” was incorporated in the Double Roller Ginning beater area to control the feeding of short staple Bengal Desi Cotton to improve the productivity of the same. In the present Jumbo Model of the Double Roller Gin is most commonly used.



A photograph of improved Double Roller Gin with Auto Feeder / Lattice Feeder

## 2. RELATED WORK

In literature, we study remarkable advancement has taken place in the ginning technologies in during and post TMC era in India. It has kept the momentum of modernization of cotton ginning & pressing sector of India. Increased productivity of ginning machines, reduction of manpower and electrical power, reduction in contamination and improved cotton quality are benefits of these developments which resulted in increased export of cotton from India. Further, the developments taken in the cotton ginning & pressing technologies in India have made India a net exporter of these technologies, machinery and turnkey projects to various countries. Roller ginning technology

would be a viable alternative for ginning the cotton produced in Bangladesh.[1]

The recent advances in higher per hour output in Saw Gin and Rotobar can increase the output by each machine, however no significant power efficiency or fiber friendliness could be achieved, whereas the Double Roller Ginning is providing total solution in terms of lowering the cost per unit and improving the ginning plant efficiency.[2]

The introduction of fully automatic plants for all the ginning technologies in the world man power requirement for all of them is more or less similar, hence the ginning technology which is most suitable for the type of cotton available for ginning should be selected i.e. for the black seed long and extra-long staple cotton if it is clean McCarthy Single Roller or Double Roller should be selected but if it is machine picked / having higher trash then Rotobar should be used. For fuzzy seed cotton up to medium staple cotton if it is having higher trash Saw Gin set up should be used however if it is handpicked / clean Double Roller should be used to obtain best fiber parameters.[3]

It appears that the share of Double Roller Ginning and Rotobar Rotary Knife Roller Ginning will significantly increase whereas the share of Single Roller McCarthy Roller Ginning and Saw Ginning may decline in not too distant future. The manufacturing of roller ginning is increasing rapidly in the countries like India, China and Turkey and may see growth in the USA as well.[4]

A bale press for a mini-cotton ginnery was designed and tested to study the economic feasibility and operating cost of a complete mini-cotton ginnery at various estimated utilization levels.[5]

With new developments the Double Roller Ginning Technology has become most advantageous particularly in context of Africa and Asia and in the future may be used by many other countries in the other part of the world, which is evident from the fact that most recently some ginning factories in the PERU & EGYPT have started using Double Roller Ginning Technology based ginning factories. Due to wide spread acceptance of this technology after various developments as indicated above, the production of Double Roller Gins has increased from around 3000 prior to 10 years back to now about 12000 Double Roller Gins per annum in year 2008, thus this technology is the fastest developing ginning technology in the present times.[6]

### 3. PROBLEM DEFINITION

- Irregular feeding of lint through the feeder to ginning machine, it decreases the production rate of seed and fiber.
- It also affects the quality of the fiber and seed.
- Seeds coming out of lower portion of hopper

### 4. PROJECT OBJECTIVES

- To determine the best levels of control factors.
- To improve the performance of the Cotton Seed Separation Machine.
- The processes/products are made ROBUST against all variations.
- Uniform feeding of seed cotton.

### 5. INVESTIGATIONAL OUTCOME

To achieve the objective of this project, we have proposed following techniques

Identification of machine parameter then Performance on machine and calculating the parameter.

Optimization of parameter by implementation of Taguchi Method to find out most effective parameter. Validation then result take place.

### 6. CONCLUSION

This review paper proposes a technique to perform the regular feeding and improve the production rate and quality of fiber and seed.

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