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Empowering Hands and Weaving the Dreams of Viksit Bharat 2047 – "The Lotus Yarn Initiative"

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Abstract

Innovative natural material plays an essential role in the handicraft sector. Mostly all the Indian traditional textiles consist of natural fibre which has its own essence and value. Till date, artisans love to continue practicing and refining their indigenous techniques. With the increasing population and demand, technological advancement in natural fiber manufacturing is a major concern. Moving towards the contribution in fulfilling the dreams of "Viksit Bharat 2047" the present study throws light on experimenting the precious fibre hidden in wetlands. The study focuses on indigenous spinning systems, technological advancement for manufacturing of Lotus fibre, testing, lab to land approach by training the women for extraction and spinning, implementing Lotus yarn in developing Khadi and handloom fabrics and exhibiting them in various platforms. Results revealed that it was possible to develop 100 % Lotus hand spun yarn of 28's and 50's that was used to develop Khadi fabrics. Considering the mass production and technological aspect, the approach for design and fabrication of apparatus was possible and feasible in developing 60's Lotus yarn which was used in developing hand woven stoles using Bhujodi weaving of Kutch. Training of women was successfully conducted and helped them to manage some of their financial crisis. Exhibition of the fabrics has remarkably attracted the fashion designers, handloom artisan weavers, startup agencies and array of yarn, dyeing and fabric manufacturing industries. Lotus fiber being natural material and manufacturing itself is a craft and require lot of skill and patience. Hence the entire value chain of Lotus petiole – fiber - yarn – fabric will be a novel future fiber in the field of textiles that will contribute to the pillars of "Viksit Bharat -2047".

Keywords: Lotus, Petiole, Yarn, Fabric, Spinning, Handicrafts.

1. Introduction

'Viksit Bharat' means 'Developed India'. Our honourable Prime minister and the entire team is constantly working to expand a role of textile sector in building a developed nation by 2047. Fiber is a basic unit for developing any textile yarn and fabric Bhuyan and Gogoi (2020, p. 1005). Fiber yielding plant has a huge commercial importance. It has valuable contribution to

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the economy and leads to improving the livelihood of the communities and environment Srivastava and Rastogi (2018, p. 1) Handicraft industry abundantly use natural fibers and conventional manual methods for developing various products. Common natural fibers like Silk, Wool, Cotton, Jute, etc are used in traditional handloom textiles. The focus of the entire World is towards sustainability, designers and weavers tremendously search for sustainable and novel natural fibers which is eco-friendly in its true sense in entire product development process.

India is a country of wetland ecosystem. There are significant number of minor and major plants found in the wetlands are considered as a bioresources Mishra, Panda and Sahu (2012, p .658). One of them is Lotus (Nelumbo Nucifera Gaertn.) is an important cash crop each and every part of the plant has a several applications. Lotus cultivators used to sell flowers, seeds, fruits, and rhizomes. But they are less aware about the petioles which are generally thrown away while cutting and bundling the flower and sometimes left in the pond during picking the flower. Ponds are considered as an essential component of hydrological systems and it is responsible for various roles in biosphere Kumar and Pratap (2015, p.848). According to the biological evidence, it is found that the bud of Lotus flower faces difficulty to open if the cut stems are left in the wetlands Netlak and Imsabai (2016, p. 32). This hygrowaste containing fibers are produced in bulk. Extracted fibers can be explored for diversified uses in textiles

Lotus has a strong symbol of purity and spirituality in Myanmar. Extraction of fibers were practiced since 1910. In 1990s the designers of Japan have started the workshop to develop the foreign market for the fabric. But due to the low production and demand the fabric remained rare Tomar and Yadav (2019, p. 210). Extraction of the Lotus fiber is practised by small communities in Myanmar, Manipur, Vietnam and Cambodia by the manual extraction process which is labour intensive and time consuming. Fibers are extracted and twisting by the hand which is directly used in developing fabrics on table loom and backstrap loom which hinders this precious fiber with low production rate. The present study gives a scientific path for this aquatic fiber in terms of extraction, systematic spinning, testing for quality in terms of production, characteristics and

shell life of the end product, technological advancement for its drawbacks and implementing it in traditional handloom textiles as a novel valuable product. The study has emphasized the importance of supporting local communities especially empowering rural women for extracting and spinning Lotus fibers. Developed fabrics were displayed in different exhibitions for its promotion and awareness.

2. Methodology

The study is experimental and exploratory in nature divided into following points:

Sourcing of Lotus Petioles: Nelumbo Nucifera Gaertn. species that is a petiole of pink Lotus was used. Waste Lotus petioles were collected from Lotus Flower vendors and cultivators from near and around Vadodara district of Gujarat shown in Figure 1.

Figure 1 Sourcing of waste Lotus petioles

Manual extraction process of Fibers: Bunch of petioles were taken together, slited at the consecutive sections along with stretching and extracting the fibers. Extracted fibers were winded on the pern without twisting which is called as "unspun yarn" which was followed by indigenous spinning for imparting strength.

Preparation of handspun yarns: Extracted unspun yarn was initially tried for spinning through various indigenous spinning systems: Drop spindle (Takli), Box Charkha (Peti Charkha) and 2 spindle Ambar Charkha. Two different types of yarns were developed one was spun using Box Charkha (Peti Charkha) and another was by Ambar Charkha. Two different types of handspun yarns that is LY-1 (handspun Lotus yarn; 2 petioles; technique Ambar Charkha) and LY-2 (handspun Lotus yarn; 3 petioles; technique Peti Charkha) were

developed by varieting the number of petioles and spinning techniques. The spinning was done by the researcher by taking assistance from expert spinner Mr. Bakul Shah. Yarns were tested for strength, fineness and twist as per ASTM D 885.

Design and fabrication of apparatus: Considering the basic aspects of the extraction process of Lotus fiber and morphology of Lotus petiole in terms of internal and external structure, diameter, length variation, speed, tension and uniformity, specific apparatus design was prepared in the CAD software and final fabrication of the apparatus was done by taking assistance from mechanical and robotic engineers from Vadodara district of Gujarat. Researchers have got patent grant for fabricated apparatus IN201921032058.

Preparation of yarn from fabricated apparatus and its testing: The apparatus is semi-automatic in nature. It consists of input and output chamber. Bunch of petioles were loaded in the input chamber which consist of spinning mechanism along with stretching. The output chamber consist of yarn winding mechanism that collects all the extracted and spinned yarn uniformly over the pern. The developed yarn LY-3 (3 petioles; extracted and spun Lotus yarn from fabricated apparatus) was tested for strength, fineness and twist as per ASTM D 885.

Fabric development and its testing: Two different varieties of handspun yarns were subjected for developing Khadi fabrics. Weaving was done by weavers of Udyog Bharti under KVIC, Gondal, Gujarat. The yarn developed from fabricated apparatus was used to develop handloom fabrics by taking assistance from artisan weaver of Bhujodi, Kutch. Fabrics were tested for

thickness, weight, fabric count, stiffness, strength, pilling, abrasion and shrinkage. The Kawabata analysis was also done in CIRCOT Mumbai. Composition of the fabrics are shown in Table 2.

Table 2. Composition of the fabrics

Fabric name	Warp	Weft
LF Fabric -1	120's Cotton handspun	80's Lotus handspun by Ambar Charkha
LF Fabric -2	120's Cotton handspun	50's Lotus handspun by Peti Charkha
LF Fabric -3	80's mill spun	60's extracted and spun from fabricated apparatus

Training the women

After establishing the process and analysis of the testing results researcher planned to take this work in the community and initiate a startup project. For conducting training programme, researchers searched on internet about different NGOs working in Vadodara District of Gujarat. Researchers purposively selected NGO Happy Faces, Vadodara. Founder of NGO showed interest to start women empowerment activities and suggested to train the ladies of Zadeshwar village at Akshar Chowk, Atladara, Vadodara. The entire training programme was done in collaboration with NGO Happy Faces, Vadodara. The training programme was named as "Project Sulbha". The NGO run the street school in Zadeshwar village. In this school children of the village get free education in the morning time and in afternoon time parents of these children specially the mothers and girls (above 18 years of age) were trained for Lotus fiber extraction and spinning. The training programme was done in the school in their vicinity only so that women can save time for transportation and meanwhile they can take care of their family members. In initial stage three weeks training for fiber extraction was given to 30 ladies. Then as per the quantity, quality and dedication towards the work, researchers selected 10 ladies for final workshop. These 10 ladies were further trained for spinning. Training for spinning was given by researchers and expert spinner Mr. Bakul Shah. Consent of all the ladies were taken prior to the workshop. The same group of ladies were further trained to operate the fabricated apparatus. Ladies were paid for this work. The funds for the entire project were obtained through various bodies. Initially for the fiber extraction workshop through manual method in that stage the funds were obtained by the members of Happy faces NGO Vadodara. Workshop for hand spinning was funded by GARGI – "Centre for holistic development for women" research scholarship by Dr. Babasaheb Ambedkar Open University, Ahmedabad and further workshop for training ladies to operate fabricated apparatus was funded under SSIP 2.0 grant from Centre for startup and innovation of The Maharaja Sayajirao University of Baroda, Vadodara.

Development of products and exhibitions: As per the demand of various national and in international buyers and consumers handspun yarns were used to develop Lotus Khadi Yardages. The yarns developed from the fabricated apparatus was used to develop handwoven

stoles using Bhujodi weaving. Developed products were exhibited in three different exhibitions.

3. Results and discussions

Extraction of Lotus fiber

For the manual extraction process, bunch of (2-3) petiole as per the specific fineness requirement was taken together which was slited along with stretching and winding on the pern without imparting additional twist Figure 2. This delicate fiber requires lot of skill and patience for maintaining proper tension during stretching, slitting and end to end joining. In the fabricated apparatus, the petioles are loaded in the input device which consist of long PVC which has a spinning mechanism along with the provision of stretching simultaneously the spun yarn are winded uniformly on the attached pern assembly in the output device. The apparatus has a provision of extraction, spinning and winding all operation one at the time. The apparatus is user friendly and works on solar energy Figure 3.

Figure 2 Manual extraction of Lotus Fiber

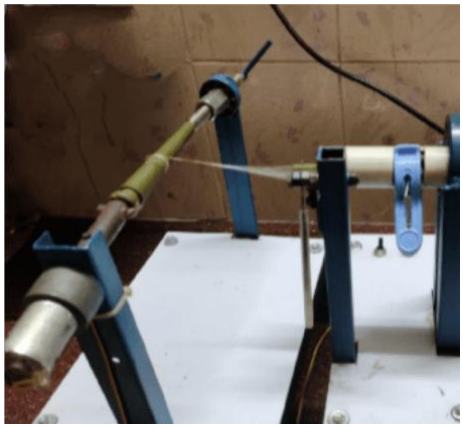

Figure 3 Extraction of Lotus fiber from Fabricated apparatus

Spinning and Properties of Lotus yarn

Lotus fiber extraction process is the full of art and skill. Spinning imparts strength and durability to the yarn. Khadi fabric is alive from ancient time till modern era and it has a share in Indian economy. Entire Khadi sector provides the huge number of employments specifically in the rural India. There is the great demand of Khadi products in the international market and export. Recently Khadi sector is also implementing novel fiber in blended proportion like Poly Khadi, Silk Khadi, Banana Khadi, Wool Khadi etc. Hence Lotus fiber extracted manually that symbolizes the art and skill of the extractor was further

subjected to develop yarn by different indigenous spinning techniques – Box (Peti) Charkha Figure 8 and 2-spindle Ambar Charkha Figure 9. It was observed that it is possible to spun Lotus fiber extracted from three petioles without any frequent breakages in Box (Peti) Charkha Figure 5. Concentrating on the consumption of petiole and increasing the fineness, fibers extracted from the two petioles were spun on modernized two spindle Ambar Charkha Figure 4. For the Lotus fiber the systematic processing line like creel was developed for the smooth supply of the raw material. Yarn production by Ambar Charkha was much faster that Box (Peti)

Charkha. Win (2020, P. 347) mentioned that four to five petiole together are required to develop Lotus yarn. Dhama and Singh (2022, p.33) reported that six to seven Lotus petiole are required for Lotus yarn preparation. But here in the present research it was possible to extract and spun fine Lotus yarn from two petiole. In today's era, technological advancement is the need of an hour. Hence the specific apparatus was fabricated for Lotus fiber extraction and spinning which is operated by renewable energy that is through solar cell Figure 6. The apparatus is very productive and useful in obtaining high quality Lotus yarn Figure 10 . As shown in Table 3, it was observed that yarn (LY-3) has obtained high tenacity of 42.06 gf/tex followed (LY-1) yarn developed from Ambar Charkha that is 18.537 and (LY-2) yarn developed from Box (Peti) Charkha. It was observed that yarn developed from apparatus has a higher twist (10 tpi) followed by yarn prepared Ambar Charkha (6.3 tpi) and spun by Box (Peti Charkha). Fine yarns are considered as a highly prized commodity which enables the fabric to be made luxurious and soft handle. All the yarn developed were fine for the clothing applications.

Figure 4 Spinning of Lotus yarn – Ambar Charkha

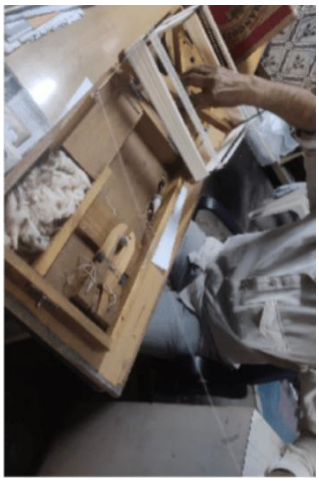

Figure 5 Spinning of Lotus yarn– Box (Peti) Charkha

Figure 6 Spinning of Lotus yarn – Fabricated Apparatus

Figure 8 Lotus yarn – Ambar Charkha

Figure 9 Lotus yarn – Box (Peti Charkha)

Figure 10 Lotus yarn – Fabricated Apparatus

Table 3. Properties of Lotus yarn

Yarn type	Fineness (Cotton Count – 'S')	Twist (TPI)	Tenacity (gf/tex)
LY-1	80	6.3	18.537
LY-2	50	2	5.76
LY-3	60	10	42.06

LY-1 (handspun Lotus yarn; 2 petioles; technique Ambar Charkha) LY-2 (handspun Lotus yarn; 3 petioles; technique Peti Charkha) LY-3 (handspun Lotus yarn; 3 petioles; technique Peti Charkha)

Properties of constructed fabrics

All the three fabrics were soft in touch and possess distinct characteristics. Fabrics were light in weight (GSM) Table 4 which fall under the category of light weight fabrics Young (2015, p.20). Amongst all the fabric, LF -3 (Figure. 13) has high tensile strength in weft direction due to the quality of the yarn extracted and spun from the fabricated apparatus Table 5. Drape plays a very essential role for the designer as it influences the appearance of garment. Amongst all the fabric, LF-1 Fabric (Figure. 11) has a low drape co-efficient due to high fineness of the Lotus yarn developed from the set of two petiole in the extraction process Table 6. Particular apparel is considered as serviceable when it is appropriate for specific end use. All the fabrics has a neglible pilling (Grade -5 that is no pilling) and 0 % shrinkage. LF- 3 fabric has obtained higher number of abrasion cycles (700) means the fabric will have good in wear and tear property. LF-1 and LF-2 (Figure. 12) fabrics has obtained lesser number of abrasion cycles (200) means these fabrics can be used for specific usage were durability and wear and tear is not a problem. Kawabata analysis revealed that these three fabrics can be used in women's suiting.

Figure 11 LF – 1

Figure 12 LF - 2

Figure 13 LF - 3

Table 4. Preliminary properties of fabrics

Fabric type	Fabric weight (grams)	Fabric count	Thickness (mm)	Cover factor (k)
LF - 1	80	52×34	0.34	7.7
LF - 2	82	50 × 44	0.39	8.2

LF - 3	125	32×23	0.41	5.5

LF Fabric – 1 - Handspun fabric (Warp – Handspun Cotton yarn - 120'; Weft – Handspun Lotus yarn by Ambar Charkha: 2 petiole - 2/80's) LF Fabric – 2 - Handspun fabric (Warp – Handspun Cotton yarn - 120's; Weft – Handspun Lotus yarn by Peti charkha: 3 petiole - 3/50's)

LF Fabric – 3 -Handloom fabric (Warp –Cotton mill spun - 80's; Weft – extracted and spun Lotus yarn from fabricated apparatus :3 petiole - 60's)

Table 5. Tensile strength of fabrics

Fabric type	**Maximum Load (kgf)**		**Extension (mm)**	
	Warp	**Weft**	**Warp**	**Weft**
LF - 1	19.39	6.50	15.14	10.5
LF - 2	7.75	6.79	7.49	4.6
LF - 3	19.79	32.55	14.70	10.48

LF Fabric – 1 - Handspun fabric (Warp – Handspun Cotton yarn - 120's ; Weft – Handspun Lotus yarn by Ambar Charkha: 2 petiole - 2/80's) LF Fabric – 2 - Handspun fabric (Warp – Handspun Cotton yarn - 120's ; Weft – Handspun Lotus yarn by Peti charkha : 3 petiole - 3/50's)

LF Fabric – 3 -Handloom fabric (Warp –Cotton mill spun - 80's ; Weft – extracted and spun Lotus yarn from fabricated apparatus :3 petiole - 60's)

Table 6. Drape co-efficient of fabrics

Fabric type	**Drape Co-efficient (%)**
LAHY	29
LPHY	38
LMY	32

LF Fabric – 1 - Handspun fabric (Warp – Handspun Cotton yarn - 120's ; Weft – Handspun Lotus yarn by Ambar Charkha: 2 petiole - 2/80's) LF Fabric – 2 - Handspun fabric (Warp – Handspun Cotton yarn - 120's ; Weft – Handspun Lotus yarn by Peti charkha : 3 petiole - 3/50's)

LF Fabric – 3 -Handloom fabric (Warp –Cotton mill spun - 80's ; Weft – extracted and spun Lotus yarn from fabricated apparatus :3 petiole - 60's)

Product Development

Handspun yarns developed from Ambar Charkha were used to develop Lotus Khadi yardages Figure.14 and Lotus Khadi Saree Figure.15 shown in Figure. The yarns developed from fabricated apparatus was used to develop Lotus handwoven stoles Figure.15 using Bhujodi

weaving. Images of the products are shown in Figure 5.

Figure 14 Lotus Khadi yardage

Figure 15 Lotus Khadi saree

Figure 16 Lotus handwoven stoles

Training the group of women

The group of women learned the manual extraction process, hand spinning techniques and operation of apparatus. With the time they achieved production capacity along with the quality. Few of the women from the group also worked as a leader to collect the petioles, arranging the extraction and spinning unit, collecting, calculating the output and communicating even in the absence of researchers Figure 17.

Figure 17 Training Unit for Lotus fiber extraction and spinning

Display of products

To showcase the hard work and dedication of the women in the limelight, researchers decided to display the products on International Women's Day, 8 March, 2022 Figure 18. Exhibition was held in Eva Mall, Manjalpur, Vadodara. Ladies quoted that "we are very lucky to learn such kind of new skill in our life and it has helped to manage some of the financial crisis". They quoted that "earning the money by their own hard work has a different essence and it gives an immense satisfaction. They are ready to continue this work in upcoming future. Total 100 peoples visited the stall, they like the feel, softness and drape of the Lotus handwoven stoles and Lotus Khadi yardages.

Gujarat Technological University start up and innovation centre in collaboration with AIC (Atal Incubation Centre) and ACCWF (Ahmedabad Chamber of Commerce Welfare Foundation) jointly conducted "Agripreneurs conclave" (Agri – startups exhibition). The programme was held on 21-22 July, 2022 at GTU campus, Chandkheda, Gujarat Figure 19. The name of the stall was – "Agrowaste to Eco-Textiles: - Lotus Petiole finds a new place in Fashion Industry". Different start up agencies, people associated with the agriculture, textiles, fashion and robotics visited this stall. They like the entire concept of conversion of aquatic waste into sustainable fiber. Various start up agencies showed interest in investing on this Lotus fiber fabric preparation. Designers showed interest in purchasing the products.

Due to wide media coverage, vice president and members of Southern Gujarat Chamber of Commerce and Industry (SGCCL) contacted and approached the researchers for exhibiting Lotus fiber products in Weave Knit 2022 (The complete fabric show) 2nd Edition, exhibition. The exhibition was conducted for three days that is 23 to 25 July, 2023 at Sarsana, Surat Figure 20. The name of the stall was "Padmapalash". Fabric manufacturing industries: - Nilkant fabrics, Vedanta fabrics, Yogeshwar Textiles, Batsons Textiles, Dhanlaxmi Textiles, Knit world, Jenny Fashion, Shree Hari Tex etc from Surat, Gujarat visited the stall. Peoples from the industry like the feel, drape and texture of the fabrics. Different yarn manufacturers like Shanghvi spinners, Agarwal Fabtex private limited, Colour Trendz etc. visited the stall. They liked the fineness and feel of the yarns.

Figure 18. Exhibition of products in Vadodara

Figure 19. Exhibition of products in GTU Campus

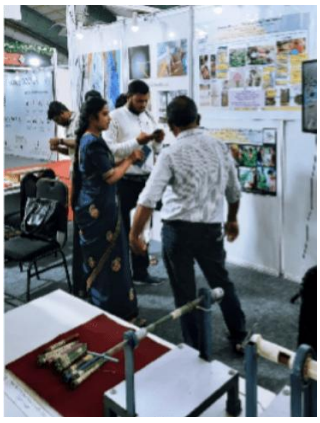

Figure 20. Display of products in Surat

Contribution of Lotus fiber value chain towards Viksit Bharat 2047

India has a resolute vision towards "Viksit Bharat" which can be achieved by the collective contribution from each and every field Fazal, (2024,p 39). The contribution of the present research towards the pillars (GYAN) of Viksit Bharat Figure 21.

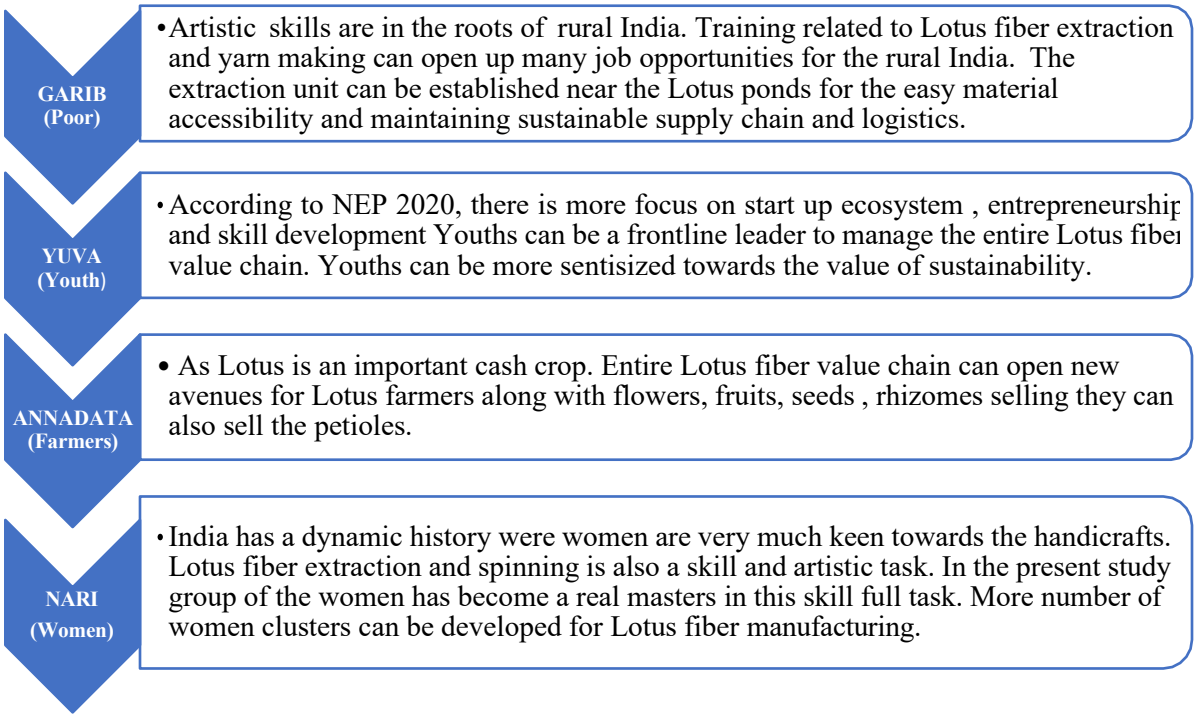

Figure 21. Contribution of Lotus fiber value chain towards the pillars of Viksit Bharat

4. Conclusions

India is known for its prestigious handloom textiles which majorly consist of natural fibres. Designers, weavers and consumers have become more conscious towards unique product containing natural fibre manufactured by environmentally friendly technique and biodegradable in nature. Lotus fiber will be novel fibre in the area of sustainable luxurious textiles. Lotus grows in the mud but the fiber is extremely soft, delicate and good for the skin pertaining antibacterial and cytotoxic properties. Lotus Khadi fabrics has rhythmic irregularities that is identity and true essence of the hand spun yarn. In the arena of natural minor fiber, the cost also plays a major role. Invention of the apparatus has made a marked difference in Lotus fiber extraction in terms of productivity and quality. Inventions of apparatus, implementation of indigenous system of spinning, training and exhibition has given a complete shape and future path for the commercialization of the Lotus fabric manufacturing. Every single effort will be helpful towards "Developed India". The present research work will be helpful for the fulfilling the dreams of "Viksit Bharat".

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