DETERMINATION AND ANALYSIS OF THE MECHANICAL DAMAGE DEGREE OF COTTONSEED RESULTING FROM THE LINTING PROCESS

Kamola Insopaliyevna Ortiqova,
doctoral student (DSc), Department of Textile Industry Technology,
Namangan State Technical University, Uzbekistan
+998 97 426 50 55 ortiqovakamola1990@gmail.com
Inamova Maftuna Dedamirza qizi,
doctoral student (DSc), Department of Textile Industry Technology,
Namangan State Technical University, Uzbekistan
+998945026233 inamova93@mail.ru
T.A.Motasim Billah,
Master's degree, Namangan State Technical University, Uzbeksitan
+8801762175628 motasim04@gmail.com

Abstract. This article addresses the issue of determining and analyzing the degree of mechanical damage to cottonseed resulting from the linting process. The study investigates the levels of seed damage under various rotational speeds and operating modes. Based on statistical and technological analysis, optimal operating conditions are developed. In addition, the main structural and technological factors influencing the degree of damage are identified, and recommendations are provided to improve the efficiency of linter machines.
Keywords: linter machine, frequency converter, saw cylinder, electric motor, technological process, automation, product quality, mechanical damage, linear speed.

Introduction. In seed cotton processing enterprises, the technological stages such as conveying, drying, removal of impurities, fiber separation from seed cotton, lint removal from seed, seed cleaning, grading, treatment, packaging, storage, and transportation are carried out using equipment in accordance with established standards [1].

Materials and Methods. Currently, conventional linter machines widely used in the cotton industry - especially the constant-speed operation of their saw cylinders and beaters - are observed to cause significant mechanical damage to seed cotton. This results in various types of seed damage, including hull cracking, kernel exposure, crushing, and deformation (Figure 1). Consequently, the germination capacity of the

seed decreases, an excessive amount of seed hull fragments is detected in the final product, and the quality indicators of the lint deteriorate [2].

The main cause of these issues is the mismatch between the linear velocities of the saw cylinder and the beater within the working chamber of the linter machine, as well as the lack of automatic adjustment according to different cotton varieties or seed conditions.

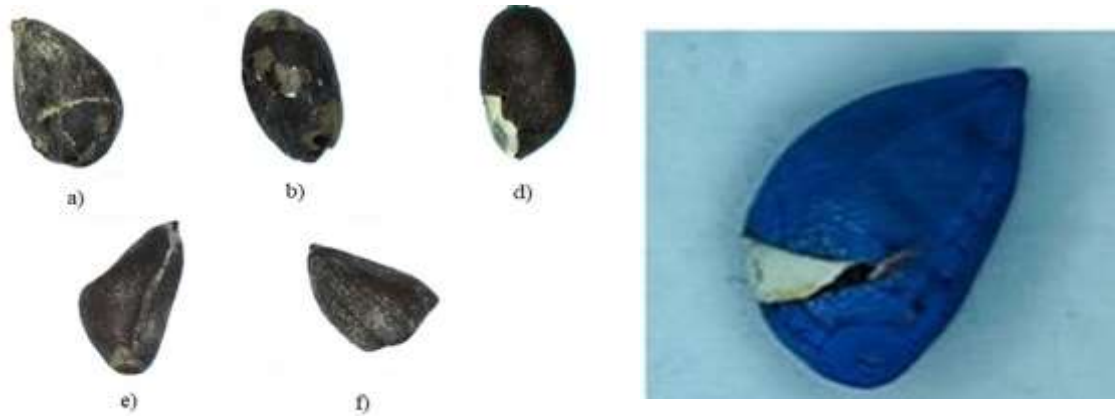

Figure 1. Visual appearance of damaged cottonseeds

a) Surface cracks b) Surface pits d) Surface damage
e) Deformations f) Cracks / Fractures

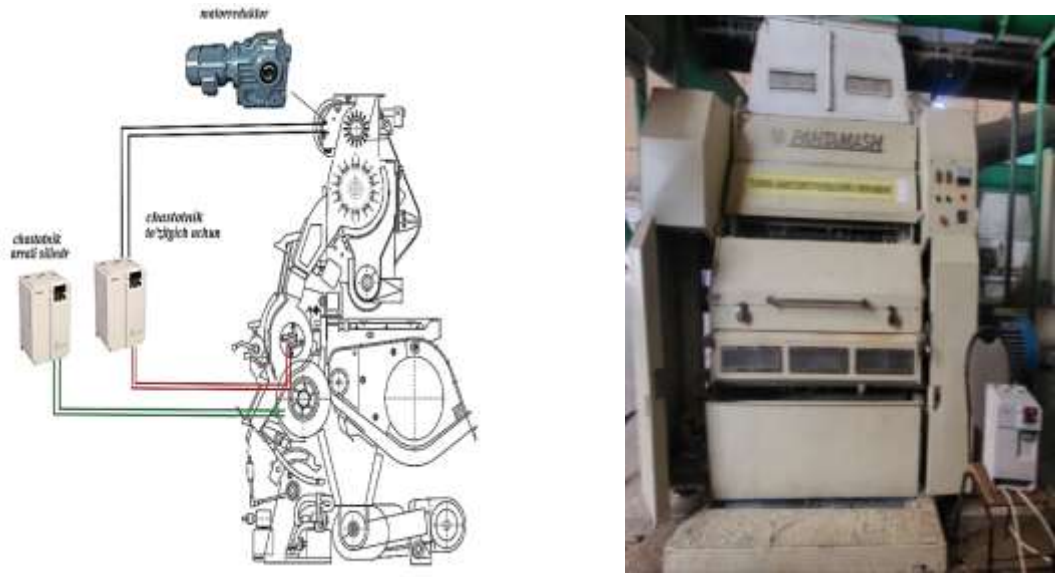

Figure 2. Newly Designed Linter Machine with Automatic Control System

In our study, the proposed technological solution allows for the separate and precise control of the rotational speeds of the saw cylinder and the beater using frequency converters. This makes it possible to coordinate the linear velocities of both working units, maintaining the optimal speed ratio (V_1/V_2) between the saw cylinder and the beater [3]. This is a critical factor, as the mismatch in their speeds is one of the main causes of seed crushing, hull cracking, and kernel damage.

To determine the mechanical damage to cottonseed under different rotational speeds of the saw cylinder and beater, experimental tests were conducted using a 5LP-160 linter machine installed in the linting section of the main building at the cotton processing plant belonging to "NT Chust G'alla Cluster" LLC (Figure 1). The tests were carried out on Namangan-34 variety, R-1 generation, hand-picked cotton with a moisture content of 7.8% and impurity level of 3.0%.

Results and Discussion. From the linter machine output, two working samples of 50 grams each were collected. The samples were placed in a glass container and treated with 20–30 ml of sulfuric acid with a density of 1.84 g/cm³. After mixing for approximately 10 minutes to completely remove the lint, the samples were thoroughly rinsed and dried using filter paper (Figure 2).

The degree of mechanical damage to the cottonseed was determined through visual inspection in accordance with Uzbek Standard O'z DSt 603-2020 and GOST 13056.7-81. In each experimental replication, 200 cottonseeds were selected and examined under a microscope to assess their damage.

Figure 3. Samples Collected for the Experiment

The degree of mechanical damage to cottonseed was determined using the following formula [4]:

$$M_{damage} = \frac{C * 100}{W + C}$$

Where:

C – number of undamaged whole seeds
W – number of damaged seeds

Table 1.

Mechanical Damage Rates of Cottonseed Based on Experimental Results

№	Conducted Experiments	Mechanical Damage to Cottonseed
1	Total number of seeds: 200 Number of damaged seeds: 6	$M_{damage} = \frac{C*100}{W+C} = \frac{6*100}{200} = 3\ \%$
2	Total number of seeds: 200 Number of damaged seeds: 4	$M_{damage} = \frac{C*100}{W+C} = \frac{4*100}{200} = 2\ \%$
3	Total number of seeds: 200 Number of damaged seeds: 8	$M_{damage} = \frac{C*100}{W+C} = \frac{8*100}{200} = 4\ \%$

Average Mechanical Damage Percentage:

$$\text{Average} = \frac{2\% + 3\% + 4\% = 3\%}{3} = 3\%$$

According to the results of three repeated experiments, samples of 200 cottonseeds were taken and analyzed each time. The number of damaged seeds was 4, 6, and 8 respectively, which corresponds to 2%, 3%, and 4%. The average level of mechanical damage based on these experimental results was exactly 3% (Tab 1).

Conclusion. Based on the conducted research, the level of mechanical damage to the cottonseeds exiting the linter machine was analyzed under laboratory conditions. The condition of seed damage was studied under various design parameters and operating modes, and their impact on technological indicators was evaluated. Experimental tests showed that in existing conventional machines, the level of seed damage is relatively high, which negatively affects their quality as planting material.

In contrast, in the linter machine modernized based on the proposed new technological solution, the rotational speeds of the saw cylinder and the beater were controlled using frequency converters. This allowed for the optimization of the mechanical forces acting on the seeds. The test results demonstrated that the level of damage to cottonseeds was significantly reduced when using the upgraded equipment.

REFERENCES

1. Order of the Minister of Agriculture of the Republic of Uzbekistan “On the approval of the regulation on the procedure for adjusting equipment in accordance with established standards during the processing of seed cotton at seed-processing enterprises” [Registered by the Ministry of Justice of the Republic of Uzbekistan on June 19, 2024, registration number 3519].
2. K. Ortiqova, The Role and Importance of Seed Cotton, Technical Cottonseed, and Lint in Industry, Scientific-Technical Journal “Science and Innovations in the Textile and Fashion Industry” – Namangan, 2025. – No. 2. – pp. 171–175.
3. K.Ortiqova, A.Umarov, Sarimsakov A. Analysis of Speeds of Cylinders of Saw Gins and Linters and Determination of Critical Frequencies for them // Scientific Research Publishing, Engineering, 2020, 12, 715-722. DOI: 10.4236/eng.2020.1210050
4. The standard used to determine the level of mechanical damage to cottonseeds is O‘z DSt 603:2020.
5. Inamova Maftuna Dedamirza qizi, Sarimsakov Olimjon Sharipjanovich, & Yo'ldashev Xasanboy Sulaymon O'g'li. (2023). Arra tishlaridan paxta tolasini ilib olish jarayonini matematik modelini ishlab chiqish. International conference on multidisciplinary science, 1(5), 174–177. https://doi.org/10.5281/zenodo.10231714
6. Yo‘Ldashev Hasanboy Sulaymon O‘G‘Li, Inamova Maftuna Dedamirza Qizi, & Sarimsakov Olimjon Sharifjanovich (2023). Arra tishlaridan paxta tolasini yechib olish jarayoni parametrlarini ilmiy asoslash. Илм-фан ва инновацион ривожланиш / Наука и инновационное развитие, 6 (6), 84-95. doi: 10.36522/2181-9637-2023-6-9
7. Najmitdinov Shuxrat Abdukarimovich, Yuldashev Khasanboy Sulayman o'g'li, & Sharipov Xayrullo No'monjanovich. (2023). Тола ажратиш жараёнида хомашё валиги зичлиги ва тезлигининг аҳамияти ўрганиш ва таққослаш. TECHNICAL SCIENCE RESEARCH IN UZBEKISTAN, 1(5), 250–256. https://doi.org/10.5281/zenodo.10416875
8. Шукрулло Немаджонов 1,* Юлдашев Хасанбой 1 , Олимджон Саримсаков 1. (2024). АНАЛИЗ ХЛОПКОВОГО ВОЛОКНА И ВОЗДУШНОГО ПОТОКА С ПОМОЩЬЮ МАТЕМАТИКИ [Data set]. Zenodo. https://doi.org/10.5281/zenodo.14364718
9. Yo'ldashev Xasanboy Sulaymon O'g'li, Inamova Maftuna Dedamirza Qizi, Mahmudova Yulduzxon Qutbiddin qizi, & Sarimsakov Olimjon Sharipjanovich. (2023). Arra tishlaridan paxta tolasini echib olish jarayoni parametrlarini asoslash. JOURNAL OF UNIVERSAL SCIENCE RESEARCH, 1(11), 665–671. https://doi.org/10.5281/zenodo.10250904

10. Yo'ldashev Xasanboy Sulaymon o'g'li . Qurbanov Dilmurod Maripjanovich . Maxmudova Gulshanoy Odiljon Qizi. (2021). INVESTIGATION OF FOREIGN LINT CLEANING SYSTEM TECHNOLOGIES. PEDAGOGLAR yuridik, tibbiy, ijtimoiy, ilmiy jurnal, 11(1), 151–161. https://doi.org/10.5281/zenodo.5813657
11. Xasanboy Yo'ldashev, Olimjon Sarimsakov, & Sharibboy Ergashev. (2024). PAXTA TOLASI BILAN HAVO ARALASHMASI OQIMI HARAKATINI MODELLASHTIRISH. Al-farg'oniy avlodlari, 1(3), 139–144. https://doi.org/10.5281/zenodo.13954931
12. Yoldashev Khasanboy, Komiljon Abduraximov, Maftuna Inamova, & Kamoldin Mirgulshanov. (2021). Study Of The Process Of Cleaning Seedcotton. International Scientific and Current Research Conferences, 1(01), 44–50. Retrieved from https://orientalpublication.com/index.php/iscrc/article/view/191
13. Yuldashev Khasanboy Sulaymon ugli, Sarimsakov Olimjon Sharifjanovich, & Kayumov Abdul-Malik Khamidovich. (2023). Increasing the efficiency of fiber cleaning by improving the process of removing cotton fiber from the teeth of the saw. Multidisciplinary Journal of Science and Technology, 3(5), 346–349. https://doi.org/10.5281/zenodo.10439656
14. Xasanboy, Y., & Azamjon, D. Theoretical Analysis of storing, cleaning, processing of seed cotton. Scientific Journal Impact Factor.
15. Yoldashev Khasanboy, Maftuna Inamova, Mansur Qobilov, & Abrorbek Abduxaliqov. (2021). Effect Of Moisture Contenent In The Process Of Storing, Drying And Cleaning The Seed Cotton. International Scientific and Current Research Conferences, 1(01), 34–39. Retrieved from https://orientalpublication.com/index.php/iscrc/article/view/189
16. Yoldashev Khasanboy, Maftuna Inamova, Mansur Qobilov, & Abrorbek Abduxaliqov. (2021). Effect Of Moisture Contenent In The Process Of Storing, Drying And Cleaning The Seed Cotton. *International Scientific and Current Research Conferences*, *1*(01), 34–39. Retrieved from https://www.orientalpublication.com/index.php/iscrc/article/view/189
17. Sarimsakov Olimjon Sharipjanovich, Kurbanov Dilmurod Maripjanovich, Yo'ldashev Xasanboy Sulaymon O'gli, & Jurayev Yo'ldashxon Yunusxon O'g'li. (2022). INVESTIGATION OF LOSING FIBER DURING CLEANING COTTON. https://doi.org/10.5281/zenodo.6559924
18. Sharipov Xayrullo Numonjanovich, Yo'ldashev Xasanboy Sulaymon O'gli, Jurayev Yo'ldashxon Yunusxon O'g'li, & Urinboyev Bekzod Baxtiyor o'g'li. (2022).

RESEARCH OF LOSING FIBER CLEANER TECHNOLOGIES AND FOREIGN LINT CLEANER TECHNOLOGIES. https://doi.org/10.5281/zenodo.6559910

19. Madumarov Sanjarbek Rustamjonovich, Jurayev Yuldashhon Yunuskhan Ugli, Yuldashev Khasanboy Sulayman corner. (2022). GENERAL INFORMATION ON THE IMPORTANCE OF FEEDSTOCK DENSITY AND SPEED IN THE FIBER SEPARATION PROCESS. ACADEMIC RESEARCH IN MODERN SCIENCE, 1(16), 57–61. https://doi.org/10.5281/zenodo.7229260

20. Jurayev Yuldashhon Yunusxon ugli, Yuldashev Khasanboy Sulayman ugli, Tuhktaev Sherzod Solijanovich. (2022). INVESTIGATION OF FIBER LOSS IN IMPURITIES FROM THE SS-15A SEPARATOR. EURASIAN JOURNAL OF ACADEMIC RESEARCH, 2(11), 425–431. https://doi.org/10.5281/zenodo.7193675

21. Yuldashev, K.; Sharipov, K.; Najmitdinov, S.; Inamova, M.; Ruzimatov, S. Modelling cotton fiber doffing from saw teeth based on a mathematical model. E3S Web of Conferences 2024, 537, 08017. https://doi.org/10.1051/e3sconf/202453708017.

22. Muhsinov Ibrohim, Isayevshahboz, & Yuldashev Xasanboy. (2021). Theoretical Analysis Of The Motion Of Raw Cotton With Uniform Feeder In A Cotton Cleaner. *The American Journal of Engineering and Technology*, *3*(01), 13–20. https://doi.org/10.37547/tajet/Volume03Issue01-04

23. Sulaymonov Abror, Inamove Maftuna, Yuldashev Khasanboy. (2022). THEORETICAL STUDIES OF THE NATURE OF THE INTERACTION OF COTTON SEEDS IN THE GAP BETWEEN THE AGITATOR BLADE AND THE SAW CYLINDER. EURASIAN JOURNAL OF ACADEMIC RESEARCH, 2(11), 666–672. https://doi.org/10.5281/zenodo.7218857

24. Sharipjanovich, S. O., Numonjonovich, S. X., & Rustamjonovich, M. S. (2022). INVESTIGATION OF SEPARATION OF USABLE FIBERS ADDED TO CONTAMINANTS DURING CLEANING COTTON. *O'ZBEKISTONDA FANLARARO INNOVATSIYALAR VA ILMIY TADQIQOTLAR JURNALI*, *1*(8), 661-669. View of INVESTIGATION OF SEPARATION OF USABLE FIBERS ADDED TO CONTAMINANTS DURING CLEANING COTTON (bestpublication.org)

25. Najmitdinov Shuxrat Abdukarimovich, Yuldashev Khasanboy Sulayman o'g'li, & Sharipov Xayrullo No'monjanovich. (2023). Тола ажратиш жараёнида хомашё валиги зичлиги ва тезлигининг аҳамияти ўрганиш ва таққослаш. TECHNICAL SCIENCE RESEARCH IN UZBEKISTAN, 1(5), 250–256. https://doi.org/10.5281/zenodo.10416875

26. Azimov, S. S., Tursunov, I. T., & Yuldashev, K. S. (2022). DEVELOPMENT OF THE DESIGN OF A FEEDER OF VIBRATION ACTION FOR SUPPLYING COTTON SEEDS TO LINTER MACHINES Proceeding IX International Conference «Industrial Technologies and Engineering» ICITE–2022, Volume IV M. *Auezov South Kazakhstan University, Shymkent, Kazakhstan December*, 09-10.

27. Olimjon Sarimsakov, Khasanboy Yuldashev, Sherzod Tuxtaev, Bekzod Urinboyev, Utkirbek Xoshimov; Methodology for performing aerodynamic measurements in cleaning seed cotton. *AIP Conf. Proc.* 23 June 2023; 2789 (1): 040128. https://doi.org/10.1063/5.0145700