

Digital instruments for precise grading of jute fibre

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Grading jute fibre is essential in determining the quality and price of the final product. In India, the prevailing method of grading is the hand and eye approach, which is subjective and lacks scientific basis. However, the development of digital instruments offers a more objective and scientific assessment of jute fibre. Grading jute fibre involves considering physical parameters such as bundle strength, defects, root content, colour, and fineness. These parameters help categorize the fibre into different subdivisions and determine its overall quality. While the hand and eye method is still commonly used in procurement centers, it is time-consuming and prone to human error and bias. On the contrary, digital instruments provide a more efficient and unbiased approach to grading jute fibre. Digital instruments such as automatic bundle strength testers, fineness meters, and colour and lustre meters expedite the grading process. They offer accurate and consistent measurements, reducing the reliance on subjective judgment. This ensures that jute growers receive a fair and appropriate price for their product. To promote transparency and fairness, jute purchasing centers should embrace these digital instruments for grading jute fibre. By doing so, they can overcome the drawbacks of the traditional method and establish a more transparent and unbiased evaluation system.

Keywords: Fibre, Grading, Hand and eye method, Instrument, Jute

JUTE is the second most important natural fibre after cotton in terms of area coverage production and consumption in the India. It is mainly cultivated in south and Southeast Asia countries namely India, Bangladesh, China, Nepal, and Thailand for fibre. India and Bangladesh are leading jute producing countries and accounts for 95% world's jute production. India alone accounts for around 50% of estimated global jute production in the globe. In India, jute is mainly grown in eastern region of the country i.e. West Bengal, Bihar, Odisha, Assam, Tripura, Meghalaya, Andhra Pradesh and Telangana. Among all jute growing states, West Bengal, Assam and Bihar contributes almost 99% of India's production. West Bengal accounted for 80.2% of total jute acreage and 82.3% of total production. As per the Ministry

of Textiles (2021), the jute sector supports the livelihood of around 40 lakh farm families in India and provides direct employment to 3.7 lakh workers in organized mills and diversified sector.

Lack of retting facility, low price of fibre and poor knowledge about the grading system are among the various factors responsible for low area coverage of jute. Farmers managed to produce quality jute fibre with limited retting facilities, but not getting a good price for their product led to uninterest for growing jute. Jute fibre does not have a uniform quality throughout India. This varies from place to place depending on the soil type, weather conditions, and type of water used for retting. Due to such variations, fibre quality is not uniform. Therefore, grading of the fibre is important for commercial purposes. Good quality

fibre produces high-value products such as home textiles, jute geo-textiles, jute composites, handicrafts, and fashion accessories etc. whereas lower grade fibre is utilized for manufacturing sacks and hessian. Classification of the fibre quality based on its physical properties is called jute grading. It is a process of establishment of certain standards based on the intrinsic physical properties of the fibre with a view to sub-divide it into several grades or classes. The fibre which spins into the fine yarn is considered to be of very good quality. The minimum support price of fibre depends on the quality of fibre. In India, jute is sold by visual assessment (Hand and eye method). Traditional 'hand and eye method' of assessing the quality parameters of jute fibre is causing disadvantage to farmers. Often farmers have to sell the

products less than what the product deserves. The BIS recommends both the method of grading i.e. hand and eye method and instrumental method. Instrumental method of grading is objective assessment of fibre, rapid, accurate and grading is un-bias. However, availability of instruments is a big challenge.

Evolution of Grading system

The Indian Standard of the jute grading system was published first in the year 1950 and has been revised five times till date. The original standard covered white (*Corchorus capsularis*) and tossa (*Corchorus olitorius*) jute and classified them into 4 grades, namely, tops, middles, bottoms and cross(X) considering the 'place of origin' as basic guideline. But due to disadvantages and inconveniences caused for the growers, as the grades were varying within the same states or districts on the basis of its location at top, middle, bottom etc. and was not sufficient for proper classification of the fibre. On the basis of initiative of JTTL, the first revision of the grading system was done and DAISEE (*Corchorus olitorius*) jute was included in addition to WHITE and TOSSA. The WHITE jute was classified into 8 grades, namely W1, W2, W3, W4, W5, W6, W7 and W8; and TOSSA and DAISEE jute into 8 grades, namely, TD1, TD2, TD3, TD4, TD5, TD6, TD7 and TD8 on the basis of scientific parameters in the year 1969. The revised system was endorsed by Jute Mills Association, Jute Balers Association, different jute development organisations and farmers. The system was accepted by BIS and the revised Indian Standard was notified accordingly. In the second revision, the scores of different parameters were revised by JTTL on the basis of experiences of jute graders in the year 1975 to facilitate effective implementation of the standard. In the third revision, 'Defects' -parameter in respect of grades W2 to W5 for WHITE jute and TD2 to TD5 for TOSSA and DAISEE were modified in the year 1987. Fourth revision was done in the year 2003 to incorporate modified scores for different quality characteristics

and maximum root content for better implementation of jute growers and traders. Recently, IS: 271 (2020) reduced of classification from 8 to 5 grades: WHITE jute : W-1, W-2, W-3, W-4, and W-5; TOSSA and DAISEE jute : TD-1, TD-2, TD-3, TD-4, and TD-5.

Grading instruments

For grading jute fibre, the Bureau of Indian Standard recommends the hand and eye method as well as the instrument method. Only hand and eye grading was recommended until 1986. With the development of mechanical instruments, such as a bundle strength/tensile strength tester, an air flow fineness meter, and a colour and luster meter, the Instrumental method of grading of jute fibre was first published in IS: 7032 (1986) (Parts 1 to 8) for objective analysis of fibre. The comparison between hand and eye method and instrumental method of grading is summarized in Table 1. In the hand and eye method of grading, the grader assesses the fibre based on his/her experience and assigns the grade arbitrary. This method is fast and most prevalent even today in most the procurement centres. Organoleptic grading is biased and non-scientific, denying farmers the appropriate price for their produce. In contrast, the instrumental grading method measures grading parameters of the fibre with instruments. Among five parameters recommended by IS: 271 (2020), three parameters i.e., strength, fineness and colour of fibre are measured by a bundle strength/tensile strength tester, an air flow fineness meter, and a colour and luster meter and the rest, such as root content and defects, is assessed subjectively. It has been reported that digital instruments reading are more accurate than hand and eye method tested readings. As result, farmers will definitely obtain an appropriate price for their produce if instrumental grading is used at procurement centers.

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Table 1. Comparison of hand and eye and instrumental method of grading

Hand and eye method	Instrumentation method
Assessment is subjective	Assessment is objective
Faster	Slightly slower
Grading can be a biased	No/less human error and unbiased
Final grade is arbitrary	Grade determination is more accurate
Farmers may deprived to get appropriate price of jute due to arbitrary grading	Farmers will obtain appropriate price

industries' Research association) have developed some mechanical instruments like bundle strength tester/tensile strength tester, air flow fineness meter and colour meter for instrumental grading of fibre. Sample preparation time and manual calculation are major drawbacks of these instruments. A new generation of digital instruments is developed to overcome the limitations of mechanical instruments.

Digital grading instruments

Bundle strength of fibre: Strength is the measure of the load, the fibre can withstand before it breaks. There are three instruments based on constant rate of loading, constant rate of elongation and constant rate of traverse were recommended by BIS for measuring bundle strength of fibre. Automatic electronic fibre bundle strength tester for jute comprised DC motor, jaws and clamp holder and S-type load cell. There are two clamp holders, one is attached to load cell and other is moveable connected to DC motor through linkage. Inorder to apply constant load on to fibre, instrument has DC motor with linkage to convert rotary to back and forth motion of fibre holder motion. Apart from tenacity, instrument also provides breaking load (kg), elongation during breaking. Instrument readings are compared with traditional bundle strength tester and found a good correlation. Furthermore, time taken to ascertain bundle strength less than semiautomatic bundle strength tester and mechanical instrument.



Automatic bundle strength tester

Fineness of fibre: The fineness is the measure of the diameter or weight per unit length of fibre filament. It is expressed in terms of Tex. Digital fineness meter works on the principle of airflow method has been developed to measure the fineness of fibre. The instrument is comprised of air pump, reservoir, pressure sensors and cylindrical plug cell. The results indicated that good correlation between mechanical air flow fineness and digital air flow fineness. The main advantage is rapid measurement, reduces the human error which is inevitable in mechanical instrument while maintaining pressure difference. Besides being used for jute, it can be used for other fibres with varying pressure difference and weight of sample.

Colour: Colour is the property



Digital fineness meter

of a fibre, which distinguishes its appearance as redness, yellowness, greyness etc. It consists of incandescent light source, sensor, display and wooden platform to place the sample. In this instrument, incandescent source of light and



Digital colour and luster meter

photodiode sensor are used to accept the reflected light from the sample under test. The digital colour and luster meter has good correlation with mechanical colour meter.

Way forward

The digital instruments demonstrated promising performance characteristics, indicating their potential for rapid and accurate assessment of fibre quality. The current standard recommended by BIS includes both grading methods. However, the hand and eye method is preferred due to its simplicity and faster process, especially when digital instruments are scarce. To ensure unbiased grading, BIS should enforce the use of instrument-based grading exclusively. In addition, BIS should consider reducing the number of samples required for testing jute fibre, as the current preparation process is time-consuming. Researchers and instrument developers should focus on creating user-friendly, fast, accurate, and convenient instruments to measure grading parameters.

Artificial intelligence has become crucial in detecting, identifying, and measuring objects, including jute fibre and fabric defects, using machine learning and deep learning techniques. This demonstrates the feasibility of using AI-powered tools for jute grading as well. Researchers should concentrate on developing integrated instruments capable of measuring all parameters for jute grading. Exploring the possibility of mobile/scanner gadgets/tools using image machine learning alongside a few mechanical setups, like bundle strength measurement, could offer a comprehensive solution. The main focus should be on providing these instruments to farmers rather than industrial players, as farmers are essential in maintaining the quality of jute. Hands-on training and demonstrations can familiarize farmers with the quality of jute fibre based on their testing experience.

SUMMARY

The traditional organoleptic and visual method of jute assessment has certain drawbacks, including bias and lack of scientific basis. In order to achieve a more objective assessment of jute fibre, digital grading instruments have been developed and are currently in use. The method of grading using digital instruments provides a more scientific and objective approach. Additionally, these instruments significantly reduce the time required for fibre assessment compared to mechanical instruments. By employing instrumental grading at procurement centers, farmers can obtain a fair price for their produce due to the fast and accurate readings provided by these instruments.

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