# Longer not stiffer

## Targeting jute fibre quality

*Jute is a phloem bast fibre crop grown for its fibres that are used in the manufacture of various goods. Due to its cheapness and biodegradable nature, jute is now in greater demand than other natural fibres. However, the fibre is short, making it hard to produce some jute products; moreover, the fibre is also stiffer than other plant fibres, due to its high content of cellular lignin. Efforts are now under way by the Basic and Applied Research on Jute (BARJ) Project at the Bangladesh Jute Research Institute under the leadership of Professor Maqsudul Alam, to identify genes affecting phloem fibre development that allow breeding of jute plants with higher quality fibre.*

Jute is grown in Bangladesh where it is used for the manufacturing of various fibre-based goods. The fibres are derived from the stem of the plant in the vascular phloem tissues. Jute fibres are used as a model to study fibre development in plants. The fibres of this plant are generally short compared with other plant fibres, and also contain more cellular lignin, making them stiffer. From an economical point of view, having longer jute fibres that are less stiff would enable better and more diverse jute products to be manufactured. At the Bangladesh Jute Research Institute, the Basic and Applied Research on Jute (BARJ) Project team have explored the jute genome to identify a specific family of genes that regulate fibre cell development in jute. This provides new targets to improve the quality of jute fibres for use in the textile industry.


Jute is an important cash crop in Bangladesh.

### THE FABRIC OF FIBRE

A fibre is a thread or filament from a natural or artificial source. In plants, a fibre is considered an individual cell. These vary in type and location, such as within or outside the vascular xylem tissues. In bast fibre plants such as jute, fibres are from vascular phloem tissues. The vascular system of a plant provides structural support and also acts like a plumbing system, allowing the transport of water, minerals and food (that the plant produces) across the plant. In this way, xylem transports water from the roots all the way to the top of a tall tree, and phloem transports the food made in the leaves to various parts of the plant that require it.

The vascular tissues are comprised of a specific type of cells called sclerenchyma cells that make these tissues tough, thereby enabling their supporting and conducting functions. Sclerenchyma cells are elongated with tapering ends and have thick cell walls full of lignin (a polymer). The function of the cell wall is to offer shape and protection to the plant cell. Cell walls are made up of several chemical compounds, including carbohydrates such as cellulose, hemicellulose and pectin. Cell walls can be primary, which are thin, flexible, and formed during cell growth; in contrast, secondary cell walls are formed inside the primary cell wall once the cell has stopped growing. Secondary cell walls strengthen the primary cell wall, offering more protection; this is because it is made up of lignin, which is embedded with the other chemical constituents of the cell wall.


Jute is used for the manufacturing of various fibre-based goods.

Phloem bast fibres in jute are sclerenchyma cells that grow and develop secondary cell walls to produce the mature, tough fibres containing lignin. This formation of the secondary cell wall with deposition of lignin determines the quality of the jute fibre. The mature fibre cell contains cellulose, hemicellulose and lignin, but it is the lignin that determines how stiff the fibre becomes. In addition, the growth of the cell also determines how long the fibre will be. Jute fibres are the shortest, compared with other fibre crops such as flax and cotton. By studying the fibre initiation process in detail, scientists can understand how the length and strength of the fibre are controlled. This involves understanding the functions of genes that control fibre development.

### GENES TO FIBRES

Along with carbohydrates, the structure of cell walls also contains numerous proteins that are required for proper functioning of the cell wall. This allows the growth of the cell and also offers protection from the environment. Proteins are synthesised in a cell via their genetic codes in the DNA. In any living organism, DNA contains genes, which are sequences of chemicals arranged in a specific manner. These instructions in the gene are used by the cell to make a "message" (messenger RNA) which is then translated to make a protein (made of chemicals called amino acids). Therefore, in order to understand the role of various proteins in a cell, it is important to identify the genes that encode these proteins.

A family of proteins that function in cell wall structure and development are arabinogalactans, that are divided into various classes. Fasciclin-like arabinogalactan proteins (FLA) are present in the cell walls of numerous plant species. FLAs function to mediate cell-cell adhesion and binding of proteins to the cell surface, thereby enabling communication between cells. FLAs have also been shown to regulate cell wall development, and also cell length in some species. Fibre cell length is an important property regulating jute fibre quality; therefore, identifying

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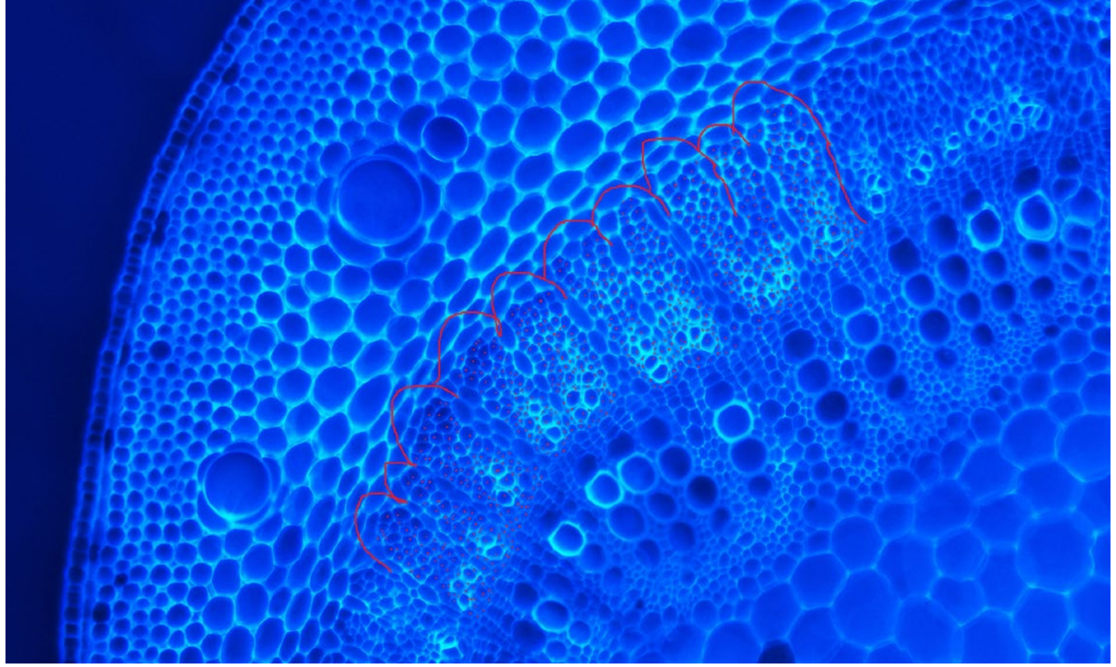

The Basic and Applied Research on Jute (BARJ) Project at Bangladesh Jute Research Institute is identifying genes affecting phloem fibre development that allow breeding of jute plants with higher quality fibre.

genes that encode FLA proteins present in fibres is an important priority.

**FERRETING FOR FLAS**

In an attempt to identify genes regulating phloem fibre development in jute, The Bangladesh Jute Research Institute team have recently searched the jute genome for *FLA* genes. The jute genome (entire genetic content) has recently been sequenced, thereby uncovering the DNA sequences of numerous genes. However, the identities of these genes are being determined. Using online tools and databases to compare genomes of various species, the scientists hunted for jute genes similar to previously identified *FLA* genes from other plant species. The authors identified 19 jute *FLA* genes; some of the encoded proteins were identified to possess regions of amino acids conserved across other FLAs. Further experiments to study *FLA* gene expression showed that these genes were expressed (i.e. produced mRNA) at different stages of fibre development, suggesting their involvement in this process. In particular, the expression of some genes correlated with fibre cell elongation and some correlated with secondary cell wall formation, when lignin deposition occurs.

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Jute vegetable fibre.

**Their work will enable targeted breeding of jute varieties for longer, not stiffer fibres.**

The authors' findings have laid the foundation for further work to identify the function of different FLAs in jute phloem fibre development. This will enable targeted breeding of jute varieties for longer, not stiffer fibres.

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## Research Objectives

Identification and characterisation of fasciclin-like arabinogalactan genes from the jute genome that regulate bast fibre cell development in jute. This provides the foundation for understanding functional roles in bast fibre development and may help to identify candidate genes to select for in the breeding programme of jute variety development.

## References


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## Personal Response

***Is FLA the sole determinant of fibre quality, or are there other proteins that might be necessary for longer, softer fibres?***

" Like other phenotypic characteristics, jute fibre quality is not only dependent on FLA. It is also associated with other proteins such as expansins, pectin methylesterase (PME), pectin methylesterase inhibitor (PMEI), and GA oxidase. Transcription factors such as Myb, and No Apical Meristem (NAC) are also involved in fibre elongation steps. However, FLA protein plays an important role in fibre elongation, especially FLA11 and 12 which have the ability to expand fibre length by modifying stem biomechanics. "

***What is the timeline for generating jute with better fibre quality once a target gene has been identified?***

" Fibre quality is not controlled by a single gene, it's polygenic in nature. Selecting target genes for developing jute with a higher quality fibre is challenging and time consuming. After identifying the target gene, the regulation of the target gene will be modified using a molecular cloning approach for developing transgenic jute. Next, screening of transgenic jute plants using antibiotic selection, followed by PCR. The quality of fibre will need to be compared with existing varieties. In addition, other negative effects will also be examined. Finally, the screening will continue over 6–7 generations to yield the desired trait. Therefore, it will take 7–8 years to produce jute with better fibre quality after finding the target gene. "


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