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Weaving Social Development: An Exploratory Study of Adapting Traditional Textiles Using Indigenous Organic Wool for the Modern Interior Textiles Market

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Abstract**—**The interior design profession aims to create aesthetically pleasing design solutions for human habitats but of late, growing awareness about depleting environmental resources, both tangible and intangible, and damages to the eco-system led to the quest for creating healthy and sustainable interior environments. The paper proposes adapting traditionally produced organic wool textiles for the mainstream interior design industry. This can create sustainable livelihoods whereby eco-friendly bridges can be built between Interior designers and consumers and pastoral communities. This study focuses on traditional textiles produced by two pastoral communities from India that use organic wool from indigenous sheep varieties. The *Gaddi* communities of Himachal Pradesh use wool from the Gaddi sheep breed to create *Pattu* (a multi-purpose textile). The *Kurumas* of Telangana weave a blanket called the *Gongadi*, using wool from the *Black Deccani* variety of sheep. These communities have traditionally reared indigenous sheep breeds for their wool and produce hand-spun and hand-woven textiles for their own consumption, using traditional processes that are chemical free. Based on data collected personally from field visits and documentation of traditional crafts of these pastoral communities, and using traditionally produced indigenous organic wool, the authors have developed innovative textile samples by including design interventions and exploring dyeing and weaving techniques. As part of the secondary research, the role of pastoralism in sustaining the eco-systems of Himachal Pradesh and Telangana was studied, and also the role of organic wool in creating healthy interior environments. The authors found that natural wool from indigenous sheep breeds can be used to create interior textiles that have the potential to be marketed to an urban audience, and this will help create earnings for pastoral communities. Literature studies have shown that organic & sustainable wool can reduce indoor pollution & toxicity levels in interiors and further help in creating healthier interior environments. Revival of indigenous breeds of sheep can further help in rejuvenating dying crafts, and promotion of these indigenous textiles can help in sustaining traditional eco-systems and the pastoral communities whose way of life is endangered today. Based on research and findings, the authors propose that adapting traditional textiles can have potential for application in Interiors, creating eco-friendly spaces. Interior textiles produced through such sustainable processes can help reduce indoor pollution, give livelihood opportunities to traditional economies, and leave almost zero carbon foot-print while being in sync with available natural resources, hence ultimately benefiting the society. The win-win situation for all the stakeholders in this eco-friendly model makes it pertinent to re-think how we design lifestyle textiles for interiors. This study illustrates a specific example from the two pastoral communities and can be used as a model that can work equally well in any community, regardless of geography.

Keywords**—**Design Intervention, Eco-Friendly, Healthy Interiors, Indigenous, Organic Wool, Pastoralism, Sustainability

I. Introduction

THE interior design profession has primarily been concerned with creating aesthetic settings for human habitats and other spaces. Over the years, the interior materials industry has grown exponentially, with increased industrial production and more and more exotic materials becoming easily available everywhere due to advances in transportation. This was not the case in earlier times when the average house-holder or builder would have relied on the local area for sourcing materials, except for the rich and powerful sections of society, for whom costs were not a concern. This easy availability of materials from far distances does have a cost: the environmental carbon footprint.

Textiles have an important role to play in the interiors, and are useful due to their versatility in application in various forms like upholstery, drapery, floorcoverings, wall paneling and other decorative uses. However, this comes at a cost as the growing demand for textiles, like all other building materials, has led to mass-production of the same. The industrial processes use lots of chemicals during the process of yarn washing, dyeing, printing and glazing [12]. Since mass produced textiles use a lot of chemicals they take a toll on the environment. Today, industrially produced textiles in the market have slowly edged out traditional hand-woven textiles due to cost considerations and mass production requirements.

Of late, there has been a growing awareness of environmental issues that have enabled the common man and the users to recognize the need for environmentally sustainable interiors and how this impacts the health of the users and the global environment.

Alluding to the transformation of the once agrarian society to an industrial one and now the technological society we are currently living in, Alvin Toffler named today's age as the 'Third Age'. In his book, Toffler argues that human beings "will need to develop a different mindset to consider the future of our own selves and the planet, and this will include reappraising our natural resources and our own relationship

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with Nature." [21]

One of the most important components of Interior design, material selection and specification is also the most expensive one. The materials can be of two types, hard and soft, with the hard variety having a longer life span and the soft ones can be short-lived in comparison. As these interior materials are increasingly being produced in factories using chemicals, these chemicals continue to reside in the interior space and can affect the physiological and psychological health and well-being of the occupants [12]. Since most of the building materials being used today are of a synthetic nature or heavily use natural materials during and after processing, the damage to the environment is two-fold: a) The natural resources are depleted b) Chemicals and harmful substances are employed to manufacture man-made and processed materials that involve use of energy and generate effluents. Apart from these two, the products used in the interiors continue to give off toxic emissions and gases thus deteriorating the indoor air quality. When it comes to creating Interior Design solutions, furnishings, materials and finishes play a very important role. The interior furnishings, materials and finishes require significant quantities of natural resources for their extraction, transport, processing, reuse, recycling and disposal [3].

Since sustainability is the watchword these days, and there are several ways to bring sustainability in the Interior design strategies, it is beyond the scope of this study. This paper focuses on using textiles as a means of introducing sustainable features in Interior Design. Naturally produced organic fabric is not harmful and has inherent beauty and cultural value. For this reason, organic wool was selected by the authors to be used as a material that can bring about sustainability.

One of the most commonly used materials in interior design industry; textiles find use as carpeting, furnishings, upholstery and floor and wall coverings. A simple and plain space can be transformed into an interesting and colorful one by judiciously selecting and applying textiles in varied forms [8]. Since textiles are very important element in interiors, using ecofriendly and sustainable textiles can directly lead to creating sustainable interior environment.

The research methodology in this paper includes primary research on pastoral communities, taking the example of two such communities from two distinct geographical regions of India. Apart from secondary research, we have also conducted field visits to gain a better understanding of the traditional practices and processes of wool production and weaving as practiced traditionally by the Gaddi tribe from Himachal Pradesh, and the Kurumas from Telangana region. As part of design intervention, we have also explored the materials practically, and tried to create design solutions that can be utilized to produce textiles that can suit contemporary Interior tastes.

By attending workshops conducted by Kuruma craftsmen on spinning and weaving the Gongadi using traditional tools and organic Deccani wool, at Delhi in 2016, we were able to see the traditional process of hand-weaving organic wool, which also enabled us to get a glimpse of the way of life of the Kurumas. We have studied the Gaddi and the Kuruma way of life in a bid to understand how these pastoral societies exist and function in today. Before we move further in this paper it is important to understand the definition of sustainability and sustainable design.

II. Sustainability and Sustainable Design

As per the Merriam–Webster's Collegiate Dictionary the word "Sustainable" can be defined as something that refers to or is a means of using or harvesting a resource in such a manner that it does not deplete or damage the resource in any form. This can also refer to a way of life that is based on using sustainable materials and methods [6], [18], [23].

According to World Commission on Environment and Development (WECD), 'sustainable design refers to a more global approach – it refers to the health, safety and welfare of the planet, in such a way so that it is possible for this generation to meet their needs without jeopardizing the ability of future generations to meet their own needs' [20], [24].

As per the Environmental Protection Agency (EPA) 'Sustainability is about achieving the balance of three principles: Environmental sustainability, economic sustainability, and social sustainability' [7].

We believe that, environmentally sustainable interiors can be brought through by using strategically-chosen materials that affect the aesthetics of the space, along with being environmentally friendly too. Such materials should also be easy to install and maintain.

Sustainable interior design is defined as "interior design in which all systems and materials are designed with an emphasis on integration into a whole for the purpose of minimizing negative impacts on the environment and occupants and maximizing positive impacts on environmental, economic and social systems over the life cycle of a building" [1], [11].

Based on recommendations from LEED, there are several ways to incorporate sustainable and eco-friendly practices in interior design [23]. However, for the purpose of this study, the authors have studied the materials aspect by focusing on textiles made from organic wool as a material for application in Interiors

By incorporating eco-friendly materials and techniques into interiors, it is possible to significantly lessen environmental impacts like depletion of natural resources, energy consumption and pollution. This will be beneficial for the users and the surrounding ecosystem equally. This will also help improve the built environment and will ultimately have a positive effect on the lifecycle of a building and its performance [23].

According to Jones, environmentally sustainable interior design should aim at the following principles: Respect for nature and natural systems, respect for people and the goal of creating healthy habitats, respect for the cycle of life, which includes that in nature all waste products are useful, and respect for the conservation of natural resources [13].

In order to develop a sustainable design solution for interiors it is important that the source of the material should also follow a sustainable system right from the grass-roots level.

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III. Organic Wool

Organic Wool is wool manufactured from natural fiber obtained from the coat of the sheep that grows naturally and does not require any type of chemicals during the production /manufacturing process. Natural wool is a rapidly renewable resource as the sheep are sheared annually. As per USGBC guidelines, a 'Rapidly Renewable Resource' must be planted and harvested in less than a ten-year cycle [22], [23]. Global Organic Textile Standards (GOTS) specifies that organic wool must follow the following standards:

- The sheep must be fed organic food only
- No genetic engineering is permitted
- No synthetic hormones or supplements are given to the sheep
- No pesticides or chemicals should be used in the pasture and grazing areas.
- Using synthetic pesticides on pastures is prohibited and the sheep cannot be treated with parasiticides, which can be toxic to both the sheep and the people exposed to them.
- Good cultural and management practices for livestock must be used [19].

A. Properties of Organic Wool

Since the authors have focused on the benefits of using organic wool, it is also necessary to understand the definition of traditional organic wool i.e. natural wool produced with traditional methods and know-how [14].

1) Organic wool is a protein fiber formed in the skin of the sheep, and is thus one hundred percent natural, not man-made.
2) Water-absorption: The inner core of wool fiber is Hydrophilic by nature (it is highly water absorbent) and can absorb moisture from the surrounding air up to one-third of its own weight. With moisture regain figure of 16-18%, wool fibers can absorb and release moisture from surrounding air without compromising its thermal efficiency. This feature also makes wool a breathable fabric, along with its ability to retain colours and shapes
3) Wicking: Wool has a unique property that allows its fibers to absorb excess water vapor from the air and releasing the gained moisture when the humidity level decreases in the surrounding atmosphere. This wicking property of wool helps in Passive Humidity control in interior environments and maintains thermal comfort for the occupants.
4) Density: Wool in its natural, untreated form is a dense material and this density helps in acoustical control in areas where sound-proofing is required
5) Flame resistance: As wool is naturally flame resistant and self-extinguishes, wool fibers do not burst into flames but smoulder and burn out, and thus fire does not spread to the surroundings. Unlike synthetic and man-made fabrics, wool does not melt or drip when heated
6) Elasticity: Since wool fibers can be bent up to 30,000 times without danger of breaking or damage, this natural elasticity (called the Crimp or Wave) in wool allows the fiber to be stretched 130% and still spring back to its original place when it has dried [14].
7) Thermal Insulation: As wool also possesses thermal insulating properties, it finds use as a thermal insulation material for interiors (R-value of Wool is 3.5/inch of thickness)
8) Wool also has the ability to regulate the humidity of an interior due to the matrix inside the cortical cell. The matrix consists of high Sulphur proteins that cause the Sulphur atoms to attract and absorb water molecules [14].
9) Felting Ability: The scaly and coarse nature of wool fibers enable them to be joined together to form 'felted' wool fabric, using water and soap with the help of the process of agitation [14].
10) It can retain colors and dyes, being colorfast
11) Thanks to its hygroscopic abilities, natural wool can absorb, and release moisture accompanied by heat generation and wool insulation helps to reduce energy costs and prevents the loss of energy to the external environment, thus reducing carbon emissions [14].
12) It is a renewable resource that gets renewed annually
13) Natural wool is bio-degradable [14].
14) Wool has endless applications that range from industrial to building materials, apparel and home furnishings.
15) It can be processed as a woven or non-woven, or knitted textile.

IV. Role of Organic Wool in Creating Healthy Interior Environments

There are various studies that state that the textiles that are not organic and other furnishing and finishing materials that are used in interiors like laminates, polishes etc. release a variety of chemicals that are volatile in nature and are emitted in the interior environment. These are known as Volatile Organic Compounds (VOCs). These chemicals adversely affect the quality of indoor air i.e. air present inside any interior space which further have adverse effects on the health of the users of that interior space [7]. These VOCs can be carcinogenic and can lead to Sick Building Syndrome, asthma, headaches, nausea, eye irritations, etc. As humans spend a major chunk of their lives indoors (up to 90%), therefore healthy interiors are very important [23].

To remove the impact of pollution and pollutants from the indoor environment, Passive Removal Materials (PRM) are used in order to cleanse the interiors and the indoor air of toxic chemicals, pollutants and VOCs [5]. The structure of the organic wool fiber itself has many properties which makes it a Passive removal material (PRM). The research has also found that chemically untreated wool has the capability to improve the indoor environment quality (IEQ) and the health of the users of the interior space by absorbing the indoor air pollutants, regulating the humidity content and through acoustical and temperature control [4], [23].

Based on the secondary research and properties of organic wool as stated above, the authors propose that sustainable textiles made from organic wool when used in interiors have the potential to improve the quality of the indoor air thus resulting in creating healthy and sustainable interior environments.

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This research is focused towards the study of two traditional pastoral communities of India producing organic wool using traditional methods and know-how. Organic wool and textiles produced from the wool in these communities are a very important part of their culture and livelihoods.

The authors have studied the sustainable traditional practices and processes of wool production and weaving as practiced traditionally by the **Gaddi** and the **Kurumas** to understand how the textiles made by these comminutes can be used in interiors for creating sustainable interior environment.

V. The Pastoral Connection: Focus on Two Communities

Pastoralism is a lifestyle of communities that is centered around herding livestock. It can be Nomadic, Semi-Nomadic or Transhumant. The pastoral populations are low - population mobile groups with complex information systems, depending on local and traditional knowledge for their survival, and maintaining separate cultural identities of tribe/clan.

Around 7% of the population of India (around 88 million people) identifies itself with the pastoral lifestyle and inhabits various areas of the country. Spread across Kashmir, Ladakh and Himachal Pradesh in the North, pastoral communities are also found in the South-Central regions like Telangana, Andhra Pradesh and Karnataka, and in Kutchh, Saurashtra and parts of Rajasthan in the Western part of the country. A small number is also found in the Coorg region of Karnataka in the South, as well parts of North east India [2] [9]. These communities rely on rearing and herding livestock like sheep, goats, buffalos, cows, camels and yaks. Some of the better known pastoral groups of India are the *Gujjar*, the *Bakarwals*, the *Rabari*, the *Gaddi*, the *Raika,* the *Dhangar*, the *Bishnoi*, the *Kuruba*, the *Kuruma*, the *Golla* and the *Toda communities*.

The government policy makers have been projecting this profession as unproductive and unfruitful for modern economic growth. However, recent reports point out the fact that India is among the highest producers of milk and meat, a large part of which comes from pastoralist groups. Even during India's colonial past during the British Empire, these pastoral communities were treated as backward classes, and as such, they have faced centuries of neglect, and continue to do so even today [20].

India's rich crafts and living skills form the cultural identity of its various peoples, and these are passed on from generation to generation and such legacies form a means of sustenance for various communities engaged in traditional cultural productions and methods.

A. The Gaddis of Himachal Pradesh

Gaddi folk traditions tell stories of their migration from the Indian plains, due to persecution by the Mughal emperor Aurangzeb. They settled in the upper reaches of the Dhauladhar range in Himachal Pradesh, and are mainly concentrated in the districts of *Bharmaur* and *Chamba*. Over the centuries, they have also spread out to parts of Kangra and Punjab regions.

During summers, the *Gaddis* take their herds to high-altitude pasturelands in the *Pangi* valley and *Lahaul-Spiti* region where they hold customary grazing rights. In the colder months, the quest for fodder and grazing areas takes the Gaddis and their herds to the lower valleys of Kangra region in Himachal Pradesh, where some families own agricultural land have fixed settlements [20].

The Gaddis live in large combined families with some menfolk going away with their flocks of sheep to pastures for fodder, leaving behind most of their womenfolk to tend to their farmed lands.

Gaddi menfolk wear a knee length felted garment called the **Cholu** which is made up of the ecru-colored, sturdy fabric called the "Pattu "(Made of organic wool sourced from Gaddi sheep and handspun and handwoven). The Cholu costume lasts for a long time, and is passed from one generation to the next.

Fig. 1 Gaddi shepherd wearing Cholu with Dora [20]

As this textile made from the natural wool of Gaddi sheep has water-repellent and thermos-regulatory properties, it serves the Gaddis very well in the wet and cold weather. This multipurpose cloak can also be used by the Gaddi shepherds to protect newborn lambs during heavy rains. Around the waist and over the **Cholu**, both Gaddi men and women wear a 20-yard-long black felted natural wool cord called the **Dora** as shown in Fig. 2, which is used at times to pull up stricken sheep that have fallen down slopes, and also comes in handy as a support to the solar plexus while climbing the cliffs and mountain sides.

The Pattu is reserved solely for men; however the Dora is used by both men and women. The women wear bright colorful cotton skirts (called the Launchadi) and red cotton head coverings, but they all tie the natural wool Dora around their waists. The Dora is a sort of social marker for the Gaddi community.

B. The Process of Making Woollen Fabric Using Gaddi Wool

The Gaddi sheep are generally sheared twice in a year (at the onset of spring and autumn) using simple metal shears. The fleece is washed and dried by the tribeswomen, and the fibers are carded using a metal hand-held comb or taken to a local ginning mill. The resultant wool has two natural colors, black and ecru. These two-color variants are sometimes combined to get a gray colored yarn. The cleaned and carded wool is then hand-spun, using the traditional wooden spinning wheel called

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the **Charkha**. Since this yarn is not very strong, it is twisted with wooden spindle called **Katli** to add strength to the yarn. The task of spinning is done by both the sexes using the drop-spindle method.

Fig. 2 Hand spinning wheel (Charkha)

The traditional loom is housed on the upper floors of a Gaddi dwelling. The shuttle is long and hollow and the weft yarn is inserted manually. The fabric is woven in plain weaves in single colors. Traditionally, the fabric has flat weaves, and is of a single color. To add some ornamentation, stripes and checks might also be woven sometimes. The weaves are generally wool in both warp and weft, but sometimes Khadi cotton overlaid with wool can also be used, and warps of Khadi could also be teemed with wool wefts.

Fig. 3 Gaddi loom in black and white wool (Saho Valley, Chamba)

The resultant woven woolen fabric is more than a meter wide and approximately five meters long. It is then felted using mechanical rubbing by stamping with feet and soaping.

The process is repeated three to four times to get the desired felt quality. Traditionally the organic wool from the Gaddi sheep is used to make blankets and coverings using handloom.

*C. The **Kurumas** from Telangana Region*

The Kurumas are a community of traditional shepherds, living in the semi-arid region of Telangana. They are known as Kurumas in Telangana, and Kurubas in Karnataka and as Dhangars in Maharashtra. The name Kuruma is derived from Kuri or Kuru meaning sheep – or the ones who rear sheep. While the basic occupation of the Kurumas is rearing sheep, predominantly the Deccani variety, they are also engaged in other occupations like agriculture and weaving the Gongadi, a blanket woven using the handspun wool obtained from the Deccani sheep.

Fig. 4 Black and White Pattu–handspun and handwoven Phtograph taken at Saho Valley, Chamba

Fig. 5 Kuruma shepherd with Deccani sheep flock [10]

The Deccani breed of sheep is very well adapted to its local climate, where the temperature ranges from 8 degrees Celsius to 45 degrees Celsius. The coarse nature of the fleece helps to weather such temperature variations, and also the rains and the cold season in the semi-arid regions of Telangana and other neighboring areas. The sheep breed is extant in a large area spread across the states of Telangana, Andhra Pradesh, Karnataka and Maharashtra (some of the communities are sedentary/settled and some of them are migratory groups). Grazing for sheep is generally done on common property resources and harvested agricultural fields post-harvesting. Where there are no common grazing areas, the shepherds take grazing land from the local farmers on lease. The farmers benefit by this arrangement as the sheep droppings are a rich source of nutrients for the soil, and they pay the herders money or barter with food-grains in return [9].

Due to the extreme seasonal changes, the grazers migrate to neighboring states in search of greener pastureland for grazing, and this migration can range from 2 months to 8 months. Some communities have settled in villages and own and till their own land too.

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D. About the Gongadi Textile

The Gongadi blanket (woven using the handspun wool obtained from the Deccani sheep) is an integral part of the lifestyle of the Kuruma shepherds and is considered a symbol of their culture. The herders wear this blanket on the shoulders. The Gongadi is also worn on ceremonial socio-cultural occasions like weddings and festivals, thus it is seen as an identity for the community.

There is no standard size as each community or village will have its own traditional measure for the Gongadi but a majority of these Gongadis admeasure 115 inches long and 52 inches wide.

Gongadi blankets are 100% hand-made, naturally coloured and no chemicals are dyes are used in tits manufacture.

The blankets are maintain their original colour and do not fade even after repeated washing. In fact, the colour deepens with time

A single Gongadi blanket uses up to 3 kilograms of natural wool yarn. As each sheep can yield around 500 grams of raw wool, and each kilogram of wool yarn requires one and a half to two kilos of raw wool, it was found that raw wool from seven sheep is needed to make one kilo of yarn, and thus wool from 20 sheep is used to make one blanket [16].

Over the years, the Deccani sheep has adapted itself to the particular climate of their native region, and has become a part of the ecosystem. If the breed is endangered, the delicate balance of flora and fauna, and the symbiotic relationships that these species form will also be at risk. Governmental efforts at introducing non-native sheep species that produce better quality wool have not been particularly successful due to adaptability issues.

The Deccani sheep is the source of livelihood that provides the grazers with income, wool, meat and manure. Loss of sheep will spell loss of livelihood and traditional knowledge.

E. The Process of Making Gongadi Fabric Using Deccani Wool

A Deccani sheep can yield up to 500 to 700 grams of wool in a year, and wool shearing happens twice a year (spring and autumn season). The wool is sheared manually and the yield is taken by the shepherd to be sold, while a portion is retained by the grazer to either weave it at home or given to weavers to weave the Gongadi.

Wool fibers are sorted according to color and wool carding is done by women with a bow like wooden instrument that has a leather string. Sometimes, the fibers are carded by machine. The carding process untangles fibers and removes dust and impurities [15].

Both men and women are involved in the spinning of the yarn. The wooden spindle is turned by hand while the women are sitting on a stool. It takes approximately three weeks to produce three kilos of wool by working 3-4 hours a day.

In the warping process, the wool is wrapped on a structure consisting of seven pegs which is either fixed on the ground or on a hanging frame. The yarn is sized with tamarind seed paste thrice and then prepared for the healds of cotton thread that are made manually every time a Gongadi has to be woven [15].

Fig.6 Spinning of wool using wooden spindle

Gongadi is woven on a pit loom which is foldable and can be kept aside when weaving for the day is finished. This type of loom is portable and well suited for the nomadic lifestyle of the pastoral communities. Yarn is filled manually in a wooden shuttle of bamboo with one end closed and an opening in the other end for filling the yarn. The loom does not have a treadle and the weaver manually lifts the sticks to insert the bobbins.

Fig. 7 Pit loom for Gongadi weaving [10]

It takes 2-3 days to finish a Gongadi and once it is finished, the remaining warp yarns are twisted by hand to make a fringe detail in the end known as the *Kada* (a design detail done with a white wool yarn on a black Gongadi). Kada making.is a complex skill where interlacing the white yarn is interlaced with black yarn, forming geometric motifs like leaves and flowers. Some popular Kada motifs are Nimmakaya kada (lime border pattern), Sala kada (simple kada pattern), Pattu kada (silk kada), Allamadla kada (Four designs in one Kada pattern). The finished Gongadi is sold in the weekly local markets. The Deccani wool is also used to make bags. A waist band is also made in colorful yarns in black base for the folklorist/storyteller. It has significance as a religious symbol and considered sacred by the shepherd community and the weaving of a Gongudi is done on auspicious days. Some of the Kada patterns are shown in Figs. 8 and 9.

Fig. 8 Tummakaya Kada [10]

Fig. 9 Nimmakaya Kada [10]

VI. Research Findings

Although both the Pastoralist communities and the sheep are facing challenges the reasons are region specific and breed specific. Table I shows various pointers which compare the two scenarios.

A. Present status of Gaddi Wool

The Gaddi community is facing a threat of extinction as the traditional source of their survival and subsistence, i.e. the pastures are diminishing day by day due to Governmental policy of turning pasture land into wildlife reserves.

The new generation of Gaddis does not want to continue living in the traditional mold as it is a hard lifestyle with a lot of hardships and few comforts. The attraction of better money prospects and lifestyles in the cities are spurring Gaddi youngsters to abandon their traditional life and move to the cities. As a result, the unique Gaddi heritage and their textiles and sustainable practices are endangered, including their hereditary livelihoods and crafts and their heritage.

TABLE I
Comparison Of Gaddi and Deccani Sheep

Pointers	Gaddi Sheep	Deccani Sheep
Geographical region	Himachal Pradesh, mainly in Chamba and Kangra Districts (Dhauladar range of Himalayas)	Maharashtra, Andhra Pradesh, Karnataka and Telangana (Deccan Plateau with arid and dry weather and poor soil)
Pastoralist Community	Gaddi Transhumance tribe	Kuruba, Golla, Dhangar, Matangs
Number of sheep	Declining gradually	Pure breed is Declining at an alarming rate
Endangered /Extinct	Not endangered Reducing in number	Sheep almost vanished in 1990s Revival from 2004 till now
Migration Route	From Himachal Pradesh to Lahaul and Spiti in Jammu and Kashmir to plains of Punjab	From Western Ghats to Konkan Coast to Eastern Ghats. Many tribes in Maharashtra are stationary now.
Ecosystems	Himalayan region under stress due to declining snowfall and rising temperatures, over population and increased developmental projects	Deccan Plateau is facing depleting grazing land due to developmental projects, recurrent droughts and water shortage.
Dilution of breed	No	Yes, with meat producing sheep due to Government policies
Revival attempt	None	NGOs and co-operative of artisans are active e.g. Anthra, DGMPS
Wool quantity per sheep (annual)	1.5-2 Kg	Up to 5 Kg
Fleece color	White, and black	Black, grey and brown
Spinning and weaving	Drop spindle, Hand spinning wheel and handloom using no electricity	Drop spindle, Hand spinning wheel and Pit-loom using no electricity
Wool blanket /textile production rate	2-5 days for a six yard “Pattu” blanket which is felted as well.	15-30 days for making six feet by nine feet “Gongadi” Blanket
Consumption and sales pattern	Self-consumption of textiles home textile in Gaddi homes	Self-consumption, Local market, Exports to US, EU and Australia. Online sales for local market

The numbers of Gaddi sheep are also dwindling due to several reasons, chief among them are listed below:

1) Governmental policies of declaring forested areas as nature reserves to aid the preservation of indigenous wildlife has a direct effect on the pastoral communities’ traditional livelihoods that are based on pastoralism and livestock rearing. Such moves have ended up into taking away the traditionally grazing lands.
2) The state governments are also encouraging the pastoralists to strike roots and settle into an agrarian mode of life, by taking over state land and district using it for farming.
3) Widespread construction and urban proliferation in hilly areas, along with construction of hydel power projects has led to a lot of changes to the natural landscape. New roads are being built every day, and tunnels etc. being laid, thus altering courses of natural streams, and rivers, and this creates obstacles to the traditional grazing routes that the nomadic Gaddis use while searching for fodder for their animals.
4) Global warming is affecting the Himalayan region, like everywhere as well and the glaciers are retreating day by day. These temperatures are changes are making it difficult of the sheep to acclimatize themselves.
5) The Government has encouraged the introduction of meat-yielding breeds as this fetches more revenue Owing to these factors, a lot of flocks of Gaddi sheep have

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already disappeared. The Lahaul and Spiti districts of Himachal Pradesh used to have large flocks of Gaddi sheep but they are not found there anymore, and is a testament to the fact that climate change, and human intervention to chase bigger profits has caused such a decline in their numbers.

B. Advantages of Gaddi wool –

1) Gaddi wool is organic as the sheep are fed in natural pastures and no chemical growth supplements are given to them nor are they treated with any parasiticides.
2) The textile material is produced in a sustainable and eco-friendly way.
3) No chemicals are used in the cleaning/washing, dyeing or the weaving processes.
4) The handloom fabric uses zero energy except for the manual effort.
5) The natural fabric has water repellent and fire retardant properties.
6) Natural wool textile is bio-degradable.

C. Scope for Improvement in Lacking Areas

Since the Gaddis weave and consume the textiles within their own family and community, there is very little awareness or availability of these in the markets, and hence nil demand. No dyes are used, and the textile is quite plain and natural colored. The fabric can be coarse, lacks fineness and finishing. The weaving styles and patterns employed are very simple (plain weaves basic checks only). Gaddi young men do not want to wear this fabric and the art will slowly die. Sheep rearing is declining as it is seen as too much of hard work and considered unprofitable by the younger generation who prefer seeking employment in modern occupations like travel and tourism which forms the bulk of the revenue of the state of Himachal Pradesh.

VII. Present Status of Deccani Wool and Gongadi Craft

Today, Gongadi weaving has declined due to many social and economic factors. The main push came from the state policies towards pastoral communities in general.

The traditional barter system of exchanging Gongadi for other goods was replaced by currency transactions and gave rise to middlemen and also led to the formation of government controlled wool co-operatives. The traditional supply chain linkages slowly died out weakening the connections among the shepherd, the shearer, the spinner, the weaver and the Kada makers. The younger generation did not want to take up this craft and the shepherding profession and many have migrated to nearby cities for alternative employment.

Causes of the decline of indigenous Deccani sheep variety:

1) Introduction of meat producing sheep breeds has affected the Deccani sheep's predominance. The numbers of the indigenous Deccani breed has fast declined due to its replacement by mutton-yielding breeds. This was caused Government's policies that favored rearing of new sheep breeds to generate more income as meat demand was rising for local and export market.
2) Detrimental policies adopted by the princely state and the colonial administration as well as the usurping of common grazing areas as State land, which resulted in forceful eviction of the pastoral communities
3) "Mixing" of the Deccani breed with other breeds has also diluted the gene pool and the quality of wool has become low. Lack of good quality wool caused the weavers to stop weaving the Gongadi and made them seek out alternative means for earning. The artisans almost stopped weaving Gongadi even for their personal. Reduced wool supply in turn resulted in the decline of spinning activity by women of the villages. Weavers also shifted to mundane professions and most have now become daily wage earners.
4) Poor or almost nil veterinary care has been available to the pastoral communities, as they have generally been kept out of the ambit of the Government veterinary healthcare programs
5) Forest protection schemes have robbed the pastoral people of their customary grazing lands (which were earlier considered common property)
6) Developmental works like roads, bridges dams etc. have drastically altered the landscape of rural and forest areas, thus shrinking the available areas that a grazer could use to feed their livestock.
7) Use of pesticides and chemicals in agricultural land has led to poisoning of the sheep that graze in such contaminated areas
8) Gongadi woven on power loom also started competing with handwoven Gongadis as the machine produced material was cheaper in comparison
9) Easy availability of cheap wool blankets dumped by Western countries also became available in the local market, giving hard competition to the handloom ones.

These factors in combination resulted in dilution of the Deccani breed and activities associated with it. The number of pure breed sheep declined drastically, and thus causing the decline in the number of spinners, weavers and sellers associated with wool markets [16].

Despite these hurdles, the craft survives today as Gongadi has great cultural significance in the life of the shepherd communities like Kurumas, Dhangars, Gollas and Kurubas who have herded sheep for thousands of years. These people believe that sheep were created specially by God and the shepherds have a duty to rear this sheep. The life of the community rotates around the sheep and various studies done later on raised awareness of how sheep, land, people and crafts are interlined with their livelihood while promoting it as a best option given the ecological conditions of Deccani plateau. The Deccani sheep breed is more resilient and adapted for extreme temperature, cold winters and seasonal heavy rainfall. Compared to other new breeds, this breed is more disease resistant. It has lower water and fodder need than other injected mixed breeds, and is able to withstand even long periods of drought [10].

The handwoven variety lasts more than a lifetime, and some people continued to prefer handloom Gongadi, despite its

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higher cost. In spite of the many challenges facing Gongadi weaving, there have been sustained community efforts by certain experts in this field to revive this weaving tradition. NGOs like Anthra and Shramik Kala, and some individuals like Geeta Patil and Gopi Krishna have been working tirelessly to this end, and due to this revival, some weavers have started selling their products online and are also exporting them. Now, Gongadi is woven by all caste members in Karnataka and Telangana villages.

VIII. Results

Based on findings from the case studies, data collected and research done, the authors found that traditionally produced organic wool has potential to improve the quality of the indoor air inside any indoor Space. It is thus capable to improve the health of occupants through the absorption of indoor air pollutants, humidity regulation and acoustic control. Natural wool in its untreated form itself has many properties that makes it a Passive removal material (PRM) [14], [23]. Natural wool has the ability to remove Formaldehyde, Nitrogen Dioxide and Sulphur Dioxide from indoor air [14], [23].

The, textiles made from organic wool when used as furnishings, and textiles for interiors can be safely and easily washed and cleaned to remove the pollutants absorbed and trapped in them. We believe that increased use of sustainable textiles will in turn help to promote the concept of sustainable interior design. In this research, we discovered that the organic wool from the Gaddi and the Deccani varieties of sheep have unique properties like moisture absorption, thermal insulation against heat and cold, flame resistance and the ability to maintain the original shape. The traditionally produced textiles of the Gaddi and the Gongadi from the Kuruma community can be used in the interiors textiles industry. They can also be used as acoustic material for sound-proofing. The natural wool also acts as a sink for absorbing chemical pollutants in the interior space.

The Kurumas believe that the wool is a pain reliever and due to its thermal properties, it is said to combat fever. It is warm in winters and cold in summers, making it ideal for all seasons.

The contemporary designs created using handmade techniques add to the aesthetics apart from the inherent functional benefits. Custom design solutions can also be an advantage here. The textile designs application in interiors have been done keeping in mind the design for increased surface area which will further help to improve the acoustic, humidity level and VOC absorption when used in an interior space [14], [23].

Owing to the sustainable process used in its manufacture and eco-friendly character, this wool is proposed here as an integral component of a circular model of economy for interior textiles.

IX. Proposed Design Solutions

Keeping in mind the unique properties of natural wool sourced from the *Gaddi* and *Deccani* sheep breeds, the authors are proposing design intervention solutions by adapting this traditionally produced organic wool for textiles for use in the Interior Design industry. The following areas were explored–

1) **Virgin wool -** As this is virgin wool and has good thermal and water resistant properties, the chemical treatments were avoided to retain the inherent properties intact.
2) **Natural dyes** – The wool in ecru color was spun in a loose manner on hand spinning wheel at a Gaddi village in the Saho Valley of the Chamba district. The two-ply yarn was dyed in natural dyes sourced from Indian suppliers like Swetha Traders (Jaipur). Various sources from nature like roots, leaves, flowers, bark and insects gave dyes like Indigo (Indigoferra Tinctoria), Madder root (Rubia tinctorum), Gavarchini root, Alkanet bark, Lac dye, Myrobalan, Pomegranate peel, Turmeric, Tea and eucalyptus leaves were employed for dyeing the wool yarn [25]. The mordants used were generally Alum salt and Vinegar. However, for darker shades Ferrous Sulphate (*Kashish* in local language) was used as an after treatment. The process of dyeing the woolen yarn in Indigo colour is trickier as compared to the ones used for other dyes, and involves using soda ash flakes and hydrogen sulphite [25]. The yarn and woven fabrics were dyed in desired colors. The Gongadi fabric is naturally black in colour, and no dyes were used in this case, as the authors wanted to retain the characteristic unique look of the traditional textile from the Kuruma community.
3) **Handloom Weaves** – The explorations on handloom was done at the afore-mentioned Gaddi village in Himalayas as well as in the Textiles Lab of Pearl Academy at New Delhi as shown in Figs. 10-15. The checks created by using natural black wool of Gaddi sheep and dyed yarns in plain weave took place at Saho valley as shown in Fig. 4. The samples developed in the lab were more complex with weaves like Satin, Twill and Hounds-tooth as shown in pictures. Combining cotton yarn in the warp and Gaddi wool in various colors as the weft, the experimental weaves produced a finer look to the wool yarn, thus increasing the aesthetic value of the final product and can bring about the development of more interesting options with increased appeal value for the consumers to choose from.

Fig. 10 Handwoven sample of plain weave using Gaddi wool

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Fig. 11 Handwoven sample with Gaddi wool

Fig. 12 Handwoven sample of satin weave with Gaddi wool

Fig. 13 Handwoven sample of tapestry using Gaddi wool

Fig. 14 Handwoven sample of tapestry using Gaddi wool

Fig. 15 Handwoven sample of twill weave using Gaddi wool

A. Proposed uses of Textiles with Design Interventions

The textile /fabric that is made out of the organic wool from Gaddi and Deccani sheep can be used in various forms for horizontal and vertical surfaces in modern Interiors for residential and commercial sectors. These horizontal and vertical surfaces include, false ceiling, partitions, paneling, flooring material, paneling behind bed, window blinds, upholstery, tapestry etc. It can be used to create folding screens that act as dividers between two rooms.

Fig. 16 Folding screen using organic Gaddi wool

Fig. 17 Folding screen using black Deccani wool Gongadi

Fig. 18 Organic Gaddi wool Crocheted carpet and cushion

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Fig. 19 Organic Gaddi wool as carpet, flooring, wall covering

Fig. 20 Organic Deccani Sheep wool as carpet

Fig. 21 Deccani Wool Gongadi as blind for windows

Fig. 22 Organic Gaddi wool used as window blind

Fig. 23 Colorful blinds using organic Gaddi wool

Fig. 24 Organic Gaddi Wool as wall paneling

Fig. 25 Organic Gaddi Wool as wall paneling and cushions

The interior furnishings made out of the natural wool can also be used for wellness purposes.

Fig. 26 Organic Gaddi wool felt fabric used in ceiling

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Using hand technique of crochet as Gaddi women practice a lot of hand technique like hand knitting and crochet. Throws, cushion covers. Uneven yarn can be used for blinds as it allows light to penetrate inside the room.

Fig. 27 Organic Gaddi wool crocheted cushion cover

To relate to the modern interior textile market the technique of laser cutting can be further applied on it with modern designs that go well with present day interiors. The use of such textile will not only help to reduce the indoor air pollution but will further add aesthetics/value to the design of the modern interior space.

X. Discussion

Firstly, any product or by-product formed using the Gaddi and Deccani wool is re-usable, recyclable and renewable due to its organic nature and longevity. This aspect aligns well with the "cradle to cradle" concept of circular economy.

Secondly, the entire process is in harmony with the balanced eco-systems of Mother Nature, while preserving the rapidly depleting natural resources of the two regions that were studied by the authors.

The traditional lifestyles of the pastoral communities have age-old patterns that are aligned with the aims of sustainable living, as the wastage of materials and resources are negligible, and the carbon footprint is minimal. Such processes do not use any energy from fossil fuels or electricity and are purely a human endeavour using human manual labour.

In case of both these crafts, if creative and committed interventions are not done than they will soon become history. A very strong reason why these crafts are still surviving is because of the cultural significances they hold in the lives of the two communities. The death of these two crafts would result in multiple losses:

1) Loss of an art and craft form
2) The knowledge and skill associated,
3) Loss of the indigenous sheep breeds and the knowledge of using it as a source of wool which will further lead to disturbing the ecosystem.

The ideas for interior product development done authors have demonstrated are a small way to demonstrate the possibilities and potential of using such traditional textiles to adapt them for modern interior uses. This can help energize and revive the dying crafts and can provide additional sources of income to the tribespeople who till now have only been producing these textiles for self-consumption. With the ongoing awareness and desire for things hand-made and organic and eco-friendly, there is definitely a place for such products, a niche market it might be.

Organic wool from both Gaddi and Deccani sheep has unique properties in itself and has the potential to be blended into new contemporary lifestyles using some innovative ideas and fresh approach. Developing new products for Interior market using traditional techniques and processes can open up new opportunity areas for the two pastoral communities. This will provide employment and help to empower women and the younger generation.

The intervention by the authors will also make the new product more attractive to the modern buyer, as the introduction of colours, and weaving patterns will add more aesthetical value to the product that is already possessing the cachet of eco-friendly and hand-made, which is in great demand.

With newer options for earnings, this will give livelihood opportunities to traditional economies, and can also help in developing a sense of pride and self-sufficiency for women, thus helping to improve their status within the family structure as well their society, providing them with a sense of self-respect.

As seen in the study of the lifestyle of the Gaddi people, the Gaddi way of life is connected inexorably with the wool from the Gaddi sheep. Similarly, in the case of the Kurumas, it is the wool from the Deccani sheep that plays this central role. The very survival of these communities (Gaddis, Kurumas) and the organic wool from their indigenous sheep breeds (Gaddi and Deccani) are entwined with one another like the warp and the weft.

For any developing nation, innovations in indigenous crafts/products using traditional materials and indigenous processes are very crucial in order to achieve cumulative growth, both economically and socially.

By utilizing the indigenous knowledge and existing resources available and in turn also generating new employment opportunities, innovations brought to a traditional craft can empower the individual as well as the community itself, which will also lead to economic growth and help bring social change to the community [17].

This will further help in preserving the culture, heritage and lifestyle of this pastoralist community and prevent the depleting number of sheep in that region. More sheep population will result in better soil quality due to composting process of sheep droppings being used in the fields as manure making the environment green and sustainable. Any wool waste during the process of manufacturing or finishing when buried in the soil can also be used in agriculture and composting. The organic wool has the quality to improve improves the water retention and water distribution in soil acting as a slow release fertilizer.

We propose that textiles produced by these communities with some design intervention as required for the modern Interior textile market can help in creating sustainable interior environments by judiciously applying them in interior spaces.

These measures will also help to develop pride amongst the communities in their traditional systems. Rather than following

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the systems of urban economy, the proposed design intervention ideas may result in improving the usable value of products for contemporary taste of the customers

XI. Conclusion

Based on the design solutions and research findings etc. the authors have proposed a model as shown in Fig. 28.

The proposed model can help in preserving the culture, heritage and lifestyle of the pastoralist communities and also revive the dwindling number of sheep in these regions. This model will help us to protect the environment, culture, traditions of our country, its natural resources, and the functions and viability of natural ecosystems on which all life depends:

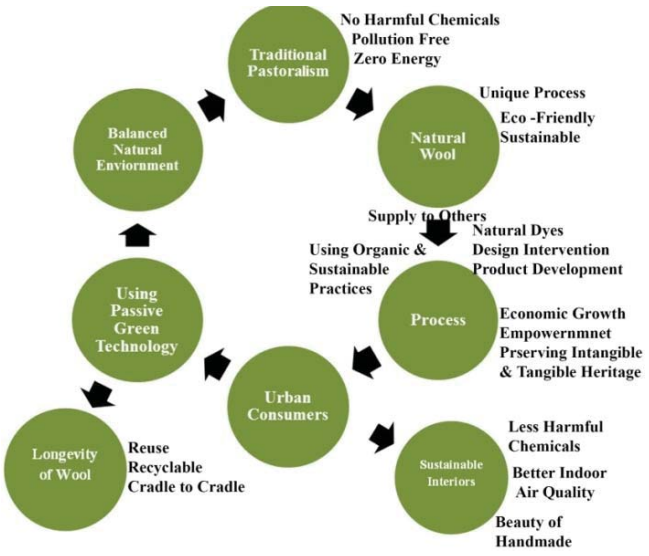

Fig. 28 Proposed Model of Sustaianbility from Pastoralist to Consumers (by authors)

However, on the other hand the authors also feel that adapting this model is not an easy task. There would be some limitations in the process of application of this model like availability of raw material in terms of quantity. The entire design process that is involved in the model is slow as it is based on the quantity of wool that is produced, and the craftsmen will further take on the weaving part forward. The manual weaving process is time-consuming and at times, seasonal too. This can result in high cost of products made by these communities as compared to the machine made products that are easily available in the market. We should also discuss drawbacks or trade-offs of such a model and be cognizant of challenges like cost, supply chain, availability of quantities, the slow process etc.

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References

[1] Araji, M.T. and Shakour, S.A, *Realizing the environmental impact of soft materials: criteria for utilization and design specification* , 2013, 560–571 as cited in Hayles, S. Carolyn, 'Environmentally sustainable interior design: A snapshot of current supply of and demand for green, sustainable or Fair Trade products for interior design practice', *International Journal of Sustainable Built Environment,* Volume 4, Issue 1, June 2015, Pages 100-108.

[2] Bhatia, S. and Arora, R., *Biodiversity and Conservation of Indian Sheep Genetic Resources – An Overview*, Asian-Australian Journal of Animal Science, Vol 18, No. 10: 1387-1402 https://www.ajas.info/upload/pdf/18_216.pdf (accessed 21 May 2018).

[3] *California Integrated Waste Management Board,* 2002 cited in Hayles, S. Carolyn, 'Environmentally sustainable interior design: A snapshot of current supply of and demand for green, sustainable or Fair Trade products for interior design practice', International Journal of Sustainable Built Environment, Volume 4, Issue 1, June 2015, Pages 100-108, [website], https://ac.els-cdn.com/S2212609015000138/1-s2.0-S2212609015000138-main.pdf?_tid=b645a60e-aa3a-46fe-a774-1b0453ee4049&acdnat=1528958903_357f6e3179bb1e388653b364069293f9, (accessed 28 April 2018).

[4] CPSC, *The Inside Story - A Guide to Indoor Air Quality, CPSC Document*, 2008, https://www.cpsc.gov/Safety-Education/Safety-Guides/Home/The-Inside-Story-A-Guide-to-Indoor-Air-Quality, (accessed 25 May, 2018).

[5] Daniel, Lu., *Evaluating Wool Curtain's Ability to Remove Indoor Formaldehyde: A Full-Scale Proof of Concept*. School of Engineering, University of Texas at Austin. 2013, https://utexas.box.com/s/rq7qatsw5ubjccxwfr002un6avmnk2ab, (accessed 12February, 2018).

[6] Ecoofficiency, *What is Sustainability?,* http://www.eco-officiency.com/what_is_sustainability.html (accessed 30 April 2018).

[7] *Environmental Protection Agency (EPA),* Introduction to Indoor Air Quality, https://www.epa.gov/indoor-air-quality-iaq/introduction-indoor-air-quality, (accessed 22 February 2018).

[8] Fathy A, "Sustainable Textile Materials in Interiors", in Proc. 11th International Conference on Urban Regeneration and Sustainability. WIT Press, 2016, https://www.witpress.com/Secure/elibrary/papers/SC16/SC16053FU1.pdf (accessed 30 March 2018).

[9] Ghotge, N. S. & Kishore, K., *Pastoralism in India: The Warp and the Weft* , 2016, http://www.anthra.org/publications/research-papers/pastoralism-india-warp-weft/, (accessed 15 May 2018).

[10] Gongadi: The wool craft of Telangana, Deccani Gorrela Mekala Pempakadarla Sangham and Food Sovereignty Alliance, India, 2016.

[11] Guerin, D. and Kang, M. *The Characteristics of Interior Designers Who Practice Environmentally Sustainable Interior Design Environment and Behavior* Vol 41 No 2 2009 p:170-184, cited in Hayles, S. Carolyn, 'Environmentally sustainable interior design: A snapshot of current supply of and demand for green, sustainable or Fair Trade products for interior design practice', *International Journal of Sustainable Built Environment,* Volume 4, Issue 1, June 2015, Pages 100-108.

[12] Hayles,S. Carolyn., " Environmentally Sustainable Interior Design: A Snapshot of current supply of and demand for green, sustainable or fair trade products for interior design practice," International journal of sustainable built environment, Volume 4,Issue1, June 2015, pages100-108,https://ac.els-cdn.com/S2212609015000138/1-s2.0-S2212609015000138-main.pdf?_tid=b645a60e-aa3a-46fe-a774-1b0453ee4049&acdnat=1528958903_357f6e3179bb1e388653b364069293f9, (accessed 28 April 2018).

[13] Jones, L., *Environmentally Responsible Design: Green and Sustainable Design for Interior Designer*, New Jersey, John Wiley & Sons Inc, 2008.

[14] Kinney, T., 'Wool : Master's Design Thesis', Master Thesis, The University of Texas at Austin School of Architecture, Spring 2014.

[15] Kulkarni T. and Kambli, *The Blanket of the Shepherds of North Karnataka*, National Institute of Design. Ahmedabad, India: NID

[16] Mallick, A. , Reviving the Ba Ba Black Sheep of Telangana: The Yarn of the Gongadi blanket, 2017, https://www.thenewsminute.com/article/reviving-ba-ba-black-sheep-telangana-yarn-gongadi-blanket-55389, (accessed 12 April 2018).

[17] Mehta, S and Punekar, R.M., *Exploring Indigenous Innovations: Ascertaining the scope for design interventions for their successful commercialization*, *http://www.shashankmehta.com/Research%20Papers%20pdfs/Exploring%20Indigenous%20Innovations%20-%20Ascertaining.pdf* (accessed 22

Open Science Index, Materials and Textile Engineering Vol:13, No:2, 2019 publications.waset.org/10009989.pdf

April 2018).
[18] Merriam-Webster Dictionary,2005, www.m-w.com (accessed 25 May 2018)
[19] O Ecotextiles, *What does organic wool mean?, 2008 https://oecotextiles.wordpress.com/2009/08/11/what-does-organic-wool-mean/,* (accessed 5 March 2018).
[20] Randhawa T. S.,*The Last Wanderers: Nomads and Gypsies of India*. Ahmedabad, Grantha Corporation and Mapin Publishing Pvt. Ltd., 1996.
[21] Toffler, A., Third Wave, Bantam Books, 1989.
[22] U.S. Green Building Council (USGBC) Guidelines, cited in Winchip, S. M, *Sustainable Design for Interior Enviornment,*. New York, Fairchild Publications, 2007.
[23] Winchip, S. M, *Sustainable Design for Interior Enviornment,*. New York, Fairchild Publications, 2007.
[24] World Commission on Environment and Development (WECD), *our common Future: The world commission on Environment and Development*, New York, Oxford University Press, 1987.
[25] Yusuf, M., Shabbir, M. & Mohammed, F., Natural Colorants: Historical, Processing and Sustainable Prospects. *Nat Prod Bioprospect, Vol.7 (1): 123-145.* https://link.springer.com/article/10.1007%2Fs13659-017-0119-9 (accessed 20 February 2018).

Open Science Index, Materials and Textile Engineering Vol:13, No:2, 2019 publications.waset.org/10009989.pdf