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EQUIPMENT AND TECHNICAL MEANS USED FOR THE MECHANIZATION OF LABOR-INTENSIVE PROCESSES AT SEED COTTON PREPARATION POINTS AND COTTON GINNING PLANTS

Abdullaev Azimjon Adizovich

2nd-year PhD student at Bukhara State University of Technology

Annotation

This work analyzes two methods used in the stacking of seed cotton - pneumatic and belt (conveyor) methods - and highlights the differences between them. The operating principles, technical characteristics, advantages, and disadvantages of each method are described in detail. In addition, their impact on labor productivity, energy consumption, and overall production efficiency is comparatively evaluated. Based on the analysis, conclusions and recommendations for improving the seed cotton stacking process are provided.

Keywords

seed cotton, stacking, pneumatic method, belt method, mechanization, advantages, disadvantages, labor productivity, energy consumption, technological process.

CHIGITLI PAXTA TAYYORLASH PUNKTLARI VA PAXTA TOZALASH ZAVODLARIDA SERMEHNAT ISHLARNI MEXANIZATSIYALASHDA ISHLATILADIGAN ASBOB-USKUNALAR

Annotatsiya

Ushbu ishda chigitli paxtani g‘aramlash jarayonlarida qo‘llaniladigan ikki xil usul – pnevmatik va tasmali usullarning o‘zaro farqlari tahlil qilinadi. Har bir usulning ishlash prinsipi, texnik xususiyatlari, afzallik va kamchiliklari keng yoritiladi. Shuningdek, ushbu usullarning mehnat unumdorligiga, energiya sarfiga va ishlab chiqarish samaradorligiga ta’siri qiyosiy ravishda o‘rganiladi. Tadqiqot natijalari asosida paxtani g‘aramlash jarayonini takomillashtirish bo‘yicha xulosalar beriladi.

Kalit so‘zlar

chigitli paxta, g‘aramlash, pnevmatik usul, tasmali usul, mexanizatsiya, afzalliklar, kamchiliklar, mehnat unumdorligi, energiya sarfi, texnologik jarayon.

ОБОРУДОВАНИЕ И ТЕХНИЧЕСКИЕ СРЕДСТВА, ПРИМЕНЯЕМЫЕ ДЛЯ МЕХАНИЗАЦИИ ТРУДОЁМКИХ ПРОЦЕССОВ НА ПУНКТАХ ПОДГОТОВКИ ХЛОПКА-СЫРЦА И ХЛОПКООЧИСТИТЕЛЬНЫХ ЗАВОДАХ

Аннотация

В данной работе проводится сравнительный анализ двух методов, применяемых в процессах складирования хлопка-сырца - пневматического и ленточного. Подробно рассматриваются принципы работы каждого метода, их технические характеристики, а также преимущества и недостатки. Кроме того, в сравнительном аспекте изучается влияние данных методов на производительность труда, энергопотребление и

эффективность производства. На основе результатов исследования сформулированы выводы и рекомендации по совершенствованию процесса складирования хлопка-сырца.

Ключевые слова

хлопок-сырец, складирование, пневматический метод, ленточный метод, механизация, преимущества, недостатки, производительность труда, энергопотребление, технологический процесс.

INTRODUCTION

The mechanization of labor-intensive processes in seed cotton preparation points and cotton ginning plants has become an essential factor in enhancing the efficiency, productivity, and sustainability of the cotton industry. As one of the key sectors in agricultural and industrial production, cotton processing requires the implementation of advanced technical solutions to reduce manual labor, minimize production losses, and ensure high-quality output. In this context, the use of modern equipment and technological systems plays a crucial role in optimizing operational processes and improving overall performance.

Moreover, the mechanization of these processes contributes not only to economic efficiency but also to improved working conditions and occupational safety. By reducing the physical burden on workers and minimizing exposure to hazardous environments such as dust and heavy loads, modern mechanized systems enhance labor protection and promote sustainable industrial practices. In addition, energy efficiency and resource optimization have become increasingly important in contemporary production systems, making the selection and implementation of appropriate equipment a critical aspect of industrial modernization. This study focuses on the analysis of equipment and technical means used for the mechanization of labor-intensive operations at seed cotton preparation points and cotton ginning plants. It aims to evaluate their functional characteristics, operational advantages, and potential limitations, as well as their impact on productivity, energy consumption, and technological efficiency. The findings of this research are expected to contribute to the improvement of mechanization processes and support the development of more efficient and sustainable cotton processing systems.

METHODS AND LEVEL OF STUDY

The mechanization of labor-intensive processes in seed cotton preparation and cotton ginning plants has been widely studied in the fields of agricultural engineering and industrial technology. Previous research has emphasized the importance of introducing modern equipment and automated systems to improve productivity, reduce labor costs, and enhance the quality of processed cotton. In particular, studies have focused on the development and application of conveyor systems, pneumatic transport technologies, and mechanical loaders, which significantly optimize the handling and processing of seed cotton. Despite the progress in this field, there remain challenges related to the selection of optimal equipment, balancing energy efficiency with productivity, and adapting technologies to specific production conditions. Therefore, a comparative and systematic analysis of different mechanization tools and methods remains highly relevant.

This study employs a комплекс and comparative approach to analyze the equipment used for the mechanization of labor-intensive processes in seed cotton preparation points and cotton ginning plants. The research methodology is based on both theoretical and practical analysis. Finally, a system-based approach is employed to examine the integration of mechanized equipment within the overall technological process of cotton preparation and ginning. This approach allows for the identification of key factors influencing system performance and provides a basis for developing recommendations aimed at improving mechanization efficiency.

RESEARCH RESULTS

The conducted research on the mechanization of labor-intensive processes at seed cotton preparation points and cotton ginning plants demonstrates that the integration of modern equipment significantly improves production efficiency, reduces manual labor, and enhances the overall technological performance of the system. The results confirm that the application of mechanized systems-particularly pneumatic and belt-based technologies-plays a decisive role in optimizing cotton handling, transportation, and storage processes. First, the analysis of mechanized transportation systems shows that pneumatic conveying methods provide high efficiency in transferring seed cotton over long distances and in vertically complex production environments. These systems ensure continuous material flow, reduce the need for manual handling, and minimize contamination risks. The research findings indicate that pneumatic systems are particularly effective in large-scale operations where flexibility and automation are critical. However, it was also observed that these systems require higher energy consumption and more advanced maintenance, which may increase operational costs if not properly managed.

In contrast, belt conveyor systems demonstrated strong performance in terms of energy efficiency, reliability, and ease of operation. The results show that belt-based technologies are highly suitable for short- and medium-distance transportation within production facilities. They require relatively low energy input and offer stable and predictable performance, making them a cost-effective solution for many cotton processing plants. Additionally, belt systems are easier to install and maintain, which contributes to reduced downtime and increased operational continuity. The comparative analysis between pneumatic and belt systems reveals that there is no universal solution suitable for all production conditions. Instead, the optimal choice depends on factors such as plant layout, production scale, energy availability, and technological requirements. In many cases, the most effective approach is the комбинированное применение (combined application) of both systems, where pneumatic transport is used for long-distance or vertical movement, while belt conveyors handle horizontal and localized transportation tasks.

Furthermore, the study highlights that the mechanization of stacking (g‘aramlash) processes significantly improves labor productivity. The use of mechanized loaders, stackers, and automated feeding systems reduces the physical workload on workers and ensures more uniform and controlled stacking of seed cotton. This leads to better storage conditions, reduced losses, and improved quality preservation of raw materials. The research also demonstrates that the implementation of mechanized equipment positively affects key performance indicators such as labor productivity, energy consumption, and production efficiency. In particular, labor productivity increases due to the reduction of manual operations and the acceleration of technological processes. At the same time, although certain systems (such as pneumatic transport) may consume more energy, the overall efficiency gains and reduction in labor costs компенсируют these expenditures, resulting in improved economic performance.

Another important result of the study is the impact of mechanization on workplace safety and working conditions. The findings show that mechanized systems reduce workers’ exposure to dust, heavy loads, and physically demanding tasks, thereby lowering the risk of occupational injuries and health issues. This contributes to the creation of safer and more sustainable production environments. In addition, the integration of modern control and monitoring technologies further enhances the effectiveness of mechanized systems. The use of sensors, automated control units, and digital monitoring tools enables real-time supervision of production processes, early detection of malfunctions, and optimization of equipment performance. This not only improves operational reliability but also supports data-driven decision-making in production management.

The results of the research also indicate that the proper selection, combination, and maintenance of mechanized equipment are critical factors for achieving maximum efficiency. Plants that adopt a systematic approach to mechanization-taking into account technological compatibility, energy efficiency, and operational requirements-are able to achieve higher levels of productivity and competitiveness. Overall, the study confirms that the mechanization of labor-intensive processes in seed cotton preparation points and cotton ginning plants is a key driver of modernization in the cotton industry. The effective use of advanced equipment and technologies leads to improved production performance, reduced labor intensity, enhanced product quality, and greater sustainability of industrial operations. These findings provide a solid foundation for further research and practical implementation aimed at optimizing mechanization systems in cotton processing enterprises.

CONCLUSIONS

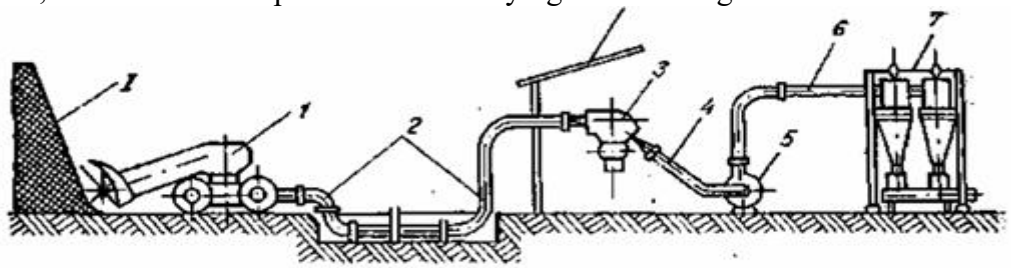
The results of this study confirm that the mechanization of labor-intensive processes at seed cotton preparation points and cotton ginning plants is a critical factor in improving the efficiency, sustainability, and competitiveness of cotton processing systems. The introduction and effective utilization of modern equipment significantly reduce manual labor, enhance operational reliability, and ensure the continuity of technological processes. One of the key conclusions of the research is that mechanized systems, particularly pneumatic and belt-based technologies, provide substantial improvements in the transportation, handling, and storage of seed cotton. Pneumatic systems offer high flexibility and efficiency for long-distance and vertically complex operations, while belt conveyor systems demonstrate superior performance in terms of energy efficiency, simplicity, and reliability for short- and medium-distance transport. The study establishes that the optimal solution lies not in the exclusive use of one system but in their рациональное сочетание (rational combination), adapted to the specific technological and spatial conditions of the production environment.

Another important conclusion is that the mechanization of stacking and feeding processes leads to a significant increase in labor productivity. By minimizing manual operations and introducing automated or semi-automated equipment, production processes become faster, more consistent, and less dependent on human factors. This not only improves efficiency but also enhances the quality and preservation of raw cotton during storage and processing. The research also highlights that mechanization contributes to the reduction of production losses and the improvement of product quality. Mechanized systems ensure more controlled and uniform handling of seed cotton, thereby reducing contamination, damage, and waste. This is particularly important in maintaining the quality standards required for further industrial processing and export competitiveness. In terms of energy consumption, the findings indicate that although certain mechanized systems-especially pneumatic transport-may require higher energy input, their overall contribution to production efficiency and labor cost reduction justifies their application. Therefore, energy efficiency should be evaluated in relation to the total economic and technological benefits rather than as an isolated parameter.

The processes of preparing, transporting, and stacking seed cotton constitute one of the most important stages in the cotton industry. In order to increase labor productivity and reduce manual work in these processes, various mechanized methods are widely applied. Among them, pneumatic conveying systems are extensively used in the cotton ginning industry for transporting seed cotton and fiber both within workshops and between different production units. Pneumatic conveying operates in two main modes: suction (negative pressure) and pressure (positive pressure) systems. In the suction system, a fan creates a vacuum by drawing air through pipelines, causing the cotton to move along with the airflow inside the pipes. The widespread use of pneumatic conveying in the cotton processing industry is primarily due to its ability to transport

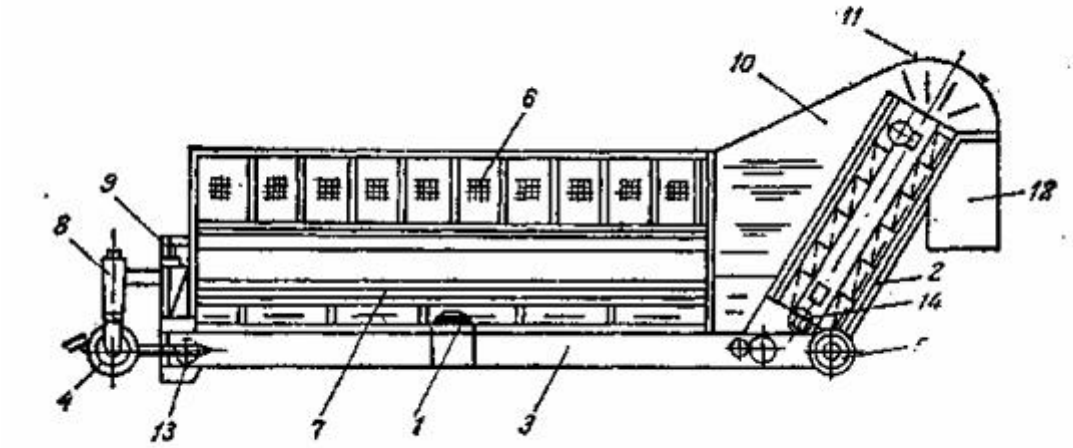
seed cotton and its by-products without causing damage or loss. In addition, pneumatic systems are compact in design, and their pipelines can be installed in various directions across the территории of cotton processing plants and preparation points, providing significant flexibility in layout and operation.

However, compared to other conveying methods, pneumatic systems generally consume more energy. Despite this drawback, pneumatic transport is typically integrated into a continuous technological process across all workshops of a cotton ginning plant. Therefore, its stable and efficient operation has a direct and significant impact on the overall productivity of cotton ginning facilities, as well as on the performance of drying and cleaning sections.



167- расм. Сўрувчи пневмотранспорт установкасининг схемаси:
I — чигитли пахта бунти; *II* — заводнинг тозалаш цехи.

The PLA belt feeder is designed to receive seed cotton delivered in bulk (without bags) by self-dumping truck-trailers and tractor trailers, and to transfer it to conveyor systems. Figure 188 illustrates the PLA-type feeder.



188- расм. ПЛА маркали лентали таъминлагич кесимининг схемаси.

The feeder consists of the following main components: a dual-belt horizontal conveyor (1), a pin-type elevator (2) mounted on the frame (3), and trolleys with wheels (4, 5). Fixed (6) and retractable (7) side panels are attached to the side beams of the frame. Wheel 4 is mounted via a box (9) and a cantilever (8) to allow rotation, which facilitates easy movement of the feeder along a track. The pin-type elevator (2) is surrounded by protective copper panels (10). The discharge side of the elevator is enclosed with a box-type cover (11) equipped with a chute (12). The chute (12) directs the seed cotton precisely into the hopper of the belt conveyor.

Comparative analysis of pneumatic and belt (conveyor) transport systems used in seed cotton reception and ginning processes:

1. **Technical adaptability:** Pneumatic transport systems demonstrate high adaptability for guiding cotton along complex trajectories and within constrained spaces. However, belt conveyors (for example, PLA-type feeders) stand out by providing a stable productivity exceeding 12 tons per hour.

2. **Energy efficiency:** Comparative studies show that pneumatic systems consume significantly more energy to generate the required air flow. In belt feeders, the primary energy expenditure is for belt movement and mechanical lifting of cotton, which reduces production costs.

3. **Product quality preservation:** Both methods allow cotton to be transported without damage. Pneumatic systems offer the added advantage of partially cleaning cotton with air, whereas belt systems minimize the risk of mechanical damage to cotton fibers.

4. **Optimal solution:** To optimize the ginning process, a combined approach based on the plant's technological layout is recommended. Specifically, belt feeders (PLA-type) are preferable for receiving cotton from transport vehicles due to their high productivity, while pneumatic devices are more suitable for directing cotton to higher layers of the gin for remote control and flexibility. A significant outcome of the study is the positive impact of mechanization on occupational safety and working conditions. The reduction of physically demanding tasks, heavy lifting, and exposure to dust and harmful environments leads to improved worker health, lower risk of injuries, and increased job satisfaction. This aligns with modern industrial requirements for safe and sustainable production practices.

Furthermore, the study concludes that the integration of advanced monitoring and control systems enhances the performance and reliability of mechanized equipment. The use of digital technologies, sensors, and automated control mechanisms enables real-time process optimization, timely maintenance, and efficient resource management. This transition towards intelligent and automated production systems represents an important direction for the future development of the cotton industry. The research also emphasizes that the successful implementation of mechanization depends on a systematic and комплексный подход (comprehensive approach), which includes proper equipment selection, technological compatibility, regular maintenance, and the training of qualified personnel. Without these supporting factors, the full potential of mechanized systems cannot be realized.

In addition, it is concluded that further совершенствование (improvement) of mechanization technologies should focus on increasing energy efficiency, reducing operational costs, and enhancing adaptability to different production conditions. The development of innovative equipment and the modernization of existing systems will play a key role in achieving these objectives.

Overall, the findings of this study demonstrate that the mechanization of labor-intensive processes is not merely a technical upgrade but a strategic necessity for the modernization and sustainable development of cotton processing enterprises. The adoption of advanced equipment and integrated technological solutions ensures higher productivity, better resource utilization, improved product quality, and enhanced social and economic outcomes. These conclusions provide a solid scientific and practical basis for further research and for the development of effective strategies aimed at optimizing mechanization processes in seed cotton preparation points and cotton ginning plants.

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