Review of Literature

2. REVIEW OF LITERATURE

The literature reviews of the study comprises of the following headings :

2.1 Natural Fibres – Properties and their Importance

2.2 Spinning, Weaving and Processing of Natural Fibres

2.3 Importance of Blends and Mixture Fabrics

2.4 Nonwovens – Needle Punching

2.5 Advantages and Disadvantages of Woven and Nonwoven Fabrics

2.6 Applications of Woven and Nonwoven Fabrics in Different Fields of Technical Textiles

2.1 NATURAL FIBRES – PROPERTIES AND THEIR IMPORTANCE

The natural fibres are produced by plants, animals and minerals ; and vegetable fibres include cotton, linen, jute, flax, ramie, sisal and hemp, says Bhatnagar (2007). Anandjiwala (2007) is of the opinion that the majorities of nature fibres are from plant and belong to the lignocellulosic category and that the fibres of flax, kenaf, hemp, coir and sisal contain lower amounts of cellulose and higher amounts of lignin. Besides cotton, other natural fibres such as flax, kenaf, ramie and calico are finding more frequent use, particularly in the area of technical textiles used as insulating materials in car manufacturing, for geo and agricultural textiles and in the construction industry. The geo textiles and textiles for construction industry, fulfill a variety of tasks ; separation, drainage, filtration, armouring, protection, sealing and erosion control and as agricultural textiles in plant cultivation matting and substrates, expresses Bullinger (2009).

The natural fibres offer the advantages of weight reduction of 10-30 per cent, good mechanical and manufacturing properties, good performance, no emission of toxic substances and overall reduction in costs, stresses Yu (2009). In an age of growing environmental awareness, synthetic geo textiles are disadvantageous since these are not biodegradable, and cause soil pollution. Further, their production processes cause air and water pollution. Hence the search for a suitable natural geo textile is inevitable, narrate Nandan et al. (2008). In recent years, the increasing demand for pollution-free and eco-friendly textile goods has put more pressure on cotton textiles. In this context, jute being a natural fibre has a lot of potential to supplement cotton wherever there is possibility of using it, feel Chellamani et al. (2003).

Sara (2009) remarks that, fibre diameter greatly influences fabrics performance and that large fibres are crisp, rough and stiff. Large fibres also resist crushing a property that is important in products such as carpets.

TABLE – I

PHYSICAL PROPERTIES OF HEMP, SISAL AND JUTE FIBRES

S.No.	Fibre	Diameter (μm)	Absolute density (Kg / m^3)	Bulk density (Kg / m^3)	Porosity (%)	Non-cellulose	Cellulose
1.	Hemp	67.84	1505	1468	2.46	5.46	91.95
2.	Sisal	167.85	1428	1273	10.85	10.30	77.74
3.	Jute	45.44	1532	1358	11.36	3.77	84.44

Source : Mwaikambo and Ansell (2001).

TABLE – II

FIBRE PROPERTIES

Material Properties	Hemp	Jute	Sisal	Cotton
Tensile strength (Mpa)	550 – 900	400 – 800	600 – 700	400
E-Modules (GPa)	70	10 – 30	38	12
Stiffness / Weight ratio E / Density	47	7 – 21	29	8
Elongation at fail (%)	1.6	1.8	2 – 3	3 – 10
Moisture absorption (%)	8	12	11	8 – 25

Source : Lo (2006).

Cellulosic fabrics are especially susceptible to damage by mildew and bacteria. Various antimildew and antibacterial chemicals including chlorinated phenols and organometallic compounds are applied to these fabrics to retard biological degradation. In addition, treatment of cellulose fabrics with formaldehyde reactants such as melaminen formaldehyde will also protect the fabrics from biological degradation, says Kelly (1990). John (1987) suggests that high durability geo textiles may be disadvantageous where these are used to control surface erosion as there are risks of livestock eating them and snaring of plants.

Natural fibre geo textiles are found to have superior properties in comparison to the mid-range of synthetic geo textiles for soil reinforcement, when considering strength and frictional resistance. The high degree of frictional resistance of the vegetable fibre geo textiles is probably developed from both the coarseness of the natural fibre yarns and novel structures, feels Anand (2008). Vijayakumar and

Vittopa (2006) stress that coir is a natural fibre extracted from the exocarp of the fruit of coconut palm *Cocus nucifera*, which is largely used in the manufacture of yarn, cordage and wide range furnishings. Mahish and Nayak (2007) describe coir as cent per cent organic biodegradable lignocellulosic fibre and the hardest natural fibre because of high lignin content. In the field of geo textiles, coir can be used for filtration preventing the mixing of fine soil and a coarse material.

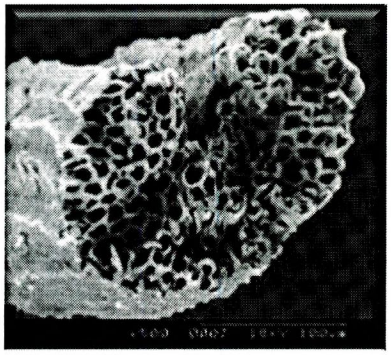
A sisal plant can produce about 200-250 leaves. Each leaf contains 1000-1200 fibre bundles, composed of 4 per cent fibre, 0.75 per cent cuticle, 8 per cent dry matter, and 87.25 per cent water. Each leaf contains about 100 fibres, say Saxena et al. (2008). The creamy white to yellow coloured sisal fibres consist of the chemicals namely cellulose of 60-70 per cent, hemicelluloses of 12-16 per cent, lignin of 10-11 per cent, express Sanyal et al. (2008). Sisal is well suited for technical application because of the interesting properties of this fibre and it accounts for approximately 70 per cent of the commercial production of all such fibres, say Mussig and Stevens (2010).

2.1.1 *Agave americana*

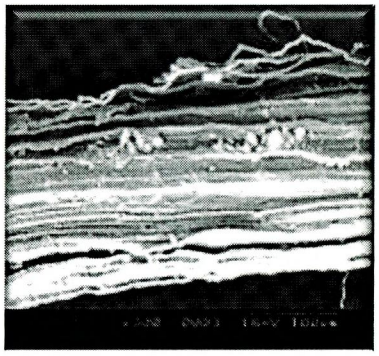
Agave americana is one of the largest agaves, 3-6 feet tall and with flower stalk more than 20 feet tall, describes Tull (2003). The leaves are 15-25 cms wide and 1-2 meters long. They are very smooth and hard nearly rigid and mostly is of gray to gray blue leaves with significant amount of horizontal stripes on the back. *Agave americana* inflorescence is a panicle that rises 16-26 feet above the plant. It has 15-35 branches with bloom on the upper half to third of the stalk. The flowers are yellow and occur from June-August. Plants usually bloom after about 10 years of growth in the ground particularly in warm climates, upto 35 years or more in cool climates. *Agave americana* is a species of 6-10 feet tall and 13 feet wide, explains Gary (2004).

High elongation, specific resistance and low density values of *Agave americana* is appreciable when compared to other fibres of the same class, reveal Msahli et al. (2006). The chemical composition present in sisal fibres as Cellulose – 73.1 per cent, Hemi cellulose – 13.3 per cent, Lignin – 11.0 per cent, Pectin – 0.9 per cent, Wax – 0.3 per cent and others – 1.4 per cent, expresses Mishra (2000). When exposed to the influence of some external factors, the *Agave americana* L. fibres globally present a high resistance to chemical agents such as acids and alkalis, as

well as to UV rays for 108 hours. Nevertheless, they become very fragile when exposed to high temperatures upto 180°C. Their behaviour after immersion in pure water or sea water is similar, and leads to classical softening, causing a decrease in initial modulus without any important loss in tenacity or failure strain. Thus, according to their properties, *Agave americana* L. fibres can be used in technical applications such as reinforced materials and geo textiles – http://www.autexrj.org/no1-2006/0170. pdfq,p.12.



Cross sectional view of *Agave americana* fibre



Longitudinal view of *Agave americana* fibre

2.1.2 Cotton

Cotton has always ruled the textile world and is highly known as the 'King' among fibres, say Pant and Nayak (2004). Cotton is considered as a chief international commodity and plays a crucial role in several sectors of the national economy, explains Narayanan (2006). Cotton is the purest form of cellulose that can be found in nature and excels the physical and chemical homogeneity of any other vegetable fibre, review Gopalakrishnan and Aravindhan (2005).

Cotton fibres are made up of cellulose, which constitutes approximately 90 per cent. In addition to this water is 5-8 per cent and the rest of the weight is contributed by other natural impurities, indicate Gupta et al. (2005). If the cotton fibres are seen through the microscope, they show a formation of the shape like a fine braid. If the cotton is fine, the number of strands is more, states Nakamura (2000).

2.1.3 Jute

Jute has the potential to be used for several textile and industrial applications. In addition to packaging material, jute is now being increasingly used in apparels,

floor coverings, home furnishings, fibre composites, as substitutes in wood industry, paper industry, automotive industry, soft luggage and geo textiles, says Chavan (2001). The biodegradability of natural fibres and nutrients for the plant growth and hence application of geo-jute as a short term stabilization programme has cost advantage over the synthetics, stresses Roul (2009). The geo textiles mass per unit area falls within the range of 100 to 1,000 g / m sq. The hygroscopicity of jute is higher than that of cotton and the strength of jute fibre increases first and then remains more or less unchanged but at moist condition, the jute fibre shows lesser strength, comments Sur (2005).

2.1.4 Hemp

Hemp is an amazing fibre. The hemp plant grows quickly and does not need pesticides because it does not attract pests. Hemp fibres are processed from the stalk of the plant and are longer, stronger and more absorbent than cotton. Fabrics made of atleast 50 per cent hemp block out the sun's rays more effectively than other fibres, reports Duerr (2011). Hemp is the term often used in a generic sense, and is applied to fibres derived from entirely different plants. Sun hemp is yielded by a species of Crotalaria, Manila hemp by a wild plantain and sisal hemp by an aloe (*Agave americana*), says Midgley (2007). Hemp is an annual herbaceous plant used for cloth and paper making. It grows in North India and has proved to be an effective practice for increasing fibre production. It grows to a height of 4.0-5.0 metres in 160-210 days, expresses Singh (2010).

2.2 SPINNING, WEAVING AND PROCESSING OF NATURAL FIBRES

2.2.1 Spinning

Harder (2004) defines yarn as the result of twisted fibres which are spun together to create continuous threads. Simple yarn is the construction of only one kind of fibre and the manner in which the fibres are twisted will be the same throughout the length of the yarn, highlights Parvathi (2007). Twisted fibres or yarns have diagonal lines that correspond with the cross bars in the letters S or Z. Flax, ramie, milk weed and Indian hemp fibres always show S twist and hemp, sisal and jute fibres always show a natural Z twist, says Buchanan (1999). Twisted fibres or yarns have diagonal lines that correspond with the cross bars in the letters S or Z. Flax, ramie, milk weed and Indian hemp fibres always show S twist and hemp, sisal and jute fibres always show a natural Z twist. A higher tensile strength of the natural

fibre sliver could be achieved by twisting, emphasize Fakirov and Bhattacharyya (2007).

2.2.2 Weaving

Vidyasagar (2000) is of view that the interlacement of warp and filling yarns for a weave of which the plain weave is the most popular. Weaving is the method of interlacing the warp and filling yarns to form a fabric. The warp yarns are parallel to each other and run lengthwise through the fabric or along the weaving machine direction, describes Adanur (2001). Mussig and Stevens (2010) reiterate that plain weave has simplest possible pattern and maximum possible frequency of interlacement of yarns and are not easily displaced giving firmness to the fabric thereby resisting slippage of yarns.

Woven structures have the greatest history of application in textile manufacturing. These fabrics consist of two sets of yarns mutually interlaced into a textile fabric structure. Fabric area density and cover factor influence strength, thickness, stiffness, stability, porosity, filtering quality and abrasion resistance of fabrics, say Demboski and Bogoeva-Gareva (2005).

In weaving process, the weft yarns are inserted in an opening between the warp yarns by means of a shuttle. To create the opening for the shuttle some warp yarns are lifted by their harnesses while others are held stationary and once the shuttle goes through the open warp yarns the beater is pulled forward to push the weft in place, describe House and Brean (2000).

The woven fabrics as intertwining two arrays of textile yarns placed at a 90° angle where the lengthwise or warp yarns should be parallel to the length of the fabric, while the filler or weft yarns are interlaced at right angles to warp yarns. Out of the basic weaves of plain, twill and satin, the plain weave pattern is the most common and therefore is utilized most of the time and ribs are formed on the fabric surface because one yarn is thicker than the opposing yarn, outline Petraco and Kubic (2004).

Plain weave is the simplest weave in which warp and filling yarns are of the same size and are interwoven one-to-one. They also add that in an unbalanced plain weave warp and filling yarns are unequal in number or thickness, express Dianne et al. (2003).

2.2.3 Processing

2.2.3.1 Scouring and Bleaching

Alkalisation successfully modifies structure of natural fibres (hemp, jute, sisal and kapok) and these modifications will most likely improve performance of natural fibre composites by promoting better fibre to resin bonding, feel Bledzki et al. (2002). Scouring removes impurities of natural fibres, yarns, fabrics and garments. It improves the hydrophilicity, say Cavaco-Paulo and Gubitz (2003). Scouring is an important operation by which natural impurities namely greases, waxes and fats as well as acquired impurities are removed from the fabric. The grey cloth after desizing contains fats and waxes that hinders the absorbency of the material leading to improper dyeing, printing and finishing, recommends Pardeshi (2004).

Of the most common oxidizing agents namely sodium or calcium hypochlorites, hydrogen peroxide and sodium chlorite, hydrogen peroxide continues to be popular because it is nontoxic and odourless and the whiteness obtained is relatively permanent and non yellowing, indicates Rao (2001). Hydrogen peroxide is widely used in the textile industry as it is free from chlorine atom, decreases pollution and improves the product quality. The stabilizing agents namely sodium and magnesium salts are commonly used to control the decomposition of hydrogen peroxide, recommends Mondal (2002).

2.2.3.2 Biopolishing

The technological approach to stone washing was first used in America in 1990 which involves washing the jeans with cellulase, an enzyme derived from a tropical fungus, narrate Lawler and Weilson (2002). The process of biopolishing involves treating new cotton fabrics with cellulases which remove the loose or protruding microfibrils present on the cotton fibres surface, advocates Gary (2002). Cotton and other natural fibres based on cellulose can be improved by an enzymatic treatment known as biopolishing. As the name suggests, the treatment gives the fabric a smoother and glossier appearance. The treatment is used to remove "fuzz" – the tiny strands of fibre that protrude from the surface of the yarn and gives soft and smoother handling and superior brightness, express Straathof and Adlecreutz (2000).

Biopolishing is reported to improve softness, and surface appearance by reducing surface fuzziness of fabric when applied under specific conditions, narrate Rao et al. (2003). Cellulase refers to a group of enzymes which, act together,

hydrolyze cellulose, describe Kholiya et al. (2008). Cellulases are also used to prevent pilling and improve the smoothness and colour brightness of cotton fabrics in a process which is called biopolishing, says Roda (2007). Cellulases for textile applications became the third largest application and one of the fastest growing markets for industrial enzymes. Cellulase preparations are applied for quality improvement of cellulosic textile fabrics. They are used in biopolishing of cellulose made fabrics. The action of cellulases consists of the removal of impurities and small loose fibre ends from the fabric surface, narrate Stevens and Verhe (2004).

2.2.3.3 Dyeing

The 'Natural dye' refers to the dyes obtained from insects, plants and mineral substances and is used for dyeing textile materials. the main natural dye substances, used in India have been extracted from roots, barks, flowers and fruits of various dye producing plants, account Mondel et al. (2004). Today with the increase in public awareness of ecological and environmental problems related to the use of synthetic dyes, interest in natural dyes has gained momentum, say Shrivastava et al. (2005). Natural dyes are being looked at as an "eco-solution" to the ill effects of synthetic dyes, point out Dheeraj et al. (2003). The drawbacks of synthetic dyes have prompted the environmentalists to look for eco-friendly products and technologies, say Pruthi et al. (2006).

The demand for "greeners" living has recently led to an increased interest in natural dyes, states Wells (2000). Banerjee et al. (2010) emphasize the importance of the use of natural dyes due to the diverse changes in physical, chemical and biological characteristics of air, water and soil by virtue of addition of unwanted materials which are harmful to all living organisms including mankind.

Lac is derived from lac resin, the hardened secretion of the lac insect, the only known resin of animal origin. The lac insect Kerria lacca, formerly known as Laccifer lac, is a natural parasite of a variety of trees in large areas of Southern Asia, says Goffer (2007). Panda (2000) narrates catechu dye extract from the inner wood is a brittle compact substance of chocolate colour containing much tannin and an acid called catechuric acid, it has a stringent taste but no smell and is soluble in water and he also adds that the dye occurs in dark brown masses with a very astringent taste. Cutch / Catechu dyed textile possess antimicrobial property and can be very useful in protection of clothing from common microbes and ropes which are

used for anchoring ships are also dyed with cutch and these ropes are free from microbes available in the sea. Catechu or cutch dyed textiles possess antimicrobial property and can be very useful in protection clothing from common microbes and ropes which are used for anchoring ships, suggest Khan et al. (2010). Most of the natural dyes fall under mordant dyes and madder is one such dye, feel Hoiberg and Ramachandani (2000).

In general natural dyes are fixed on the fibre through a suitable metal salt known as mordant. The word mordant is derived from Latin word "Modere" which means "to bite", views Gill and Singh (2005). According to Bechtold and Mussak (2009) mordants are used for fixation of the dye stuff, increasing the fastness properties or variation in the colour appearance. Mordants are used for fixation of the dyestuff, increasing the fastness properties or variation in the colour appearance. Generally small variation in the colour depth are found by the three mordanting types. According to Phukan and Phukan (2003), mordanting is done mainly by three ways. Mordants can be applied to the fabric before, at the time of dyeing or after dyeing, reveal Vankar et al. (2001).

2.2.3.4 Special Finishes

Flame retardant (FR) finishes function by blocking the flames access to fuel and hindering further flame propagation. Flame retardance is the resistance to combustion of a material when tested under specified conditions, says Kadolph (2009).

Flame retardant finishes inhibit the ignition rate and flame spread and encourage a fabric to self extinguish. This is required in many non residential settings to meet the needs, says Nielson (2007).

Liquid compositions comprising urea and a boron containing compound for imparting fire resistance to cellulosic products. The boron containing compound typically comprises boric acids : borates (boric acid salts), boric oxides (any compound containing boron and oxygen and mixtures thereof) (http://www.wipo.int/pct&b/en/wo.jsp?wo=200907596).

Cellulosics have lower heat of combustion 4.3 kcal/ g. A Tc value of 350-420°C indicates relatively easy ignition. A small flame is enough to ignite these fabrics. Combustion spreads rapidly and can cause fatal burns within 15 seconds of ignition. By contrast, flame retardant treated cotton is self extinguishing and

completely safe for use, feel Carr (1995). Finishes that repel water, oil and dry dirt are important in all parts of the textile market – for clothing, home and technical textiles. Water repellency is achieved using different product groups, but oil repellency is attained only with fluorocarbon polymers (Schindler and Hauser, 2004). Oil and soil repellent coatings are of high commercial interest as easy care of easy-to-clean application, express Mahltig and Textor (2008).

2.3 IMPORTANCE OF BLENDS AND MIXTURE FABRICS

In order to overcome or minimize the disadvantages and shortcomings, jute and other fibres can be blended or unionized with other prospective textile fibres or yarns, points out Ghosh (2004). Spencer (2001) states that the properties of more than one type of fibre may be incorporated into a fabric as a result of blending the fibres.

Mixtures are fabrics made of 2 or more different fibres, each one spun into a separate yarn. Mixtures unite the different properties of 2 or more fibres in order to cover up less desirable characteristics in any of the fibres and give an improved fabric performance, reduce costs and give different textures and colours, express McArthur et al. (2001).

2.4 NONWOVENS – NEEDLE PUNCHING

2.4.1 Nonwovens

Nonwovens and other value-added textiles belong to technical textiles which help with improvements in human lifestyle. The next phase of growth and development of the nonwovens industry will be focused on value added products with enhanced functionality, apparels and suitable products, say Ramkumar and Sata (2008).

Balasubramanian (2009) avers that nonwoven textiles represent a unique way of forming a fabric, which has many advantages over woven textiles. Total nonwoven production world over has risen from 4.5 million tons in 2000 to 6 million tons in 2008. Present nonwoven production in India is very low compared to this. Thus there is a great potential for expansion of this technology in India as the government is committed to increase manufacturing at an accelerated rate. Ramkumar (2010) stresses the scope for environmental friendly nonwoven products to meet the global demand in the field of geo textiles, insulation materials and construction materials.

Nonwovens are used extensively in many technical textiles. Some of these are readymade filters, geo textiles, insulating materials, labour protection devices and protective clothing and also sanitary goods, enumerate Albrecht et al. (2002). Nonwoven fabrics from the blends of natural fibres and manmade fibres have excellent impact properties, dimensional stability and good noise and vibration properties and the manufacture of these fabrics for automotive applications offers shorter cycle times, lower capital costs and rapid and inexpensive prototyping, narrates Lewin (2007).

The most obvious feature of nonwoven fabrics is the random orientation of the filaments. The fabric is formed by spreading filaments or staple fibres cut of 50 mm length on to a conveyor belt, expresses Forrester (2001). Bell (2006) is of the opinion that fabric weights of 300-1000 g / sq.m. usually are necessary to give acceptable levels of fabric strength for civil engineering purposes. He also adds that the needle punched nonwoven fabrics offer a high resistance to tearing as a stress causes the filaments to move towards the direction of the applied force.

2.4.2 Needle Punching

Hutten (2007) views that needle punching is a process by which fibres are entangled and mechanically interlocked by puncturing the web with a series of barbed needles and the density and strength of the web can be regulated by the strokes per minute of the web, the advance rate of the web, and the degree of penetration of the needles. Miller and Drillon (2003) emphasize the importance of the parameters of needle guage, depth of stitch and density of stitch in the process of needle punching. They further say that it is a bonding process that causes a reduction in thickness and a rise in compactness, the effect of which decreases with growing needle guage and increases with growing stitch density.

In needle punched fabrics the fabrics are interlocked and the web obtains stability and strength with weight ranging from 200 to 1500 gram per meter square, stresses Tracton (2005). Nonwoven fabrics are form of fibre assemblage with lesser regularity and uniformity in structure than woven fabric, report Sawyer et al. (2008).

Among the many techniques for fabrication, needle punching process attracts much interest because it provides a uniform fibrous structure and can be easily applied to large parts with cost effectiveness, inform Curzio et al. (2008). Wettability of jute fibre is good among all the long vegetable fibres. The porous needle-punched

nonwoven structure is expected to improve the water holding capacity of the fabric. It is also expected that the density of fabric may play a significant role in water absorbency of such nonwoven fabric, discusses Senguptha (2009).

2.5 ADVANTAGES AND DISADVANTAGES OF WOVEN AND NONWOVEN FABRICS

Midha and Kothari (2003) emphasize that in a nonwoven, single fibre characteristics assume a dominant role, since the effects of weave pattern, yarn twist, weave density are absent, and the single fibre rather than the yarn is the filtering element of the structure. They also add that single fibre may affect and control filtration performance by their geometric properties, surface finish, electrical properties, hardness and other mechanical properties. Sharma (2010) feels the plain weave is the tightest having smallest pore opening in the fabric consequently retaining particle quickly. In filtration, the needle felted nonwoven fabrics are mostly applicable for filter media as these have higher permeability and pre unit area and also have high filtration efficiency.

2.6 APPLICATIONS OF WOVEN AND NONWOVEN FABRICS IN DIFFERENT FIELDS OF TECHNICAL TEXTILES

Textiles are divided into clothing, household fabrics and technical textiles, clothing and household fabrics (curtain, textile wall paper, upholstery fabrics, carpet and floor coverings). But this definition is not acceptable. So all textile products, which are designed for the most part to conform to their functionality, are technical textiles. Cloth tech involves clothing shoes, and home tech involves upholstery, interior decorating, carpets, floor coverings, enumerate Wulfhorst et al. (2006). The range of technical research is so great, innovations concerning the natural performance characteristics of textiles would generally fall within the definition of technical textiles, emphasize Gale and Kaur (2004).

Compared to all other textile branches the technical textile industry is the only one that is constantly growing with high innovation potential and resources much higher than in the average textiles and clothing industry, stress Streitz et al. (2007). Mandan et al. (2008) suggest that natural forms of geo textiles are made out of fibres from jute, coir and sisal and utilized for erosion, soil conservation and other civil and bioengineering applications as nonwoven fabrics have permeability and high strength characteristics.

Technical textiles are high performance, special textile materials and products that are manufactured primarily for their technical and performance properties rather than their aesthetic or decorative properties. Technical textiles are becoming very popular all over the world due to several functional requirements, user friendliness, eco friendliness, health and safety, cost effectiveness, durability, high strength, light weight, versatility, customization and logistical convenience. Technical textiles are also known as industrial textiles, functional textiles, performance textiles, engineering textiles, invisible textiles and hi-tech textiles. Technical textiles are increasingly being used in various industries such as agro textile, clothing textile, construction textile, geo textile, eco textile, home textile, industrial textile, medical textile, packaging textile, protective textile, sport textile and transport textile, express Rakshit et al. (2007).

2.6.1 Cloth tex

In clothing applications, demand for natural fibres is growing, while in non-clothing applications the demand for manmade fibres is rising. Hence the demand for natural fibres is unlikely to exceed the average growth rate of around 2 per cent per year achieved in recent years for consumption of textiles for clothing applications, point out Audet and Safadi (2004). It is often necessary to improve the properties of garments such as crease resistance, water repellency and stain resistance without closing up the fabric pores and altering its feel and appearance, expresses Ghosh (2004). The term 'comfort' is 'the absence of displeasure or discomfort' or 'a neutral state compared to the more active state of pleasure' (http://www.textilepapers.tripod.com/smart.htm.-Slater (1977)).

In recent years, textile materials have found in applications in the cosmetics field. A new sector of cosmetic textiles is introduced and several commercial cosmetic textile products are currently available in the market on contact with human body and skin, cosmetic textiles are designed to transfer an active substance for cosmetic purpose, express Cheng et al. (2008).

2.6.2 Home tex

Woven carpets are more expensive than nonwoven types, but worth their cost since they are more durable. These carpets are used in reception areas, corridors, dining rooms and bed rooms. Carpets are used extensively because of their

attractive appearance, safety factor, warmth and sound insulation, stress Raghubalan and Raghubalan (2007).

Jute must always be boiled before bleaching with 5 per cent solution of soda ash and washed after the lye-boil. Jute is bleached with 10-12 per cent solution of hydrogen peroxide containing 2 per cent ammonia 20° Baume. The jute is steeped in the bath for one or 2 days at 77° to 86°F, after which it is taken out and air dried. The cleaned material may also be dipped in the above bleaching liquor and properly steeped in the surplus liquor being expressed by a squeezing machine and the still damp material dried slowly at 68°F (Tailfer, 2008). The table linen should be absorbent and durable (www.thefreedictionary.com/ place-mat).

Place mat – a mat serving as table linen for an individual place setting. Mat – a small pad of material that is used to protect surface from an object placed on it. Table cloth – a cloth for covering the top of a table, especially during a meal (www.thefreedictionary.com/tablecloth). Table clothes protect tables from food and drink spills and surface stretches. They can also protect the table from paint, glue or ink when the table is used for art projects or writing (www.ehow.com/facts-5686765-functions-tablecloth-html). The rise of national speciality retain chain focusing exclusively on home furnishings has attracted new consumers in search of home textiles. Today home furnishings stores generate nearly 30 per cent of home textile sales. Home textiles include rugs, throws, pillows, table linens and curtains, feels Danziger (2004).

2.6.3 Agro tex

The modern agricultural technologies make even more demand for materials that are eco-compatible and attainable at competitive price. The number of biodegradable items for agricultural application to enter the market is going to increase in the early future, stress Chielini and Solero (2003). The biodegradation of a substance is the process in which microorganisms use the substance as food source. It occurs by reaction between the enzymes secreted by the organism and the polymer chains or additives, which make up the compound. The degradation involves bondscisson reactions in the backbone of polymers, so that the original form disappears. Usually, biodegradation products are not toxic or environmentally harmful, express Bharath et al. (2010). Mazumdar (2004) expresses that thick mulches are unnecessary and these hamper the soil in getting aerated. Mussig and

Stevens (2010) suggest nature fibres as substitute for plastics in agro textiles for the protection of young plantings or serve as a base layer and are advantageous due to their biodegradability. They also add that the production cost of natural fibres is higher. Dreistadt and Clark (2004) express that the organic mulches have major advantages of gradually improving soil quality as they decompose and release minerals and organic matter there by enriching deficient soils by replacing nutrients and enhancing earthworm populations.

Reduction in soil temperature helps to develop healthy mother bamboos by preventing diseases which could be accomplished by reducing the thickness of mulch to about 20 cm, reducing mulch during the second half of the sprouting period and shortening length of the mulching period, says Dachang (2003). Soil temperature influences the plant growth only indirectly by affecting the physical, chemical and biological processes in soil and plant. The primary source of heat energy to soil being sun, practices like mulching encourage the heat absorption and the flow in soil and these discourage heat loss to the atmosphere and would help in heat storage and temperature rise, propose Tripathi and Tomas (2002). Somasundaram and Arokiaraj (2004) say that the soil temperature affects the physical and chemical processes on growing on in the soil, and it influences the rate of absorption of water and solutes, germination of seeds and rate of growth of the underground portions of the plant body.

Mulch increase yield, water use efficiency and profitability, while simultaneously decreasing weed pressure. They also express that through proper mulching, the problems of surface evaporation and soil moisture deficit in dry season can be solved to a great extent, recommend Sarangi et al. (2010). The mulch is important to keep the soil moist and cool as the crops are usually grown during the dry season under irrigation. Mulch is also applied under flowers and strawberries, mainly to protect the fragile and valuable products from becoming soiled, and it also saves labour, narrate Bot and Benites (2005). It is necessary to control weeds at the early stages of crop growth to achieve desired productivity and it is a common practice with the farmers of taking manual weeding 4-5 times depending on the intensity of weed infestation and availability of labour that involves excessive cost, stress Rajkumara et al. (2010). Kumar and Singh (2010) express that weeds compete with crop plants for soil moisture, nutrients, light and space. When improved production technology is adopted, the weed management becomes more important

so as to improve the efficiency of applied inputs. Although weeds emerge simultaneously with crop plants but due to their better adaptation and survival mechanism under adverse condition and also due to their fast growing habit they over power crop plants.

Gliessman and Engles (2000) suggest that mulching is one of the most effective ways of modifying the conditions of an agroecosystem. They further add that a layer of mulch can radically change the soil temperature regime, conserve soil moisture, reduce weed growth and contribute organic matter and nutrients to the soil as it decays. Hunter (2004) expresses that in recent years, much attention has been focused on mulches and interest has been boosted by the search to recycle useful materials for soil enrichment. Ellefson and Winger (2004) are of opinion that mulch softens the impact of falling rainwater and slows it down there by soaking it into the soil before running off. They also add that if further prevents soil from being distributed or washed from around plants. Mason (2004) expresses that mulches are useful in nurseries for controlling weed growth, keeping plant roots moist and cool and as a clean surface to cover the ground. He also adds that mulching done along fence-lines beside buildings and any other areas prevent many problems. Gupta (2007)–I reveals the disadvantage of trash mulching for its tendency to permit the growth of sedges and grasses through it.

Mandal (2002)–I defines the process of weed eradication as the elimination of all live plant parts and seeds of a weed from a site. He also defines weed control as the process of killing weeds for economic and other reasons. Ramamoorthy and Subbian (2006) define weeds as plants that growth where it is not desired. He also adds that weeds are pernicious and harmful plants that interfere with agricultural operations, increase labour, add to the cost of cultivation and reduce yield of crops. Dreistadt (2001) views that hand weeding is disadvantageous as a higher percentage weeds will be mixed with high weed populations, when weeds resemble the crop, growers may not be able to afford the labour cost and weeds very close to the crop stem probably cannot be hoed or pulled out without damaging the crop plant.

In all plots it was seen that loss in NPK and organic carbon was higher in control plots than in the plots treated with coir geo textiles as protective covering. Also biodegradation of coir fabric contributes to the increase in nutrient content in the treated plots, narrate Vishnudas et al. (2005). Haq et al. (2005) comment, pH is one of the important factors that determines the growth and morphology of

microorganisms as they are sensitive to the concentration of hydrogen ions present in the medium. Earlier studies revealed that fungi required slightly acidic pH and bacteria required neutral pH for optimum growth. Indiscriminate use of inorganic fertilizer alone creates unfavourable soil physical conditions and biological systems which ultimately affects soil health and this could be overcome by the use of organic crop residues as mulch along with mineral fertilizers for maintaining soil health and sustainable crop production, point out Sutaria et al. (2010).

David (2003) is of the opinion that natural fibres like jute, coir, coconut, sisal and ramie as distinct from manmade fibres have been utilized in applications where durability is not an issue. He also adds that the products designed to reduce soil erosion are of commonest enduses for such materials where gradual degradation over a period of a year or two is an advantage over the more durable synthetic products. Wilhelm et al. (2002) express that agricultural nonwovens are the materials that often serve as a storage and transportation medium for functional fillers such as water, water-storing material, fertilizers or plant seed. They also add that agricultural nonwovens are known for their evenness, sufficient stability, elasticity, bio-degradability and thermal effects too. The addition of organic matter to the soil usually increases the water holding capacity of the soil and increases the number of microspores and macrospores in the soil either by gluing soil particles together or by creating favourable living conditions for soil organisms, highlight Troeh and Thompson (2008). The areas of textile application in agriculture are for hose, rope, conveyor belts and composites. For weed control jute and wool fibres were used which over one or five year period becomes manure for the next crop, enumerate Sankhe and Chitris (2002). Sarkar et al. (2010) narrate the use of sisal waste for mulching to conserve soil moisture, to improve soil conditions and add nutrient to the soil. Roiley and Shry (2004) suggest that when organic mulches are used, especially saw dust, additional nitrogen fertilizer must be applied to maintain good growth because the rotting process of organic mulches robs the soil nitrogen. Cellulose fibres are not a direct nutrient for microorganisms, but some fungi convert cellulose to glucose, which is a good nutrient for microorganisms, narrates Schumacher (2007).

The advantage of replacing commercial plastics with their biodegradable counter parts is due to economical and environmental reasons as removal and disposal of traditional plastics can be very expensive and difficult. Upadhyaya and Blackshaw (2007) enumerate that, on heavy wet, clay soils, plastic mulches restrict

soil microbial activity, leading to anaerobic soil condition. The toxic by-products resulting from anaerobic decomposition can kill plants growing in the mulch. After cropping, lifting and disposal may be a problem with plastic and other durable mulches. Paper nonwoven natural fibre and degradable plastic mulches have the advantage of breaking down naturally and can be incorporated into the soil after use, highlights Naylor (2002).

Mulchmats are used to suppress weed growth in horticulture applications. It covers the soil, blocking of light and preventing the competitive weed growth around seedlings, it also reduces the need for herbicides, express Sakthivel et al. (2009). Elevitch and Wilkinson (2004) stress the benefits of mulch that it improves nutrient and water retention in soil, encourages favourable soil and microbial activity, reduces labour and maintenance costs and improves soil health. Garbing (2008) expresses that a properly applied mulch is one of the simplest and most effective ways for saving labour, improving soil and getting better crops. Subramaniam et al. (2009) add the uses of agro-textile products as ground covers, sunscreen, bird protection nets, plant nets, wind shields, monofil nets, root ball nets, insect meshes, turf protection, tape nets and cherry covers.

Euser and Specht (2005) express that healthy soil requires organic matter beneficial to soil organisms to decompose the organic matter, thereby creating nutrients for plants. They also add that fertilizers only provide nutrients and do nothing to help the soil. Kolay (2000) suggests that agronomic soil conservation methods are crop rotation, mulching, contour farming, strip cropping and growing grasses and forest trees. He further adds that the organic materials like leaves and straw protect the land against the beating action of rain drops and later decay to form humus.

2.6.4 Geo tex

The use of natural geo textiles for short-term / temporary applications to strengthen soil has a particular niche in geotechnical engineering. These also solve the problems safely, efficiently and economically stress, Horrocks and Anand (2000).

Tholkappiyan (2010) affirms that geo textiles with natural fibres such as jute, coir and sisal are emerging as an alternative to polymeric geo textiles and these find their application in temporary or noncritical structures where a shorter life may be adequate. Kliche (1999) gives the definition of ASTM for geo textile as any

permeable textile material used with foundation, soil, rock, earth or any other geotechnical engineering related material as an integral part of a manmade project structure or system.

Storm water polluted by pollutants from impervious surfaces has become a serious problem that can negatively affect the environment and people and so there is a need for a long-term simulation of a system for catchment, pretreatment and treatment of polluted runoff water, highlight Rodriguz-Hernandez et al. (2010). The water pollution management requires impoundment of storm runoff for a specified period of time before being discharged, stresses Sivaramakrishnan (2010). Filtration means that a textile fabric separates the fine-grained and coarse-grained soil layers, while water flows as pressure-free as possible from fine-grained to coarse-grained layer, view Wulfhorst et al. (2006).

Domestic sewage and agricultural runoff are the chief sources of allochthonous nitrogenous organic matter. The high concentration of nitrate in water is indicative of pollution. This is an important plant nutrient, when present in excess it causes ubiquitous growth of algae, often present in blooms, says Saxena (1990). Coir is an eco-friendly, natural, biodegradable, durable, renewable, low-cost and sustainable product. Novel applications of coir as natural geo textiles for the protection of soils in woven and nonwoven opened up new opportunities for further technological developments, express Jorg and Christian (2010).

Fluet (1987) points out that the mechanically needle punched nonwoven natural geo textiles form a three dimensional structure of fibres makes difference in filtration performance compared with woven or grid like planar fabric structures. He also adds that the fibre distance distribution along the cross section allows partial penetration of the soil into the nonwoven geo textiles thereby reducing clogging possibility also.

Martin and Lorne (2002) state that geo textiles could significantly influence the flow and the transfer of pollutants such as heavy metals. Geo textiles are not presumed to interact directly with these pollutants, due to the low chemical reactivity of their fibres. But they may interact with the soil to produce a new soil geo textile system with new characteristics. When geo textiles are put into the soil, they constitute a particular layer with a particular structure. This structural heterogeneity could modify the soil around geo textiles due to soil particle movement and other

physical and chemical processes. Total alkalinity is the measure of capacity of water to neutralize a strong acid. The alkalinity in water is generally imparted by the salts, carbonates, bicarbonates, phosphates, nitrates together with hydroxyl ions in free state. The total hardness (TH) of water is mainly due to the presence of bicarbonates of calcium and magnesium ions. Total hardness values between 150 and 300 mg / l means the water is hard and the value greater than 300 mean it is very hard, expresses Babar (2007).

Gupta (1999) defines the bulk density as the mass weight per unit volume of a dry soil including pore space. It is expressed in mega gram per cubic meter (mg / m^3) in metric system and g / cc in CGS system. Farias et al. (2006) emphasize that soil erosion can be a major problem in modern societies. Fertile soil losses due to runoff can cause reductions in crop production, increase of sediments in rivers and lakes and considerable environmental damage, which are commonly very expensive to be repaired in an advanced state of the erosive process. Sediment transportation by runoff can cause problems to civil engineering works such as roads and reservoirs.