We Claim,

1. An eco-friendly hygro fabric comprising alkali soluble wool fiber component in the core of the yarn surrounded by cotton and/or other fiber component as a sheath, at the blow room, drawing or roving stage, of the yarn-making process and further comprising spinning into the yarn for manufacture of looped fabric or flat fabric.

2. The eco-friendly hygro fabric as claimed in claim 1, wherein the alkali used for solubalizing wool is NaOH.

3. The eco-friendly hygro fabric as claimed in claim 1, wherein the dissolution of wool, during wet processing, in NaOH solution creates an airy yarn characterized in having better absorbency, quick drying and soft hand.

4. The eco-friendly hygro fabric as claimed in claim 1, wherein wool fiber component is in range of 5% to 40%.

5. The eco-friendly hygro fabric as claimed in claim 1, wherein the other fiber component comprises of cotton, linen, silk, viscose, bamboo, polyester, nylon, polypropylene, sea weed fibers, modal fibers, charcoal fibers, eucalyptus fibers or blends thereof.

6. The eco-friendly hygro fabric as claimed in claim 1, wherein blending of wool fibers along with cotton or other fibers is carried out in the blow room of cotton spinning system.

7. The eco-friendly hygro fabric as claimed in claim 1, wherein blending of wool fibers along with cotton or other fibers can be in slivers, separately processed in blow room and cards, along with cotton/other fiber slivers in the draw frame of a cotton spinning system.

8. The eco-friendly hygro fabric as claimed in claim 1, wherein blending of wool with cotton or other fibers is carried out in blow room as illustrated in Fig. 3 comprises:
   a. processing through carding and breaker draw frame, and;

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b. blending this mixed sliver with 100% cotton slivers on finisher draw frame to get the final desired wool proportion in the final yarn.

9. The eco-friendly hygro fabric as claimed in claim 1, wherein blending of wool fibers with cotton or other fibers is carried out by process as illustrated in fig. 1 comprises:
   a. inserting wool fiber slivers into the middle of cotton or other fiber slivers at the feeding end of the drafting zone of the speed frame;
   b. twisting on the speed frame, and;
   c. spinning the yarn at ring spinning.

10. The eco-friendly hygro fabric as claimed in claim 1, wherein the looped fabric is a terry fabric, including wash cloth, hand towel, bath sheet, bath mat, baby hood, medicinal towels, institutional towels, pleasure fabrics and the like.

11. The eco-friendly hygro fabric as claimed in claim 10, wherein a set of longitudinal warp yarn for forming pile loops in the terry fabric, the ground warp and weft in terry fabric are yarns in longitudinal and transverse yarn used by interlacing each other to form the ground fabric.

12. The eco-friendly hygro fabric as claimed in claim 11, wherein said pile warp has a count ranging from Ne 1/6's to 1/50's, ends per cm is in range of 21 to 34 picks are in range of 10 to 28, loop length is in range of 0.5 to 17cm, pile height is in range of 0.25 to 8.5cm, terry loops are created from 2.5, 3, 4, 5 and/or 6 pick mechanism, GSM ranges from 200 to 1700.

13. The eco-friendly hygro fabric as claimed in claim 11, wherein the pile warp can be in single or double configuration.

14. The eco-friendly hygro fabric as claimed in claim 1, wherein the looped fabric is a rug or carpet, including rugs of tuft on one or both sides, uncut or cut loops, doormats, tub mats, bed room mats, indoor play room carpets and like.

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15. The eco-friendly hygro fabric as claimed in claim 14, wherein the tufted loop yarn in the rugs/carpets is the yarn used to tuft the rug/carpet.

16. The eco-friendly hygro fabric as claimed in claim 15, compromises a base fabric over which the tufts are formed.

17. The eco-friendly hygro fabric as claimed in claim 16, wherein the base fabric is cotton canvas, high density polyethylene woven fabric, polypropylene woven fabric or any other similar fabric.

18. The eco-friendly hygro fabric as claimed in claim 14, wherein the rug or carpet is of non-cut loop or cut loop, with or without latex backing.

19. The eco-friendly hygro fabric as claimed in claim 14, wherein said pile warp has a count ranging from Ne 2's to 20's, loop height is in range of 3mm to 34mm, loops density is in range of 18 to 96 per square inch, GSM is in range of 1000 to 3000.

20. The eco-friendly hygro fabric as claimed in claim 14, wherein the pile warp can be in single or double configuration selected from 2/2's, 3/2's, 4/2's.

21. The eco-friendly hygro fabric as claimed in claim 14, wherein the loop yarn may be grey, bright, white, dope dyed or yarn dyed.

22. The eco-friendly hygro fabric as claimed in claim 1, is a flat fabric, including bed sheets, sheeting fabrics, duvets, shams, quilt fabrics, pillow case fabric and like.

23. The eco-friendly hygro fabric as claimed in claim 22, wherein the thread count is in range of 48 to 1600, ends per cm is in range of 8 to 110, picks per cm is in range of 5 to 72, warp and weft count is in range of Ne 20's to 120's.

24. The eco-friendly hygro fabric as claimed in claim 22, wherein the warp and weft can be in single or double configuration.

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25. The eco-friendly hygro fabric as claimed in claim 22, wherein the yarn may be dyed, plain dyed or printed.

26. The eco-friendly hygro fabric as claimed in claim 22, fabric has construction in satin, sateen, twill or plain.

27. The fabric as claimed in claim 10, wherein the process for manufacturing of said terry fabric is as illustrated in Fig. 2.

28. The fabric as claimed in claim 22, wherein the process for manufacturing of said flat fabric is as depicted in fig. 4.

29. The fabric as claimed in claim 1, wherein the process for manufacturing of hygro yarn consisting of 85:15 blend of cotton and wool fiber is as depicted in Fig. 5(a) and (b).

30. The fabric as claimed in claim 14, wherein the process for manufacturing of said rug or carpet is as depicted in Fig. 6 and 7.

Dated this 6th Day of January, 2010

For Welspun Global Brands Limited

Dr. Gopakumar G. Nair
(Reg. No. IN/PA 509)
(Authorized Signatory)

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Field of Invention:

The present invention generally relates to a novel eco-friendly hygro fabric, more particularly to a terry fabric and variations thereof, including rugs and carpets and flat fabrics such as Bed sheets (including Duvets, Blankets, comforters and other bed covers) by using 'hygro' yarn in the loops/tufts of terry/rugs and warp or weft of flat fabrics, such as bed linen. The present invention further relates to the technical aspect of producing 'hygro' yarn by using wool fibers, and external appearance and characteristics of the obtained terry, terry related forms, tufted rugs and flat fabrics, such as bed linen (including blankets, comforters and other bed covers) and variations therefore and processes thereof.

Background of the Invention:

The word "Hygro" refers to the phenomenon of absorption of water or moisture by yarns and fabrics including sheets, towels and toweling fabrics and rugs/carpets.

Towels are generally thick materials. The thicker the towel, the greater the surface area, and thus a greater amount of water can be absorbed. When a towel fabric encounters a water droplet, the pile loops first remove the droplet by sucking the droplet between the space available among the pile loops and then absorbing the water inside the yarn in the space between the fibers in the yarn. The latter part is true to flat fabrics as well. The absorbed water then enters the lumen of the cotton fiber.

Loop/Terry fabrics are formed with three types of yarns. The ground warp is a longitudinal set of yarns forming the base fabric. The pile warp is again a set of longitudinal warp yarns that are used to form the loop piles on the fabric surface. The weft yarn forms the transverse yarn that interlaces with the ground and the pile warp to form the fabric.

A ground fabric made of cotton yarn and provided with loops of cotton fiber yarn to form a looped fabric. The ground fabric has a ground weave that is obtained by a technique with, two and half, three weft insertions or by a technique with four or five or six weft insertions. The looped fabric has a weight between 200 and 1700 gm/m. The number of warp threads per cm fabric is between 16.5 and 34, and the number of weft threads per

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cm fabric is between 10 and 28, and the number of loops per cm fabric is between 3 and 9. The looped fabric may be used as a terry. The terry fabric may be yarn dyed/fabric dyed and/or valor finished as required.

Normally, the yarns used in terry fabrics are coarse and range from Ne (Number English) 6's to 50's in single as well as doubled configuration for pile, weft and ground yarns. The coarse yarn has a greater number of fibers in the cross section. Similarly the warp and weft yarn count, in the case of flat fabrics range from Ne 20's to Ne 120's in single as well as doubled configuration depending on the construction. The yarn used for tufted loops in rugs/carpets range from Ne 2's to Ne 20's.

The yarns used in terry fabrics are all cotton except for yarns used in decorative designs and embellishments on the fabric. For example, the decorative yarns used in towels are about 15-30 grams of a total towel weight of about 420-500 grams.

Decorative designs and embellishments are formed using polyester filament, polyester spun yarn, viscose filament yarn, viscose spun yarn, mercerized cotton yarn, modal yarns, chenille yarn, modified viscose yarn and combinations thereof.

A "bed sheet" is a piece of cloth used to cover a mattress. It is this sheet that one typically lies on. In many areas of the world, a second flat bed sheet is laid on top of the sheet covering the mattress. This is known as a "top sheet" and when a top sheet is used, the sheet covering the mattress is known as a "bottom sheet". One sleeps between the two bed sheets. Blankets, comforters, duvets, sham and other bed covers, such as pillow covers are then placed on top of the second bed sheet.

Bed sheets come in two main varieties flat or fitted. A flat bed sheet is simply a rectangular sheet of cloth, while a fitted bed sheet has its four corners and sometimes two or four sides, fitted with elastic, to be used only as a bottom sheet. The purpose of a fitted bottom sheet is to keep it from slipping off the mattress while the bed is in use. A particular way of folding and tucking while making the bed, known as "hospital corners", is sometimes used when the bottom sheet is flat rather than fitted.

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Bed sheets were traditionally white, but now various colors and patterns are used. The quality of bed sheets is often conveyed by the thread count - the number of threads per square inch of material. In general, the higher the thread count, the softer the sheet, but the weave and type of thread may affect the "hand" of the material so that a sheet with a lower thread count may actually be softer than one with a higher count.

Usually a flat bed sheet is over locked around the edges to form four seams. One of the seams is wider than the other three and helps with orienting the sheet correctly on the mattress. The wider seam goes at the head end of the mattress. Sometimes the sides do not have seams, but are finished with the selvedge only.

When making a bed, the patterned or monogrammed side of the top sheet is placed facing down and then the top edge is folded towards the foot of the bed, exposing the design.

"Bed size" refers to the dimensions of a mattress and the names by which standard sizes are called. The dimensions and names vary considerably around the world, with most countries having their own standards and terminology.

While, the "double" size appears to be standard amongst English speaking countries, based on the imperial measurement; the sizes for other bed types tend to vary. The European sizes differ, not merely because of difference based on use of the metric system.

A king-sized bed differs from the other sizes in implementation, as it is not common to have a king-sized box spring; rather, two smaller box-springs are used under a king-sized mattress. It is a common misconception that on a U.S. "standard" or "eastern king", the box springs are identical in size to a "twin extra-long," however "twin extra-long" mattresses next to each other add up to 78 inches wide instead of the 76 inch width that is standard for an "eastern king". California King: 72 × 84 in a common size on the West Coast of the United State, also called a "Western King", "West Coast King", "Cal King", or "WC King".

Sheet is a woven fabric. The number of threads used in weaving is counted by the square inch. For example a thread count of 180 means a weave of 100 vertical threads per square inch, called the warp, and 80 horizontal threads, called the weft. The thickness of the

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thread is also a factor in this equation. The finer the thread the more number of them in one square inch, giving a higher thread count.

The range of construction is from Thread count 48 to 1600, with ends per inch ranging from 20 to 275 and picks per inch from 13 to 180.

Another thing to be aware of is ply. Two ply fabrics is made by twisting the yarns together before weaving, whereas single ply uses a single thread. Using two ply yarns doubles the thread count. So to compare the two remember that a single ply with a thread count of 100 is equal to a two ply with a count of 200. Thread count can go as high as 800 or 1600 threads. The term percale means a thread count of at least 100.

A higher thread count is not necessarily better because the higher the thread counts the thinner and more delicate the fibers will be, unless it is 2 ply. Since 2 ply doubles the thread count this makes the cotton heavier, not necessarily what you want in bed sheets.

Of course a high thread count is not the only determinant of quality in bed linen. The treatment that the cotton fiber has received, for example mercerizing, (Mercerizing is a chemical treatment which produces increased strength and a sateen finish which accepts dyes more readily) and the way in which the bed linen is woven and finished, all contribute to the quality of the finished product.

The flat fabrics such as sheeting are made from 100% cotton, blends of polyester and cotton, blends of polyester and viscose, blends of cotton and modal, blends of cotton and silk and modal, blends of cotton and bamboo, blends of cotton and sea weed fibers, blends of cotton and silver fibers, blends of cotton and charcoal fibers, blends of cotton and eucalyptus fibers and any combinations thereof.

Rugs are thick woven or tufted floor mats of shaggy or thick piled surface. Rugs are tufted floor covering used in specific areas of application. Rugs may have thick piles on one or both sides of the backing fabric. The thick piled surface is also sheared to give the surface soft velvety touch.

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Rugs may have tufting on one surface, and latex or rubber coating on the other surface to hold the tufts in place; as otherwise, the tufts may get dislodged from the backing fabric. Further, the latex or rubber coating acts as anti-skid surface.

Rugs are formed with a backing fabric and pile yarns for tufting. The backing fabric is normally a cotton canvas or HDPE (High Density Poly Ethylene) or PP (Polypropylene, with or without Nylon fleece) woven fabric or non-woven fabric of polypropylene fibers.

The tufting pile yarns are usually selected from natural fiber yarns such as, cotton, linen, hemp, sisal, wool, silk, ramie, banana fiber or regenerated cellulose fiber yarns such as, viscose, bamboo, modal, rose, eucalyptus or synthetic fiber yarns such as, nylon, polyester and polypropylene.

Loop densities range from 2.5 to 14.88 per sq. cm (16 to 96 per Sq. Inch) and loop heights of 3 mm to 34 mm. the count of the tufting yarn used ranges from Ne 2's to 20's (count is the weight per unit length). In the case of rugs and carpets the tuft loops are formed on tufting machines where in the loop yarn is tufted on to the base fabric by needles. The tufting can be of yarn dyed varieties or piece dyed varieties.

The terry woven fabrics and terry woven toweling are made from, for example, 100% cotton yarns, blends of cotton and viscose, blends of cotton, blends of silk and modal, bamboo fiber yarns, blends of cotton and bamboo yarns, eucalyptus fiber yarns; and blends of cotton and eucalyptus fiber yarns.

Flat fabrics, such as sheeting, may be made from 100% cotton, blends of polyester and cotton, blends of polyester and viscose, blends of cotton and modal, blends of cotton, silk and modal, bamboo fiber yarns, blends of cotton and bamboo yarns, eucalyptus fiber yarns; and blends of cotton and eucalyptus fiber yarns and any combinations thereof.

Rugs/carpets may be made from 100% cotton, blends of polyester and cotton, blends of polyester and viscose, blends of cotton and modal, blends of cotton, silk and modal, bamboo fiber yarns, blends of cotton and bamboo yarns, eucalyptus fiber yarns and

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blends of cotton and eucalyptus fiber yams, in the tufted loops and any combinations thereof.

Most fibers have absorbent properties, and the extent of absorption depends on the type of fiber, their blends and the structure of the yarn made therefrom.

By suitable modifications in the yarn structure, it is possible to increase the wicking property of the yarn, in effect increasing the hydrophilic nature, thereby making the yarns quick absorbing and bulky.

Further, the amount of twist in the yarn affects the properties of the towel products. The pile yarn is generally a low-twist yarn. Pile loops provide maximum surface area for the absorption of water and the low twist aids in the absorption by imparting wicking properties to the yarn. Ground warp and weft are generally hard-twisted compared to the pile yarn.

The ground and weft yarn twist factors generally range from about 3.8 to about 4.58, depending upon the towel construction. In contrast, the twist factor in the pile yarn generally ranges from about 3.2 to about 3.8.

Similarly in the case of flat fabrics, such as bed linen, the twist factor for warp and weft ranges from about 3.8 to about 4.58.

In the case of tufted loops in the rugs/carpets the twist factor depends on the number of plies in the yarn and ranges from 2.8 to 4.5.

Moreover, the greater the amount of free air space available within the yarn results in quicker and more complete the absorption of the water. Hence, to increase the amount of free space, (similarly as the air space increases the drying of the towel after absorption also increases) structural changes in the yarn has to be made.

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One such attempt for increasing the free air space was disclosed in PCT International Patent Publication No. WO 2007/054827 wherein Polyvinyl Alcohol ("PVA") is used as the soluble component.

A plethora of techniques for production of core spun yarn are known in prior art. JP62-162030 discloses one such technique, where in an already prepared short fiber roving wound on the bobbin is creeled and inserted in the middle of the another short fiber fleece (sliver) entering the drafting zone of the Yarn Spinnig Machine, both the fleece and roving entering through a specially designed fleece guide and roving guide, thus covering the pre made short fiber roving (B) with outer short fiber fleece (A), creating a covered yarn which has been named Two Layer Structure Spun Yarn by the inventors. This is evident from the diagram provided, where short fiber roving (B) is shown wound on the bobbin above and the fleece guide is in line with the drafting zone. The entire activity is carried out on the yarn spinning system.

The Japanese method is similar to the method normally used in making core spun yarn viz. Lycra in the core and cotton in the covering, where the stretched Lycra is fed from a bobbin above in the middle of the roving fleece in the front of drafting zone of the ring spinning machine, to make a Lycra core yarn for use in stretch garments.

However, the polyvinyl alcohol ("PVA") is also considered as plastic and results in a coagulated residue in hot water. This plastic substance tends to clog the drains, and also results in to a solid mass, in the filter press of the effluent treatment process and therefore gets categorized as hazardous sludge, which has to be sent to government approved burial sites according to the environmental rules and regulations. This solid though biodegradable, takes longer time to degrade and if incinerated for decomposition, liberates carbon dioxide into atmosphere also, incomplete combustion leads to release of carbon monoxide also.

The Global Organic Textile Standard (GOTS) for producing organic products made from organically grown cotton prohibits the use of PVA in the manufacturing thereby imposing a restriction on the use of Hygro yarns made by using PVA.

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In order to overcome the above environmental issues and restrictions on the production of organic textiles, it was the objective of inventors to explore the possibilities of using other fibers in place of PVA for producing the twist-less or the Hygro yarn.

During the course of exploration it was found that Wool, a natural protein fiber tends to dissolve in Sodium hydroxide solution (Caustic Soda Lye) at certain concentration and that the use of sodium hydroxide (NaOH) is permitted in the GOTS. Wool is natural fiber, biodegradable and is environment friendly.

Wool is taken from animals of the Caprinae family, principally sheep, but the hair of certain species of other mammals including: goats, llamas, and rabbits may also be called wool. Because of the crimp, wool fabrics have a greater bulk than other textiles, and retain air, which causes the product to retain heat. Wool fibers are hygroscopic, meaning they readily absorb and give off moisture.

Wool can absorb moisture almost one-third of its own weight Wool ignites at a higher temperature than cotton fibers and some synthetics. It has lower rate of flame spread, low heat release, low heat of combustion, and doesn't melt or drip; it forms a char which is insulating and self-extinguishing, and contributes less to toxic gases and smoke than other flooring products, when used in carpets.

Wool carpets are specified for high safety environments, such as trains and aircraft. Wool is static electricity resistant, as the retention of moisture within the fabric prevents a build up of static.

Wool straight off a sheep, known as "grease wool" or "wool in the grease", contains a high level of valuable lanolin, as well as dirt, dead skin, sweat residue, and vegetable matter. Before the wool can be used for commercial purposes, it must be scoured, or cleaned. Scouring may be as simple as a bath in warm water, or as complicated as an industrial process using detergent and alkali, and specialized equipment. In commercial wool, vegetable matter is often removed by chemical carbonization.

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The quality of wool is determined by the following factors, fiber diameter, crimp, yield, color, and staple strength. Fiber diameter is the single most important wool characteristic determining quality

Wool is also separated into grades based on the measurement of the wool's diameter in microns. These grades may vary depending on the breed or purpose of the wool. For example:

- < 17.5 - Ultra fine Merino
- 17.6-18.5 - Superfine Merino
- < 19.5 - Fine Merino
- 19.6-20.5 - Fine medium Merino
- 20.6-22.5 - Medium Merino
- 22.6 < - Strong Merino
- < 24.5 - Fine
- 24.5–31.4 - Medium
- 31.5-35.4 - Fine cross bred
- 35.5 < - coarse cross bred.

Fibers that are finer than 25 microns are used for manufacturing garments, while coarser grades are used for outerwear or rugs. The finer the wool, the softer it will be, while coarser grades are more durable and less prone to pilling.

Australia is the leading producer of wool which is mostly from Merino sheep. New Zealand is the second largest producer of wool, but is the largest producer of crossbred wool. China is the third largest producer of wool.

Keeping with the times, organic wool is becoming more and more popular. This wool is very limited in supply and much of it comes from New Zealand and Australia. Organic wool is becoming easier to find in clothing and other products, though these products often carry a higher price. Wool is environmentally preferable (as compared to petroleum-based Nylon or Polypropylene) as a material for carpets as well, in particular when combined with a natural binding and the use of formaldehyde-free glues.

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Shoddy or recycled wool is made by cutting or tearing apart existing wool fabric and re-spinning the resulting fibers. As this process makes the wool fibers shorter, the remanufactured fabric is inferior to the original. The recycled wool may be mixed with raw wool, wool noil, or another fiber such as cotton to increase the average fiber length. Such yarns are typically used as weft yarns with a cotton warp.

- Strength: Wool is the weakest of the natural fibers. Various wool fabrics are made more durable, by using selected grades of recycled wool. The fiber is strengthened by the use of ply yarns.
- Elasticity: The fiber is very elastic and can be stretched to 25 to 30 percent of the natural length. Wool and wool blend fabrics are given mechanical crimps and also chemical treatments to increase the elasticity. Chemical treatments lead to improved shape retention.
- Resilience: Wool fiber has high resilience; therefore it does not wrinkle much. The wrinkles, if any, smooth when the fabric is steamed.
- Absorbency: Wool tends to be a water repellent, but if the moisture seeps in, it can absorb about 20 percent of its weight.
- Heat Conductivity: The natural fiber is a non conductor of heat; therefore wool is excellent for manufacturing winter wear garments, carpets and rugs.

A micron is the measurement used to express the diameter of a wool fiber. The lower microns, the finer are the fibers. Fiber diameter is the most important characteristic of wool in determining its greasy value.

Every fleece comprises a very wide range of fiber diameters - for example a typical Merino fleece will contain fibers of as low as 10 microns in diameter, and there could be fibers with diameters exceeding 25 microns, depending on the age and health (or nutrition) of the sheep. What is usually referred to as wool's "micron" is the mean of the fiber diameters or average diameter. This may be measured in a number of different ways. Longer wools are processed in the worsted system (weaving), which are called combing types and are generally around 51 millimeters (mm) and longer. Short stapled wools are

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more profitably used in the woolen section where high grade material may be produced from superfine wool. Staple length (mm) is highly correlated with mean fiber length in the top (hauteur).

Although traditionally, staple length only referred to animal fibers, it is now used when referring to animal and manufactured fibers as well.

Cashmere wool, usually simply known as cashmere, is a fiber obtained from the Cashmere goat. The word cashmere derives from an old spelling of Kashmir. Cashmere wool is fine in texture, and it is also strong, light, and soft; when it is made into garments, they are extremely warm to wear.

Merino wool is finely crimped and soft. Staples are commonly 65 mm (2.5 inches) to 100 mm (4 inches) long. The quality of wool is determined by the following factors, fiber diameter, crimp, yield, color, and staple strength. Fiber diameter is the single most important wool characteristic determining quality and price.

Merino wool is typically 3-5 inches in length and is very fine (between 12-24 microns). The finest and most valuable wool comes from Merino hogget. Wool taken from sheep produced for meat is typically coarser, and has fibers that are 1.5 to 6 inches in length. Damage or breaks in the wool can occur if the sheep is stressed while it is growing its fleece, resulting in a thin spot where the fleece is likely to break.

Summary on Invention:

Accordingly, the invention provides a novel yarn and fabric comprising alkali soluble wool fibers blended with other fibers to manufacture soft terry fabrics or flat fabrics, such as bed linen or rugs/ carpets, which are highly hydrophilic in nature and bulky, (herein referred to as "Hygro Towels" or "Hygro Toweling Fabrics" or "Hygro fabrics" or "Hygro flat fabrics" or "Hygro Rugs" or "Hygro Carpets") The yarns and fabrics hence formed are highly hydrophilic and can absorb between 65 to 75% of the water contacting the yarn or fabric and are quick drying, increases in bulk after drying, and have a lower tendency to lint.

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The invention further provides a method for making Hygro Toweling Fabrics, Hygro flat fabrics and Hygro Rugs/carpets.

DEFINITIONS OF TERMS

Absorbency:	The propensity of a material to take in and retain liquid, usually water.
Blend:	A textile containing two or more different fibers, variants of the same fiber or different colors and grades of the same fiber.
Blending:	The mixing of quantities of the same fiber taken from many lots or of different types of fiber to produce a uniform result.
Carding:	A process in manufacturing spun yarn in which the fibers are separated, distributed, equalized and formed into a web. The web can be very thin or thick. The process of carding removes some impurities, and a certain amount of short or broken fibers.
Core Spinning:	A yarn spinning process by which a filament (usually elastic under tension) is covered with a sheath of staple fibers to produce a stretchable yarn. The resultant yarn and fabric have the characteristics of the sheath fiber along with the advantage of stretch and recovery.
Core Yarn:	A yarn made by winding one yarn around another to give the appearance of a yarn made solely of the outer yarn.
Denier:	Refers to the thickness of a fiber. The measurement of the diameter of the fiber.
Hank:	A definite length of textile material that varies according to the material. A hank of wool is 560 yards, cotton and silk is 840 yards, and linen is 300 yards.
OE	OE or Open End spinning is a different spinning technique of making yarn other than the ring spun yarn, wherein the yarn is made directly from sliver by using rotor-spinning technology.
Pile:	A surface effect on a fabric formed by tufts or loops of yarn that stand up from the body of the fabric.

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Spinning:	The final step in the production of yarn. The twisting of the sliver or roving.
Sliver:	The sliver is a continuous strand of loosely assembled fibers without twist. The production of the sliver is the first step in the textile operation that brings the staple fiber into a form that can be drawn and eventually twisted into a spun yarn.
Warp:	In woven fabric, the yarns that run lengthwise and are interwoven with the fill (weft) yarns.
Weft:	In woven fabric, the filling yarns that runs perpendicular to the warp yarns.
Yarn:	a continuous strand of textile fibers created when a cluster of individual fibers are twisted around one another.

Brief Description of Drawings:

Fig 1 depicts the process flow diagram for manufacturing of hygro-yarn using wool fibers, in roving core.

Fig. 2 depicts the process flow chart for manufacturing of toweling fabric or flat fabric or bed linen.

Fig. 3 depicts flow chart for spinning hygro yarn using blow room and draw frame blend.

Fig. 4 depicts flow chart for sheet manufacturing.

Fig. 5(a) and (b) depicts flow chart for spinning of cotton+wool per loop yarn for tufting

Fig. 6 depicts a flow chart for table top tufted rugs

Fig. 7 depicts a flow chart for machine tufted rugs

Detailed Description of the Invention:

The invention will now be described in details in connection with certain preferred and optional embodiments so that various aspects thereof may be more fully understood and appreciated.

It must be noted that as used herein and in the appended claims, the singular forms "a", "an", and "the" include plural reference unless the context clearly dictates otherwise. Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of skill in the art to which the disclosed

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invention belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, the preferred methods, devices, and materials are as described.

Accordingly, the present invention describes pile yarn in terry woven fabric, warp yarn or weft yarn in flat fabrics (Bed Linen), tuft yarn in rugs/carpets, that contain Sodium Hydroxide(Caustic or NaOH) soluble wool fibers, in its core, and cotton and/or other fibers on the outside or wool blended with other fibers. .

Further, described is a process wherein pile yarn containing wool fibers in core or as blend is woven with cotton weft and warp yarns to produce terry fabrics, such as towels. The fabric is then scoured using Sodium Hydroxide (Caustic or NaOH) to dissolve the wool fibers. The amount of fibers dissolved, depends upon the count of the yarn or yarns used. The amount of wool present can vary from 5% to 40% of the weight of the yarn. This produces hollow air space throughout the pile yarn, corresponding to an increase in the air space in the pile yarn. By increasing the air space in the pile yarn, the resulting towels are softer and bulkier than standard cotton towels. When the % of Cotton is less than 95% and wool is 5% and above, the other component may consist of Organic Cotton, linen, silk, viscose, bamboo, polyester, nylon, polypropylene or any other fiber of choice.

In the case of flat fabrics (bed linen) the warp and/or weft yarn similarly contain Sodium Hydroxide(Caustic or NaOH) soluble fibers, such as wool fibers, in its core or in blend with cotton and or other fibers on the outside (surrounding the core) or as blended mixture. This increases the air space throughout the yarn, thereby making the fabric, bulkier and softer.

In the case of Tufted fabrics (Rugs/Carpets) the tuft yarn, tufted on canvas/HDPE woven/PP woven fabrics, similarly contain, Sodium Hydroxide(Caustic or NaOH) soluble wool fibers, in its core or in blend with cotton and or other fibers, surrounding the core or as blended mixture. This increases the air space throughout the yarn, thereby making the rug/carpet, bulkier and softer.

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The pile yarn described herein typically contains cotton fibers and a fiber, which dissolves in Sodium Hydroxide (Caustic or NaOH), such as wool fiber. The wool core yarn is used only in the pile of the towel or toweling fabric, whereas in the case of a flat fabric, such as sheeting, warp and/or weft yarn can be of a wool core/blend configuration.

The cotton that forms the outer surface of the pile yarn of terry fabric or warp-weft yarn of sheets or the tufts of rugs/carpets, can be of any origin; for example, Indian, Egyptian, Australian, United States of America (USA), Syria, Russia etc. In place of cotton, the pile yarn may contain cotton blends, silk fibers, modal fibers, acrylic fibers, blends of cotton and bamboo, blends of cotton and sea weed fibers, blends of cotton and silver fibers, blends of cotton and charcoal fibers, blends of cotton and eucalyptus fibers.

The warp-weft yarn in flat fabrics may have blends of polyester and cotton, blends of polyester and viscose, blends of cotton and modal, blends of cotton and silk and modal, blends of cotton and, bamboo, blends of cotton and sea weed fibers, blends of cotton and silver fibers, blends of cotton and charcoal fibers, blends of cotton and eucalyptus fiber and any combinations thereof. The sheath or outer covering of the yarn or fabric may be 100% cotton or a combination of any of the foregoing blends.

Wool is a natural fiber plucked from the fleece of sheep, cleaned, processed (carbonized) to remove impurities. Wool fibers are easily dissolved in Sodium Hydroxide (Caustic or NaOH) at 50-120°C. (The Caustic Flake, which are of 100% concentration, a solution of 4 to 6 grams per liter in water will enable the wool to dissolve and if the caustic lye of concentration 48 to 52 % is used then 9 to 12 grams per liter in water is sufficient), during scouring, for removing the natural wax, etc.

Accordingly in one of the embodiment, the present invention provides following methods for introduction of wool fiber in cotton yarn using cotton spinning system.

a. Blending of wool fibers along with cotton fibers in the blow room of cotton spinning system at desired proportion and spin the blended yarn in the usual manner; and/or

b. Blending wool fiber slivers separately processed in blow room and cards, along with cotton fiber slivers in the draw frame of a cotton spinning system, and to continue

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producing the yarn on ring spinning or open end spinning machine. As the fibers were homogeneously blended in this process, spinning of yarn on ring or open end system was possible; and/or

c. A combination of a) and b) whereby the cotton and wool are blended in blow room in requisite proportion, processing through carding and breaker draw frame and blending this mixed sliver with 100% cotton slivers on finisher draw frame to get the final desired wool proportion in the final yarn. The roving, spinning and coning are same as described above; and/or

d. Inserting wool fiber slivers into the middle of cotton slivers at the feeding end of the drafting zone of the speed frame, twisting on the speed frame, and subsequently spinning the yarn at ring spinning. This was considered a potential system after trial and error refinements were made; and/or

e. The yarn can either be spun on the Ring Spinning System or the Open End Spinning System, except procedure d).

And finally twisting of the cotton/wool yarn, in the Two for one twister to, get a composite yarn of cotton/ wool twisted yarn.

In preferred embodiment, the invention provides method for making the pile yarn or warp-weft yarn, as detailed below.

Method of Forming Wool Sliver:

The wool fibers are first processed through a blow room in the cotton spinning system. It is here that the fibers are made into slivers through the process of carding and use of a draw frame (one or two passages as required in order to ensure uniformity of fibers in the stream). The range of wool sliver hank is from 0.05 to 0.130. The hank is the weight per unit length of the sliver as per the number English System of Count Notation.

A wool fiber sliver is made on the draw frame with a finer hank greater than or equal to 0.05 hank. The microns of the wool fibers are typically from 28 to 36 mic. It has a length

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that is equal to or more than 25 mm and shorter than 110 mm. (25, 32, 44 mm and 58 mm fiber can be used with or without modifications in the machine parameters in spinning, by selecting wool of 25-50mm range). The wool can be, including, but not limited to Australian, New Zealand, and China, Cashmere wool or shoddy wool procured, with micron ranging from 28 to 36 and length from 25-50, 50-75, 52-100 etc. The wool comber noil and or shoddy have a range from 25-50mm in length. The wool fiber dissolves in Sodium Hydroxide (Caustic or NaOH) at a temperature from about 50°C to 110°C.

Method of Forming Sliver from fibers forming the outer covering:

The outer cover sliver (sheath) may be made from cotton blends, silk fibers, modal fibers, or acrylic fibers, blends of cotton and bamboo; blends of cotton and sea weed fibers; blends of cotton and silver fibers, blends of cotton and charcoal fibers or blends of cotton and eucalyptus fibers.

The warp-weft yarn in flat fabrics may have blends of polyester and cotton; blends of polyester and viscose; blends of cotton and modal; blends of cotton and silk and modal; blends of cotton and, bamboo; blends of cotton and sea weed fibers; blends of cotton and silver fibers: blends of cotton and charcoal fibers, blends of cotton and eucalyptus fibers and any combinations thereof.

In case of blended sliver, each component is separately processed through carding and the individual carded slivers are subsequently blended together on draw frames.

The cotton sliver may contain cotton from any country of origin, including but not limited to India, Egypt, Australia, US, Syria, and Russia. The cotton sliver is prepared by processing through the blow room, carding, draw frames, combers and final draw frames, producing a 0.05 hank sliver and above.

After carding, the cotton sliver is subjected to combing to remove short fibers. The amount of noil or fibers that are less than 12 mm, removed ranges from 7% to 24% of the weight of the feed material. For example, the weight can be 8%, 10%, 12%, 15%, 16%, 18%, 20%, 22%, 24% of the weight of the feed material.

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Configuring Wool fibers in the core:

It is to be understood that a combination of blends may be used in the place of 100% cotton in the outer cover as mentioned earlier. Configuring the wool fibers in the core of the cotton yarn (and other fibers) makes the Hygro yarn. This can be accomplished in a variety of ways. In one embodiment, the wool fibers are added on the core-spinning machine. Here, the wool roving is fed in the path of the cotton roving in the drafting zone of the ring frame.

In a second embodiment, wool roving is introduced in the path of cotton roving on the roving machine. Alternatively, the wool can be added to the middle of the cotton roving by reversing the rotation of flyer in the counter-clock-wise direction, which is opposite to the direction of the normal flyer rotation (i.e. the clockwise direction). In both situations, the wool fibers are placed in the middle of the cotton sliver during the process of manufacturing the roving on the roving machine.

The sliver is a continuous strand of loosely assembled fibers without twist. The production of the sliver is the first step in the textile operation that brings the staple fiber into a form that can be drawn and eventually twisted into a spun yarn.

Suitable arrangements, such as guide pulleys on a roving machine creel, are made for guiding the wool sliver and the cotton sliver from the drawing cans at the creel side of the speed frame. Specially designed condensers are incorporated for feeding wool sliver at the inlet, and at the back and middle zones of the drafting system on the speed frame, to ensure that the wool sliver always stays in the middle of the cotton sliver.

The twisting of the roving with wool fibers in the middle is done in the normal fashion, i.e. with clock-wise rotation of the flyer to give 'Z' twist. Alternatively, the roving can have a 'S' twist, by reversing the direction of the rotation of the flyer to a counter-clockwise direction.

The roving produced by these methods has a twist multiplier to optimize the working conditions. The roving hank ranges from 0.5 to 5.0 hanks.

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Spinning the Wool Core Roving

It is to be understood that a combination of blends may be used in the place of 100% cotton in the outer cover as mentioned earlier. The yarn is spun on ring frames using the normal settings. For example, all of the setting parameters on ring frame are determined based on the type of wool fibers and other fibers used to make the yarn. The yarn spun on the Ring Spinning has a count ranging from about Ne 8s to about 30s for terry fabrics, about Ne. 20s to about 120s for flat fabrics and Ne 2's to 20's for tufting yarns in rugs/carpets. Where doubled and plied yarn is to be made, two or more single yarns are assembled on assembly winders, doubled or plied on two-for-one twisters with a TPI (twists per inch) from about 6.5 to about 14.5 TPI in 'S' direction in case towel double yarns. The twist direction can be Z over S or Z over Z. The resultant counts would be about 2/8s to about 2/30s, for terry fabrics. Similarly the doubled yarns for flat fabrics may be from about 20/2's to about 120/2s with about 50 to 85 % of single yarn TPI as doubled yarn TPI in either Z over S or Z over Z configuration , same would be the case with rug/carper tuft yarns. The machinery settings depend on the fiber length and the settings will be as per the recommendation of the machine manufacturer for these lengths.

The processing parameters depend on the wool fiber and cotton used and/or other fibers used in the blend. The ring spun yarn is wound into large packages on the Auto coner using suitable settings and process parameters.

In another embodiment, the present invention provides manufacturing of Cotton/wool yarn by inserting wool in the core of roving using method comprising following steps;

a. Inserting wool fiber slivers into the middle of cotton slivers at the feeding end of the drafting zone of the speed frame;
b. twisting on the speed frame, and;
c. subsequently spinning the yarn at ring spinning.

This was considered a potential system after trial and error refinements were made.

In further embodiment the invention provides a hygro towels and the process for manufacturing thereof which is detailed below.

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Terry towels are formed from three types of yarn. The first type of yarn is the ground warp. The ground warp is the longitudinal set of yarn forming the base fabric. The second type of yarn is the pile warp. The pile warp is placed in the longitudinal direction and produces the pile loops on the towel surface. The pile loops provide a large surface area for maximizing the absorption of water. The third type of yarn is the weft yarn. The weft yarns are laid perpendicular to the pile yarns, and interlace with pile or ground yarn to form the fabric of the towel. The ground and the weft yarns are standard cotton yarns that are generally used in towel manufacturing processes.

The ground yarn has a count ranging from about Ne 2/10s to about Ne 2/50s and from about Ne 10s to about Ne 16s in single yarn, combed or carded. In the preferred embodiment, the ground yarn is about 2/24s carded. The weft yarn has a count ranging from about Ne 8s to about Ne 50s both carded/combed, Ring and Open End yarn.

The Twist Multiplier for weft yarn and ground yarn is from about 3.4 to about 4.2 Z twist. The weft and ground yarn may be dyed. The dyed or grey ground yarn is then sent to warping and to weaving.

Weaving of Pile, Weft, and Ground Yarns (terry fabrics):

The ground, weft, and pile yarns are woven together under normal conditions. The terry fabric can be made on 56, 60, 70 reeds; however, reed space is not a limiting factor.

The terry weave can be 2.5 pick, 3 pick, 4 pick, 5 pick, and 6 pick terry, preferably, the weave is 3 pick terries. The pile height is in the range of 3.6 to 8.5mm.

Dissolving the Wool fiber:

After the weaving is completed, the fabric roll is scoured using Sodium Hydroxide (Caustic or NaOH) (The Caustic Flake, which are of 100% concentration, a solution of 4 to 6 grams per liter in water will enable the wool to dissolve and if the caustic lye of concentration 48 to 52 % is used then 9 to 12 grams per liter in water is sufficient) and dyed in the normal fashion in a fabric dying machine. While scouring, bleaching and

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dyeing, the operating temperature ranges from about 95°C to about 120°C preferably, the temperature is about 120°C.

The liquor ratio is a ratio of the material (weight) to water (volume). The liquor ratio should be sufficient to facilitate prompt dissolution of the wool, while allowing free movement of the fabric. The liquor ratio ranges from about 1:5 to about 1:30; preferably the liquor ratio is 1:7.

The material is typically wound into the shape of a rope prior to entering the fabric-dyeing machine. The rotation of the material is essential to promote rapid dissolution of wool. A continual overflow of water is also desired.

After washing, the liquor is drained and fresh water is injected for rinsing to eliminate all the dissolved wool. The water is at a temperature ranging from about 55 °C to about 100 °C; preferably 100 °C. Therefore, the fabric is rinsed in hot water after draining to wash away any wool residue. This rinsing step also ensures that any loose fibers drain out along with the drain water.

Drying and straightening the fabric:

After unloading the material from the washing and rinsing vessel, the material is hydro-extracted in a Hydro-extractor in the standard manner to reduce the moisture from 200% to 60%. A rope is passed through rope opener, which is equipped with drumbeaters both at feed and delivery ends, to straighten the twist in the rope. Then the material is passed two times through a hot air dryer (e.g. Alea) which is equipped with drumbeaters at both the feed and delivery ends. This ensures proper lifting of the pile. The first drying is carried out at about 120 °C. The second drying occurs at a higher temperature, such as 150 °C for 4 to 5 minutes. The full width fabric is then passed through hot air stenter and a weft straightener to straighten the fabric and return it to its proper dimensions.

Conditioning (optional)

The towels are then passed through the shearing machine on both the sides. The blade/laser on the shearing machine is set such that only protruding fibers are cut, and the piles are not cut. This ensures reduced linting during washing of towel subsequently. This

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process is optional depending on the amount of protruding fibers the fabric is then carried through length cutting, length hemming, cross cutting, cross hemming, checking, folding, and packing according to the standard practice.

The method of processing can also be continuous bleaching and continuous dyeing range followed by hot air drying and stentering. Care is to be exercised to ensure that the wool dissolves completely, during the process. The other conditions of processing remains as described above for terry fabrics. The following show the sequence of operations.

PRE TREATMENT RANGE (PTR)

- Impregnation chamber
- Steamer

The above two processes are for desizing and wool dissolution

- Two compartment Washing
- Impregnation chamber and steamer for bleaching
- Three compartment washing.
- Neutralizing range

CONTINUOUS DYEING RANGE (CDR)

- Cooling cylinders
- Padders/steamer
- Thee washing compartments (one of them for Oxidizing in the case of Vat colors)
- Soaping
- Two washing compartments
- Neutralizing and softening.

Bleaching and Dyeing Process:

The towels with wool core spun yarn in the pile and cotton yarn in weft and ground is processed in the dyeing house in rope form. The scouring and bleaching can be either in a continuous bleaching range or an exhaust dyeing machine. The liquor ratio in either case is 1:7.

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In case of wool core spun yarn made towels scouring or bleaching is carried out with detergent, hydrogen peroxide, stabilizer and 10 gms per liter of caustic lye (48-52%) at a temperature of 98°C for 30 minutes followed by cold wash, peroxide killing and neutralization with Green acid to start the dyeing process.

The scouring and or bleaching process dissolves the wool component and goes in to the drain.

The dyeing is carried out in the ecosoft machine with following dyes and chemicals for 2-3 hours at 60°C. The dyes used are Huntsman EN and bi-functional class.

In further embodiment, the invention provides a process for manufacturing of yarn that contains cotton and wool fibers for manufacture of sheeting and related fabrics the process is detailed below.

1. Cotton + Wool (50% + 50%) blending

   Blow Room: Cotton Shankar 6 along with wool 38-44 mm of 29 micron manually blended in the ratio 50:50 and the mixture is processed through regular blow room with lesser beating points, cotton from Indian origin, Egyptian, American Pima, Australian or of any other origin with properties ranging from 25-34 mm, 2.5% span length, 3.5-4.5 micronire, 20-34 gms/tex, 2.0-3.5 short fiber index can be used, similarly the micron of the wool fibers is typically from 28 to 36 microns. It has a length that is equal to or more than 25 mm and shorter than 110 mm. (25, 32, 44 mm and 58 mm fiber can be used with or without modifications in the machine parameters in spinning, by selecting wool of 25-50mm range). The wool can be of Australian, New Zealand, and Chinese origin or Cashmere wool or shoddy wool procured, with microns ranging from 28 to 44 and length from 25-50, 50-75, 52-100 etc. The wool comber noil and or shoddy have a range from 25-50mm in length. The wool fiber dissolves in Sodium Hydroxide (Caustic or NaOH) at a temperature from about 50°C to 110°C.

   Card: through the carding machine, with a Hank (Weight/unit length) of 0.110 (Range 0.095 to 0.130)

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Card slivers (Cotton + Wool) are passed through Breaker Drawing, 4 ends up (6, 8 ends up can also be possible) Drg. hank 0.110 is maintained (Range 0.095 to 0.130)

2. 100% Cotton combed

   Shankar 6 cotton was separately processed in regular blow room, carding and breaker drawing to produce a sliver of hanks 0.110. These slivers are then combed to remove short fibers, to up grade the quality.

   Unilap with 22 ends up and a lap weight of 75 gm/meter, processed through combing machine to get a sliver hank of 0.110 (Range 0.095 to 0.130), after removing a noil of 10% (noil are the short fibers removed in the combing process ranging from 8% to 24%)

3. 100% Cotton Carded

   Blow room for cotton: Shankar 6 cotton was separately processed in regular blow room, carding and breaker drawing to produce a sliver of hanks 0.110.

4. Blending of cotton with wool, combed cotton and carded cotton slivers in finisher draw frame:

   Draw Frame: In the Finisher Drawing the Cotton Carded sliver, 2 ends, the Combed Cotton sliver 4 ends, and Cotton + Wool Sliver, 1 end are blended (6 ends of cotton and 1 end of Cotton + Wool to give Cotton 92.86%, wool 7.14% blend) and drawn to produce a hank of 0.110

   Speed Frame: The Sliver is attenuated and twisted and wound on to bobbins to produce Roving of 1.0 hank (range 0.5 to 3.0) with a TPI (twist per inch) of 1.2 (range 0.9-1.55)

   Ring Frame: The count spun was Ne (Number English, number of 840 yards hank in one lb) 40's, (Range of count from 20's to 120's) with a TPI of 27.2(Twist multiplier of 4.3,) (range of TM 2.8 –4.5)

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Auto Cone: Ring yarn was wound in to a large package of 2.5 kgs on paper cones.

In yet another embodiment, the invention provides a process for manufacturing of sheet, the process of which is detailed below.

Sheets are formed from two types of yarn. The first type of yarn is the warp. The warp is the longitudinal set of yarn forming the fabric. The second type of yarn is the weft yarn. The weft yarns are laid perpendicular to the warp yarns, and interlace with warp yarn to form the fabric of the sheet. The warp and the weft yarns are standard yarns that are generally used in sheet manufacturing processes.

Production of the Warp yarn:

The warp yarns normally are cotton yarns in single /double yarn configuration made of cotton yarn or the blends of cotton, viscose, polyester, silk etc., The count ranging from Ne 20's to 120's in single and Ne 2/20's to 2/120s in double configuration, with twist multipliers from 2.8 to 4.5 in single and twist multiplier of 2.8 to 4.5 with TPI of 9.5 to 39 in the double configuration. In the current embodiment the Warp yarn is a blend of cotton and wool fiber yarn (Cotton 92.86%, wool 7.14%) with a count of Ne 40's and TM of 4.3 (This count becomes finer to Ne 42.85, once the wool component is dissolved during processing)

Production of the Weft Yarns:

The Weft yarn has a count ranging from Ne 20's to Ne 120's in single and Ne 2/20 s to Ne 2/120s combed or carded. In the preferred embodiment, the weft yarn is of combed cotton yarn, with a count of Ne 40's and TM of 4.3.

Warp and Weft yarns are prepared according to standard procedures. However, during combing only 8-24% of the noil is removed. Typically 8 %, 10%, 12%, 14%, or 16%, 18%, 20%, 22%, 24% of the noil is removed. The TM for warp yarn and weft yarn is from 2.8 to 4.5 Z twist. The warp and weft yarn may be dyed. The dyed or grey warp/weft yarns are sent to warping and to weaving.

Normally, when the warp yarn is in single, the yarn is sized to impart additional strength to the yarn to withstand the stresses and strains of weaving.

Weaving of Warp and Weft Yarns:

The warp and weft yarns are woven together under normal conditions. The sheet fabric can be made on 54, 56, 60, 70, 72 reeds, with 4 to 5 ends in a dent. In the preferred embodiment, the reed is 54. The picks/cm, range from 14 to 85, in the preferred embodiment the pick/cm is 28.34.

The sheet weave can be satin, sateen, twill, plain (percale) etc. In the preferred embodiment, the weave is Sateen.

Desizing, Bleaching and dyeing of fabric:

After the weaving is completed, the fabric roll is desized, bleached and dyed in the normal fashion in a fabric dyeing machine. While scouring, bleaching and dyeing, the operating temperature ranges from 95°C to 120 °C. In the preferred embodiment, the temperature is 120°C.

The liquor ratio is a ratio of the material (weight) to water (volume). The liquor ratio should be sufficient to facilitate free movement of the fabric. Typically the liquor ratio ranges from 1:5 to 1:30. In the preferred embodiment the liquor ratio is 1:7.

The scouring or bleaching is carried out with a detergent, hydrogen peroxide, stabilizer, and 10 grams per liter of Caustic lye (48%-52%) at a temperature of 98°C for 30 minutes followed by cold wash, peroxide killer and neutralized with Green acid before the dyeing process.

The material is typically converged into the shape of a rope prior to entering the fabric-dyeing machine. A continual overflow of water is also desired.

A rinsing step also ensures that any loose fibers drain out along with the drain water.

Drying and straightening the sheets:

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After unloading the material from the washing and rinsing vessel, the material is hydro-extracted in a Hydro-extractor in the standard manner to reduce the moisture from 200% to 60%. A rope is passed through rope opener, which is equipped with drum beaters both at feed and delivery ends, to straighten the twist in the rope. Then the material is passed two times through a hot air dryer (e.g. Alea), the first drying is carried out at 120 °C. The second drying occurs at a lower temperature, such as 150°C for 4 to 5 minutes. The full width fabric is then passed through hot air stenter and a weft straightener to straighten the fabric and return it to its proper dimensions. Alternatively the drying after rope opening can be in a tumble drier where the fabric is dried in hot air along with tumbling for getting softness and bulk in the sheet.

Alternatively the desizing, bleaching and dyeing can be performed on the continuous dyeing range, where all the above operations are carried out continuously.

Desizing, Scouring, Bleaching and Dyeing Process:

The sheet is processed in the dyeing house in rope form. The desizing, scouring and bleaching can be either in a continuous bleaching range or a soft flow dyeing machine. The desizing is with 0.43 grams/liter (gpl) of desizing agent with 1:7 liquor ratios. In either case the bleaching is with Hydrogen Peroxide with a liquor ratio of 1:7. The vessel capacity of soft flow dyeing is 50 kgs (1:15, 1:20, 1:30 can also be considered depending on the capacity of vessel). The bleaching is for duration of 30 minutes at 98°C.

The scouring or bleaching is carried out with a detergent, hydrogen peroxide, stabilizer, and 10 grams per liter of Caustic lye (48%-52%) at a temperature of 98°C for 30 minutes followed by cold wash, peroxide killer and neutralized with Green acid before the dyeing process. The caustic treatment renders wool to dissolve completely, thereby rendering it hygroscopic.

The dyeing is carried out in the eco-soft machine with following dyes and chemicals for 2-3 hours at 60°C. The dyes used are Huntsman FN and bi-functional class to get a shade of Brilliant Blue.

a) Difix Blue FF : 3.7%

b) Yellow Fn2r (Cibacron) : 0.013%

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c) Red (Fn2bl (Cibacron) : 0.308%
d) Sodium Sulfate : 70gpl
e) Soda Ash Light : 20gpl

After dyeing the bath is neutralized with Green Acid – 0.438 gpl at 60°C for 10 minutes.

This is followed by soaping with Miranon Ama – 0.88 gms/lit and Sodium Hexameta Phosphate – 1.75 gms/lit for 10 minutes at 60°C and further neutralized by treating with Green acid 0.48 gpl followed by softener treatment with Turbulant 86 – 1.75% and Accent11086 – 1.75% for 10 minutes.

In another embodiment, the invention provides a method making a tufting yarn to be used as loop containing cotton, wool fibers in different proportions and combinations that can be used to form soft tufted rugs and similar fabrics which has the properties of high absorbency, quick drying for use as rugs, carpets, floor coverings etc. The process is detailed below.

1. Cotton + Wool (85+15%):
   Blow Room: Cotton Shankar 6 and Wool 38-44mm X 29 mic are manually mixed in bins at 85 :15 proportion and is processed through regular blow room, (This Indian cotton has a characteristics of 2.5% span length of 30 mm ,micron ire of 3.8,strength of 28 gms/tex, short fiber index of 2.5) cotton from Indian origin, Egyptian, American Pima, Australian or of any other origin with properties ranging from 25-34 mm, 2.5% span length, 3.5 4.5 micron ire, 20-34 gms/tex, 2.0-5.5 short fiber index can be used.

   Similarly the microns of the wool fibers are typically from 28 to 36 microns. It has a length that is equal to or more than 25 mm and shorter than 110 mm. (25, 32, 44 mm and 58 mm fiber can be used with or without modifications in the machine parameters in spinning, by selecting wool of 25-50mm range). The wool can be of Australian, New Zealand, and China, Cashmere wool or shoddy wool procured, with microns ranging from 28 to 44 and length from 25-50, 50-75, 52-100 etc. The wool comber

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noil and or shoddy have a range from 25-50mm in length. The wool fiber dissolves in Sodium Hydroxide (Caustic or NaOH) at a temperature from about 50°C to 110°C.

Card: through the carding machine, with a Hank (Weight / unit length) of 0.100 (Range 0.105 to 0.120).

Card slivers are passed through Breaker Drawing, 6 ends up (8 ends up can also be possible) Drg hank 0.080(Range 0.050 to 0.130).

In the Finisher Drawing the once drawn slivers from breaker are doubled (6 ends up) and drafted to get homogeneous blend of cotton and wool and drawn to produce a hank of 0.080.

Speed Frame: The Sliver is attenuated and twisted and wound on to bobbins to produce Roving of 0.45 hanks (range 0.30 to 3.0) with a TPI (twist per inch) of 0.9 (range 0.7-1.55).

Ring Frame: The count spun was Ne 6's, (Ne=Number English, number of 840 yards hank in one lb) (Range of count from 5's to 30's) with a TPI of 8.99(Twist multiplier of 3.8,) (range of TM 2.8 –4.5).

Auto Cone: Ring yarn was wound in to a large package of 2.5 kgs on paper cones.

The yarn can also be made on open end spinning machines, where direct sliver of finisher drawing is fed on to the machine. The count range possible is from Ne 2's to Ne 30's

2. Twisting for 4 ply yarn:
   Twisting is carried out on the Two for One twister. Four yarns of Ne. 6's are assembled on the parallel winding machine or the assembly winder on to a cheese.

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This cheese is then mounted in the TFO and twisting is carried out. The twist direction will be "S". The twist imparted is 3.5 twists per inch (range from 3.0 to 24). The twisted yarn is wound on to cheeses/cones for use on tufting machine.

In another embodiment, the invention provides a method for making rugs. Rugs are formed from loop pile yarn for tufting on the canvas or woven fabric, viz., HDPE, PP woven fabrics.

The tufting is carried out on automatic tufting machines or on table tufting machines.

Machines as used for production of rugs of instant invention, is selected from All Loop (ALP) Machine, Multi Loop Cut Level (MLCL) Machine or All Cut Pile Machine (ACP)

An All Loop (ALP) Machine having gauge of 3/16 inch or 3/8 inch, resulting in production of linear loops, with capability to have loop densities in range of 16 to 80 per sq. inch and capable of introducing pile heights of 3mm to 34 mm, can be employed for manufacturing the rug of invention. The creel capacity of the said machine is 1728 cheeses.

A Multi Loop Cut Level (MLCL) Machine having gauge of 1/8 inch, resulting in production of linear loops, with capability to have loop densities in range of 20 to 80 per sq. inch and loop height of 3 to 20mm and cut pile height of 4 to 22 mm, can be employed for manufacturing the rug of invention. The creel capacity of the said machine is 2592 cheeses.

All Cut Pile Machine (ACP) having 1/8" gauge, capable of introducing pile height from 3mm to 34mm, with possible pile density of 20 to96 per sq. inch can be employed for manufacturing the rug of invention. The creel capacity of said machine is 2592 cheeses.

All Cut Pile Machine (ACP) having 3/16 inch gauge, capable of introducing pile height from 3 to 34 mm and density of 18 to 88 per sq. inch can be employed for manufacturing the rug of invention. The creel capacity of said machine is 1728 cheeses.

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Table-tufting Machine, having a gauge of 3/16 inch, which is capable of introducing pile height of 3mm to 30 mm and a pile density of 18 to 53 per sq. inch, can be employed for manufacturing the rug of invention. The creel capacity of said machine is 8 cheeses. In case of table tufting, the tufting is done on the pre-stitched (piped) backing of the requisite size.

In further embodiment, the invention provides a process for manufacturing the rugs as detailed below.

A pile loop yarn for tufting that contains cotton and Wool fibers, for making and using such a yarn in the rugs and related fabrics is described herein. In the preferred embodiment, the tufting loop yarn is of single yarn Ne1/6's (Cotton 85% Wool 15 %), plied in to 4 ply yarn i.e. 4/6's, with a resultant count of Ne1.5 tufted on a Polypropylene base fabric, for making tufted rug fabric.

Production of the Tufted Fabric:

A Multi Loop Cut Level (MLCL) Machine having gauge of 1/8 inch, resulting in production of linear loops, tuft length of 30mm, was considered for manufacturing the rug of invention. The creel capacity of the said machine is 2592 cheeses.

Latex coating:

Second stage is coating, wherein, the tufted roll, from tufting step, are loaded on to the Latex coating machine, where the coating is a continuous operation. The supply of mixture of foam latex, accelerator and gel is through automated system. The thickness of the coat and controlling of the GSM is done through microprocessor based programs. The embossing of the latex backing to introduce anti-skid property and baking and drying of latex are carried out by system itself. In the current embodiment the coat given was Lick Coat, with coating GSM of 300, at a machine speed of 5 meters/min. The latex used is 100% synthetic latex Vita, with out any additions.

Cutting and Stitching:

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Third stage is cutting wherein; cutting of the tufted and coated rug fabric is carried out on the automatic infra red guided cutting machine to the requisite size as per the specifications.

The cut and coated rugs are further stitched on four sides on stitching machines with folders for guiding the piping cloth or all the four sides are over locked with the pile yarn instead of piping cloth.

Desizing, Bleaching and dyeing of fabric:

After the Stitching is complete, the rugs are washed, scoured, bleached and dyed in the normal fashion in a Piece dyeing machine, such as EZM machine. While scouring, bleaching and dyeing, the operating temperature 60°C- 100°C is maintained.

The liquor ratio is a ratio of the material (weight) to water (volume). The liquor ratio should be sufficient to facilitate free movement of the fabric. Typically the liquor ratio ranges from 1:5 to 1:30. In the preferred embodiment the liquor ratio is 1:7. A continual overflow of water is also desired. The scouring or bleaching is carried out with a detergent, hydrogen peroxide, stabilizer and 10 grams per liter of Caustic lye (48%-52%) at a temperature of 98°C for 30 minutes followed by cold wash, peroxide killer and neutralized with Green acid before the dyeing process. The caustic treatment renders wool to dissolve completely, thereby rendering it hygroscopic.

The dyeing is carried out in the same machine with following dyes and chemicals for 2-3 hours at 60°C. The dyes used are Huntsman FN and bi-functional class.

The rugs are first kept wetting after bleaching and scouring, for 10 min. at 70°C and at 60°C for leveling for 5 minutes. The dyeing is carried out for 3-5 hours at 60° after adding dyes, salt and soda maintaining a pH of 7. After dyeing is complete the liquor is drained and in the end softener is added with fresh water at 55°C for 10 minutes with a pH of 5.5. Drained and rinsed before unloading from the dyeing machine.

Drying of the Rugs:

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After unloading the material from the dyeing vessel, the material is hydro-extracted in a Hydro-extractor in the standard manner to reduce the moisture from 200% to 60%. Then the material is loaded in to Triventa Tumble drying machine and the rugs are dried at 85°C for about 90 to 100 minutes. The tumbling ensures softness and bulk in the rug.

The rugs are unloaded from the drier and loaded in trolleys and sent to Intermediate storage (IMS) from where it is issued to finishing area.

Finishing of the Rugs:

The rugs as per batch are issued by IMS to the finishing. Here the carvers cut the protruding loops etc from the face and all the four sides of the rug and send to checking area where the checkers sort out the defective pieces and the passed pieces are sent to poly bag packing.

The rugs after polypacking pass through metal detectors and then are packed in cartons as specified.

The instant invention is more specifically explained by following examples. However, it should be understood that the scope of the present invention is not limited by the examples in any manner. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific embodiments of the invention described herein. Such equivalents are intended to be encompassed by the scope of claims.

EXAMPLES:

EXAMPLE 1:

The following details illustrate typical pile yarn manufacturing parameters, towel construction parameters, and processing details.

Pile Yarn Manufacturing Parameters

The Wool fiber used in this example is 29 micron x 38-44 mm (Av) fiber and Shankar 6 cotton of Indian origin with 2.5% span length of 28 to 32 mm, micronaire of 3.6 to 4.2,

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fiber strength of 21 Gtex to 24 Gtex, uniformity ratio of 45 to 47% and short fiber index 3.5 to 5.5. The cotton and Wool fibers were blended to produce a pile yarn containing 80% S-6 Combed Sliver (18% Noil) and 20% wool (29 mic).

The spinning process parameters and yarn properties for Wool/Cotton Pile Yarn are described below.

Cotton Sliver Preparation (Combed):

The cotton used for the preferred embodiment of Ne13's is Shankar-6 having the following parameters:-

2.5% span length	: 28 to 32 mm
Micronaire	: 3.6 to 4.2
Fibre Strength	: 21 to 24 gtex.
Uniformity ratio	: 45 to 47.
Short fibre index	: 3.5 to 5.5%.

The cotton is processed through blow room having bale plucker, Axi-flow, Multi-mixer, CVT3 beater and Dustex.

The cotton is processed from blow room through to carding where the fibers are individualized. The hank of the card sliver is maintained at 0.1 with a delivery speed of 145 meter/minute.

The cotton sliver from carding is then processed through a breaker drawing where at the feed end the number of doublings are 6 and a hank delivered kept at 0.12. The delivery speed is 450 meters per minute.

Since combing is necessary to remove short fibers, the draw frame slivers are processed through Unilap machine with 24 doublings and formed into a lap of 75 gms/meter weight.

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The lap is processed on the combing machine with 6 heads and one delivery resulting in a sliver hank of 0.12. The combers are worked at 350 nips/minute with a forward feed of 5.2 mm per nip. The extracted noil is 18%.

The combed cotton sliver is then passed through a finisher draw frame with a feed hank of 0.12, 7 ends up, with a delivery hank of 0.075 and speed of 400 meter/minute. The sliver hank is kept coarse at 0.075 in order to have complete covering of the wool fiber stream during roving preparation.

Wool Sliver Preparation:

The Wool fiber used is 38-44 mm x 29 mic. The wool fibers are first passed through blow room having a feeder and a mono cylinder beater only. This is because the wool fiber is long fiber and is clean (Received after carbonization) without any impurities.

The wool fibers, from blow room go to the carding machines where the cards are run at 110-mtrs/minute delivery speed and a hank of 0.13. On the cards the flat speeds are kept low at 90 to 110 mm per minute to minimize wastage.

The card sliver (wool) is then processed through breaker draw frame with 6 ends up and a delivery hank of 0.14. The machine is run at 300 meter per minute.

A second passage drawing in Finisher draw frame with 4 ends up and a delivery hank of 0.30 is given for making the fibers more parallel with one another. The delivery hank is kept fine at 0.30 to enable the wool sliver occupy middle portion on the cotton sliver while being passed on to the speed frame. The delivery speed is kept at 250 to 300 meter/minute.

Inserting the Wool Sliver in the middle of cotton sliver and twisting on speed frame:

The finisher draw frame sliver cans of both cotton and Wool are kept at the feed end of the speed frame. The cotton sliver has a normal path from the back to front, whereas the wool sliver passes through a special feed guide, an inlet condenser before occupying the

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middle portion on the cotton sliver in the main feed condenser of the speed frame drafting system.

A specially designed middle condenser is also incorporated in the back zone of the drafting system to retain the Wool sliver in the middle of the cotton sliver.

When this combination of cotton and Wool sliver emerge out of the drafting zone on the speed frame, due to twist flowing from the flyer to the nip of the front rollers of the drafting zone, the wool sliver gets wrapped up by the surrounding cotton, thus pushing the wool sliver in the core.

The twisting and winding on to the bobbin on speed frame is normal as with any other cotton system. The hank of roving is 0.58. This gives a blend of 80% cotton and 20% wool in the core.

Ring Spinning:

The core roving so produced on the speed frame is then spun into yarn on the cotton ring spinning frame. In the preferred embodiment Ne 13s the roving of 0.58 hanks is drafted 22.41 times on the drafting system of ring frame and spun into yarn with 13.8 TPI. The machine is generally run at 10000 to 13000 rpm. In the preferred embodiment the speed is 10000 rpm. The yarn from Ring Frame bobbins is wound into large packages on the Auto-coners.

The Wool core yarn parameters before dissolution of Wool:

The table 1 enumerates the properties of the Ne 13's core spun yarn with 20% wool in the core and 80% cotton sheath.

Table 1:

Average count	12.90
Average lea strength lbs	208.0
CSP (Count Strength product)	2683
Count CV%	1.32
Strength CV%	5.03

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Average TPI	13.87
Average U% (percent mean deviation)	10.46
Thin places/Km (-50%)	0.5
Thick places/Km (+50%)	120.9
Neps/Km (+200%)	92.0
Total imperfection/km	213.4
Hairiness Index	9.32
Average breaking force (Gms)	830
Average RKm (Nm/kgf)	17.77
Rkm CV%	9.60
Elongation at break %	5.81
Elongation CV%	9.31

Bleaching and Dyeing Process:

The towels with wool core spun yarn in the pile and cotton yarn in weft and ground is processed in the dyeing house in rope form. The scouring and bleaching can be either in a continuous bleaching range or an exhaust dyeing machine. The liquor ratio in either case is 1:7.

In case of with wool core spun yarn made towels scouring or bleaching is carried out with detergent, hydrogen peroxide, stabilizer and 10 gms per liter of caustic lye (48-52%) at a temperature of 98°C for 30 minutes followed by cold wash, peroxide killing and neutralization with Green acid to start the dyeing process.

The scouring and or bleaching process dissolves the wool component and goes in to the drain.

The dyeing is carried out in the ecosoft machine with following dyes and chemicals for 2-3 hours at 60°C. The dyes used are Huntsman EN and bi-functional class

Typical example:

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a) Blue Fnr Cibacron : 3 gms

b) Yellow Fn2r (Cibacron) : 11 gms

c) Red Fn2bl (Cibacron) : 7 gms

d) Sodium Hexameta Phosphate : 175 gms

e) Sodium Sulfate : 3500 gms

f) Soda Ash Light : 875 gms

g) Caustic Soda Lye – 48% : 263 gms

After dyeing, the bath is neutralized with Acetic Acid (Green acid) – 438 gms at 60°C for 10 minutes.

This is followed by soaping with Miranon Ama – 88 gms and Sodium Hexameta Phosphate – 175 gms for 10 minutes at 60°C and further neutralized by treating with Riddix Ana – 88 gms and Acetic Acid – 88 gms followed by softener treatment with Turbulant 86 – 438 gms and Tobler-Csi – 525 gms for 10 minutes.

The properties for the towels formed using the pile yarn described above are provided in Tables 2-4.

Table 2: On loom specifications

Reed space for terry	81.48cm
Reed space for towel	86.48cm
Number of towels per Reed Space	3
Pile Ratio	7.01
Pile height	6.4 mm
Reed/cm	11.02
Picks/Inch	41.91
Type of Terry	3 pick
Rpm	380
Finished Reed/inch pile	32.56

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Pile Yarn count	13s Wool Hygro
Weft Yarn Count	11s OE (18.9 TPI)
Ground Yarn Count	11 OE (16.9 TPI)

The properties of the fabric when it is removed from the loom, *i.e.* the grey towel, are listed in Table 3.

Table 3: Grey Towel Specifications

Grey width	79.04 cm
Grey length	137 cm
Weight of towel	567.48 g
Plain portion in width	5 cm
Plain portion in length	8 cm
Terry portion in length	120.8 cm
Selvedge to selvedge width	84.04 cm

The properties of the finished soft terry towel are listed below in Table 4.

Table 4: Finished Terry Towel Specifications

Dimensions	69 cm x 127 cm
Plain portion in width	5.0 cm
Terry portion in width	67.8 cm
GSM	518
Weight of finished towel	453.927 g
Weight of Grey Towel	567.48 g
Weight loss (%)	20%
Plain portion in length	2.4 cm
Design portion in length	10.8 cm
Terry portion in length	120.8 cm

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Shrinkage (%)	20.18%
Finished width of towel	72.60 cm

EXAMPLE 2:

Warp Yarn Manufacturing Parameters

The properties of the 1/40's Cotton Wool (Cotton 92.86%, wool 7.14%) yarn is as under

Average count	39.75
Average lea strength lbs	58.0
CSP (Count Strength product)	2305
Count CV%	1.44
Strength CV%	4.97
Average TPI	27.3
Average U% (percent mean deviation)	10.18
Thin places/Km (-50%)	4.5
Thick places/Km (+50%)	32.3
Neps/Km (+200%)	73.8
Total imperfection/km	110.6
Hairiness Index	7.3
Average breaking force (Gms)	196.8
Average RKm (Nm/kgf)	14.72
Rkm CV%	8.7
Elongation at break %	4.56
Elongation CV%	11.77

The properties for the sheets formed using the warp yarn described above are provided in Tables 5-6.

Table 5: On loom specifications

Reed Count(D/2 inch)	**108**
Reed space in inches	125.5

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Ends Per Inch on reed	160
Ends Per Inch on loom	72
Width shrinkage L – G	4.4
Ref. Thread Count	250
Sort description	40x40 /164/73-12 Sateen
Picks/cm	17.3
Efficiency expected	85 %
Rpm	400
Warp Yarn count	40's cotton /wool (Cotton 92.86%, wool 7.14%) Cotton combed 10% noil
Weft Yarn Count	40's cotton / wool (Cotton 92.86%, wool 7.14%) Cotton combed 10% noil

The properties of the fabric when it is removed from the loom, *i.e.* the grey towel, are listed in Table 6.

Table 6: Grey Sheet Specifications

Grey width	120"
Grey length GLM	469
Grey GSM	153.9
Plain portion in width	6 cm
Calculated Grey Thread Count	240.04
Total picks per repeat	72
Total weight in Gms in a repeat	138

Desizing, Scouring, Bleaching and Dyeing Process:

The sheet is processed in the dyeing house in rope form. The desizing, scouring and bleaching can be either in a continuous bleaching range or a soft flow dyeing machine. The desizing is with 0.43 Grams/liter (GPL) of desizing agent with 1:7 liquor ratios. In either case the bleaching is with Hydrogen Peroxide with a liquor ratio of 1:7. The vessel

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capacity of soft flow dyeing is 50 kgs (1:15, 1:20, 1:30 can also be considered depending on the capacity of vessel). The bleaching is for duration of 30 minutes at 98°C.

The scouring or bleaching is carried out with a detergent, hydrogen peroxide, stabilizer, and 10 grams per liter of Caustic lye (48%-52%) at a temperature of 98°C for 30 minutes followed by cold wash, peroxide killer and neutralized with Green acid before the dyeing process. The caustic treatment renders wool to dissolve completely, thereby rendering it hygroscopic.

The dyeing is carried out in the eco-soft machine with following dyes and chemicals for 2-3 hours at 60°C. The dyes used are Huntsman FN and bi-functional class to get a shade of Brilliant Blue

a) Difix Blue FF : 3.7%
b) Yellow Fn2r (Cibacron) : 0.013%
c) Red (Fn2bl (Cibacron) : 0.308%
d) Sodium Sulfate : 70gpl
e) Soda Ash Light : 20gpl

After dyeing the bath is neutralized with Green Acid – 0.438 gpl at 60°C for 10 minutes.

This is followed by soaping with Miranon Ama – 0.88 gms/lit and Sodium Hexameta Phosphate – 1.75 gms/lit for 10 minutes at 60°C and further neutralized by treating with Green acid 0.48 gpl followed by softener treatment with Turbulant 86 – 1.75% and Accentl1086 – 1.75% for 10 minutes.

EXAMPLE 3:

Loop Yarn Manufacturing Parameters

In the preferred embodiment the loop yarn is a cabled yarn of single yarn of Cotton and Wool (85:15)

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The properties of the 1/6's Cotton Wool (85: 15) yarn is as under are provided in Table No.7

Table: 7

Test Reports of **6's/1 Cotton/Wool Karded Yarn.**	
Mixing	Cotton/Wool 85:15
TM	3.8
Wrapping Test Results	Cones
Average Count (Ne)	6.09
Avg Strength	412.5
CSP	2538
Count Cv%	1.35
Strength Cv %	5.08
T.P.I.Test Results	
Average T.P.I.	8.99
T.P.I. Cv%	3.20
T.M	3.65
Uster Test Results	
Avg. U%	10.25
Thin/Km. (-50%)	0.7
Thick/Km.(+50%)	53.0
Neps/Km.(+200%)	88.86
Total Imperfections/Km.	142.6
Hairiness	12.77
Sh	3.05
UTR-3 Test Results	
B-Force	1567.4
Avg R.Km (Nm* Kgf).	15.88
R.Km Cv %	10.23

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Elongation %	5.43
Elongation Cv %	6.37

The specification for the Rugs formed using the pile yarn described above is provided in Table 8.

Table No.8

I	**Specification sheet for the RUG**		
1.	Design	Smart Rug Diagonal Stripe	Smart Rug Diagonal Stripe
2.	Colors	6	6
3.	Finish Size in CM	40x60	50x80
4.	Finish GSM	1520	1520
5.	Finish Wt Gms	365	608
6.	Corner	Square corner	Square corner
7.	Grey Size in Inches	**16.2"x24.1"**	**20.2"x32.4"**
8.	Planned QTY	1200	800
II	**Tufting**		
1.	Machine Tufting Gauge	1/8 MLCL	1/8 MLCL
2.	Rug Construction	Cut Loop Diamond Rug	Cut Loop Diamond Rug
3.	Yarn Type	85% Cotton/ 15% Wool Hygro	85% Cotton/ 15% Wool Hygro
4.	Supplier	SPINNING	SPINNING
5.	Yarn Count	4/6s Ne Karded	4/6s Ne Karded
6.	TPI	3.5	3.5
7.	Twist Direction	S	S
8.	Yarn gsm	1136	1136
9.	Backing gsm	108	108

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10.	PP Backing type	Non Fleece	Non Fleece
11.	Stitch/10 cm	29.3	29.3
12.	tuft length	30 mm	30 mm
13.	Tufting Width"	81"+ 81"	81"+ 81"
14.	Slitting width"	81"+ 81"	81"+ 81"
15.	No of splits/width	5 + 5 = 10	4 + 4 = 8
16.	Linear Meters Reqd	85	95
III	**Coating**		
1.	Type Of Coat	Lick Coat	Lick Coat
2.	Coating gsm	300	300
3.	Slitting width"	81"+ 81"	81"+ 81"
4.	Total Meters Reqd	85	95
IV	**Cutting**		
1.	Grey Cut Size	**20.2"x32.4"**	**20.2"x32.4"**
2.	Shape	Square corner	Square corner
3.	Grey Weight gms	458	762
4.	No of Pcs required	1200	800
V	**Sewing**		
1.	Tape Width mm	38	38
2.	Type Of Tape	Straight	Straight
3.	Sewing Thread	100% Cotton	100% Cotton
VI	**Dyeing**		
1.	Temp	60^0 C	60^0 C
2.	MLR	7	7
1	Wetting	70^0 C for 10 min	70^0 C for 10 min
2	Leveling	60^0 C for 5 min	60^0 C for 5 min

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3	Scouring/bleaching	10 grams per liter of Caustic lye (48%-52%) at a temperature of 98°C for 30 minutes/peroxide and detergent	10 grams per liter of Caustic lye (48%-52%) at a temperature of 98°C for 30 minutes/peroxide and detergent
4	Dyes	CIBA-YELLOW FN2R ,CIBA RED FN-3GL, CIBACRON BLUE CD	CIBA-YELLOW FN2R ,CIBA RED FN-3GL, CIBACRON BLUE CD
5	Salt	60^0 C for 10 min	60^0 C for 10 min
6	Soda	60^0 C for 20 min	60^0 C for 20 min
7	Neutralisation	pH-7	pH-7
8	Softner	55^0 C for 10 min, pH-5.5	55^0 C for 10 min, pH-5.5
	Drying		
	Temp	85^0 C	85^0 C
	Time	99 min	99 min

Scouring, Bleaching and Dyeing Process:

The rugs processed in the dyeing house in piece form. The desizing, scouring and bleaching are in an EZM dyeing machine. In this case the bleaching is with Hydrogen Peroxide with a liquor ratio of 1:7. The vessel capacity of EZM dyeing is 50 kgs (1:15, 1:20, 1:30 can also be considered depending on the capacity of vessel). The bleaching is for duration of 30 minutes at 98°C.

The scouring or bleaching is carried out with a detergent, hydrogen peroxide, stabilizer, and 10 grams per liter of Caustic lye (48%-52%) at a temperature of 98°C for 30 minutes followed by cold wash, peroxide killer and neutralized with Green acid before the dyeing

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process. The caustic treatment renders wool to dissolve completely, thereby rendering it hygroscopic.

The dyeing is carried out in the eco-soft machine with following dyes and chemicals for 2-3 hours at 60°C. The dyes used are Huntsman FN and bi-functional class to get a shade of Dune.

a) Yellow FN2R : 3.7%

b) Blue CD (Cibacron) : 0.013%

c) Red (FN3GL (Cibacron) : 0.308%

d) Sodium Sulfate : 70gpl

e) Soda Ash Light : 20gpl

After dyeing the bath is neutralized with Green Acid – 0.438 gpl at 60°C for 10 minutes. This is followed by soaping with Miranon Ama – 0.88 gms/lit and Sodium Hexameta Phosphate – 1.75 gms/lit for 10 minutes at 60°C and further neutralized by treating with Green acid 0.48 gpl followed by softener treatment with Turbulant 86 – 1.75% and Accent11086 – 1.75% for 10 minutes.

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We Claim,

1. An eco-friendly hygro fabric comprising alkali soluble wool fiber component in the core of the yarn surrounded by cotton and/or other fiber component as a sheath, at the blow room, drawing or roving stage, of the yarn-making process and further comprising spinning into the yarn for manufacture of looped fabric or flat fabric.

2. The eco-friendly hygro fabric as claimed in claim 1, wherein the alkali used for solubalizing wool is NaOH.

3. The eco-friendly hygro fabric as claimed in claim 1, wherein the dissolution of wool, during wet processing, in NaOH solution creates an airy yarn characterized in having better absorbency, quick drying and soft hand.

4. The eco-friendly hygro fabric as claimed in claim 1, wherein wool fiber component is in range of 5% to 40%.

5. The eco-friendly hygro fabric as claimed in claim 1, wherein the other fiber component comprises of cotton, linen, silk, viscose, bamboo, polyester, nylon, polypropylene, sea weed fibers, modal fibers, charcoal fibers, eucalyptus fibers or blends thereof.

6. The eco-friendly hygro fabric as claimed in claim 1, wherein blending of wool fibers along with cotton or other fibers is carried out in the blow room of cotton spinning system.

7. The eco-friendly hygro fabric as claimed in claim 1, wherein blending of wool fibers along with cotton or other fibers can be in slivers, separately processed in blow room and cards, along with cotton/other fiber slivers in the draw frame of a cotton spinning system.

8. The eco-friendly hygro fabric as claimed in claim 1, wherein blending of wool with cotton or other fibers is carried out in blow room as illustrated in Fig. 3 comprises:
   a. processing through carding and breaker draw frame, and;

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b. blending this mixed sliver with 100% cotton slivers on finisher draw frame to get the final desired wool proportion in the final yarn.

9. The eco-friendly hygro fabric as claimed in claim 1, wherein blending of wool fibers with cotton or other fibers is carried out by process as illustrated in fig. 1 comprises:
   a. inserting wool fiber slivers into the middle of cotton or other fiber slivers at the feeding end of the drafting zone of the speed frame;
   b. twisting on the speed frame, and;
   c. spinning the yarn at ring spinning.

10. The eco-friendly hygro fabric as claimed in claim 1, wherein the looped fabric is a terry fabric, including wash cloth, hand towel, bath sheet, bath mat, baby hood, medicinal towels, institutional towels, pleasure fabrics and the like.

11. The eco-friendly hygro fabric as claimed in claim 10, wherein a set of longitudinal warp yarn for forming pile loops in the terry fabric, the ground warp and weft in terry fabric are yarns in longitudinal and transverse yarn used by interlacing each other to form the ground fabric.

12. The eco-friendly hygro fabric as claimed in claim 11, wherein said pile warp has a count ranging from Ne 1/6's to 1/50's, ends per cm is in range of 21 to 34 picks are in range of 10 to 28, loop length is in range of 0.5 to 17cm, pile height is in range of 0.25 to 8.5cm, terry loops are created from 2.5, 3, 4, 5 and/or 6 pick mechanism, GSM ranges from 200 to 1700.

13. The eco-friendly hygro fabric as claimed in claim 11, wherein the pile warp can be in single or double configuration.

14. The eco-friendly hygro fabric as claimed in claim 1, wherein the looped fabric is a rug or carpet, including rugs of tuft on one or both sides, uncut or cut loops, doormats, tub mats, bed room mats, indoor play room carpets and like.

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15. The eco-friendly hygro fabric as claimed in claim 14, wherein the tufted loop yarn in the rugs/carpets is the yarn used to tuft the rug/carpet.

16. The eco-friendly hygro fabric as claimed in claim 15, compromises a base fabric over which the tufts are formed.

17. The eco-friendly hygro fabric as claimed in claim 16, wherein the base fabric is cotton canvas, high density polyethylene woven fabric, polypropylene woven fabric or any other similar fabric.

18. The eco-friendly hygro fabric as claimed in claim 14, wherein the rug or carpet is of non-cut loop or cut loop, with or without latex backing.

19. The eco-friendly hygro fabric as claimed in claim 14, wherein said pile warp has a count ranging from Ne 2's to 20's, loop height is in range of 3mm to 34mm, loops density is in range of 18 to 96 per square inch, GSM is in range of 1000 to 3000.

20. The eco-friendly hygro fabric as claimed in claim 14, wherein the pile warp can be in single or double configuration selected from 2/2's, 3/2's, 4/2's.

21. The eco-friendly hygro fabric as claimed in claim 14, wherein the loop yarn may be grey, bright, white, dope dyed or yarn dyed.

22. The eco-friendly hygro fabric as claimed in claim 1, is a flat fabric, including bed sheets, sheeting fabrics, duvets, shams, quilt fabrics, pillow case fabric and like.

23. The eco-friendly hygro fabric as claimed in claim 22, wherein the thread count is in range of 48 to 1600, ends per cm is in range of 8 to 110, picks per cm is in range of 5 to 72, warp and weft count is in range of Ne 20's to 120's.

24. The eco-friendly hygro fabric as claimed in claim 22, wherein the warp and weft can be in single or double configuration.

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25. The eco-friendly hygro fabric as claimed in claim 22, wherein the yarn may be dyed, plain dyed or printed.

26. The eco-friendly hygro fabric as claimed in claim 22, fabric has construction in satin, sateen, twill or plain.

27. The fabric as claimed in claim 10, wherein the process for manufacturing of said terry fabric is as illustrated in Fig. 2.

28. The fabric as claimed in claim 22, wherein the process for manufacturing of said flat fabric is as depicted in fig. 4.

29. The fabric as claimed in claim 1, wherein the process for manufacturing of hygro yarn consisting of 85:15 blend of cotton and wool fiber is as depicted in Fig. 5(a) and (b).

30. The fabric as claimed in claim 14, wherein the process for manufacturing of said rug or carpet is as depicted in Fig. 6 and 7.

Dated this 6th Day of January, 2010

For Welspun Global Brands Limited

Dr. Gopakumar G. Nair
(Reg. No. IN/PA 509)
(Authorized Signatory)

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