Cotton Ginning Technologies - Selection Criteria for Optimum Results

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Preface:

Ginning is the mechanical process for separating cotton into its constituents namely lint (Cotton Fibre) and Cotton Seed. The Seed Cotton that comes from the field has to be subjected to various treatments in the ginning factories depending upon its inherent characteristics such as trash contents, moisture contents, length of the fibre, variety of seed i.e. fuzzy or black, method of seed cotton transportation, storage practices, handling practices inside the ginning factories and finally subjected to ginning process for separation of fibre and seed before packing into bales etc. Ideally the quality of the constituents i.e. cotton fibre and cotton seed before ginning and after ginning must be more or less same however it is seen that substantial damage is caused to quality parameters during processes in the ginning factories.

The selection of cotton for spinning is made on the basis of fibre quality and any damage in the same during the process of ginning reduces the value of the fibre and results in lowering down of value in total textile value chain.

The development of high speed spinning and weaving machinery has necessitated requirement of better cotton fibre parameters and any damage in quality caused while ginning cannot be rectified later and the defect is carried forward to yarn and fabrics during spinning and weaving process.

The economics of ginning operation is greatly affected by the damage in the quality of the constituents i.e. cotton fibre and cotton seed and lower realization due to same affects down the line to the farmer / grower as the pressure of the lower realization by ginners results in lower price for seed cotton being paid to him.

The economics of ginning operation depends upon the proper selection of ginning technology suitable for various characteristics of the seed cotton to optimize the quality parameters and operational costs, thus the selection of suitable ginning technology is of paramount importance.

Ginning Technologies widely used in the World:

The following ginning technologies are being used in the world:

1. ***Saw Ginning***: The Saw Gin belongs to second-generation tool invented by Eli Whitney in 1794, in the USA and the latest version is shown in following figure. It consists of a series of circular saws, 305 to 407 mm (12 to 18 inches) in diameter. All the saws are mounted closely on an axle and are made to revolve at high speed in order to tear the lint away from a roll of seed cotton. The saw projects slightly between bars or ribs, which are so, spaced that they prevent the seed from going forward. Fibres are thus torn away from the seeds with high speed. The seed cotton is fed continuously into a rounded box or hopper. The action of the saws keeps it revolving in a loosely compacted roll. The seed falls through a grid into a collecting

box or seed conveyor. The lint is whipped off the teeth of the saws by high-speed brushes or an air blast.

Fig. Saw Gin

The Saw Ginning Technology is normally used for short and medium staple cotton i.e. up to 28 mm and the plant designs developed so far in the world is keeping in view the machine picked cotton with higher trash contents and most of the cleaning equipments and feeders to the gins have been designed to handle high trash cotton however the fibre parameters get deteriorated in terms of neps, length and spinability parameters more particularly when any long or extra long fibre is ginned on Saw Gin.

2. ***Roller Gins:*** The roller gins are classified as oscillatory knife gin and rotary knife gin depending upon the type of motion of moving knife. Oscillatory type gins are further classified as single roller (SR) and Double roller (DR) depending on the number of rollers used per machine.

a) ***Single Roller Gin - McCarthy Gin***

The principle of working of single roller gin is popularly known as McCarthy principle named after its proponent and shown in Figure.

Figure Single Roller Gin

It lies in picking and then moving the cotton fibres between the roller and fixed knife preventing the seeds to pass through. The seed cotton, when thrown into the hopper, passes through the machine. While the machine is working, at each elevation of the moving knife the grids lift the cotton to the level of the stationary knife-edge and of the exposed surface of the rollers. The free ends of the fibres are gripped, in the grooves of the rotating roller, and dragged forward till the seeds reach the edge of stationary knife. The edge where the fibre is caught is the ginning point. By the downward motion of the moving knife, the seeds are detached from the cotton at the ginning point and are thrown out through the slots of the grid. It is important that the grooves of the rollers should be kept well open and when the leather roller becomes smooth, rough file should be applied occasionally to the surface to keep the same grip and pull on the fibre. The seeds are then hammered by means of the rapidly moving knife whereby some fibres are separated. In subsequent cycles, the remaining fibres also get separated. This process is continued till all the fibres from the seed get removed.

The Single Roller McCarthy Gin technology is most suitable for handpicked, low trash cottons of medium, long and extra long staple length. This technology retains maximum natural fibre parameters of the cotton during the ginning hence treated best.

b) Double Roller Gin

Double Roller is the improved version of McCarthy Single Roller Gins. In a double roller (DR) gin, two spirally grooved leather rollers, pressed against two stationary knives with the help of adjustable dead loads, are made to rotate in opposite directions at a definite speed.

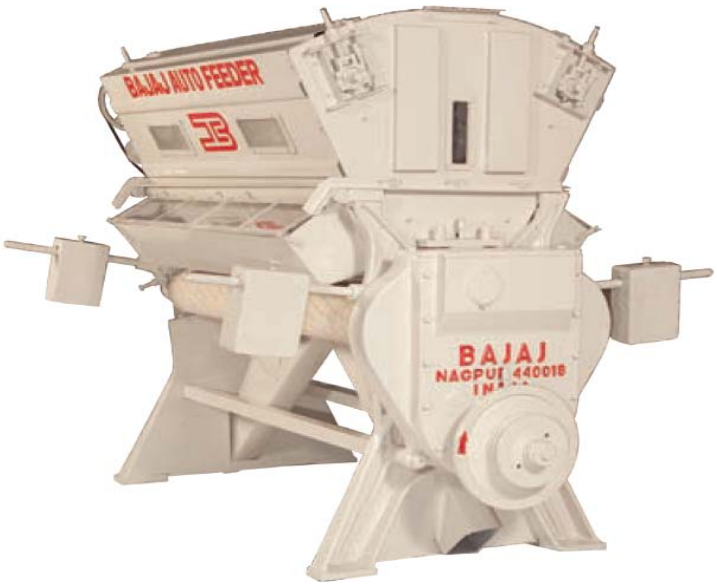

Fig. Double Roller Gin machine with auto-feeder

The three beater arms (two at end and one at the centre of beater shaft) are inserted in the beater shaft and two knives (moving knives) are then fixed to the beater arms with proper alignment. This assembly is known as beater assembly, which oscillates by means of a crank or eccentric shaft, close to the leather roller. When the seed cotton is fed to the machine in action, fibres adhere to the rough surface of the roller and are carried in between the fixed knife and the roller such that the fibres are partially gripped between them. The oscillating knives (moving knives) beat the seeds from top and separate the fibres, which are gripped from the seed end. This process is repeated a number of times till all spin-able fibres are separated from the seeds, which are carried forward on the roller and doffed out of the machine. The ginned seeds drop down through the slots provided on seed grid, which is part and parcel of beater assembly, which also oscillates along with the moving knives.

This technology also retains maximum natural fibre parameters of the cotton similar to McCarthy Single Roller Gin but produces double or more quantity of fibre at same electrical power and processing cost hence most cost effective. Therefore maximum McCarthy Single Roller Gins have been replaced by this technology in case of hand picked cotton. In Double Roller Ginning Technology one can gin all types of cotton of the world by simple setting adjustments, hence this technology has rapidly replaced majority of McCarthy Single Roller Gins and has become most preferred technology for hand picked cotton where trash contents are lower in the seed cotton.

3. ***Rotobar Gin:*** The Rotobar gin is shown in Figure (a). It works on the same principle as the roller gin as shown in Figure (b). It has a rotating instead of oscillating beater bar, and is expected to give higher amount of lint per hour. The rotary knife vibrates less due to rotary motion and is more efficient than the reciprocating knife, which wasted time during backstroke. Ginning rate and carryover (unginned seed cotton that accompanies the seed) increase with feed rate. The main components of rotary knife roller gin stand include the stationary knife, rotary knife and ginning roller. The ginning roller is the most important and expensive component in the roller gin stand. Roller covering material is made from 13 layers of plain woven cotton fabrics cemented together with rubber compound.

   Rotary-knife roller gin stands separate fibre from seed by frictional forces between a moving (roller) and fixed (stationary knife) surface. Three frictional forces exist while roller ginning cotton: (i) roller-to- stationary knife (ii) roller-to-fibre and (iii) stationary knife- to-fibre. During normal ginning, the roller-to-fibre force is greater than the stationary knife- to-fibre force; therefore, the fibre sticks to the roller surface and slips to the stationary knife surface. Also, greater the force between the stationary knife and ginning roller, the greater the frictional pulling force between the fibre and ginning roller.

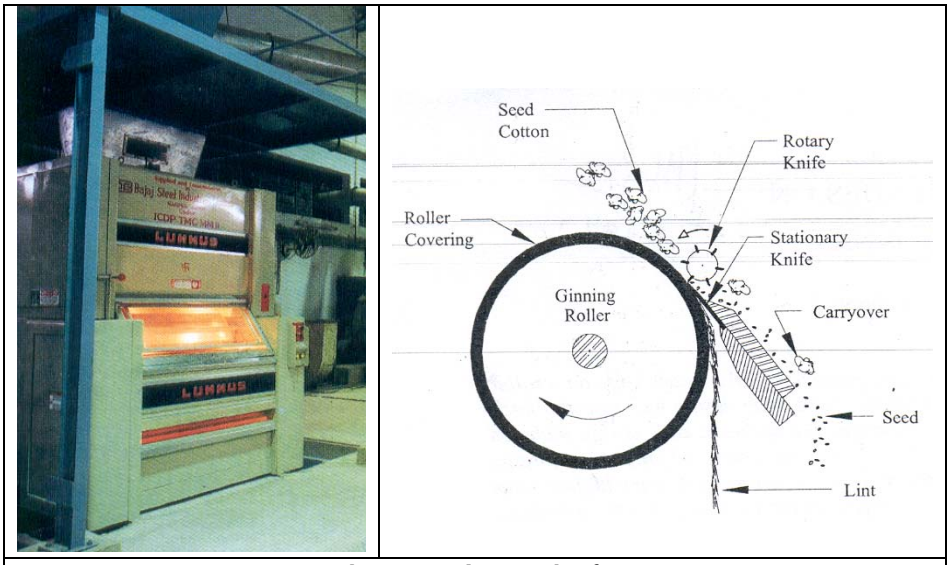

Figure Rotobar Gin and Principle of its operation

Cotton is ginned at the rate the cotton fibres (adhered to the roller surface) slip under the stationary knife. Overfeeding or feeding in bunches causes fibre and seed to entangle with each other and ginning performance gets adversely affected.

This Technology is mainly used for ginning of Pima cotton in the USA and other black seed cottons in other countries of the world however this technology is having disadvantages in the fuzzy seed cottons where unginned cotton going with seed and seed cuts are observed due to inherent technological reasons. Therefore this could not find much place in the other countries where the cotton is hand picked and clean but Rotobar does not give better results on medium or short staple cotton.

4. ***Market Share of Saw, Roller and Rotobar Gins:*** The market share of different gins depends upon socio-economic, agro-climatic conditions, the pattern of varieties grown in the country, harvesting methods, trash contents. Recently, there has been a switching from Saw Ginning to DR Ginning in the countries like; Zimbabwe, Tanzania, Malawi, Uganda, Zambia, Myanmar, Madagascar and Peru etc.

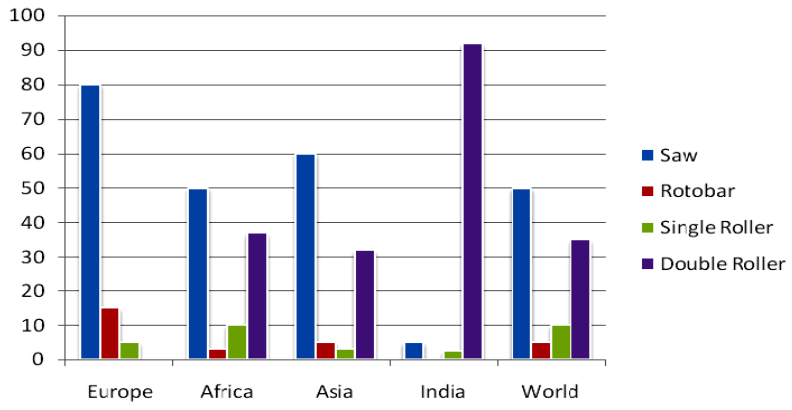

Fig. Market Share of Ginning Technologies

It is seen that Saw Gin holds about 50% world market share while Double Roller Ginning holds between 30-35%, Rotobar about 5% and McCarthy Single Roller about 10%.

The selection criteria for Ginning Technologies

Most of the people who want to start ginning factories do not have adequate knowledge about the ginning principles of various ginning technologies available in the world and they go primarily by the available machinery in their area without considering the correct requirement for the type of cotton available to them for ginning. This is many time resulting in avoidable loss of fibre and damage to fibres, finally resulting in lower realization of value.

The primary criteria which should be considered before selecting any ginning technology may be summarized as below:

1. ***Length of the fibre to be ginned.***
   If the length of the fibre is above 28 mm it will not be beneficial to select Saw Gin as some damage in the fibre length is certainly going to take place, hence Double Roller or McCarthy Single Roller Gins should be necessarily used to obtain optimum results if fuzzy seed cotton is to be ginned. Double Roller Gin being cost effective the same are preferred over McCarthy Single Roller Gins. However for black seed cotton Double Roller or McCarthy Single Roller will give equally good results but Rotobar can also be used.

2. ***Trash contents in the Seed Cotton***:
   If the trash contents in the seed cotton are on the higher side either the additional cleaning equipments should be used or only Saw Ginning should be used as in other technologies the same will choke the seed clearance grid in McCarthy Single Roller Gin or Double Roller Gin while the Saw Gin will crush the leafy material and mix it with the lint which can be separated in saw type cleaner or similar devices. Hence for the high trash machine picked seed cotton either additional cleaning equipments should be used before ginning or Saw Gins should be selected.

3. ***Moisture Contents in Seed Cotton:***
   If the moisture contents in the seed cotton are over 8% the Saw Gin should not be used to avoid any damage to the fibre. The Roller Gins can take up to 10-11% moisture but above that the drying process should be adopted before feeding the seed cotton to the ginning machines and the moisture contents should be brought down to below 10% before ginning.

4. ***Harvesting Practices:***
   If the seed cotton is machine picked it is bound to have higher initial trash contents which should either be removed before feeding to gins or the saw gins in case of short and medium staple cotton or rotobar for long and extralong cotton should be used which have in built cleaner feeder however the best thing would be to remove the higher trash at the seed cotton stage only and then use the Double Roller or McCarthy Single Roller if used would give better fibre parameters.
   For the hand picked cotton where the trash contents are lower the Double Roller or McCarthy Single Roller Gin will give best fibre parameters i.e. lowest neps and highest fibre length but there are exceptions like in Pakistan though the cotton is hand picked but due to harvesting practices it is having very high trash, hence Saw Gin is widely used.

5. ***Electrical Power Cost:***
   It is seen that Double Roller Ginning Technology is most power effective i.e. for per unit of production lowest power consumption is required in case of Double Roller therefore the consideration for power cost per unit is also very important.

Conclusion:

With 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 hand picked / clean Double Roller should be used to obtain best fibre parameters.

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