



Andalasian International Journal of Agricultural and Natural Sciences (AIJANS)

ISSN: 2745-7885 (Online)

Available in : <https://aijans.lppm.unand.ac.id/index.php/aijans>



Article

Engineering Solutions to Cotton Ginning Problems

Dadajanov Arafatali Komiljanovich

Namangan State Technical University, Uzbekistan

DOI: <https://doi.org/10.25077/aijans.v5.i02.71-77.2024>

Submission Track

Received: December 10, 2024
Final Revision: January 24, 2025
Accepted: January 28, 2025
Available Online: February 05, 2025

Keywords

Cotton, fiber, cleaning, gin, device, efficiency, productivity, saw, technology, construction, mechanical engineering

Correspondence

E-mail: arafatali@mail.ru

ABSTRACT

Cotton processing plays a pivotal role in Uzbekistan's agricultural-industrial integration, with technological advancements becoming increasingly vital for maintaining fiber quality. The ginning process, a key operation in cotton processing, often suffers efficiency losses due to moisture-induced fiber damage and mechanical wear of saw drums, particularly during autumn when cotton arrives with high humidity. Traditional ginning machines lack mechanisms to prevent raw roll formation, leading to fiber degradation and frequent downtime, with insufficient research focused on eliminating this core issue without compromising productivity. This study aims to develop an engineering solution that enhances the ginning process by addressing moisture-related challenges and mechanical limitations through a newly designed device. The proposed device eliminates the formation of raw rolls, increases fiber separation efficiency by over 30%, and extends the life span of saw drums by threefold. Additionally, it reduces downtime and energy consumption while improving fiber grade, ultimately increasing profitability. Unlike conventional ginning systems, the device integrates an optimized working chamber structure and innovative fiber cleaning mechanisms such as a drum grate with checkerboard-patterned needle heights, enhancing impurity removal without fiber loss. These innovations provide practical, cost-effective upgrades suitable for Uzbekistan's cotton enterprises, aligning scientific research with industrial needs and promoting sustainable productivity gains. The study reinforces the value of industry-academia collaboration in generating adaptive technologies for context-specific agricultural challenges.

INTRODUCTION

As a state, the Republic of Uzbekistan is progressing in education and science in all areas. Many decisions and resolutions are developed and implemented in this way. Among them are the decisions of the President of January 24, 2025 on the establishment of technical universities on the basis of regional universities[1].

Such changes will improve scientific and practical links between universities and take them to a higher level. Studying real problems of enterprises and finding real solutions in cooperation with university scientists and manufacturers creates excellent conditions for their theoretical and practical study.

The primary processing of cotton holds substantial economic and industrial importance in Uzbekistan, a country with over a century of experience in cotton cultivation and textile production. As one of the leading global producers of raw cotton, Uzbekistan has established extensive expertise in both traditional and modern ginning practices. Cotton ginning, which involves separating fiber from seeds, is a critical stage in the textile value chain. Efficient ginning not only preserves the intrinsic

quality of the cotton fiber but also directly influences the downstream quality of textile products and overall profitability. With continued reforms and modernization of regional technical universities, there is now stronger integration between research institutions and industrial enterprises, fostering targeted innovations in cotton processing[2].

However, despite advancements in ginning equipment, certain persistent problems remain unaddressed. One major issue arises during the autumn harvesting period, when high moisture levels in raw cotton, influenced by rainfall and reduced sunlight, hinder effective ginning. Conventional systems are prone to the formation of “raw rolls” during the ginning process, which damages fiber, accelerates wear on saw drums, and reduces overall productivity. Existing research by scholars such as Akhmadkhodjaev and Dadajanov has identified the structural and operational limitations of ginning devices, yet few practical, scalable design changes have been proposed to mitigate these issues without incurring additional economic and labor costs[3].

This study addresses the knowledge gap by proposing a redesigned ginning device that incorporates a modified working chamber layout and a newly engineered fiber cleaning mechanism. Unlike conventional configurations, the new design eliminates the raw roll formation by optimizing cotton feeding and fiber separation stages. The methodology involved comparative experimental analysis of the existing and new systems, evaluating parameters such as fiber quality, saw drum wear, energy consumption, and impurity separation efficiency. Engineering prototypes were tested in semi-controlled industrial conditions in collaboration with enterprise technicians[4].

It is expected that the redesigned unit will increase ginning productivity by at least 30%, reduce saw drum damage, and significantly decrease labor input related to maintenance and repairs. Preliminary findings demonstrate improved separation of mineral and organic impurities before and after the ginning chamber, while also elevating the fiber classification by one grade level. The integration of checkerboard-patterned needle drums under the grate further enhances the removal of residual impurities without damaging long fibers. These improvements not only ensure better resource utilization but also contribute to the economic sustainability of cotton-processing enterprises[5].

The broader implications of this work highlight the importance of close collaboration between academic researchers and industry practitioners in solving region-specific production challenges. By offering a structurally simple, cost-effective, and easily implementable engineering solution, this study supports ongoing efforts to modernize Uzbekistan’s cotton sector. The findings provide a model for other agricultural industries seeking to harmonize technological innovation with local industrial conditions, thus promoting resilience, efficiency, and long-term development[6].

T.Kh. Akhmadkhodjaev is one of the scientists who has completed many scientific works on the structure of the gin, which is considered the main device for processing cotton, and has presented many scientific articles and teaching aids and textbooks in this area. For example, one of the existing problems at primary cotton processing plants, one of the links in cotton processing in textile clusters, is the cotton cleaning process. This process is one of the main ones at the processing plant and is of great importance for preserving the original quality of the fiber and seeds[7].

Of course, in addition to the ginning process, there are other cleaning and drying processes in cotton processing plants, and these processes are mainly used to prepare the cotton for the ginning process. Because in the ginning process, there are certain standards for the moisture content and contamination of cotton, compliance with which ensures the quality of the ginning process. It mainly depends on weather conditions and the type of cotton. Such problems depend on the natural climate and natural location of the country. To eliminate the above problems, innovative solutions are used that define additional measures for storing cotton in Uzbekistan - the technology of storing cotton in cotton-picking bunkers called “Bunt”. However, keeping cotton in high humidity conditions, especially during the rainy season,

causes great natural and economic damage. For example, before placing cotton in gins, the process of drying cotton with high moisture content and subsequent ginning is introduced. This leads to additional labor and economic costs[8].

Therefore, in addition to the main process of ginning, the price and quality of the fiber and seeds also play a role in cotton processing plants. In order to preserve the original quality of cotton fiber and seeds, two processes of preparing it for cotton cleaning and ginning play an important role in the enterprise. So, what is more important to say is that the ginning process includes not only the operation of the gin machine, but also the processes of its preparation for ginning[9].

In the autumn period, the moisture content of cotton is higher than normal due to rain and little sun, and it is directly involved in the ginning process, in this state it cannot be ginned, and in the case of heating cotton in riots due to its moisture content, the heating process in cotton waste will cause the development of bacteria, and the original quality of fiber and seeds will decrease. Moreover, Rapid failure of the saws of the saw drums as a result of the formation of a raw roller during the technological operation of the device in the ginning process, as well as an increase in downtime due to the replacement of saws during operation. At the same time, the productivity of the cotton ginning process is low.

The primary objective of this study is to develop and evaluate a technologically advanced cotton ginning device capable of mitigating the negative effects of high-moisture raw cotton during the autumn harvest season. The research aims to enhance ginning efficiency, extend the lifespan of saw drums, and improve overall fiber quality by introducing an innovative structural redesign of the ginning chamber and fiber cleaning mechanisms. This objective aligns with Uzbekistan's broader goal of modernizing its cotton-processing sector through cost-effective, scalable engineering solutions.

METHODOLOGY

This study employed a comparative engineering research design to evaluate and enhance the ginning process under high-moisture cotton conditions. The methodology involved both the conceptual design and physical prototyping of a newly engineered cotton ginning device aimed at eliminating raw roll formation and improving fiber separation efficiency. The design process was informed by a literature review of existing technologies and structural limitations reported in prior works [1–6]. Guided by identified challenges, the research team developed a modified working chamber with an integrated fiber cleaning mechanism. This included the incorporation of a saw drum, adjustable needle drums with checkerboard-height patterns, and dual-stage impurity separators. Experimental testing was conducted at a cotton-processing facility under semi-controlled industrial conditions. Comparative analysis was performed between the newly developed device and a standard ginning unit, focusing on key performance indicators: fiber separation efficiency, saw drum wear rate, machine downtime, energy consumption, and fiber grade output. Measurements were repeated across three test cycles for consistency, and qualitative assessments were conducted with technician feedback to evaluate operational improvements. Moisture content of raw cotton was kept constant during trials, simulating typical autumn harvesting conditions. Instrumental analyses included visual inspection of fiber quality, torque-based wear testing on saw blades, and manual impurity separation tracking before and after ginning. Design performance was recorded and analyzed with respect to productivity gains, quality consistency, and maintenance intervals. These engineering metrics were then interpreted to assess the economic feasibility and practical applicability of the redesigned device in cotton ginning operations typical in Uzbekistan's climatic conditions.

RESULTS

To solve the first problem, cotton from the field should be ginned as quickly as possible, reducing the storage time in cotton ginning machines. To do this, we increase the productivity of the cotton ginning machine, reducing the number of stops for intermediate repairs[10].

Solution to the second problem – today the devices that separate the fiber from the seed have been significantly improved, many studies of their main working parts have been conducted and their best parameters have been determined. However, the main factors causing a decrease in productivity and its quality of the main working parts are the formation of a raw roller in the gin chamber, a rapid decrease in the efficiency of the saw teeth under the influence of its weight[11].

The raw roller is one of the main mechanisms for completing the process of separating cotton from seeds, serves to supply the required amount of cotton to the saw teeth in the working chamber and maintain productivity. Therefore, it will not be possible to completely abandon raw materials in these existing devices. In order to completely get rid of the raw roller, while maintaining the quality of the process and increasing productivity, it is necessary to change the design environment of the location of the main working elements in the working chamber. In the research work, taking this into account, it is envisaged to develop and implement a new device for separating fiber from seed[12].

Cotton is fed to the gin feeder by pneumatic or mechanical conveyors, and the supplier drops the cotton into the gin working chamber at the same speed. The cotton that enters the working chamber is ginned using a rotating saw drum, and the seeds are captured by a grate located at the top of the saw drum, and the fiber separated from the seeds is transferred to the next process using saws[13].

The pre-separated fibres from the seeds are mixed with the raw material roller formed by the rotation of the saw drum until it is completely separated from the fibre. The seed, completely separated from the fibre, falls down the grate and is transferred to the next process. The new technological process of the device we offer prevents the formation of a raw roll, and improves the quality and productivity of separating fiber from seeds[14].

The new device can increase the productivity of the grinding process and improve the quality of the process by preventing overconsumption of raw materials. The efficiency of the device increases by at least 30%. As a result, each type of fiber rises one level, the company will receive a large profit from the difference in the price of at least one type of fiber per year. In addition, due to the absence of influence of raw materials on saw teeth, the service life of saw teeth increases, the labor of workers, i.e. downtime for repairs, is reduced by 3 times. As a result, the cotton processing process is reduced by the saved time, and the consumption of saws is reduced by 3 times. labor, electricity and other social aspects will improve (Fig. 1)[15].

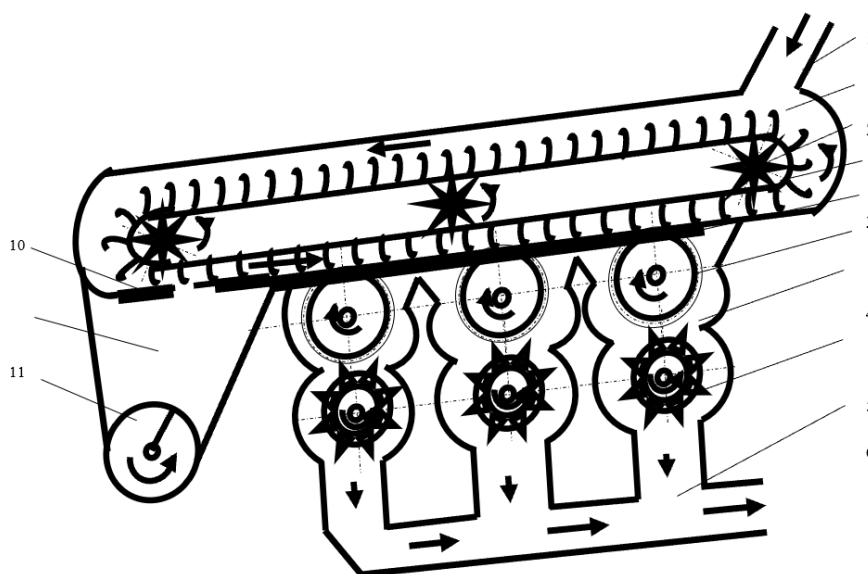


Figure 1. New design of cotton ginning machines: (1-inlet; 2-working chamber; 3-pulley; 4-hook belt; 5-grate; 6-saw drum; 7-saw drum chamber; 8-brush drum, 9-fiber outlet, 10-grate, 11-seed outlet chamber, 12-seed auger)

The device not only prevents the formation of a raw roller, but also ensures an increase in the productivity of the device several times. Before entering the cotton ginning chamber, the separation of mineral and other impurities is ensured by passing through a mesh surface, and the waste from the inclined grate installation is separated separately using a mesh surface[16].

In addition, due to the fact that the productivity of the device has been increased several times, the grates of the fiber cleaning device for cleaning the fiber separated from the cotton have been improved (Fig. 2).

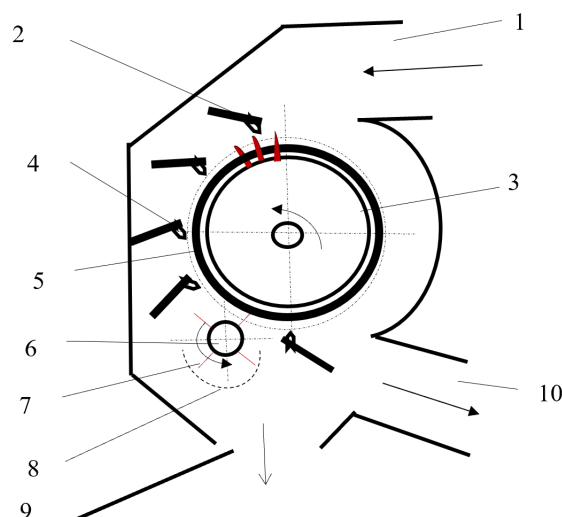


Figure 2. Drum grate fiber cleaner: (1-fiber cleaner, 2-grid, 3-saw drum, 4-plate, 5-gasket, 6-needle drum, 7-needle, 8-mesh surface, 9-outlet for foreign impurities, 10-outlet for fiber)

In order to increase the efficiency of cleaning the fiber from various impurities, the proposed fiber cleaning device is installed under each grate perpendicular to the grate surface, and the surface of the plate is parallel to the width of the saw teeth [3,4,5]. A needle drum installed in place of one grate under the drum separates various impurities in the fiber. The needles of the needle drum have different heights, the needles are installed in the drum in the form of a checkerboard[17].

To prevent long fibers mixed with the mixture separated by the needle drum from mixing with the mixture, two different grate surfaces are installed under the needle drum.

DISCUSSION

As a result of improving the fiber cleaning device after the gin, an air-spraying device was installed on the grate bars, drum knives were installed instead of grate knives, and pile, planed and saw type installations were installed according to the conditions.

This, in turn, is intended to adapt the device depending on the type of fiber and adapt it to a high-performance cotton gin.

The improvement of the ginning device and the fiber cleaning devices after ginning can be regarded as a comprehensive solution to eliminate the above problems. The implementation of scientific solutions to any production tasks in cooperation with the company's specialists creates a scientific basis for engineering solutions and creates harmony in solving problems. To provide practical justification for the results obtained, it is planned to eliminate the device's shortcomings and introduce additional innovations when implementing the prototype and production models of the device[18].

The methods used to solve the problem will ensure the integration and proximity of production and scientific institutions to each other in the future. The fact that the problem to be solved is determined not only by the scientific institution but also by the enterprise reduces the time of research by scientists in

search of a solution to the problem and ensures speed. This, in turn, ensures that the development of the enterprise goes hand in hand with scientific developments.

CONCLUSIONS

There are many problems in cotton processing plants, and to propose solutions that are structurally simple, applicable and repairable is one of the main tasks of scientists. Uzbekistan has extensive experience and scientific potential in the field of primary processing of cotton. As a result of growing and processing cotton in Uzbekistan for more than 100 years, an industrial school has been formed and is developing. Of course, the resource is large and sufficient to achieve great achievements in this area. Simplifying equipment operation technologies and making changes to the technology of operation and design of equipment using simple construction mechanisms in the process of cotton processing, increasing the productivity and efficiency of equipment, ensuring its cost-effectiveness is one of our main tasks. Great results can be achieved at the enterprise if the device, the solutions of which are shown in the article, is used in production. I hope that the use of simple and low-cost, at the same time effective and productive technologies, after studying the devices and technologies in all technological processes at the enterprise, will increase the development of the industry and production potential in the future.

REFERENCES

- [1] A. Parpiev, A. Khojiev, and A. Dadajanov, "Universal cotton cleaning device," *Scientific and Technical Journal*, no. 4, pp. 30–35, 2007.
- [2] A. Khojiev and A. Dadajanov, "The effects of complex harmonic oscillations on the efficiency of cotton cleaning," *Scientific Journal of Natural and Technical Sciences*, no. 1, pp. 324–325, 2008.
- [3] Khojiev, A. Khojiev, and A. Dadajanov, "The effect of the type and quantity of impurities on cleaning efficiency," *Scientific Bulletin*, no. 3, pp. 19–21, 2009.
- [4] A. Khojiev, A. Parpiev, and A. Dadajanov, "The effect of physical-mechanical properties of cotton on cleaning efficiency," in *Proc. Republic Scientific Conf. on Economic Reforms and Engineering Practice*, NamMIT, 2007, pp. 182–183.
- [5] A. A. Khojiev and A. K. Dadajanov, "Study of the parameters of the directing mechanism of a mesh plane with complex harmonic vibration," *Universal Journal of Materials, Production Technology and Textile Light Industry*, no. 11, pp. 104–108, 2022.
- [6] Kh. K. Tursunov, *Study of the Mechanics of Processes and Working Elements of Fiber-Cleaning Machines*, Doctoral dissertation, Tashkent, 1978.
- [7] J. Ergashev and A. Dadajanov, "New unit for separating seed from fiber," Patent IAP 116546, 2023.
- [8] A. Khojiev, A. Dadajanov, N. Qirgizaliyev, R. Sultonov, and Kh. Sotiboldiyev, "Improved feeding technology for processing machines," in *Proc. Int. Scientific Conf.*, Sec. 1, Andijan, 2018, pp. 5–9.
- [9] A. Khojiev, A. Dadajanov, and A. Khojiev, "Feeder of the saw-type fiber separator," in *Proc. Int. Scientific Conf.*, Andijan, 2020, pp. 625–626.
- [10] A. A. Khojiev, R. M. Muradov, and A. K. Dadajanov, "Enhancing the quality of cotton cleaning by using a dynamic method," in *Proc. Int. Scientific and Practical Conf.*, Boston, USA, Sept. 2020, pp. 2–5.
- [11] A. Dadajanov, A. A. Khojiev, and V. Buchinskas, "Enhancing cotton cleaning quality using a dynamic method," in *Proc. 15th Lithuanian Conf. of Young Scientists: Mechanics, Materials Science, Industrial Engineering and Management*, Vilnius, Lithuania, 2012, pp. 88–95.
- [12] A. Khojiev, A. Dadajanov, and A. Maxkamov, "Cotton fiber cleaning device," Patent IAP 03889, 2009.

- [13] A. Khojiev and A. Dadajanov, "Analysis of cotton particle movement on a vibrating surface," in *Proc. Republican Scientific-Practical Conf. on Textile and Knitwear Development*, Namangan, 2020, pp. 206–208.
- [14] R. Muradov, A. Karimov, and A. Dadajanov, "Cleaning cotton from impurities using a vibrating surface," *Scientific Bulletin*, no. 3, pp. 53–54, 2004.
- [15] A. A. Khojiev and A. K. Dadajanov, "Cleaning cotton from integrated mixtures using complex harmonic movement," in *Proc. PTLICIWS Conf.*, 2023.
- [16] R. Muradov, A. Dadajanov, A. Obidov, and A. Pirnazarov, "Cotton cleaning device," Patent IAP 03227, 2006.
- [17] A. Khojiev, A. Parpiev, A. Dadajanov, K. Dadajanov, and J. Kayumov, "Device for cleaning fibrous materials," Patent FAP 00388, 2008.
- [18] A. Khojiev, A. Karimov, and A. Dadajanov, "Dynamics of interaction between foreign impurities and cotton fiber," *Textile Problems: Scientific and Technical Journal*, no. 4, pp. 95–97, 2008.