Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

Analysis of foreign technologies in cotton raw material drying

***Shavkatjon Sayitov*[1],**
Olimjon Sarimsaqov[2],
***Erkinjon Xolmatov*[1]**
[1]Fergana State Technical University, 86 Fergana str.,
Fergana city, Fergana, Republic of Uzbekistan, 150100
[2]Namangan State Technical University, 12 I. Karimov str.,
Namangan city, Namangan, Republic of Uzbekistan,160100

Abstract. This article analyzes the importance of foreign technologies in the cotton raw material drying process, their energy efficiency, level of automation, and influence on drying quality. Modern drying technologies used in the United States, Turkey, China, and European countries were studied, and the prospects for their application in the cotton industry of Uzbekistan were considered. According to the research results, foreign resource-saving drying equipment makes it possible to preserve cotton fiber quality, reduce energy consumption, and increase production efficiency.

Keywords: cotton raw material, drying process, foreign technologies, energy efficiency, energy consumption, automation, drum dryer, moisture, temperature, airflow velocity, heat and mass transfer.

Анализ зарубежных технологий в сушке хлопка-сырца

Аннотация. В данной статье анализируется значение зарубежных технологий в процессе сушки хлопка-сырца, их энергоэффективность, уровень автоматизации и влияние на качество сушки. Изучены современные технологии сушки, применяемые в США, Турции, Китае и европейских странах, а также рассмотрены перспективы их внедрения в хлопковой промышленности Узбекистана. Согласно результатам исследования, зарубежное ресурсосберегающее сушильное оборудование позволяет сохранять качество хлопкового волокна, снижать энергопотребление и повышать эффективность производства.

1 Corresponding author : jeknil_91@mail.ru

Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

Ключевые слова: хлопок-сырец, процесс сушки, зарубежные технологии, энергоэффективность, энергопотребление, автоматизация, барабанная сушилка, влажность, температура, скорость воздушного потока, тепло- и массообмен.

Paxta xomashyosini quritishda xorijiy texnologiyalarning tahlili

Annotatsiya. Mazkur maqolada paxta xomashyosini quritish jarayonida xorijiy texnologiyalarning ahamiyati, ularning energiya samaradorligi, avtomatlashtirish darajasi hamda quritish sifatiga ta’siri tahlil qilingan. AQSH, Turkiya, Xitoy va Yevropa davlatlarida qo‘llanilayotgan zamonaviy quritish texnologiyalari o‘rganilib, ularning O‘zbekiston paxtachilik sanoatida qo‘llash istiqbollari ko‘rib chiqilgan. Tadqiqot natijalariga ko‘ra, xorijiy resurs-tejamkor quritish uskunalari paxta tolasi sifatini saqlash, energiya sarfini kamaytirish hamda ishlab chiqarish unumdorligini oshirish imkonini beradi.

Kalit so‘zlar: paxta xomashyosi, quritish jarayoni, xorijiy texnologiyalar, energiya samaradorligi, energiya sarfi avtomatlashtirish, barabanli quritgich, namlik, harorat, xavo tezligi, Issiqlik va massa almashinuvi.

INTRODUCTION

The cotton industry is considered one of the strategic sectors of the economy of Uzbekistan. In the process of cotton raw material processing, drying technology is one of the important stages that ensures the preservation of fiber quality and the efficiency of subsequent technological processes. If wet cotton is stored improperly or not dried sufficiently, fiber decay, the development of microorganisms, and deterioration of quality may occur.

In recent years, developed countries have paid great attention to energy-saving and automated drying technologies. In particular, sensor monitoring systems, infrared drying methods, automatic moisture control, and intelligent control systems have been introduced in the United States, Germany, Turkey, and China. These technologies help reduce energy consumption by 20–30% through optimization of the drying process.

The introduction of foreign technologies into the cotton industry of Uzbekistan is also considered one of the urgent issues and an important factor in increasing production efficiency.

MATERIALS AND METHODS

The main purpose of drying cotton raw materials is to reduce their moisture content to the standard level. During the drying process, heat and mass transfer occur simultaneously.The following main drying methods are used to reduce cotton moisture: drum dryers, pneumatic drying systems, infrared drying methods, vacuum drying and combined drying technologies.

Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

The drying process is influenced by the following factors:

1. Initial moisture content of cotton;
2. Temperature of the heat-carrying agent;
3. Airflow velocity;
4. Structural design of the dryer;
5. Drying duration.

Excessive reduction of moisture increases fiber brittleness, while excessive moisture worsens storage quality.

Development of Foreign Technologies

Highly productive automated drum dryers are widely used in the cotton industry of the United States. These systems include digital sensors, PLC control systems, automatic temperature regulation, and real-time moisture measurement systems. Such technologies maintain stable drying quality and reduce energy consumption. In Turkey, gas-fired heat generators are widely used in cotton drying systems. Modern Turkish equipment is characterized by high heat exchange efficiency, exhaust gas filtration systems, and automatic safety mechanisms. These technologies improve environmental safety while reducing production costs.

Drying equipment manufactured in China stands out due to its relatively low cost and high level of automation. In recent years, sensor monitoring, IoT technologies, remote control, and energy monitoring systems have become widely used.

Advantages of Modern Drying Technologies

Modern foreign equipment significantly reduces energy consumption. Heat losses are minimized through heat recirculation systems.

Table 1.

Drying Type	Energy Consumption (kWh/t)	Efficiency (%)
Traditional drum dryer	100–120	65
Infrared drying	70–85	82
Combined drying	60–75	88
Automated foreign system	55–70	90

Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

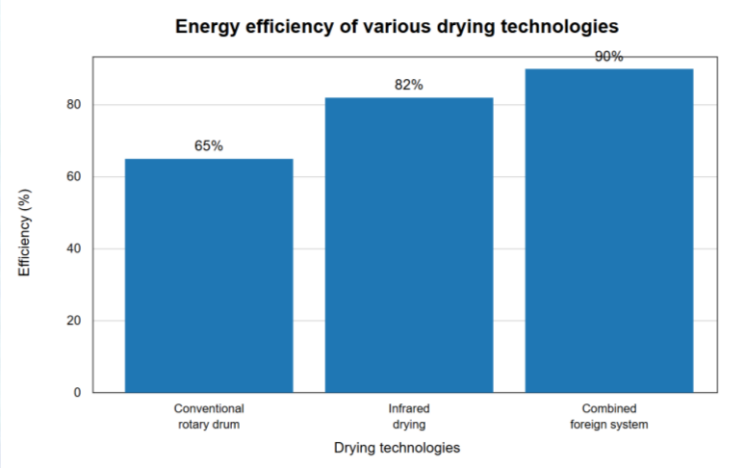


Figure 1. Energy efficiency of various drying technologies.

Automated control systems help preserve the quality of cotton fiber. As a result of drying under optimal temperature regimes, fiber burning is prevented, mechanical damage is reduced, and color degradation is avoided.

Modern foreign equipment features the following systems: PLC control, SCADA monitoring, remote control, and automatic alarm systems. This minimizes the human factor and enhances technological stability.

RESULTS

Factors Affecting the Drying Process

The drying process of raw cotton depends on several physical and technological factors, which determine the drying rate, energy consumption, and product quality.

1. Initial Moisture Content. The higher the initial moisture content of the cotton, the more energy and time are required for drying. At high moisture levels, heat transfer intensifies, but excessive workload reduces dryer efficiency.

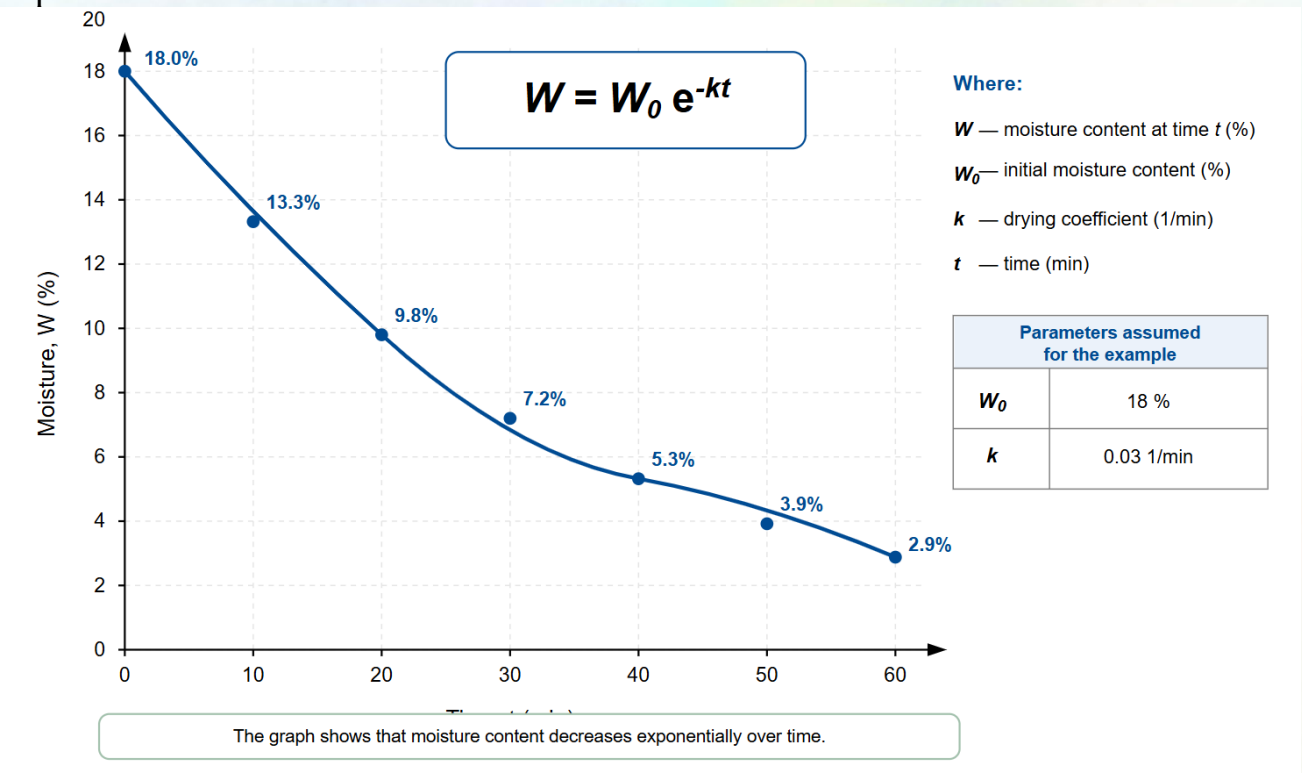
2. Temperature Regime. Drying temperature is one of the key factors. Increasing the temperature accelerates the drying rate; however, excessively high temperatures can burn the fiber or degrade its quality. Therefore, an optimal temperature regime is selected.

3. Airflow Velocity. The hot airflow acts as the primary carrier in the drying process. As air velocity increases, moisture is removed faster, but an overly strong flow can disrupt the structure of the cotton.

4. Dryer Type and Design. Drum, pneumatic, or infrared dryers each possess different efficiency levels. Modern automated systems conserve energy through heat recovery (re-utilization).

Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

5. Drying Duration. If the drying time is not properly selected, product quality deteriorates. An insufficient duration leaves residual moisture, while an excessively long duration can damage the fiber.
6. Heat and Mass Transfer. Physically, the drying process occurs on the basis of heat and mass transfer. The efficiency of this process depends on the material's surface area, air temperature, and diffusion rate.
During the drying process, the moisture content decreases according to an exponential law.



Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

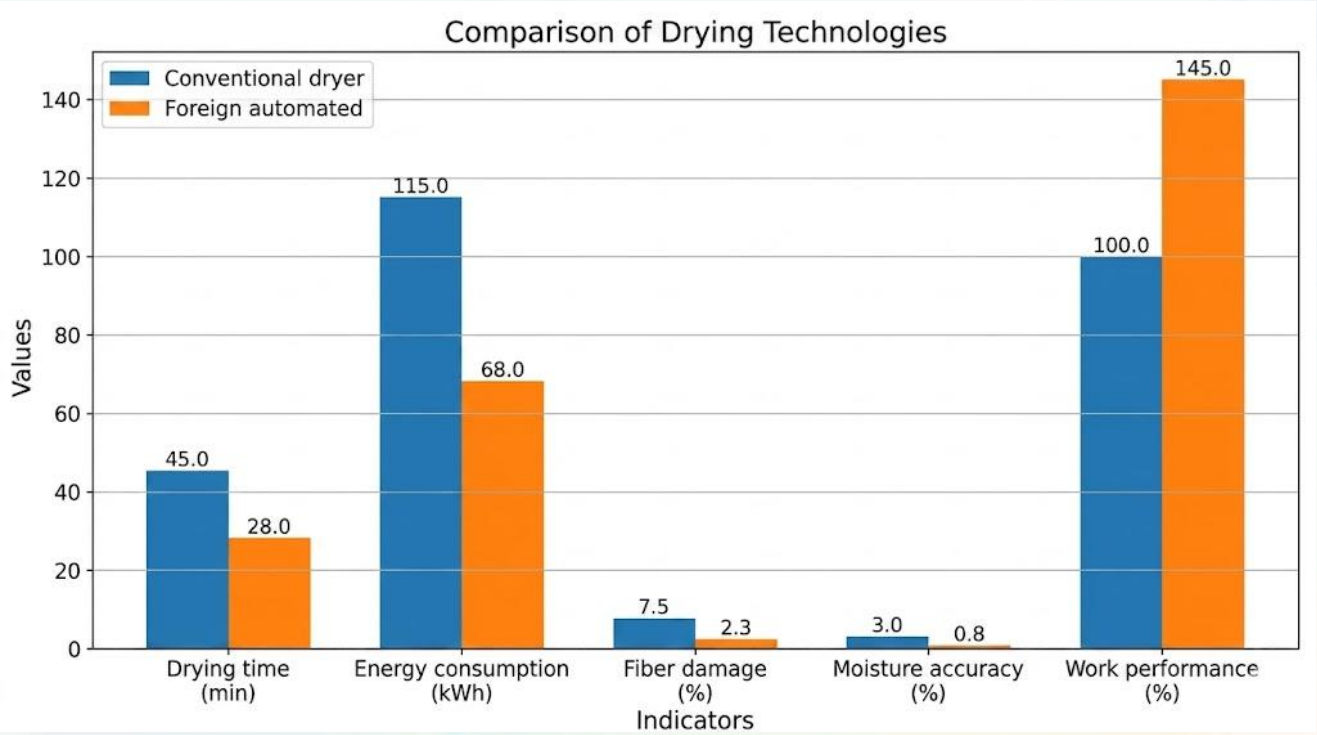


Figure 2. Comparison of drying technologies.

The results demonstrated that foreign technologies improve drying quality while reducing energy consumption.

Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

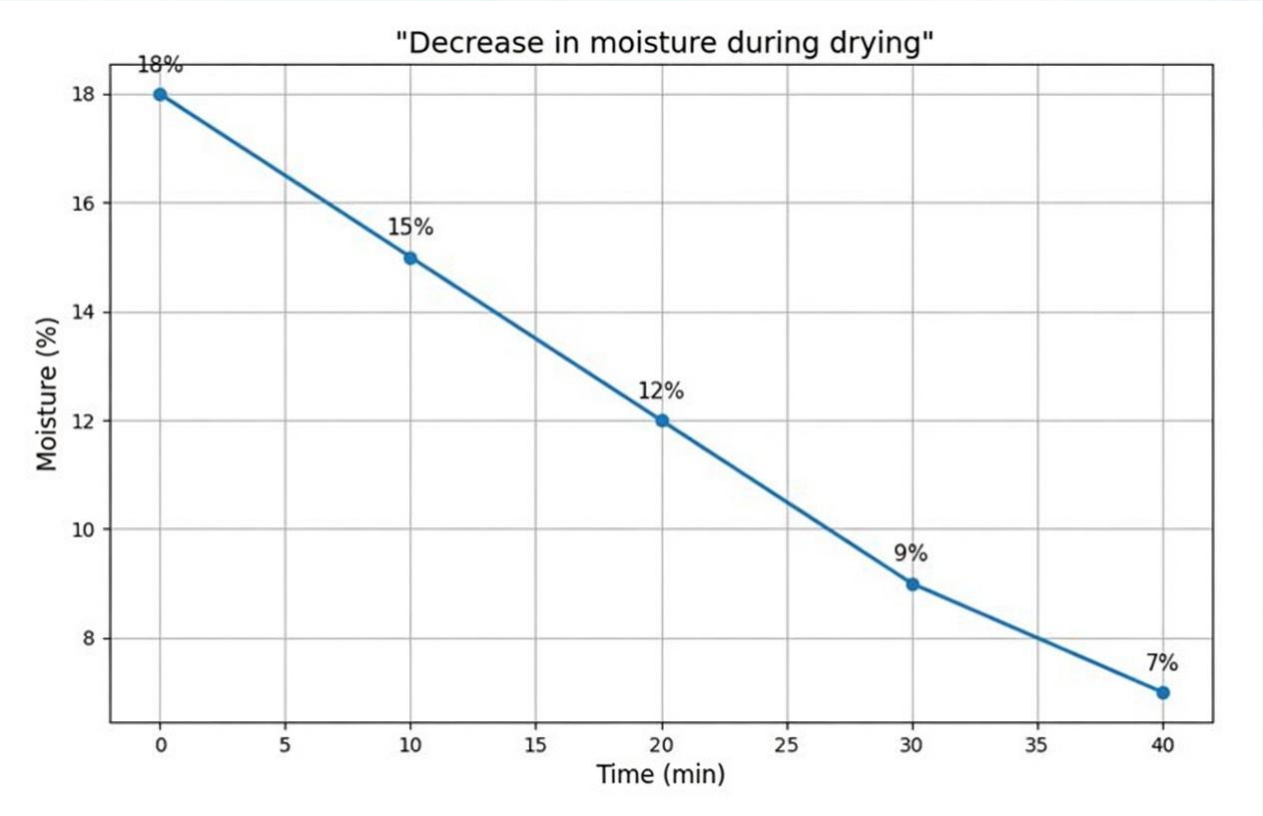


Figure 3. Decrease in Moisture During Drying.

The graph analysis shows that in the initial stage, the moisture content decreases rapidly, while in the subsequent stages, the process slows down.

Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

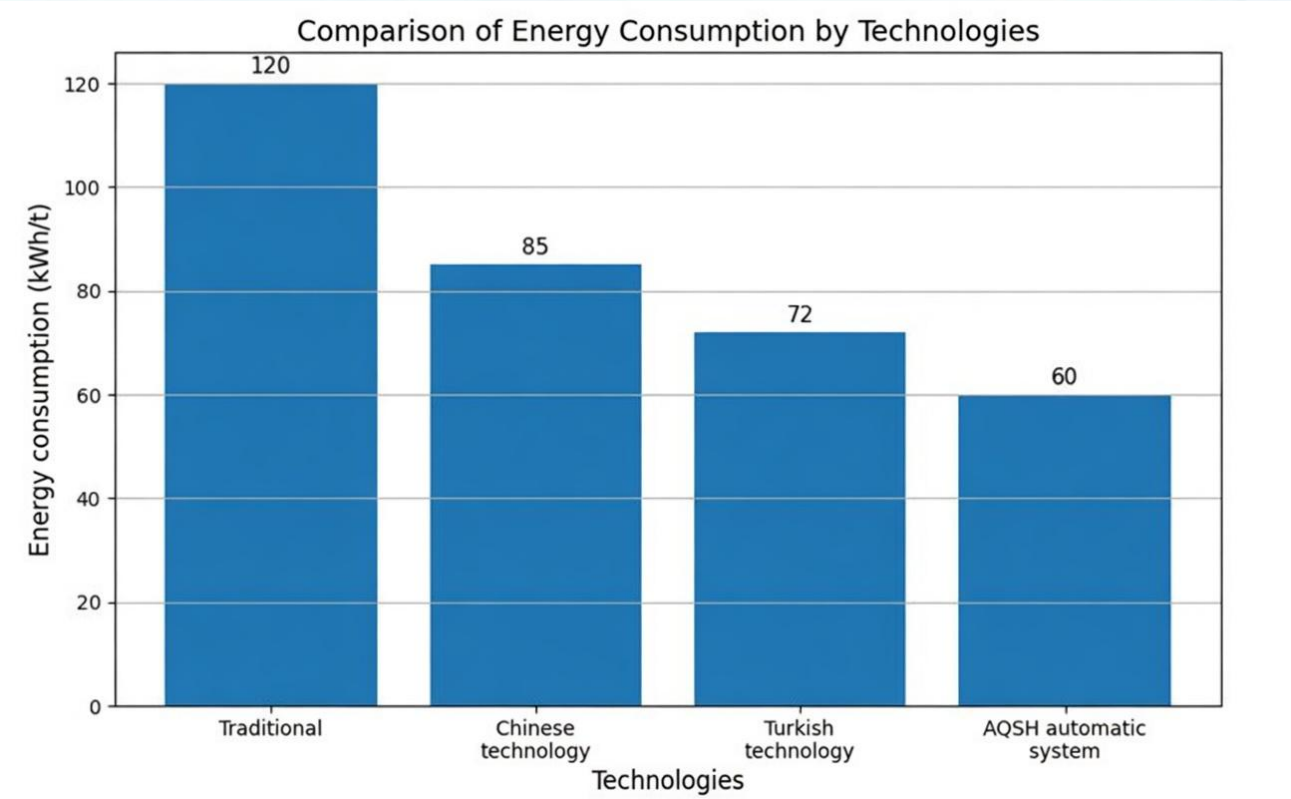


Figure 4. Comparison of Energy Consumption by Technologies

The introduction of foreign technologies in Uzbekistan's cotton industry creates the following opportunities: increasing energy efficiency, improving the export quality of products, reducing production costs, increasing the level of automation, and ensuring environmental safety.

In addition, the development of hybrid drying systems adapted to local conditions is considered a promising direction.

CONCLUSION

The application of foreign technologies in drying cotton raw materials is of great importance in increasing production efficiency. Modern automated drying equipment reduces energy consumption, preserves the quality of cotton fiber, and stabilizes the technological process.

According to the research results:

1. Foreign drying technologies increase energy efficiency by 20–35%;
2. Automation reduces the human factor;
3. Product quality is improved;
4. Drying duration is shortened.

Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

In the future, localizing foreign experience and introducing intelligent control systems in Uzbekistan's cotton industry will have significant scientific and practical importance.

References:

1. Axmedov, A. (2020). Technology of cotton raw material processing. Fan.
2. Baker, C. (2016). Principles of drying technology. Oxford Press.
3. Çelik, M. (2021). Energy efficient drying technologies. Istanbul.
4. European Cotton Research Association. (2022). European Cotton Research Association reports. Brussels.
5. Galoppi, G., et al. (2017). Experimental investigation on industrial drying process of cotton yarn bobbins: Energy consumption and drying time. Energy Procedia, 105, 478–483. https://doi.org/10.1016/j.egypro.2017.03.342
6. Gluesenkamp, K. R., et al. (2021). Efficiency limits of evaporative fabric drying methods (ORNL/TM-2021/XXXX). Oak Ridge National Laboratory.
7. Holman, J. P. (2015). Heat transfer (10th ed.). McGraw Hill.
8. Incropera, F. P., DeWitt, D. P., Bergman, T. L., & Lavine, A. S. (2017). Fundamentals of heat and mass transfer (8th ed.). Wiley.
9. Karimov, B. (2019). Fundamentals of heat and mass transfer. Toshkent.
10. Kuldashov, G. (2024). Automated system for monitoring and controlling cotton storage in stacks [Dissertation]. Toshkent.
11. Mohammed, A. H., et al. (2026). Advances in solar drying technologies: A comprehensive review. Solar Compass, 12, Article 100045. https://doi.org/10.1016/j.solcom.2026.100045
12. Mujumdar, A. S. (Ed.). (2014). Handbook of industrial drying (4th ed.). CRC Press.
13. Panigrahi, S. S., et al. (2023). On-farm grain drying system sustainability: Current energy and carbon footprint assessment. Sustainable Energy Technologies and Assessments, 56, Article 103012. https://doi.org/10.1016/j.seta.2023.103012
14. Perry, R. H., & Green, D. W. (Eds.). (2018). Perry's chemical engineers' handbook (9th ed.). McGraw Hill.
15. Rahmonov, O. (2023). Automation systems in the cotton industry. Toshkent.
16. Rashid, M. T., et al. (2022). Energy efficient drying technologies for sweet potatoes (review with relevance to fibrous materials). Trends in Food

Academicia Review-A Multidisciplinary Online Journal
ISSN (Online): 3070-6726
Website: https://academicia.org
Volume 2, Issue 5, May, 2026

Science & Technology, 119, 456–472. https://doi.org/10.1016/j.tifs.2021.12.015

17. Smith, J. (2020). Automation in agricultural drying equipment. Springer.
18. Toshmirzayev, Q. (2024). Development of resource-saving technological equipment for drying cotton raw materials [Dissertation]. Toshkent.
19. Turdiev, H. (2018). Cotton drying technologies. Toshkent.
20. Wang, L. (2021). Modern cotton processing systems. Beijing.
21. Yu, X., et al. (2025). Experimental analysis on thermodynamic performance of domestic tumble dryer. Energy Reports, 11, 1245–1256. https://doi.org/10.1016/j.egyr.2025.01.012
22. Zhang, Y. (2022). Intelligent drying systems for cotton industry. Shanghai.