Chapter 1
Introduction

One of the oldest industries in Indian economy dating back to several centuries is the Textile sector. Even today the largest contributor to the total export of India is the Textile sector. The unorganized sector of textile industries like the handloom, handicrafts, and seri-culture are operating on small scale to preserve the traditional skills and the conventional processing methods. This industry is closely linked with agriculture. The raw material, such as cotton, silk, other minor less important natural fibers like banana, pineapple, and bamboo, along with ancient culture and tradition of the country is connective with the textile industry that makes India very unique.

The universe has been blessed with splendid natural environment, which make human survival possible. The utility of this wonderful resource lies in the hands of the mankind. Most of nature’s wealth is being explored and utilized by man for centuries. But a lot more is yet to be tapped and discovered.

The utilization of the waste Bio-Mass is to create value added products will solve the environmental issues in the current scenario. The disposal of Bio-Mass waste in Agriculture can be re-cycled to produce eco-friendly products. ‘Eco-friendly’ refers to a friendly relationship between human and their habitats. In other words, human’s taking good care of the environment in which they live (Bajwa and Chawla, 2011).

Eco-textiles can be produced by keeping in mind the environmental and social compatibility in the production of textile process from fiber to fabric. Disposable waste must be given importance to deal with environmental issues. Creating awareness and exploring techniques to use the disposed material will solve many problems. Innovative thinking in handling the agricultural bio-mass waste to convert into value added products will be appreciated. Products created in such a manner will not only be eco-friendly, but also have an aesthetic performance characteristics and least possible environmental impact.

Environmental acceptability in textile products generally falls into one of the two categories. The first is that the product does not harm the user or harm the environmental impact on the manufacturing processes involved in making the product and can cover the whole life cycle of the product from cradle to grave (Bide, 2007). Sustainability in textiles refers to the use and refinement of environmental friendly methods to produce fabrics,
which means establishing practices that conserve energy and natural resources and minimize negative impact on environmental, economic and social effects (Mercer and Tyndall, 2014).

Environmentally sensitive behavior like conserving natural resources is a good indicator to influence to purchase apparel products, manufactured from disposed of waste materials. Retailers and marketers might need to encourage students to be aware of the importance of recycling of natural or synthetic disposed products and to encourage them the eminence of such objectives. Marketers in the fashion industry need to consider college students’ environmental concerns over environmental issues such as conservation of natural-resources, when confronted by the decision on marketing for apparels made from recycled resources. and conserving natural resources behaviors when they make marketing decisions for environmentally-friendly apparel products. The apparel marketers also need to develop creative marketing strategies for the eco-friendly apparel products to persuade the fashion- conscious consumers (Lee, 2011).

With the increasing standard of living, the demands of people in all areas are increasing, as well as the requirements regarding new textile materials with new or improved properties, such as the quality and comfort or for industrial use. The environmental requirements when developing new fibers is nowadays higher than before (Dubrovski, 2010).

Awareness on the environment and ecological movement has been started among the educational institutions, the media, and fashion industry. Consequently, the consumer is conscious of the environment.

The most enterprising sector contributing to protect mankind looks back to nature for aesthetic innovation of textiles. The bio-degradable natural fibers are gaining importance in the above aspect. The use of less important fibers like Jute, Banana, Pineapple, Bamboo, etc. in textiles is creating aesthetic fabric is getting popular.

Farmers around the world produce effectively huge quantities of banana and the plantations are in different agricultural system. This represents the farmer’s ingenuity, experimentation, and tradition depending on the soil conditions. This shows the economic opportunities of the banana cultivation, which is a major source of employment, currency and the most viable crop in terms of agronomic, lucrative and social terms.

Statistics from National Horticultural Board, data Base, have shown that India ranks No. 1, in the world in the production of Bananas. Tamilnadu provides nine million
tons, out of 29.7 million tons of overall production in the year 2014 in India. Areas cultivating bananas in Tamilnadu, are Theni, Trichy, Erode, Thoothukudi, Coimbatore, Kanyakumari, Thanjavur and Dindigul Districts. The varieties cultivated are Grand Nine (Robusta), Red Banana, Virupakshi, and Rasthali. Nendran is also cultivated in Tamilnadu in certain pockets of Kanyakumari and Coimbatore Districts prominently.

The banana crop has been domesticated, and this has given rise to hundreds of varieties that is being cultivated all over the world. The Indian banana shares unique characters in their appearance, flavor and on medicinal values. A systematic survey and documentation to create database should be conducted regularly by the Researchers to bring forth the niche quality of Indian bananas and preserve the genetic wealth. The utilization of the Banana Fibers in textiles is not a new concept. In a particular version of the Epic "Ramayana" from a Tamil magazine wherein 'Sita' after being abducted by Ravana needed to change her clothes and asked Hanuman for help, who wove her saree out of Banana fiber.

The banana fiber cloth was already being made around 13th century, but it was much later that it became popular. In old days, the banana trees were planted in gardens and fields, and the women fold of a family wove it into fabric for home use. Silk and cotton became much more readily available during the 19th century, but people still enjoyed wearing banana fiber cloth. ‘Kigoka’ banana fiber cloth which carries on these traditions was designated as a cultural property by the perfection in 1972 and two years later in 1974 it was made an important intangible cultural property by the nation.


Bananas are inseparable from our heritage and culture and therefore, have been accepted as the symbol of prosperity and fertility, and nurtured within the sacred precincts. In addition they have noteworthy socio-economic significance owing to its multi-faceted uses for the benefit of mankind and thus rightly referred to as “Kalpatharu” (a plant of all virtues).

• Banana plant can be grown from the poorest to the richest type of soil with varying success.
• Banana can be planted throughout the year, except in severe winter and heavy rainfall when the soil remains very wet. Unlike other vegetative growths, the flowering and fruit growth is not seasonal in Banana and are influenced by the time, type, number of plants and the temperature.

• Numerous studies all over the world have revealed that the banana fruit has a significant property to be used as medicine to reduce the risk of Colo-rectal cancer, breast cancer, and renal cell carcinoma in women.

• In the banana cultivation, the crop rotation can be done. “Crop Rotation is growing two or more crops one after the other in the same piece of land.”. This type of farming can increase the income, the quantity of bio-mass waste generation. This also improves the soil structure, soil fertility, and the organic matter content. Banana may be rotated with Paddy, Sugarcane, Pulses, and vegetables.

   Banana inter-cropping is remunerative and farmers with minimum land resources traditionally inter-crop to minimize the risk associated with single crop to ensure a stable income. Bananas are grown by small and marginal farmers, who have holdings less than a hectare.

   The banana tree is actually the largest herbaceous flowering plant throughout the world, which on an average is 6 to 7.6 meters tall. This is a lot more this humble fruit than meets the eye. This starch-rich fruit doubles as a meal many a time.

   The banana plant is a native of South Asia, growing in over 100 tropical countries. The bast plant fiber from the pseudo stem of the banana plant is gaining momentum in the recent past due to its versatile application. The fiber is degradable, renewable and has good compatibility with other natural cellulose fibers. Among many varieties, Red Banana (Musa acuminata Red Dacca), The Nendran (French plaintain AAB), Robusta (Green Banana) (green Musa acuminata Cavendish), have favorable textile qualities. These fibers can be mixed together with cotton to form a blended fabric, to be used throughout in the textile industry. Systematic surveys, documentation and creation of preliminary data will provide information for the future use research on the pseudo stem fiber.

   India has the largest cotton area in the world with about 96 lakhs (1 lakh =100,000= 10^5 ) or 9.6 million hectares under cultivation accounting for one-fourth of the
global cotton area. It contributes to 16% of the global cotton produce and has emerged as the world’s second largest cotton producer in 2006-07 (James 2008).

Cotton is a natural fiber popular for its comfort and durability (Shanthi and Krishnabai, 2010). Cotton is the backbone of the world’s textile trade. It is also known as “King of fiber” and “White gold”. Cotton is a soft white fibrous substance covering seeds of certain plants. Cotton grows in a form known as a boll around the seeds of the cotton plant, a shrub native to tropical and subtropical regions around the world, including America, India and Africa. The English name, which began to be used circa 1400, derives from the Arabic ‘qutun’ meaning cotton (Rastogi, 2009).

Cotton is a non-allergenic natural fiber that doesn’t irritate sensitive skin. Softness makes it a preferred fabric for underwear and other garments worn close to the skin, and adaptability allows it to blend easily with most of the other fibres. Cotton is one of the easiest fabrics to dye due to its whiteness in color and absorbency. It has a high absorbency rate and holds up to 27 times its own weight in water and becomes stronger when wet. Its strength and absorbency make it an ideal fabric for medical and personal hygiene products such as bandages and swabs. Cotton breathes easily as a result of its unique fiber structure (mytextilenotes.blogspot.in). Handloom industry is being the sector of concern and needs more encouragement from the consumer as well as the Government. The industry is the largest provider of employment and also one of the pillars of Indian culture and tradition, the handlooms have a special recognition in the International arena for their uniqueness. The quality of the fiber produced through handloom has its own charm and comfort to be preferred by all. The ancient art of weaving and the traditional textiles are slowly vanishing.

The industry is facing problems in the procurement of raw-materials, high prices, marketing strategies, and lack of guidance from the fashion industry. Most of the handlooms are situated in the rural areas, and this is the difficulty in reaching them. It is high time, to take action to revive this dying industry by the consumers and also by Government, and the researchers, can contribute to revert this situation, through their innovations, and finding the potential of untapped resources in nature, to the handloom industry.

A rich holistic concept ‘Khadi’ conceived by the Father of our Nation, Mahatma Gandhi was the backbone of our tradition over the past. “KHADI” means using hand spun yarn and hand woven natural fibers on the loom with the use of the “Chakra” which is the symbol our National Flag. This concept was slowly killed with the Western
technology and the discovery of synthetic fibers. Thanks to the present Government (2017), for taking sincere efforts in reviving this concept of “KHADI,” that offers opportunities for the researchers to contribute to this industry to preserve our tradition and culture, consequently, contributing to the Indian Economy.

The textile processing industry plays a major role in the environmental pollution. It is time to research on eco-friendly processes to pay the way for the use of enzymes. A lot of research since 1990s has been done on reactions catalyzed by Enzymes that are relevant to textile industry. Enzymes can replace some of the chemicals used for desizing, scouring and bleaching.

Enzymes are a type of protein that mediates and speeds the rate of a specific bio-chemical reaction and their application might replace the traditional chemicals and wet textile processing. They are gaining an increasingly important role in the textile pre-treatments and finishing processes, by operating better in ambient pressure, mild temperatures and often on neutral pH. At present, they are used in several bio-scouring and bio-polishing Industrial operations.

Processes for natural fiber based fabrics has been developed using Enzymes technology for the degradation of starch after weaving, the scouring of cotton fabric before dyeing, the removal of excess hydrogen peroxide before dyeing, modification of cotton fabric (finishing or polishing), production of Lyocell fabric, ageing of denim, modification of wool, degumming of silk and for the treatment of water effluent from textile production mills. The application of enzyme technology is very specifically targeted to a component (substrate) present in the fiber. (H.B.M. Lenting. (2003).

Besides its effectiveness, enzyme technology is preferred for its environmentally friendly character since no hazardous chemicals are used, unlike the situation in chemical processes, and the enzyme itself is also fully biodegradable. Owing to the ongoing integration of enzyme technology in an already large, and still increasing, number of partial processes, the textile production industry is shifting from a notoriously polluting industry to a cleaner one. Additionally, the textile area has been recognized as innovative. (H.B.M. Lenting, 2003).

Desizing is a process of removing the starch applied during the weaving process. The use of enzymes for desizing was introduced many years ago. The enzyme used for this purpose is mainly of bacterial origin.
Bio-scouring is a process of removal of impurities in the fabric, which is one of the areas where research has been carried intensively, and commercial products have been created. The major advantage in this process is saving of water, energy consumption and is carried out at a milder pH values and at a low temperatures, which does not damage the fabric when compared to the conventional processes, in which high temperature has to be used.

Bio-polishing is a biological process (Mojsov 2014a; Mojsov 2014b;) which employs the same Cellulase action on the surface of the cellulosic materials, where it can be carried out at any stage of wet treatment, but for most part after bleaching. Cellulase is the most popular and versatile enzyme used in textile wet processing for bio-preparation, bio-polishing, and softening of cellulosic fibers (Hebeish et al. 2013; El-Sayed et al. 2010).

The enzymes used in the pre-treatment of natural fibers are amylases, cellulases, pectinases, and proteases. The combination of eco-friendly pre-treatments with enzymes and the use of cotton and banana fibers would create excellent 'eco-green' textiles.

The dyeing industry is another area which pollutes the environment and needs attention. The use of synthetic dye and chemicals in dyeing industry should be soon replaced by natural and eco-friendly chemicals.

Color is one of the elements of nature that made the humans living more aesthetic and fascinating in the world. They are supposed to be associated with emotional qualities, season’s festivals and passion in life. In the past at dawn of civilization the people tried to ornament their surroundings similar to that of color observed in the plant soil, sky and other sources. This gave birth to a new science of colors from natural origin (Sekar, 1999).

The art of dyeing was as old as human civilization. From the historical records, it is learnt that natural colorants were available to people during Greco-Roman periods. Use of vegetable products for textile coloring at the commercial level is to an extent a virgin area nearly seven years ago. In recent years a drive for using natural dyes is noticed all over the world because in the sophisticated fashion fabrics these dye offer pastel color effect apart from being eco-friendly.

Colorants derived from root, leaf, bark, trunk, fruit, and flowers of plants. In our country 500 plant species which have been identified as useful sources of dyes.
Unfortunately, most available publications refer to less than 200 species. Some of the examples of dye sources are turmeric, mango, leaves mesta calyx, gulmohar poplar bark, and ratanjot (Surabhi, 2006.)

India is rich in natural resources and there are infinite scopes to explore and revive the application of natural dyes on textiles, having greater ready for use scientific knowledge, as is evidenced from the published works, where commercial availability of extracted in powdered form, improvement and optimization of the dyeing methods/yields; development of new shades and to the improvement of dyeing ability.

The colors are gentle, soft, subtle, and create a restful effect. The color is enhanced with age and mellows to increasing beauty. There is charm and challenge due to the uncertainty of the dyeing results. Natural dyes are used for the conservation and repair of historic textiles, better bio-degradability, and generally higher compatibility with the environment. They also act as manure, enriching the soil. Natural dyes have low toxicity, non-allergic and non-carcinogenic. It saves energy because the raw materials are not from petroleum, explains Dedhia (1998).

Gulrajani (1999) expressed that natural dyes are obtained from renewable resources, no health hazards, sometimes they act as health care. Besides, they are unsophisticated and harmonized with nature, lots of creativity are required to use them judiciously.

*Butea monosperma* a sacred tree and native of the tropical and sub-tropical parts of India and South-East Asia. The common names are Palash, Flame of the Forest, and Parrot Tree. The extract from the flower can be used as natural medicinal dye. Literature states that the flower can be used for skin disease and patients undergoing chemo-therapy. This flower can be explored for its dyeing qualities and medicinal values for producing apparels for patients.

The property of one fiber can be improved by mixing or blending it with other fibers. This can be done to enhance the appearance, to improve the quality, and also to increase the profitability of the fabric. It is more advantageous to mix two natural fibers with similar chemical constituents. Blending or mixing of fibers is done with available resources to get the best fabric. In this study, utilizing the waste to create a value-added product has been aimed.

In the present scenario, renewable sources of raw materials are what mankind is looking for an alternate. Recycling of the waste can be one of the methods to solve
environmental issues. The use of waste bio-mass from the banana after harvesting is a valuable source of textile fiber. Some of the varieties of the banana pseudo-stem fiber have good textile prospects. The raw material for the study was chosen considering the qualities and the quantity of production of pseudo-stem. The demand and the high price of cotton have opened a way for replacement of cotton with the banana pseudo stem fibers.

To give a value to the banana/cotton mixture fabric, the natural dye from the flower *Butea monosperma* with medicinal values was chosen. The study is aimed at utilizing the banana pseudo stem waste to develop an aesthetic value added fabric and also to provide employment for the rural folk.

The quest for innovation and the need to solve environment problems has led to the concept to the study. The combination of cotton with different varieties of banana fiber would be an ideal choice for the new variety of fabric. An aesthetic value could be created for the fabric by using enzymes for pre-treatment and natural dyes. Thus the raw material for the study is the pseudo stem fiber from the Red Banana, Nendran, and Robusta banana plant varieties. The Cotton fiber was selected considering the properties and the chemical constituent compatibility.

Considering the facts, this study was framed with following: The Objectives of the study “A Comparative Study on the Cotton / Banana Mixture Fabric Treated with Enzymes and Natural Dyes” is as follows:

- Identify the potential varieties of Banana to be used for the construction of a mixture fabric with cotton.
- Explore the process involved in the extraction of the fiber from the pseudo stem of three varieties of the banana plant.
- Creation of fabrics, mixing fibers from three varieties of banana pseudo-stems with cotton fibre, individually using a handloom.
- Identification of natural dyes for the mixture fabrics to create an aesthetic value.
- To collect preliminary technical information about the banana fibers, to create value-added products.
• To investigate the effect of gauge length of Red Banana, Nendran, and Robusta varieties.
• Study the moisture management of a series of cotton/banana mixture fabrics.