Never Say Dye: The Story of Coloured Cotton

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While Bt cotton has been raising waves of protest in India and other parts of the world, one of its old time cousins is making a quiet come back. It is the naturally coloured cotton – yes; cotton endowed with natural colours.

Coloured cotton is not a product of any recent genetic engineering or biotechnology. In fact, biotechnology is yet to make a mark on coloured cotton. James M Vreeland, who has been researching on coloured cotton, reports in an article in *Scientific American* (April 1999) that it has a history of more than 5000 years. Several lint colours – brown, black, mahogany red, red, khaki, pink, blue, green, dirty white and, of course, white are found in the four species of the genus *Gossypium* (*Figure* 1). The species *G. barbadense* and *G. hirsutum* were being cultivated in South and Central America as early as 2300 BC (*Figure* 2). Fibre from these was mainly used for weaving fishing nets. The idea was that colour nets might not be readily seen by the fish. In the sixteenth century AD, it was a tradition to present clothes made of coloured cotton as gifts.

The other two species – *G. arboreum* and *G. herbaceum* were cultivated mainly in Asia and Africa, about 4200 years ago. Evidence for its cultivation in India has been obtained from the remains of the Indus Valley civilization. Environmentalist Kisan Mehta notes that these cultivars have been referred to in the ancient Indian book *Vriksha Ayurveda* and they are being cultivated even now by the adivasis living in Narmada Basin in Central India. In fact, up to the middle of the 20th century, coloured cotton species *Cocanada* 1 and 2 were commercially cultivated in Andhra Pradesh and being exported to Japan. Similarly, cotton with black, brown, khaki, and creamy white linted types were grown in Assam. Kumta in Karnataka was the home for *G. herbaceum* with dull white lint. Even the world

famous Dacca muslin was made from white and colour linted *G. arboreum*. White linted cotton that must have evolved in the course of centuries of directive and selective breeding by man. It was introduced in India only in the last one hundred years.

Compared with white cotton, naturally colour lints were short, coarse and weak. They were amenable only for hand spinning. However, with the advent of power looms and ginning machines after the Industrial Revolution, the scene changed. White cotton, with its soft, long and strong fibres could easily be adapted to mechanization. Further more, when chemists were able to produce inexpensively a variety of synthetic colours and learnt the techniques of dyeing cotton fibre, naturally coloured cotton slowly faded into the background. It is reported that in the Second World War, because of the shortage of synthetic dyes, the erstwhile Soviet Union cultivated coloured cotton in large quantities to produce soldiers' uniforms.

Figure 1. The four species of Gossypium. Also shown are their relative fibre lengths.
(Source: *Scientific American*, April 1999)

Figure 2. Harvesting colour cotton in South America.
(Source: *Scientific American*, April 1999)

The Revival

Thanks to the environmental consciousness of modern society, the wheel of fortune appears to have come a full round for coloured cotton. Unlike naturally coloured cotton, white cotton has to be bleached and processed before imparting colours. Many of the processing chemicals and dyes used in cotton industry are known to cause health hazards. Chlorinated products, bleaching agents, phenols, formaldehydes, which are employed for bleaching and processing, produce skin diseases. Dyes containing traces of heavy elements such as arsenic, lead, cadmium, cobalt, zinc, chromium, are also skin irritants. Children are especially sensitive to these effects. The azodyes are proven carcinogens. Processing and dyeing are also water intensive. Discharges from cotton mills pollute water resources and affect people and aquatic life. Hence, several of these chemicals have been banned in many countries. Germany bans even import of cloth dyed with azodyes. Hence, people are turning to the environment-friendly coloured cotton. However, coloured cottons are inherently inferior to white cotton in one or more aspects. Agronomically some have fewer boll number and boll weight. Economically some are low in yield, and lint index. Technically fibres may be short, weak, and coarse, and colour may not be uniform. Hence, plant breeders are trying to produce superior varieties by crossing strains with desirable qualities to make coloured cotton more attractive and machine-friendly.

The first commercial success came in 1988 when Sally Fox of Natural Cotton Colors, USA succeeded, after eight years of breeding efforts, in producing machine-spinnable coloured cotton (*Figure* 3). Her cotton – grey, yellow, orange, and even mauve are woven into shirts, jackets, sheets and socks by some major garment manufacturers.

Figure 3. Fox fibre – long stapled, machinable colour cotton bolls developed by Sally Fox.
(Source: www.foxfibre.com)

However, blue, the colour of the versatile jeans, has eluded cotton breeders. Now genetic engineering has stepped in. Two companies – Argacetus in Wisconsin and Calgene in North

California plan to insert the genes which are responsible for the production of blue colour in the indigo plant into white cotton. They expect to produce, in one shot, machine-friendly blue cotton.

Geneticists have been studying the complex inheritance pattern of colour in cotton. The lint colour is determined by a group of genes situated at three loci, LC1, LC2, and LC3. They are dominant over the white alleles and operate in association with modifier genes that are either suppressors or intensifiers. In the presence of strong suppressors, white lint is produced. Often, the genes for lint colour are found to be pleiotropic, i.e., they control more than one trait. This has been the most important problem in the development of economically and technically superior coloured cotton. For example, the gene for brown colour in *G.arboreum* and *G.barbadense* suppresses lint length and its fineness. Similarly, green and brown lints in *G.hirsutum* inhibit fibre development. Generally, all colour genotypes have fibre qualities far below the white variety. However, not all associations are unfavorable. The varieties *Hirsutum tashkent* (brown) and *Arkansas green* have high boll weight. In addition, colour development is also influenced by many environmental factors, especially sunlight, soil nutrition, and soil type. Scientists at Dharwad have been studying the time and mechanism of colour formation. Their studies indicate that colour development in the fibre occurs between 30 and 40 days after boll formation. Until 30 days of boll formation, the fibre was white. The 40 days old bolls showed colour fibre. Solvent extraction experiments have shown that the pigment may belong to the flavonoide group. The basic aspects of gene action, their linkages with other attributes, and interaction with environmental parameters in colour production have all to be critically studied from a technical angle.

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Scientists at CICR laboratories and Cotton Research Station at Khandwa in MP, University of Agricultural Sciences at Dharwad, Karnataka and Panjabrao Krishi Vidyapeeth, Akola, Maharashtra are investigating the agronomic, economic, and technical attributes of these strains for suitable hybrid production.

Figure 4. Colour hybrids produced at the CICR Regional Station, Coimbatore by crossing naturally colour strain Gossypium hirsutum L with white linted strains. The hybrid not only retained the colour but also was also superior to the colour parent in fibre qualities.
(Photograph courtesy: V T Sundaramurthy).

For example, scientists of CICR laboratory at Coimbatore, Tamilnadu, have crossed the colour strain *G. hirsutum L* with white linted strain to produce colour hybrids with qualities such as fibre length, strength, and colour fastness better than the colour parent (*Figure* 4). These have been found capable of spinning up to 40 counts, comparable to many popular white varieties. Similarly, studies at Khandwa and Dharwad have resulted in the identification of half-a-dozen cultures with desirable properties such as moderate resistance to pests, large boll size, and good fibre qualities with shades of brown and green. Some 'Dharwad colour cotton' bolls are shown in *Figure* 5. Samples of fabrics and

Figure 5 (left). Various colour cotton bolls developed by the UAS, Dharwad, India. At the centre is white cotton.
Figure 6 (right). Fabric and dresses with mixtures of white and naturally brown of consumer preference.

In India, coloured cotton can be cultivated in Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra and Orissa. Khadi and Village Industries Commission have experimented producing dress material using coloured cotton.

dresses produced by mixing white and brown cotton are shown in *Figure* 6.

Two of the most important consumer acceptance parameters are stability and fastness of the colours to the various processes of washing, bleaching, etc. Extensive cleansing experiments conducted by scientists at Coimbatore and Dharwad have shown that treatments such as soaking, washing with hot water and detergents increased the intensity of colour with the number of washes up to 10 and remained constant thereafter. The increase in colour intensity also depended upon, among other parameters, the alkalinity of the detergent. Greater the pH, higher the intensity of colour.

The movement for naturally coloured cotton has just started. It has a long way to go. Vreeland estimates that there are 15,000 Peruvian farmers who are engaged in the cultivation of organic cotton, of which coloured cotton is a part. It is also cultivated in smallholdings in USA, China, Russia, and Israel. A few companies, for example Patagonia, Levi Strauss and Esprit have shown interest to produce clothes from coloured cotton fibres, particularly children's clothes and fancy fabrics. In Peru it is marketed under the name 'Puckacho' (meaning brown cotton) to produce daily wares. Israel has been growing green and fawn brown cotton since 1995 for blending with white cotton to produce different shades.

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However, during 1993, out of a total of 19.3 million tons of

cotton grown globally, the share of organic cotton, which included coloured cotton, was only about 6000 tons. The International Cotton Advisory Committee expects that by the year 2001 at least ten per cent of the cotton grown would be organic and of which, one-tenth would be the colour variety. India ranks third in the world in cotton production. The CICR has set up a target of 5000 to 10,000 bales of coloured cotton out of an annual total output of 1.5 million bales.

What are the problems of commercial cultivation of coloured cotton? As mentioned earlier, they are generally inferior to white in one or more aspects. Furthermore, the yield is low, about half that of white cotton (but this may be compensated by a higher price in the international market), and they are susceptible to certain types of pests. When cultivated in large areas, natural cross-pollination may occur from white linted to colour and vice-versa. Hence, isolation distance of the order of 50 meters or more may be required between varieties. Contamination may also occur during harvesting, transportation, ginning, pressing, and spinning. Since white cotton is still a major agricultural produce, its contamination with colour lint may have disastrous effects on agricultural economy. Hence, the Cotton Corporation of India has suggested certain policies and legislative measures for safe and profitable cultivation of coloured cotton. These, along with the application of biotechnology and modern farming techniques may give the much-needed boost to revive this gift of nature.

Suggested Reading

[1] James M Vreeland, Revival of Coloured Cotton, *Scientific American*, April 1999.

[2] *Journal of the Indian Society for Cotton Improvement*, Vol.21, No.2, September 1996; *Special Issue-National Seminar on Eco-Friendly Cotton*, June 1996.

[3] V T Sundaramurthy and others, *The Indian Textile Journal*, pp.126-128, October 1994.

[4] Sally Fox website: www.foxfibre.com

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