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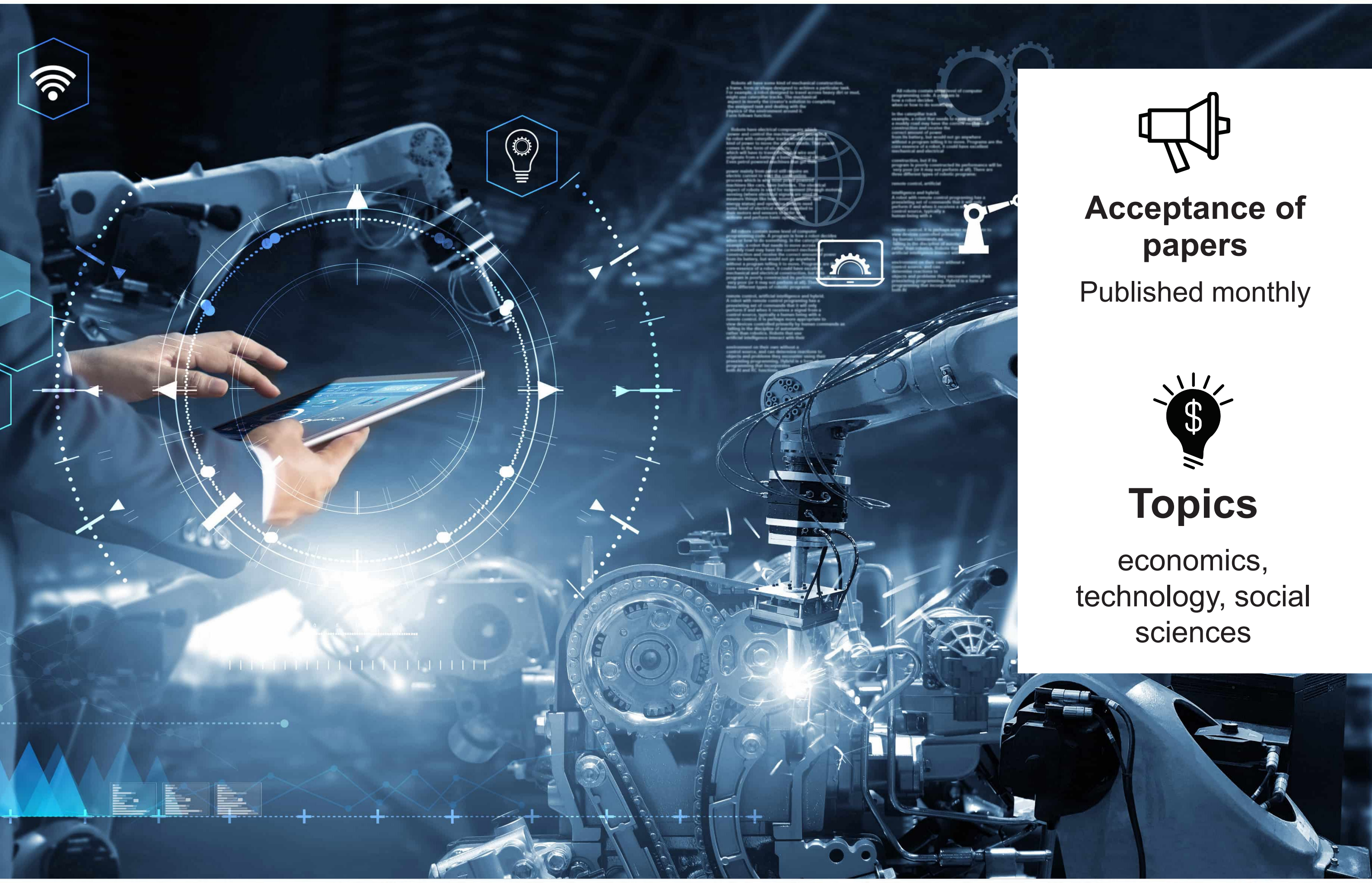

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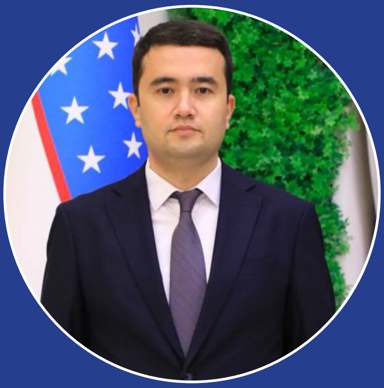

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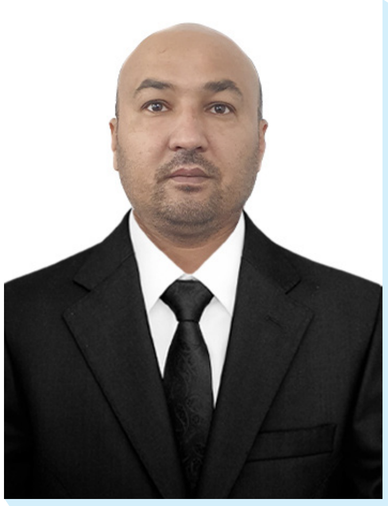
PHYSICO-MECHANICAL PROPERTIES OF COARSE FEEDS



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Abstract: The development of new technologies and technical means for grinding and distributing roughage is impossible without determining the patterns of change in their physical and mechanical properties. Analysis of scientific and technical literature shows that the physical and mechanical properties of roughage have not been sufficiently studied in the conditions of Uzbekistan. The purpose of the study is to study and analyze the physical and mechanical properties of roughage grown in Uzbekistan. In the course of research, methods of statistical analysis, methods of determining the mikrometric composition and crushing modulus of the product crushed with a ball classifier, as well as the methods specified in the existing regulatory documents were used. According to the results of the research, the angle of friction of wheat straw on the steel surface is 30o in the longitudinal direction, 32o in the transverse direction, and 29o and 30.6o of the alfalfa, respectively. when the surfaces are made of steel, they provide faster movement of nutrients along them.

Key words: mechanical, micrometric, physical, plant, animal materials, density, pressed, zootechnical, analyzing, determined, plane device.

INTRODUCTION

In the world, a number of scientific and research works are being carried out to improve the technologies and technical means of grinding coarse feed and distributing it to livestock. The physical and mechanical properties of roughage as a processed material are taken into account for the development of a coarse feed grinder and feed distribution devices of a compact design for small livestock farms, as well as to justify their parameters [1-8].

Kumar A., Abilzhanuly T., Iskakov R., Abilzhanov D., Gulyarenko A., Antil S.K., Rani V., Fawal Y.A., Tawfik M.A., Shal A.M., McRandal D.M., McNulty P.B., Jekendra Y., Ghorbani Z., Masoumi A.A., Hemmat A., Rogovoy V.D. , Karpov V.V., Gutyar E.M., Astanakulov K.D., Khatamov B.A, Gapparov Sh.Kh. and others determined the physical and mechanical properties of fodder. In this scientific-research work, the physico-mechanical properties of fodder were studied in order to harvest grain crops. But their physico-mechanical properties for grinding and distribution of roughages have not been comprehensively studied. In Uzbekistan, alfalfa hay, wheat and barley straw, corn stalks, alfalfa and natural grasses are pressed and stored for the winter [9-13]. The purpose of the study is to study the physical and mechanical properties of pressed wheat straw, alfalfa stem and alfalfa, which should be taken into account when justifying the optimal construction and parameters of the crusher devices that ensure the crushing of coarse feed to the specified size depending on the type of livestock [14-18].

REVIEW OF LITERATURE ON THE SUBJECT

Kutzbach H.D. (2000, 2003) Studied the baling process of large fodders (hay, straw). He identified the relationship between pressure and density, proving that the material has elastic-plastic properties. Main result: the efficiency of compaction is strongly dependent on pressure parameters. Main result: pelleting efficiency is strongly dependent on pressure parameters.

Shinners K.J. and co-authors (2007) studied technologies for high-density biomass pressing. Result: moisture and particle size affect energy consumption.

Molenda M. and Horabik J. (2005) studied the physical-mechanical properties of granular and fibrous materials in a comprehensive manner. Result: density and porosity directly affect the flow and storage processes.

ASABE standards (EP series) have developed methods for determining the density, strength, and other parameters of feeds. Result: a basis for standardization in the field has been established.

McDonald P. and co-authors (2010) studied the moisture of foods and its effect on food quality. Result: high moisture enhances the growth of microorganisms.

Rotz C.A. and co-authors (1991) studied the processes of hay drying and storage. Result: controlling moisture reduces nutrient loss.

Hunt D. (1990) analyzed the process of crushing feed in agricultural machinery. Result: particle size affects energy consumption and feed efficiency.

Bitra V.S.P. and others (2009) experimentally studied the energy of biomass grinding. Result: as the degree of grinding increases, energy consumption rises sharply.

Jenike A.W. (1964) developed the theory of storage and flow. Result: the flow angle and stickiness of materials are considered the main parameters.

Molenda M. (2006) Studied the friction properties of biomaterials. Result: the coefficient of friction affects the design of preservation structures.

O'Dogherty M.J. (1982) analyzed the mechanical properties of agricultural materials. Result: fibrous materials have anisotropic properties.

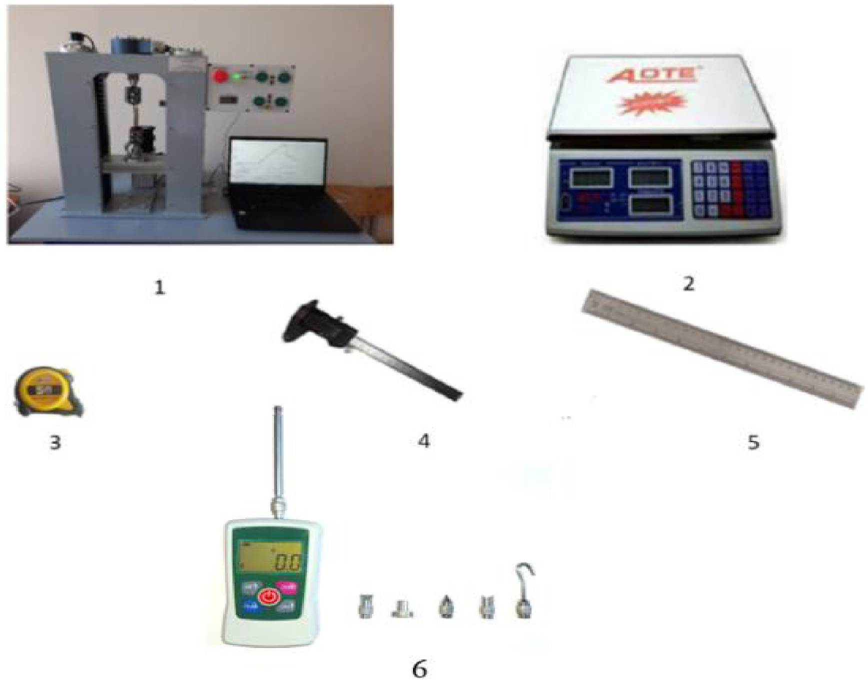
Sitkei G. (1986) conducted fundamental research on the mechanics of biological materials. Result: the deformation of nutrients changes over time.

Mani S. and co-authors (2004) studied the processes of biomass briquetting and granulation. Result: moisture and pressure should have optimal values.

Research based on DEM and CFD (2015–2023) Digital modeling of flow and mechanical processes. Result: the possibility of predicting real processes with high accuracy has emerged.

RESEARCH METHODOLOGY

Experiments to determine the physical and mechanical properties of wheat, alfalfa and corn stalks GOST 20915-2011. "Сельскохозяйственная техника. Методы определения условий испытаний" and "Physical properties of plant and animal materials" were carried out based on the methods presented in normative documents. The research program developed on the basis of these normative documents determined the length, thickness, mass of pressed wheat straw, alfalfa hay and alfalfa stalks and the ratio of their components, density, friction angle and coefficient, as well as the strength of resistance to breaking and shearing. In determining the size-mass indicators and physical-mechanical properties of pressed straw alfalfa, a ruler, a ruler, a barbell circle, an electronic scale, an inclined plane device, a DIGITAL FORCE GAUGE AMF-500 dynamometer, and a UEIM-20 for determining the breaking force are used as measuring instruments. -300 device was used (Figure 1). Experiments on the study of physical and mechanical properties of coarse feed were carried out at the laboratory bases of the Karshi Institute of Engineering and Economics, the Research Institute of Agricultural Mechanization and the "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University (Figure 1).



1 – UEIM-20-300 device; 2 – scales; 3 – roulette; 4 – barbell circle;
5 – ruler; 6 – DIGITAL FORCE GAUGE AMF-500 dynamometer.

Figure 1. Measuring instruments

ANALYSIS AND RESULTS

Taking into account that according to zootechnical requirements coarse feed is crushed into 3-5 cm length, we determined the fractions contained in pre-pressed wheat straw. To do this, they were divided into fractions up to 30 mm, 30-50 mm and larger than 50 mm (Figures 2-3). Their fractional composition was determined using the following formula according to the ratio of each separated fraction to the total mass

$$\hat{O}_i = \frac{M_i}{M_m} \cdot 100\% \qquad (1)$$

Where:

Φ_i – size up to 30 mm, 30-50 mm or fractions larger than 50 mm, %;

M_i – a mass of fractions with a size of 30 mm, 30-50 mm or more than 50 mm, kg;

M_{um} – total mass of the sample, kg.

When the sizes of wheat straw presses from the pressed roughages used in livestock feeding were studied, it was found that their length is mainly in the range of 60 cm to 90 cm, the width is about 50 cm, and the height is about 40 cm.

When analyzing the size-mass parameters and fraction composition of the pressed wheat straw, 10.42 kg or 78.2 percent of the wheat straw press with an average mass of 13.3 kg were fractions with a length greater than 50 mm, 2.34 kg or 17.6 percent of the length 30-50 mm fractions and 0.56 kg or 4.2 percent were found to be fractions up to 30 mm in length. The average density of straw bales was 83.1 kg/m^3 (Table 1).

Table 1. Fractional composition of pressed wheat straw

№	Indicator name	Xmin	Xmax	Maver	Share of the total, %
1	Total mass of wheat straw press, kg	9,75	16,89	13,32	100
2	Greater than 50 mm, kg	7,99	12,85	10,42	78,2
3	30-50 mm, up to kg	1,62	3,15	2,34	17,6
4	30 mm, up to kg	0,14	0,89	0,56	4,2

It can be seen that the part of the pressed straw that needs to be crushed is 78,2 percent (Figure 2).

a) alfalfa presses; b) general view of alfalfa press; s) general appearance of pressed straw; d) fractions with a length greater than 50 mm, e) with a length of 30-50 mm and i) with a length of up to 30 mm

Figure 2. Pressed alfalfa, wheat straw and its fractional composition

According to the morphological composition of the pressed coarse feed, the feed consists of stems, leaves and additional branches, and the maximum force against cutting is applied to its stems, and the minimum force is applied to the rest of the parts. Grinding methods of cutting, cutting, chopping, and breaking are used to grind coarse feed. Among these grinding methods, cutting grinding and cutting grinding methods are considered acceptable for grinding green feed, but when grinding dry feed, especially with hard stalks, it is advisable to use the crushing method or cutting and breaking grinding method in terms of ensuring high productivity and reducing energy consumption (Figure 3).

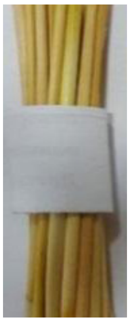
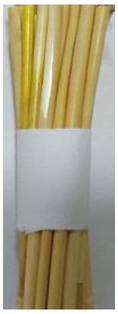
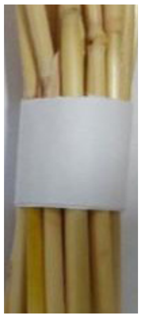
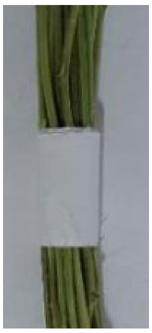
 d=1,5 mm	 d=3 mm	 d=5,5 mm
a)		
 d=1,5 mm	 d=3,0 mm	 d=4 mm
b)		

Figure 3. samples from a-wheat straw and b-alfalfa stalks

Frictional properties of coarse feed were determined using an inclined plane device. In this case, the angle of inclination of the inclined plane relative to the horizontal plane at the time of movement of the samples was taken as the friction angle of the feed. The coefficient of static friction of feed was determined according to the following expression

$$f_{fric.} = tg\varphi. \qquad (2)$$

In the experiments, it was found that the friction angle and coefficient of wheat straw is slightly different from the friction angle and coefficient of alfalfa stem. According to the determined data, the friction angle of the wheat straw press in the longitudinal direction is on average 30°12`, in the alfalfa press 29° was 24`, and in the transverse direction it was 31° 36` and 30° 18`, respectively (Table 2).

Table 2. Coarse feeds and their movement angle and friction coefficient on an inclined surface

№	Naming of components	Direction of movement of components			
		Longitudinal		Transverse	
		Angle of friction, °	Friction coefficient	Angle of friction, °	Friction coefficient
1	Straw press	30° 12`	0,58	31° 36`	0,6
2	Alfalfa press	29° 24`	0,55	30° 18`	0,58

As can be seen from the data presented in the table, the angle of friction of alfalfa differs from the angle of friction of wheat straw by 1° 12` in the longitudinal direction, and by 1° 18` in the transverse direction. This means that the friction angle of wheat and alfalfa presses is not very different from each other.

CONCLUSIONS AND SUGGESTIONS

According to the results of the research, the angle of friction of wheat straw on the steel surface is 30° in the longitudinal direction, 32o in the transverse direction, and 29° and 30.6° of the alfalfa, respectively. In the process of grinding, when the working surfaces are made of steel, the movement of nutrients along them is ensured.

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