PRODUCTION AND SCIENTIFIC STUDY OF WOOL FIBER

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Annotation: This article presents a brief overview of the various opportunities, geographical and economic factors influencing the development of the wool processing industry in our Republic. It discusses the implementation of large-scale measures aimed at producing import-substituting products through the processing of locally sourced wool, promoting their wide application, and utilizing highly efficient equipment and technologies. The article also highlights the potential uses of domestically produced wool for technical and industrial purposes, including as an insulating material for sound and heat insulation. Due to its environmentally friendly properties, wool is particularly suitable for building insulation. The article provides concise information on these aspects and related research.

Keywords: *fiber, wool, cotton, silk, wool blend, coarse wool, climate.*

Introduction. At present, the acceleration of scientific and technological progress is closely linked to the development and comprehensive study of new equipment and technologies. In order to fully strengthen the economy of our newly independent Republic of Uzbekistan, it is necessary to introduce modern technologies into industrial enterprises, utilize the achievements of science and technology, and make full use of the latest machines and equipment that offer high efficiency and productivity.

The light industry sector is developing year by year. The implementation of new production technologies, the use of high-performance, modern equipment, and, simultaneously, the application of effective management practices ensure high labor productivity and increased industrial production volumes in the sector's enterprises.

For many years, Uzbekistan was known solely as an exporter of cotton fiber. However, today the country holds vast potential not only as a supplier of cotton fiber but also as an exporter of textile products, especially finished goods, with the aim of becoming a leading player in the global textile market.

Light industry in Uzbekistan is one of the leading and rapidly developing sectors. According to data from the State Statistics Committee, in 2020, the share of this sector in the country's total industrial output was approximately 35%, around 4% of the gross domestic product (GDP), and over 40% in the volume of non-food goods production[1,2].

Wool Fiber: *Its Properties, Applications, and Strategic Role in Uzbekistan's Industrial Development*

As is well known, wool fiber is one of the oldest and most natural fibers that has been used by humans for centuries in the textile industry. This fiber is primarily obtained from sheep's fleece. Wool fiber stands out for its numerous properties and wide range of applications. It is particularly valued for its ability to retain heat, its elasticity and durability, and its fire resistance. Owing to these characteristics, wool is used in various fields, such as clothing production, carpet and textile manufacturing, and technical applications.

In Uzbekistan, the use of locally produced wool for technical and industrial purposes—such as insulation material, sound and thermal insulation—is highly advisable due to its eco-friendliness and sustainability.

There are several geographic and economic factors supporting the development of the wool-processing industry in our republic. Efforts are underway to increase the use of domestically produced wool as a substitute for imported products, promote its broader application, and introduce advanced high-efficiency equipment and technologies.

The Decree of the President of the Republic of Uzbekistan No. PF-60 dated January 28, 2022, *"On the Development Strategy of New Uzbekistan for 2022–2026,"* outlines tasks such as "filling existing gaps in the production of import-substituting goods and doubling the volume of industrial and textile product output by 2026" [2].

In achieving these goals, it is crucial to accelerate the development of the livestock sector, implement modern and innovative methods, increase the volume and variety of livestock products, ensure the consistent supply of affordable and high-quality locally produced goods to the population, and expand enterprises specialized in livestock production.

Research Methodology and Tools. Among textile products, those made from natural raw materials (such as cotton, natural silk, wool, flax, etc.) have long held a special place in the cultural traditions of our people. This is due to the fact that natural raw materials, with their complex set of characteristics, differ significantly from synthetic textile fibers. In particular, fabrics made from natural fibers are aesthetically pleasing, durable, delicate, dye well, flexible, highly absorbent, and possess many other advantageous properties. As a result, products made from natural raw materials are generally priced higher than those made from synthetic fibers.

Analysis of Results and Methods. An analysis of the global base of textile raw materials reveals a steady decline in the availability of natural textile resources (see Table 1).

Global Balance of Raw Materials in the Textile Industry (million tons)

Table-1

Year	Cotton fiber	Synthetic fibers	Cellulosic fiber	Wool	Raw silk	Total (100%)

1950	6,6	0,07	1,6	1,057	0.02	9,3
1975	11,809	7,346	2,959	1,502	0,049	23,7
1980	13,981	10,476	3,242	1,608	0,055	29,4
1985	17,540	12,515	2,999	1,673	0,059	34,8
1990	20,830	16,440	2,86	1,940	0,075	42,1
2000	19,4 (39,7%)	25,3 (51,8%)	2,5 (5,1%)	1,5 (3,0%)	0,1045 (0,2%)	48,8
2010	20,3 (25,4)	50,0 (62,5)	3,2 (4,0%)	1,7 (3,0%)	0,120 (0,16%)	75
2020	25,0 (26,7)	60,0 (64,0)	5,3 (5,6)	2,8 (3,0)	0,13 (0,14)	93,3

According to the International Silk Association's analysis:

2050 (Is projected (to)...)	23,8 (18,1%)	98,0 (74,4%)	7,8 (5,9%)	2,0 (1,5%)	0,130 (0,09%)	131,7 (100%)

Currently, approximately 28,000 to 30,000 tons of wool fibres are produced annually in the Republic of Uzbekistan. The majority of this wool is categorized as coarse and semi-coarse fiber types. The sheep and goat breeds reared in the country primarily include the Sarajin and Tajik sheep, which produce semi-coarse wool, while the Karakul, Hisori, and Jaidari breeds produce coarse wool. Wool shearing is performed twice a year—during spring and autumn. Spring wool shearing differs from autumn shearing in that the fibres contain a higher amount of down and are more commonly used for spinning. Autumn wool, on the other hand, is mainly utilized as raw material for felting and nonwoven textile production.

Wool is a valuable raw material in the textile industry. Today, wool fibres obtained from animals are extensively used in the production of fabrics, knitwear, carpets, felt, and other textile products. Wool refers to the fibres covering the surface of sheep, goats, camels, and other similar animals. In Uzbekistan, approximately 95–97% of wool is derived from sheep, 2–3% from goats, and the remaining from camels [3]. Within the Commonwealth of Independent States (CIS), the total wool yield is distributed by category as follows: fine wool accounts for 60–63%, semi-fine 10–12%, semi-coarse 5–7%, and coarse wool 16–18%.

It is well-known that spinning yarn from wool fibres is more complex compared to cotton, silk, and synthetic fibres [4]. As a result, yarn is spun from wool at both high and low linear densities, depending on the raw material [5]. Fine yarns are produced from fine and semi-fine wools, while coarse and semi-coarse wool types are used for thicker yarns. The fleece shorn from sheep in Uzbekistan consists of heterogeneous fibres, where Sarajin and Tajik breeds yield semi-coarse wool, and Karakul, Hisor, and Jaidari breeds yield coarse wool.

Due to the variability in fibre types within coarse and semi-coarse wool, and to simplify the spinning process, it is advisable to sort fibres based on their thickness. A number of studies have been conducted to mechanically sort wool fibres by thickness. In 1835, length was the primary indicator used in sorting, with 21–25 micron fibres corresponding to lengths of 50–70 mm. Later, between 1924–1925, when goat hair was sorted by length using a double-combing machine by Iozeri and Hartmann, 70% of coarse fibres were separated. In 1955, a combing machine developed by the French company “Thibault” allowed for the sorting of camel wool by fibre thickness with improved results compared to previous machines. However, mechanical sorting may cause fibre damage due to needle friction.

The diverse composition of fibres in coarse and semi-coarse wools necessitates sorting them by thickness and length to reduce complexity in the spinning process. In the first half of the 20th century, the characteristics of these fibres were studied at longer lengths (differing by 30 mm) by Prof. V. E. Gusev. Today, examining wool fibres at shorter lengths allows for initial classification and better yarn quality in spinning.

In view of this, the composition and characteristics of wool from Karakul, Hisor, and Jaidari breeds—common in Uzbekistan—have been investigated at shorter lengths. Each sample was tested with 60 repetitions, and results are presented in Table 2. Experimental results indicate that an increase in fibre length correlates with higher average linear density (0.510–3.90 tex), strength (7.02–43.4 cN), and slight increases in specific breaking strength (8.82–13.8 cN/tex) and elongation at break (30.3–43.54%).

Among the breeds studied, Karakul wool with a short length of 26 mm has the highest linear density (0.585 tex), while its long fibres (104 mm and above) are relatively thinner (2.95 tex) [6]. Various factors—such as breed, age, sex, diet, climate, and geography—affect fibre characteristics. Because native wool is heterogeneous and the fibres are crimped, evaluating physical and mechanical properties such as tensile strength and elongation in staple form is subject to error. Hence, fibres must be analyzed individually.

Studying the properties of coarse and semi-coarse wool fibres at short lengths enables optimal systems for classification by both thickness and length. Locally produced wool is primarily used for thick yarns employed in the manufacture of carpets, blankets, and nonwoven textiles. However, the coarse nature of the fibres reduces product softness. One method to overcome this limitation is to use waste silk fibres. For this, it is necessary to study the processing of waste cotton or silk fibres and the production of blended yarns.

Wool fibre characteristics fall into two main categories:

- Technological properties: spinnability, feltability, and dye uptake.

- Physicochemical properties: response to substances such as water, heat, acids, alkalis, etc.

Wool fibre consists of keratin (a protein) and contains approximately 50% carbon, 21–24% oxygen, 16–18% nitrogen, 6–7% hydrogen, and 2–5% sulfur [4]. Raw wool often contains various impurities that lower its technological quality. These contaminants originate from the animal's development, living environment, climate, and shearing conditions. Common impurities include plant matter, grease-sweat, minerals, and other foreign substances.

Sheep are usually sheared in spring and again in autumn (around September). Spring wool, which is richer in down, is referred to as “runo.” Once collected, wool is taken to sorting tables, where it is graded. Wool classification involves sorting the fleece into grades according to national standards for unwashed wool. The grader visually inspects the fleece and assigns it to the appropriate grade based on these standards.

Conclusion. In conclusion, due to its natural thermal insulation capacity, moisture regulation, and elasticity, wool fiber is considered a vital material for the textile industry. From clothing to technical and industrial applications, wool remains a versatile and sustainable textile product. In today's context—where demand for eco-friendly and sustainable materials continues to grow—wool fiber retains its significance in modern textiles and is likely to maintain its relevance in the future as well.

The study of the properties of coarse and semi-coarse wool fibers in short lengths creates opportunities for the development of an optimal classification system based on fiber thickness and length, which will contribute to improving their sorting and application efficiency.

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