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How Colourful is the Future of Naturally Coloured Cotton?

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The views expressed in this column are his own and not that of Cotton Association of India)

Naturally coloured cotton has a history of more than 5,000 years in India, Egypt and South America. The natural cotton fibre colours range widely from dark tan, brown, khaki, grey and green. In Asia, Desi coloured cotton stocks of Gossypium arboreum were cultivated by the Aryans of Mohenjodaro and Harappa from 3000 BC in Indo-Pak region. In the American continent, the Mochica Indians of Peru and natives of South and Central America were known to have created several pre-columbian stocks of the American cotton species Gossypium hirsutum coloured cotton. Later coloured cotton fibres were grown for centuries in Asia, China and Russia.

EXPERT's Column

In current times, there is negligible area under coloured cotton varieties in India and elsewhere in the world. However, there has been an infrequent resurgence of interest, mostly through environment oriented passion. Over the past 3-4 years, concerns have been raised in the Indian parliament highlighting the need to promote research and development of naturally coloured cotton varieties in India.

There are many questions on coloured cotton, but the answers are not easy. Why do we need coloured cotton? Is there a real need with an ecological perspective or environmental consonance? Or, is it a just a fanciful idea of a few individuals who are somehow inclined to believe that the petrochemical based civilization is not sustainable for mankind? Is it worth investing in research to develop naturally coloured cotton varieties suitable for high speed yarn spinning? Will there be takers? Will there be an assured market? Can we cultivate such varieties all over the country without having to worry about contamination of white cotton? Though difficult, I will attempt to address these questions in this article.

What makes the cotton fibre coloured? Brown, grey and tan are due to tannin and phenolics present as vaculoles in the fibre lumen. Green fibre is due to the presence of caffeic acid and cinnamic acid present in wax layers interspersed with cellulose layers that envelope the cotton fibres. The flavonoids responsible for the lint colour are governed by genes at three loci, LCI, LC2, and LC3 and control more than one trait (pleiotropic). It is now known that dominant or incompletely dominant genes govern inheritance of natural lint colour. The green colour is governed by one gene while brown colour is controlled by two or more genes. It has been reported that some of these genes adversely affect fibre development or length or fineness. Cotton fibres inside

developing bolls are white until the first one month of boll development. Subsequently colour develops in the fibre during the next 10 days. The fibres assume colour just before boll bursting with gradual accumulation of colour in the lumen for brown shades and around the lint for green. The boll colour intensifies within 6-7 days of exposure to sunlight after boll bursting. The pigments in naturally coloured cotton fibres, especially caffeic acid in green fibres are presumed to protect the seed embryo from harmful solar UV radiation. The fabric produced from coloured cotton fibres was found to show high levels of ultraviolet protection factor (UPF) with excellent properties to protect the skin from harmful UV rays. The natural colours are steadfast and become darker over time after repeated washings. The colours were also found to intensify in some fabrics under sunlight, while shades such as green are known to fade or change to light brown or gray after exposure to sunlight or strong detergents.

With the advent of Industrial revolution, there was demand for long and strong fibres suitable for machine spinning. Since the coloured cotton fibres were mostly of short staple category with low strength, their future dwindled in comparison with the white cotton fibres. Due to shortage in demand, the coloured cotton stocks were neglected and remained poor yielders. White fibre cotton varieties were in high demand because of the myriad possibilities to create fabrics and apparel in various hues and designs using chemical dyes. The interest in naturally coloured cotton resurfaced during the Second World War when chemical dyes were in short supply. During the time of World War-II, the Soviet Union initiated and intensified research on the development of brown and green coloured cotton varieties. Within a few years several varieties were being grown in various parts of the USSR. Later, many countries including China, India and the United States of America re-initiated efforts to explore the possibilities of cultivating coloured cotton varieties. However, due to centuries of neglect, almost all of the genetic stocks of colored cotton continued to remain poor yielders and thus were found unsuitable and unprofitable.

However blends of short staple coloured cotton fibres with long staple stronger white fibres have been used in many parts of the world to spin yarn of lighter shades. Patented technologies such as staple-core and filament-core spinning,

Photographs: Vinita Gotmare

are now used to produce composite yarns to envelope long and strong white fibres with an outer layer of naturally colored fibre. The yarn thus produced is strong but retains the natural coloured fibre as the outer core without resulting in a lighter shade as with twisted fibres in yarn produced from machine spinning.

Coloured cotton fibres received a fresh leash of life when thirty years ago, Sally Fox, a graduate entomologist developed several long and strong coloured cotton fibres patented as Fox Fiber of different shades. Sally Fox started a company 'Natural Cotton Colors Inc. in 1989 that generated renewed consumer interest and revived the fate of coloured fibres.

Interestingly, for more than 5,000 years natural dyes were also used to colour yarn. The main sources of natural dyes were from insects, fungi, lichens or plant parts such as leaves, wood, bark, roots, fruits and seeds. Some of the most extensively used sources were cochineal insects, indigo, Isatis, logwood, mulberry, butternut, henna, Acasia, saffron and madder.

There were several land races of the native Desi species Gossypium arboreum coloured cotton in India that were cultivated as a perennial trees over centuries. The legendary Dhaka muslins were also known to have been spun from white and coloured lint from the indigenous tree species. During the British period and early years of independent India, the Desi species of tree cotton varieties Cocanada 1 and Cokanada 2 were grown in rainfed parts of coastal Andhra Pradesh and the brown fibre was exported to Japan at premium prices. Buff brown coloured cotton of the Desi species Gossypium arboreum race cernuum in Assam and the light grey coloured 'Kumta' of Gossypium herbaceum species in Karnataka were under cultivation for several decades in the 19th and 20th century.

Some of the attempts in recent times resulted in the development of coloured cotton varieties of the species Gossypium hirsutum, of medium staple with high yields, moderate fibre strength and thus suitable for machine spinning. The variety JCC 1 (KC 94-2) was released in 1999 by the Jawaharlal Nehru Krishi Vidyapeeth for commercial cultivation. It showed yield potential of 15-20 q./ha and spun at 30 counts to produce bright almond brown colour. The Nandyal cotton research station of ANGRAU (Acharya NG Ranga Agricultural University, Hyderabad) developed NDLH 1, HC 2 in Gossypium hirsutum and AC 2 in Gossypium arboreum, with shades of brown. The University of Agricultural Sciences (UAS), Dharwad, released a G. arboreum variety DDCC-1 (Dharwad desi colour cotton-1). The variety produces good quality spinnable coloured fibre. A few other new cultures were identified by the University. DDB 12 with dark brown lint of 22.0 mm length and 22.0 g/tex strength has high yield potential of 25 to 26 q.ha. The medium brown lint variety DMB 225 has a staple length of 22.8 mm and strength of 20.6 g/tex. The green lint variety DGC 78 has staple length of 24.3 mm, fibre strength of 20.4 g/tex and has yield potential of 13-15 q/ha. Recently, CICR registered a new genotype MSH-53 (Vaidehi-95 - Dark Brown Linted - INGR13032) a multi-species hybrid introgressed reverted tetraploid genetic stock with fibre span length (20.8mm), fibre strength (17.2 g/tex) and micronaire value (4.1) with NBPGR in 2013.

There are more than 50 coloured cotton genetic stocks in the National gene bank of the Central Institute for Cotton Research, Nagpur that were collected indigenously or obtained from other countries such as Mexico, Egypt, Peru, Israel, Soviet and USA. Interestingly, the Desi species of coloured cotton genetic stocks (SP 3936(A), Light Brown, Malvensis, 7869 Brown and Khaki colour 8631) show good fibre traits

Photographs: Vinita Gotmare

of 20.2 to 24.0 mm fibrer length, fibre strength of 17.1 to 19.0 g/tex and good ginning percentage of 36-38%. In contrast, 10 out of the 13 main coloured cotton genotypes of American cotton species Gossypium hirsutum possess relatively inferior fibre traits at low strength of 12-16.9 g/tex and fiber length of 14 to 21 mm. The rest of three genotypes LC 1-1 , Cotanark (DB) and Kampala Brown had fibre length at 23-24 mm, but poor strength of 12-14 g/tex. Majority of the G. hirsutum coloured cotton genotypes showed poor ginning percentage of 19-33%.

It is also interesting that all the four cultivated species and 22 wild species possess coloured cotton lint. Brown coloured lint is present in G.aridum, G.armourianum, G.darwinii, G.mustelinum, G.anomalum, G.capitis-virdis, G.somalense, G.arboreum, G.stocksii, G.areysianum, G.incanum, G.australe, G.sturtianum while other colours are present in rest of the species. The wild species G.gossypioides, G.harknessii, G.herbaceum, G.longicalyx, G.robinsonii, G.sturtianum var nandewarense possess greyish fibre.

Should coloured cotton varieties occupy an area equivalent to that of white cotton? Can coloured cotton varieties be grown commercially in an extensive manner? The answers are difficult indeed. Currently, there is very limited demand of naturally coloured cottons in India. In the last few years, the demand of naturally coloured cotton has increased in some European countries, which is estimated to be about 5-6 lakh bales per annum. The requirement of textile industries is for the varieties which possess fibre length 25-29 mm and fibre strength 20 – 23 g/tex). A few of the recently developed varieties may be considered for the purpose as per the acceptability of the spinning mills. Coloured cotton varieties having short fibre (<24 mm) could be used by the handloom industries in collaboration with the Khadi Gram Udyog. It is clear that there is no premium price policy for coloured cotton. Plus, there is a lack of interest from purchaser groups and lack of assured market. Further, the market yards do not provide any special facilities for coloured cotton to be stocked or sold separately. Thus there is lack of isolation-infrastructure in market yards to prevent contamination of white cottons by the coloured cottons. It is necessary to develop marketing facilities before starting cultivation of coloured cotton on a commercial scale

There is a need to address the impending problem of contamination if commercial cultivation of coloured cotton has to be taken up. Cotton is an often cross-pollinated crop. In natural conditions, cross-pollination occurs to the extent of 5-10 per cent. Growing of naturally coloured cotton and white cotton in close proximity will facilitate the chances of contamination of white linted genotypes with coloured cotton and vice-versa. One argument is that with the existing scenario of 95% area under Bt-hybrid cotton in India, the coloured cotton varieties can now be cultivated in close proximity to the hybrids, since the seeds from the hybrid cotton fields are not used for sowing. Thus the possibility of genetic contamination of white cotton is no longer a concern. Another possibility of establishing a system for peaceful co-existence of white cotton with coloured cotton is to consider the cultivation of Desi species (Gossypium arboreum) of coloured cotton in proximity to American species (Gossypium hirsutum) of white cotton. Since the two are genetically incompatible, the possibilities of contamination through pollination is ruled out. Therefore with good planning, it should be possible to cultivate the white hybrid cotton adjacent to coloured cotton, only to ensure that physical mixture does not take place. Needless to emphasise that care must be ensured to avoid any physical contamination that may occur during picking, stacking, ginning, delinting, packing, transport and storage. Growing of white cotton in fields wherein coloured cotton of the same species was grown in the previous year may also lead to contamination through volunteer plants. However, wherever white cotton varieties (not to be confused with hybrids) are cultivated, coloured cotton should be cultivated with an isolation distance of 50 metres to avoid genetic contamination of white cotton and also to avoid the coloured cotton from getting contaminated with white cotton. Clearly, there is lack of proper incentives for such protective cultivation.

In conclusion, the future of naturally coloured cotton will eventually depend on how strong the market demand grows. Currently there is a limited niche market from special consumer groups who may prefer organically grown naturally coloured cotton. While naturally coloured cotton is a precious natural resource that needs to be conserved, the future would depend on how preciously and collectively we treat this precious resource.