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THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
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AN OVERVIEW OF SITRA'S R&D WORK AND SERVICES - 2021-22

With the general weakening of COVID-19 pandemic during the year, there was a mild respite for the industry. Backed by stability on the logistics front, there was a cautious return to normalcy in the general economic activity. The enthusiasm in the industry was also reflected in an improvement in the seeking of SITRA's services by the industry. There has been an addition of 5 members during the year. The new members include 3 full members and 2 associate members. While 1 mill opted to resign from the membership mainly because of poor operating profits, SITRA had to take the painful decision of terminating the membership of 3 mills due to persistent default in meeting membership obligations. The total membership of SITRA during the year was 147, comprising of 187 units. SITRA's services were also utilised by 39 small mills under the Technical Support Scheme. In all, 226 units have access to SITRA's services, apart from many weaving units in the decentralised sector which utilised the services offered by 7 Powerloom Service Centres, one Textile Service Centre and 4 CAD Centres.

The overall financial position of SITRA during the year had been satisfactory, resulting in a surplus income over the expenditure.

SITRA continued its focus in the R &D sphere even as it continued to address the problems of mills. Good progress was recorded on most projects during the year, most significantly those carried out as in-house projects. SITRA was working on as many as 23 projects during the year. Of them, 4 were sponsored projects. Work relating to 7 projects were completed during the year. Topics of wide-ranging interest have been studied in the projects carried out during the year. An overview of the work done during the year in different areas are given below.

FIBRE TO YARN CONVERSION

The study on Yarn fault classification using optical principle has attempted to establish an off-line optical yarn fault classification system, wherein along with the existing capacitance type yarn fault measurement, an additional optical measuring head is fixed in the same yarn path. Simultaneous measurement of yarn fault both in the capacitance and optical measuring has been planned to be carried out under identical testing conditions like speed, tension and atmospheric conditions. A comparison and analysis of results will help in establishing the clearing limits for yarns of different applications made from cotton, manufactured fibres and their blends.

With present generation ring spinning machines capable of operating at higher spindle speeds of up to 25000 rpm, with a focus on productivity, mills are increasing their spindle speeds and also their roving twist. Increase in spindle speeds has an indirect impact on the tensile characteristics of yarn. Hence, an attempt has been made to analyse the impact of spindle speeds and roving twist multiplier on the tensile characteristics of cotton yarns. Roving bobbins of 1.32, 1.39 and 1.42 TM were processed in SITRA Pilot Mill ring frame of LMW LR 6S make having a Suessen compact system. Roving bobbins with varying TM levels were spun into yarns at three different spindle speeds (18000, 20000 and 22000 rpm respectively). A total of 9 yarn samples were produced and tested. The results have shown that a drop in elongation was noticed in the range of 14% to 17% when the spindle speed increases from 18000 rpm to 20000 rpm for various roving TM levels. Also, the elongation drop was noticed in the range of 18% to 26% when the spindle speed increases from 18000 rpm to 22000 rpm. When the roving TM increases from 1.32 to 1.42, up to 8% drop in elongation was noticed.

In another study, the performance of hybrid clearers have been compared with that of previous generation clearers in terms of clearer cuts, remaining classimat faults in cone yarn, etc. Samples were collected from ring fames running two different yarn counts and processed in capacitance and optical based clearers of previous generation as well as the current generation hybrid clearers. Both on-line classimat faults and online quality data were collected. Also, cone yarn and cop yarn samples collected from all the trials were tested for Unevenness and imperfections, Classimat yarn faults and single yarn strength. The key observations from the intial work conducted has shown that while the online yarn quality measured by both the clearers are more or less similar, the total NSLT cuts were higher by 3% in Hybrid clearers and the Uster top 9,10,16 levels, total NSL faults and total thin faults were lower by 29%, 17%, 15%, 11% and 38% respectively when compared with the capacitance clearers. The overall outliers got reduced by 3% in Hybrid clearers when compared with the Capacitance clearers.

An annoying issue faced by spinning mills with regard to cotton neppiness in some of the cotton lots, which significantly influences the aesthetic characteristics of woven and knitted fabrics and also causes problems during finishing has been investigated in a study. While the initial nep number in unginned cotton is relatively small, the successive stages of processing change the nep number. The study has attempted to find the relationship between the fibre properties and the processed fibre properties by means of nepping propensity with respect to fibre length, fibre fineness and fibre maturity. Forty three ginned baled cotton samples representing different varieties of cotton grown in India were taken for the study and were tested by a high volume instrument (HVI- ASTM D 5867-12) for length, uniformity ratio, strength, elongation, and micronaire and maturity value. The following results have emerged out of the study :

- Fibre length, fibre fineness and maturity co-efficient values have a greater relation with the raw material nep count per gram
- The increase in neps after 1st passage is lower with shorter length and very high with the longer length group.
- In case of micronaire and maturity co-efficient, the nep increase after 1st passage was lower with coarser micronaire & high mature cotton and higher with finer micronaire & low maturity cotton.

Based on the study, SITRA has suggested the following guideline values to mills

- While selecting bales for mixing (as per SITRA suggestion), the permissible limits or the critical difference are to be fixed based on the average of two samples.
- For 2.5 span length 5 combs/sample and critical difference (% of mean) should be within 3.6.
- For micronaire value 5 plugs/sample and critical difference(% of mean) should be within 5.4.
- For maturity coefficient 600 fibres/sample and critical difference (% of mean) should be within 7.

Spinning mills are estimating the Nep Removal Efficiency based on nep count determined on Uster AFIS (Advanced Fibre Information System) for both feed material and delivery material. Now a days, mills are frequently facing the problem of a sudden increase in the yarn neps between lots even after maintaining a better NRE % in card / comber. To analyse this phenomenon, a novel approach to evaluate nep removal efficiency based on the nep size was attempted and based on the study, the following measures were suggested to mills towards reducing neps in the yarn :

- Estimate the nep removal efficiency for the critical nep size for the yarn count spun.
- Analyse the neps having the size of above 750 µm. which are crucial in nature and ensure that their removal is above 85%.
- Check and ensure that the critical settings in the cards are as per the recommendations to remove the large size neps from the feed.

OPERATIONAL STUDIES

A critical issue that is being faced by spinning mills these days is the worker shortage. A study has attempted to understand the reasons for the high labour turnover in mills and the measures to be initiated by mills to mitigate it. Key HR welfare measures practiced by some of the successful mills in retaining the workers have been studied with the aim of suggesting the right practices to be adopted by mills.

The commercial profitability of spinning mills during the year 2021-22 based on the Market Performance Evaluation Index (MPEI) has been evaluated and the trend in movement of the conversion cost studied based on the online survey of yarn selling price and raw material cost, which is being conducted by SITRA since April 2013. This survey by SITRA helps mills to understand the trend in the movement of count-wise yarn selling price (YSP) and raw material cost (RMC) between months and act accordingly. The usefulness of the survey report to mills to compare their RMC, YSP, net out-put value (NOV) as well as their yarn quality and productivity level with other mills every month are elaborated.

ENERGY MANAGEMENT

Two studies have been initiated during the year. The first one discusses a web based smart electronic control system to monitor and optimize energy use of OHTCs individually as such a dedicated monitoring system ensures a huge potential for savings in this ancillary. The second study attempts to understand the interrelationship between performance/ operating parameters like optimising the speed of fans in humidification plants and running hours of overhead travelling cleaners (OHTCs), optimising/minimizing lux levels, etc., to develop mathematical/empirical equations for a rational approach towards optimization, thus resulting in appreciable energy savings.

CHEMICAL PROCESSING

Under a study sponsored by the Department of Science & Technology (DST) – WOSA, Govt. of India, an attempt is being made to replace the non-biodegradable polymer and costly carrier molecules in textile materials (used as encapsulating agents) by eco-friendly and readily available raw materials, thus ensuring customer wellness through eco-friendly means. Nano-encapsulation of Vitamin E is done from natural and commercial sources, the application of nano-formulation on the textile fabric is done by Pad-Cure method and the evaluation of anti-oxidant property of finished fabric through readily available natural sources. The cytotoxicity of the nano-formulation and the nano-formulation treated fabric were evaluated as per ISO 10993:5 test on extract method. The nano-formulation showed slight toxicity against L929 cells and the nano-formulation finished fabric showed no toxic reactivity after a 24 h contact. The durability of vitamin E finishes on the fabric and release study by Franz-diffusion method are in progress.

Natural dyes extracted from two commercial food processing waste materials namely spent coffee grounds and the roasted peanut skin were characterised. The dyes were applied on silk, cotton and nylon fabrics with and without the aid of mordants using two different baths namely water bath and ultrasonic bath. The presence of color compounds in spent coffee grounds and roasted peanut skin were well illustrated by FTIR spectroscopy and GC-MS analysis.

A study on decolourization of the dye effluent water using eco-friendly nanoparticles has focussed on photo catalytic degradation of dye using nanocomposites. Initial trials were conducted using synthesized ZnO nanoparticles by verifying various parameters such as time, nanoparticle concentration, and Blue MR dye concentration and optimized for effective decolourisation. In addition to colour removal, chemical oxygen demand (COD) and biological oxygen demand (BOD) reduction were also investigated. The optical properties of the reactive blue MR dye were analyzed using a UV-Visible spectrometer. Results showed that effective decolourization can be achieved using nanocomposite treatment of dye effluent water. Further research on nanocomposite preparation and nanocomposite based decolourization are in progress.

Understanding the present day scenario where efficient use of natural resources and the reuse of recoverable wastes play a vital role in maintaining sustainability, SITRA has developed a process methodology for the reuse of ginning cotton waste in Hygiene core layers. Ginning waste collected from well reputed spinning mils in Coimbatore were processed and were characterised for various physical and chemical characteristics. The results showed that waste cotton bleached with Hydrogen peroxide was more rough and its water consumption was relatively higher than what is used while treating virgin cotton fibres which are attributed to the contaminants present in the given sample. Prior opening and cleaning of the cotton waste gave better results in terms of whiteness index and ease of processing. Bulk bleaching process can be carried out using High Temperature and High Pressure (HTHP) machines. Further reduction of water consumption may be achieved by conducting large scale trials on HT/HP processing machines. Moreover, the bleached waste cotton, processed through SITRA's optimized process methodology, was found to be free from chemicals, skin irritation components, bacterial, fungi and toxicity.

MEDICAL TEXTILES

More and more studies in recent times have started focusing on comfort properties of fabrics due to increasing demands for its comfort from users. With no comprehensive comfort index available for surgical gowns that can help users to understand the comfort properties of fabrics, SITRA took up a research work to develop a comfort index for commercially available products such as surgical gowns, sportswear, bed linens, etc., by combining the test results from sophisticated instruments available at SITRA for the measurement of comfort properties. Total Hand/Touch value was derived based on the Primary Sensory Indices (PSI) namely smoothness, softness and warmness provided by the Fabric Touch Tester (FTT) on 13 physical indices. Work during the year was relating to optimisation of multiple comfort parameters of different textile structures used with sportswear, surgical gown and bed linen fabrics. For that, desirability function approach, which is an elementary process to integrate the values of several responses in a simple quantitative measure, characteristic of the quality of compromise was used. Different properties which have a detrimental effect on comfort characteristics were evaluated individually and combined to yield an overall desirability function called global desirability function which is a reflection of how the individual desirable function has fulfilled the combined goals for all the responses. Experimental validation with the objective and subjective analysis validates that the present / suggested method can be used to blueprint a textile fabric's comfort index.

CONSULTANCY SERVICES

The requests for consultancy services have been consistent from SITRA's member as well as non-member mills over the years. Such assignments, on a wide areas of specialisation, are taken up under specific requests from mills. During the year, close to 175 consultancy assignments were attended to which were utilised by as many as 25 member mills and 203 non-member units .

TESTING AND CALIBRATION SERVICES

SITRA's physical and chemical testing laboratories, accredited by NABL for ISO/IEC-17025 for the various fibre, yarn and fabric samples are functioning in two shifts for some years now, and provide test results to the mills on a fast track. The "Rapid testing facility" has provided the option to mills to receive results on a faster pace as the process of conditioning of samples is completed quickly. Several mills are also availing SITRA test reports with NABL logo for export purposes. During the year, 87,220 tests of fibre, yarn, fabric and medical textile samples were tested for their physical, chemical or biological properties.

A total of 9768 calibration certificates, for testing of quality control instruments were issued during the year, for the 270 mills that utilised these services. Testing the quality of spinning and weaving accessories/ spares in order to select the right quality is another service being offered by SITRA and 1,097 samples covering various accessories like paper cones, worm & worm gear wheel, cots, partition pad, spinning rings, spindles, ring travellers and carton boxes received from 229 units were tested.

TRAINING

Eleven different training programmes were offered by SITRA during the year. This included 9 functional webinars/programmes, 1 international training and 16 multi-specialisation programmes in medical textiles, wherein a total of 1105 persons were trained. Under operatives training, 99 operatives were trained during the year on right methods of working in textile mills for effective performance.

SERVICES TO DECENTRALISED SECTOR

The services of the 7 Powerloom Service Centres (PSC) in Tamil Nadu, managed by SITRA, have been extensively used by the powerloom sector. A total of 34914 samples comprising of yarn and fabrics have been tested and 110 persons were trained in the area of loom maintenance, operation of shuttleless looms, calculation of fabric production, etc. The PSCs have attended to 2,437 liaison visits and also inspected 16,320 looms during the year. A total of 27 consultancy assignments were carried out and 296 designs were created during the year.

MOUs SIGNED

During the year, Memorandums of Understanding / Agreement were signed with the following organisations/ Institutions/agencies:

a) **CRODA India Company Pvt. Limited,** Mumbai, a Company engaged in the business of manufacturing, sales and marketing of a wide range of speciality chemicals and products catering to diverse industries such as personal care, health care, home care, textiles, fibres, polymer additives, polymers & coatings, agrochemicals and lubricants for a research tie-up for development of novel bio-based micro-encapsulated robust PCMs along with bio-based cross linker systems for use in Fibre and Fabric applications.

b) **ZDHC Foundation India,** Mumbai an international foundation with the objective of joint working to help industrial houses achieving greener solutions in industrial production.

c) **Vellore Institute of Technology (Fashion Institute of Technology-VFIT),** Chennai , an educational institution to achieve mutual benefit through scholarly interactions, student training, co-operative research and other forms of academic collaboration.

d) Sri Krishna Arts and Science College, Coimbatore, a NAAC accredited institution students and faculty training and internships and to develop entrepreneurs to avail the incubation facilities of SITRA's Coe-Meditech.

e) **JD Institute of Fashion Technology,** Bengaluru, for conducting training programmes and workshops on a regular basis for their students.

Non-disclosure agreements have also been signed with the following instutitons/organisations for joint working on various projects/testing/equipment design

a) **GCL International Limited,** a company with experience in techniques, methods and systems in textile testing, to carry out the necessary tests / analysis on specific tests complying to ISO/IEC 17025 accreditation standard.

b) **Circular Systems S.P.C**., Los Angeles, California 90014, United States of America. for carrying out dedicated research projects in the area of mechanical processing of textile material.

c) **Premier Evolvics Pvt. Ltd.**, a leading player in the field of quality testing, online clearing and monitoring products for the textile industry, for business alliance/relationship towards development and commercialization of a needleless electro spinning setup achieving high throughput of nano-fibres.

Felicitation by BIS

Bureau of Indian Standards, Coimbatore Branch Office felicitated SITRA with a momento during the "BIS 75th Foundation Day celebrations" held at SITRA on 06.01.22 for SITRA's contribution to the quality standards of products and its active participation on various sectional committees of BIS for drafting the standards.

PUBLICATIONS

SITRA brought out during the year, 18 publications which included 12 online reports, 5 focus and 1 Etech letter (SITRA news publication) (Annexure III).

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SITRA scientists published 8 research papers in technical journals and presented 12 papers in conferences and seminars (Annexure VI).

ORGANISATION

MEMBERSHIP

The scenario of the industry slowly returning to normalcy post the pandemic was reflected in the general interest shown by industry to utilise SITRA's services during the year. It was also seen in the membership of SITRA with 5 mills, comprising of 3 full members and 2 associate members enrolling newly during the year. While one mill opted to resign from the membership mainly because of poor operating profits, 3 mills forfeited their membership due to persistent default in payment of membership subscriptions. The total membership of SITRA during the year was 147, comprising of 187 units (Table 1).

SITRA is pleased to extend a warm welcome to the following mills which enrolled as a full members during the year:

1. Shiva Tex Yarn Limited-Coimbatore
2. Sri Saravana Mills Pvt Ltd-Dindigul
3. Ganesh Spintex pvt ltd -Coimbatore

SITRA also extends its welcome to the following mills which enrolled as an Associate member:

1. Ginni International Limited -Alwar
2. Indocount Industies -Kolhapur

SITRA's services are also utilised by 39 small mills under the Technical Support Scheme. In all, 226 units have access to SITRA's services, apart from many units in the decentralised sector which utilised the services offered by 7 Powerloom Service Centres, one Textile Service Centre and 4 CAD Centres.

FINANCE

The financial position of SITRA continued to be satisfactory during the year that ended with a surplus of income. The total recurring expenditure of SITRA during the year after depreciation and before appropriation from reserves was Rs 13.64 crores. The total income, including the grants from the Ministry of Textiles, Govt. of India was Rs 13.06 crores.

SPONSORED PROJECTS

During the year under review, SITRA was involved in 7 sponsored research projects, 2 of which were sponsored by the Ministry of Textiles (MoT), Government of India and rest of the projects by agencies such DST, BRNS and KVIC.

Work relating to the following projects, sponsored by different agencies, was completed during the year.

1. Development of Eco - Clothing by Greener Reduction Process of Natural Indigo Dye
2. Kovai kora cotton sarees, sponsored by Department of Handlooms and Textiles, Govt of Tamil Nadu
3. Medical Textile Products identified by INMAS for wound healing and radio protective equipment based on textiles, sponsored by the Defence Research and Development Organisation (DRDO)

Work relating to the following project, sponsored by MoT, is progressing well.

Table 1 Region-wise membership during the year 2021-22

Region	Spinning mills	Composite mills	Fibre manufacturers, Machinery manufacturers and others	Total
SITRA zone	115	4	5	124
Other States	18	2	2	22
Overseas	1	0	-	1
Total members	134	6	7	147
Total units	162	18	7	187

1. Development of total comfort index paradigm for textile structures

Work on the following 2 projects, sponsored by other sponsoring agencies and initiated last year, is progressing well

1. Antioxidant cosmetotextiles : Durable nano encapsulate vitamin E finishes on textile fabrics and its controlled release study (sponsored by DST).

2. Field dissemination of technology of high productivity hand operated Charka (KVIC)

During the year, SITRA also received funding for the following 3 projects in which it is working in close association with a sponsoring industry and initiated projects based on their request. Work relating to all the 3 projects has been initiated

1. Development of breathable reusable and oxo-biodegradable coverall using biocidal polyester (sponsored by Board of Research in Nuclear Sciences [BRNS])

2. Methodology for PCM (Phase Change Material) (in association with CRODA India Company Pvt. Ltd.)

3. Chitosan Nano particles (in association with Biorad Medisys Pvt. Ltd.)

MACHINERY AND EQUIPMENT

Equipping its laboratories /pilot mills with state-of-the-art machinery/instruments is a continuous activity to ensure that the institution has the latest generation machinery that can offer the best of the services to the industry. During the year under review, SITRA made a fairly large investment of Rs.51 lakhs on state of art machinery and equipment, apart from other infrastructural requirements. Some of the important machinery and equipment installed during the year include ugraded Uster Tester 4, VP Flow scope, Biodigester Tank, Shycocan Virus attenuation device, Novel Trash analyser, Thermoreactor, Digital Time totalizer, Pressure Calibrator, and Radical Projection Microscope.

STAFF

There was a marginal reduction in the staff strength of SITRA following the resignation/reirement of some of the staff during the year, even as new recruitments were made to fill in the vacant positions. The number of staff during the year stood at 86 as against 90 last year. The number at the PSCs remained the same as last year, at 30.

CONVERSION OF FIBRE TO YARN

Offline yarn fault classification using an optical system

Yarn clearing is one of the important objectives of a winding machine. Electronic yarn clearer (EYC) is one among the basic requirement of spinning mills and EYCs are working on both capacitance and optical principles. Though the market share of both clearing systems are more or less equal, the capacitance yarn clearing has an edge over the optical counterpart due to the availability of an established off line fault classification. It is claimed by the manufacturers of the optical clearers that optical measurement clears closest to the visual assessment and yarn faults are directly determined unlike capacitive measurement of the mass.

The off-line yarn fault classifying helps in

i. determining the faults in cop yarn
ii. the clearing curve to be set and
iii. determining the clearing efficiency of the yarn clearing system.

Using these, a spinner can set an optimal clearing curve for a better yarn fault removal and avoid unnecessary cuts. By way of optimum clearing of yarn, improvement in the machine efficiency in further processing can be achieved.

With a view to establish an off-line optical yarn fault classification system, along with the existing capacitance type yarn fault measuring an additional optical measuring head has been fixed in the same yarn path. Simultaneous measurement of yarn faults both in the capacitance and optical measuring can be carried out under identical testing conditions like speed, tension and atmospheric conditions.

Yarn samples of varying counts and different fibre materials can be tested for yarn faults simultaneously both in the optical and capacitance fault classification systems. The results can be compared and analyzed. The clearing limit for yarns meant for different applications made from cotton, manufactured fibres and their blends can be established. Standards/norms can also be established for the yarn faults measured with optical clearers. Establishment of this new optical system has been effected in the existing winder having a capacitance yarn fault classifying system. Analysis of various yarns are under progress.

EFFECT OF SPINDLE SPEEDS AND ROVING TWIST MULTIPLIER ON TENSILE CHARACTERISTICS OF COTTON YARNS

Now-a-days, ring spinning machines are capable of operating at higher spindle speeds of 25000 rpm in-order to improve the profitability of a spinning mill. Increase in spindle speed has an indirect impact on the tensile characteristics of yarn. Optimum tensile properties of yarn are essential for it to perform better in the downstream process such as warping, weaving and knitting. In the current scenario, while the mills are increasing their spindle speeds, they are also employing higher roving twist for various reasons. Hence, an attempt has been made to analyse the impact of spindle speeds and roving twist multiplier on tensile characteristics of cotton yarn.

Materials and Methods

For carrying out the analysis on the above objectives, combed roving bobbins of 1.32, 1.39 and 1.42 TM were collected from a member mill of SITRA. The mixing characteristic of the above roving bobbin is given below.

Fibre Properties	Details
Cotton variety	MCU 5
2.5% span length (mm)	30.3
Bundle strength (g/tex)	23.8
Micronaire (µg/inch)	4.4
Uniformity ratio (%)	47.7
Trash content (%)	2.6
Elongation (%)	6.0

Process followed in Pilot mill

The collected roving bobbins were processed on a LMW LR 6s pilot ring frame available in SITRA having Suessen compact system. Roving bobbins with varying TM levels were spun into yarn at three different spindle speeds (18000, 20000 and 22000 rpm respectively). The yarn samples of 60s C-Comp. were produced in identical conditions and tested for their tensile characteristics in Uster Tensojet (UTJ-4). The trial plan is given in Table 2.

Table 2 Trial Plan

Spindle speed (rpm)	Roving Twist Multiplier (TM)	Total no. of samples
18000	1.32,1.39 and 1.42	3
20000	1.32,1.39 and 1.42	3
22000	1.32,1.39 and 1.42	3

A total of 9 yarn samples were produced and tested. The process parameters followed in the ring frame are given in Table 3.

Table 3 Process parameters in ring frame

Parameters	Description
Count	60s C-Comp.
Roving Hank	1.10
Ring frame TPI	29
Total draft	56
Break draft	1.17
Spacer	3.5 mm

Results and Discussion

Impact of spindle speed on yarn elongation

The impact of spindle speed on yarn elongation (%) for various roving TM levels are given in Table 4.

Table 4 Impact of spindle speed on yarn elongation (%)

Roving TM	Spindle speed (rpm)	Elongation (%)	Elongation CV%
1.32	18000	4.51	8.24
	20000	3.85	10.63
	22000	3.67	9.71
1.39	18000	4.52	8.42
	20000	3.90	9.47
	22000	3.57	9.71
1.42	18000	4.16	8.80
	20000	3.64	12.38
	22000	3.53	10.31

It can be seen from Table 3 that the yarn elongation decreases as the spindle speed increases. The drop in elongation was up to 17% when the spindle speed increases from 18000 rpm to 20000 rpm at various roving TM levels which was found to be statistically significant. Also, a drop in elongation of up to 27% was noticed when the spindle speed increases from 18000 rpm to 22000 rpm which was again statistically significant. The elongation drop was mainly due to the increase in yarn tension on account of the increase in spindle speed.

Impact of various spindle speeds on breaking force and elongation

The impact of various spindle speeds on breaking force are given in Figure 1a, 1b and 1c.

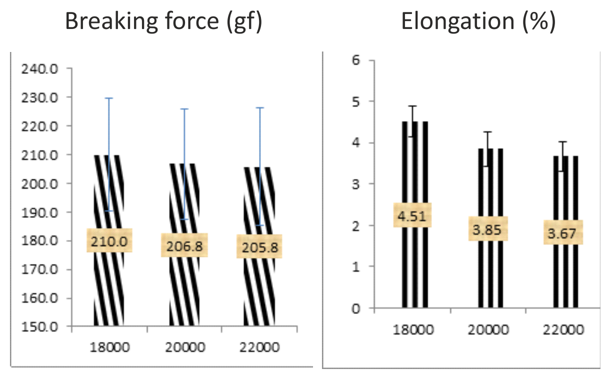

Figure 1(a) Impact of various spindle speeds on Breaking force and elongation for roving TM-1.32

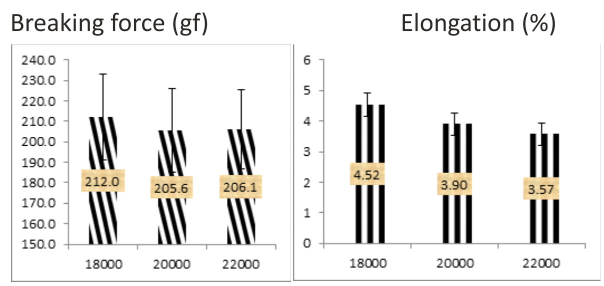

Figure 1(b) Impact of various spindle speeds on breaking force and Elongation for roving TM of 1.39

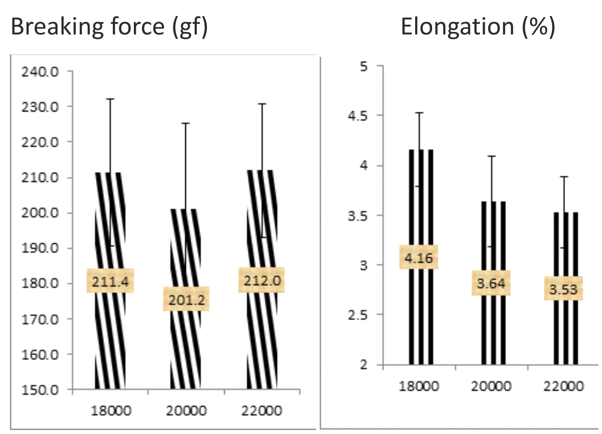

Figure 1(c) Impact of various spindle speeds on Breaking force and Elongation for roving TM of 1.42

It can be seen from Figure 1(a) to 1(c) that the elongation value decreases as the spindle speed increases from 18000 rpm to 22000 rpm at all TM levels. Breaking force was found to decrease as the spindle speed increases from 18000 rpm to 22000 rpm in 1.32 and 1.39 roving TM. In the case of roving TM 1.42, the trend was not clear for the breaking force while the elongation shows a decreasing trend.

Impact of roving twist multiplier on yarn elongation

The impact of roving twist multiplier for various spindle speeds (18,000 rpm, 20,000 rpm and 22,000 rpm) on tensile characteristics of yarn is given in Table 5.

Table 5 Impact of roving twist multiplier on yarn elongation (%)

Twist multiplier	Elongation	Elongation CV%
Spindle speed: 18000 rpm	(%)	
1.32	4.51	8.24
1.39	4.52	8.42
1.42	4.16	8.80
Spindle speed: 20000 rpm		
1.32	3.85	10.63
1.39	3.90	9.47
1.42	3.64	12.38
Spindle speed: 22000 rpm		
1.32	3.67	9.71
1.39	3.57	9.71
1.42	3.53	10.31

It can be seen from Table 4 that the yarn elongation decreases as roving TM increases. The drop in elongation % was noticed at about 8%, 6% and 4% at 18,000, 20,000 and 22,000 rpm respectively, when the roving TM was increased from 1.32 to 1.42 which was also statistically significant.

Impact of roving twist multiplier on breaking force and elongation

The impact of roving twist multiplier on breaking force and elongation are given in Figure 2a, 2b and 2c.

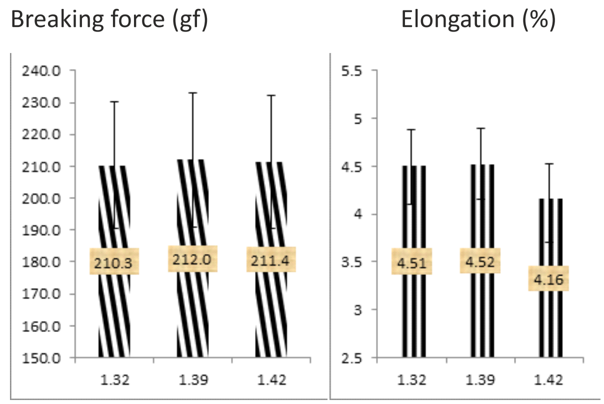

Figure 2 (a) Impact of roving twist multiplier on breaking force and elongation for 18000 rpm

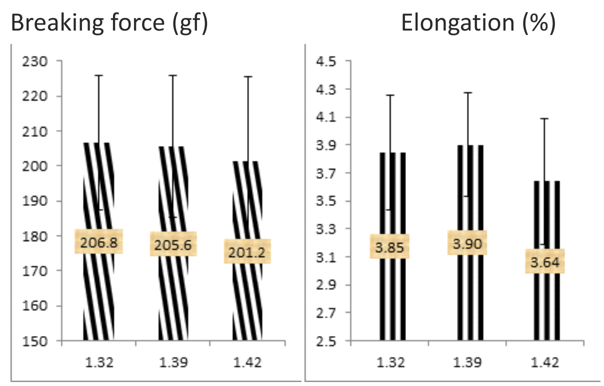

Figure 2 (b) Impact of roving twist multiplier on breaking force and elongation for 20000 rpm

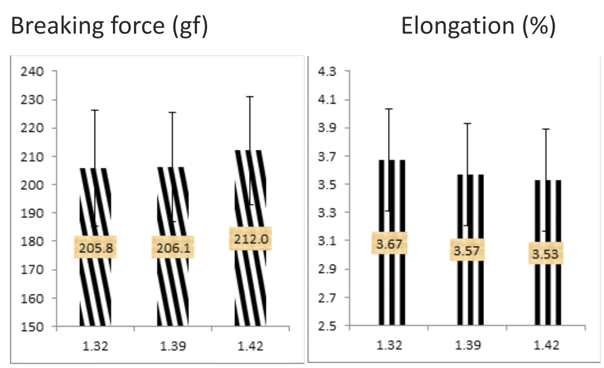

Figure 2 (c) Impact of roving twist multiplier on breaking force and elongation for 22000 rpm

From Figure 2(a) to 2 ©, at all spindle speeds, it may be seen that when the roving TM increases from 1.39 to 1.42, the elongation shows a decreasing trend which was statistically significant. However, when the roving TM changes from 1.32 to 1.39, no specific trend was observed in both elongation and breaking force at various spindle speeds.

From the above analysis, the following conclusions may be drawn :

a. The drop in elongation % was noticed in the range of 14% to 17% when the spindle speed was increased from 18000 rpm to 20000 rpm at various roving TM levels. Also, the elongation drop was noticed in the range of 18% to 26% when the spindle speed increases from 18000 rpm to 22000 rpm. The drop in elongation mentioned above is statistically significant.

b. The drop in elongation % was noticed up to 8% when the roving TM increases from 1.32 to 1.42 which is statistically significant.

STUDY ON THE OUTGOING YARN QUALITY IN CURRENT GENERATION AND LATEST GENERATION HYBRID YARN CLEARERS

In modern automatic cone winding machines, there are two types of clearers available to clear the desired yarn fault – the capacitance type and the optical type. In the capacitance method, the basic yarn mass per unit length is measured as the variation in the capacitance between electrodes when the yarn passes through. In optical method, the basic yarn diameter is measured based on the light barrier principle and based on shape and color of the wound yarn, where light is absorbed and reflected, and the received light is inversely proportional to the yarn diameter.

The yarn faults are cleared under various classifications in the yarn clearers based on the clearer setting values with allowances. With both the clearer types, the clearing is impacted based on the product of percentage of fault diameter and fault length. However, there are chances of unnecessary cuts as well as non-clearing of yarn faults occuring at critical clearing limits when the the product of percentage of fault diameter intensity and the fault length nearly meet at border level. Those faults are not cleared and allowed into the cone in both type of clearers. For instance, a slub (low twisted) that has a mass below clearing level will not be cleared by capacitance clearer, whereas based on diameter the same will be cleared in the optical clearer. Similarly, a thin yarn with a lower twist is diameter wise less than the clearing limit and based on the mass measurement will be cleared in capacitance clearer but not cleared by the optical clearer.

Hence, leading yarn clearer manufacturers of capacitance as well as optical principle based clearers have now came out with hybrid yarn clearing system using both the principles to take the dual advantage of each principle. An attempt is made to study the performance of the these hybrid clearers with their previous generation clearer in terms of clearer cuts, remaining classimat faults in cone yarn, etc.

Study plan

For studying the yarn quality, samples were collected from ring fames running two different counts and processed in capacitance and optical based clearer of previous generation as well as the current generation hybrid clearers. During the study the yarn clearer cuts, on-line classimat faults and online quality data were collected.

Table 6 Trial plan

Si no	Clearer	No of counts
1	CLR-1 - Uster-Quantum-3	2
2	CLR-2 - Uster-Quantum-4	2

Cone yarn and cop yarn samples were collected from all the trials and tested for the following quality parameters.

- Unevenness and imperfections
- Classimat yarn faults and
- Single yarn strength

Results and discussions

In this trial, Uster Quantum clearer-3 and Quantum-4 clearers were taken for comparison of clearer cuts and outgoing yarn quality. Cops collected from the ring frame were randomized and processed in the above clearer with identical settings and the obtained online and offline results are given below.

Online results

The online results were collected from the observations of yarn length of more than 1000 km. in both the clearer trials. Yarn quality results measured by the yarn clearers during the study are given in Table 7.

Table 7 Online yarn quality results

Parameter	CLR-1	CLR-2
Cvm	14.79	14.96
Sd	0.51	0.53
H	3.35	3.36
Sd	0.19	0.16
200	335	349
Sd	73	63
50	180	206
Sd	53	58
-50	13	14
Sd	12	10

CLR-1 Capacitance clearer, CLR-2 Hybrid clearer

It can be seen from the above table that the online yarn qualities measured by both the clearers are at par with each other.

Table 8 Clearer cuts / 100km

Clearer cuts	CLR-1	CLR-2
Nep	14.1	17.2
Short thick	44.0	44.2
Long thick	14.4	13.2
Long thin	1.1	1.2
Total NSLT	**73.6**	**75.8**
Count channel	**6.7**	**2.7**
PF	10.3	11.0
Splice cuts		
JP	3.5	3.2
JM	0.4	0
FD	14.3	16.9
Total	**108.8**	**109.6**

CLR-1 Capacitance clearer, CLR-2 Hybrid clearer

It can be seen from the above table that, under identical settings the overall clearer cuts per 100km are by and large comparable. The total NSLT cuts were higher by 3% in the clearer 2 when compared with clearer 1. Online Classimat data collected during the study for both yarn clearers are given in Table 9.

It can be seen from the above table that, the overall online Classimat faults measured in NSL standard classes in clearer 2 is about 3 % higher than its

Table 9 Online Classimat faults/ 100km

Class name	CLR-1		CLR-2		Sum definition
	COP	**CONE**	**COP**	**CONE**	
USTER Top 9	49.1	3.3	53.3	3.1	A4+B3+B4+C3+C4+D2+D3+D4+E
USTER Top 12	191.1	141	213.2	157.8	A3+A4+B3+B4+C3+C4+D2+D3+D4+E+F+G
USTER Top 16	282.1	219.5	308.7	240.1	A3+A4+B2+B3+B4+C1+C2+C3+C4+D1+D2+D3+D4+E+F+G
USTER Total faults NSL (Std classes)	6084	6021	6282	6213	A1+A2+A3+A4+B1+B2+B3+B4+C1+C2+C3+C4+D1+D2+D3+D4+E+F+G
USTER Total faults T (Std classes)	48.7	48.3	51.3	51	H1+H2+I1+I2

CLR-1 Capacitance clearer, CLR-2 Hybrid clearer

counterpart. When comparing the other classes also clearer 2 is observed with higher yarn faults in the range of 5% to 12%. This higher number of yarn faults measured by the clearer 2 may be due to the differences in the sensitivity and class classification.

The remaining yarn faults are lower by about 93%, 26%, 22% in Uster Top 9,10,16 respectively. Total NSL faults and total thin faults were also lower by 1% and 0.8% respectively in both the clearers when compared with the cop yarn faults.

Offine results

To validate the online results and assess the remaining faults in the outgoing cone yarn all the samples were tested in the offline testing instruments as per the standard procedure. The offline Classimat testing of cop yarn and cleared yarn samples from the both clearers were tested using Uster Classimat tester-5 and the results are given in Table 10.

Table 10 Offline classimat faults/ 100km

Class name	Cop	Clearer -1	Clearer -2	Sum definition
USTER Top 9	75.3	16.8	12.0	A4+B3+B4+C3+C4+D2+D3+D4+E
USTER Top 12	259.1	157.6	131.2	A3+A4+B3+B4+C3+C4+D2+D3+D4+E+F+G
USTER Top 16	375.2	268.8	228.8	A3+A4+B2+B3+B4+C1+C2+C3+C4+D1+D2+D3+D4+E+F+G
USTER Total faults NSL (Std classes)	7145	6,934.4	6203.2	A1+A2+A3+A4+B1+B2+B3+B4+C1+C2+C3+C4+D1+D2+D3+D4+E+F+G H1+H2+I1+I2
USTER Total faults T (Std classes)	84.9	118.4	72.8	H1+H2+I1+I2

CLR-1 Capacitance clearer, CLR-2 Hybrid clearer

It can be seen from the above table that the remaining yarn faults are lower by 78%, 39%, 28% and 3% in Uster Top 9,10,16 and Total NSL faults respectively in clearer 1. However, there is increase in the long thin faults by 39% in clearer 1. In the case of clearer 2 the yarn faults are lower by 84%, 49%, 39%,13% and 14% in Uster Top 9,10,16, Total NSL faults and Total thin faults respectively when compared with the cop yarn.

Outlier readings of NSLT and FD faults of cop yarn and cleared yarn samples are given in Table 11.

Table 11 Offline Outliers/100km

Parameter	COPS	CLR-1	CLR-2
Outlier			
N	10.8	1.6	1.6
S	25.8	0.8	1.6
L	14	0.8	0.8
T	2.2	0	0
FD	26.9	11.2	7.2
Veg	1.1	0	0.8
Total	80.8	14.4	12.0

CLR-1 Capacitance clearer, CLR-2 Hybrid clearer

It can be seen from the above table that the outliers got reduced by 82% in clearer 1 and 85% in clearer 2 when compared to the feed cop material. Yarn quality of the cop yarn and cone yarn samples tested using Uster tester 5 and Uster Tensojet are given in Table 12.

It can be seen from the above table that the Unevenness values of cone yarn samples in both the yarn clearers showed an improvement and co-efficient of variation of strength and elongation also got improved. This may be due to the removal of yarn faults and outliers present in the cop yarn.

Table 12 Offline yarn quality results

Parameter	COPS	CLR-1	CLR-2
Unevenness			
U%	12.11	12.01	11.99
CVm	15.45	15.3	15.27
DR%	24.56	25.11	18.2
1met	4.59	4.49	4.01
3met	3.77	3.73	3.23
5met	3.51	3.44	2.95
10met	3.07	3.04	2.54
Imperfections /1000met.			
Normal IPI/km	665	642	680
Extra sen. IPI/km	2953	2984	3122
H	2.93	3.16	3.34
Sh	0.73	0.82	0.87
Tensile properties			
Breaking force (gf)	212.5	213.5	213.8
Elongation%	4.87	4.9	4.84
CV%	14.5	10.89	9.52
RKM	21.59	21.69	21.72
CV%	13.09	11.57	10.6

CLR-1 Capacitance clearer, CLR-2 Hybrid clearer

Key observations

- The Online yarn quality results measured by both the clearers are more or less similar.
- The total NSLT cuts were higher by 3% with hybrid the clearer

- with hybrid clearers, the remaining yarn faults are lower by 29%, 17%, 15%, 11% and 38% in Uster Top 9,10,16 levels, Total NSL faults and Total thin faults respectively when compared with capacitance based clearer.
- The overall outliers got reduced by 3% with hybrid clearers when compared with clearer.

Further works

A detailed study will be conducted with both optical clearers and their hybrid clearers. It is also proposed to conduct trials with all the four clearers with same material for different yarn counts.

NEPPING POTENTIAL OF PRESENT INDIAN COTTON

Most of the spinning mills have problems with neppiness in some of the cotton lots, which significantly influences the aesthetic characteristics of woven and knitted fabrics. Neps also cause problems during finishing. The number of neps in a yarn depends on the nep in the raw material and the changes in the nep number in the process of transforming raw cotton in to yarn.

Nep formation is caused by various factors. Some neps form during hair growth, the others during primary processing (ginning and spinning). The initial nep number in unginned cotton is relatively small and successive stages of processing change the nep number. Increase in the nep number occur during the preliminary cleaning and ginning processes and then during the opening and cleaning process. Cotton fibre maturity is regarded as an important factor influencing the tendency of nep creation. Additionally finer cottons tend to nep more than coarser ones independent of maturity.

Fibre neps, which are classified as fibre impurities, are considered to be of great interest as quality characteristics, not only for the baled cotton but also for the spinning industry. As per ASTM book (1978) a "fibre or mechanical nep" is defined as one or more fibres occurring in a tangled and unorganized mass and is distinct from impurities including seed or trash particles apart from fibres.

Seed cotton is thought to be relatively free of neps at the time of picking and that they are produced during cotton fibre processing. Mechanical harvesting, ginning and various cleaning stages of ginned lint intended to upgrade the final product, are responsible for nep formation, each contributing to a different extent. The high percentage of immature fibres that are responsible for "white specks' in dyed fabric. The aim of this work is to find the relationship between the fibre properties and processed fibre properties by means of nepping propensity with respect to fibre length, fibre fineness and fibre maturity.

Materials and Methods

Forty three ginned baled cotton samples representing different varieties of cotton grown in India were taken for this study. All the samples were tested using high volume instrument (HVI- ASTM D 5867-12) for length, uniformity ratio, strength, elongation, and micronaire and maturity value. All the above samples were tested for maturity co-efficient by NaOH method calculated through the number of mature fibres, half mature fibres and immature fibres (IS 236-1968 Reaffirmed 2010 Method -1

The fibre quality of each sample evaluated by AFIS PRO2, on the cotton samples was five replicated of 3000 fibres. AFIS is an individual fibre tester that provides several different fibre quality measurements as well as distributions. The primary measurements include mean length by number and by weight , upper quartile length, short fibre content by number and weight , maturity, fineness, immature fibre content , fibre neps, seed coat neps and its size.

Fibre properties of the various cotton samples based on grouping of 2.5% span length is given in the Table 13.

Table 13 Fibre properties of various cotton samples (Grouping based on 2.5% span length)

Mean 2.5% Span length (mm) (Range)	Micronaire (µg/inch) (Range)	Maturity co-efficient (by NaOH) (Range)
30.07 (29.40-30.47)	4.19 (3.52-5.16)	0.819 (0.764-0.872)
31.00 (30.52-31.84)	4.53 (3.56-5.05)	0.837 (0.764-0.878)
35.66 (34.58-36.74)	3.18 (3.02-3.34)	0.801 (0.792-0.810)
38.27 (37.44-39.10)	3.59 (3.23-3.96)	0.825 (0.788-0.862)

Fibre properties of the cotton samples based on grouping of micronaire and maturity co-efficient is given in Table 14.

Table 14 Fibre properties of various cotton samples (Grouping based on Micronaire and maturity co-efficient)

Micronaire (µg/inch) (Range)	Maturity co-efficient (by NaOH) (Range)	Mean 2.5% Span length (mm) (Range)
3.60 (3.02-3.96)	0.7974 (0.764-0.862)	32.58 (39.10-29.54)
4.42 (4.01-4.98)	0.8337 (0.796-0.878)	30.59 (29.40-31.84)
5.07 (5.01-5.16)	0.8615 (0.852-0.872)	31.015 (30.47-31.51)

Each of the samples was subjected to a laboratory scale mechanical process. The trash separator (M/s.Statex) is typically used to determine the trash content of a sample and to separate the lint, trash and micro dust.

In the process of testing, the trash separator opens up the fibre tufts to single fibres with a Licker-in speed of 1240 rpm. This opening action also has the potential to cause fibre breakage and is usually considered as an aggressive fibre processing method.

A sample of 100 gram of raw cotton was processed through trash separator. Sample of single passage processed cotton 50 gram separated. A sub sample of Lint was drawn from first passage sample and was subjected to second passage through trash separator. Sample before processing are referred to as 'raw material and samples after being exposed to opening mechanism in trash separator are referred as 1st passage and 2nd passage.

The fibre quality of raw material,1st passage and 2nd passage of each sample were tested using AFIS PRO2. In our experiment, AFIS was used to obtain the neps count per gram (ASTM D-5866-12).

In this paper, an attempt is made to;

1. To find the nepping level of present Indian baled cotton
2. To evaluate the nepping potential with respect to maturity, fineness and fibre length
3. To predict the output nep count per gram after mechanical stressing of fibres

Results and Discussion

Micronaire and Maturity co-efficient

The micronaire value of a sample of cotton can provide a strong indication of its propensity for nep formation. In essence, the measurement of its micronaire value is conducted by measuring the resistance of a plug of cotton to air flow.

Although initially its micronaire value was taken to represent the fineness of cotton, it subsequently emerged that the airflow-measured micronaire value is a function of both fibre maturity and fineness (linear density), with the result that the actual fibre fineness (linear density) for cotton with a particular micronaire value will depend on fibre maturity. It has been stated that the micronaire value is a compound of about two-thirds linear density and one-third maturity.

Finer (lower) micronaire-value cotton fibres tend to form neps more easily than coarser fibres, since the former are more easily bent, buckled and entangled during mechanical manipulation due to their relatively low longitudinal rigidity. It has been stated that fine cottons can create up to a quarter of a million neps in a pound of card-web if not processed carefully. In this evaluation, results shows the finer fibre have more nep count per gram compare than the coarser micronaire fibres as shown in Figure 3.

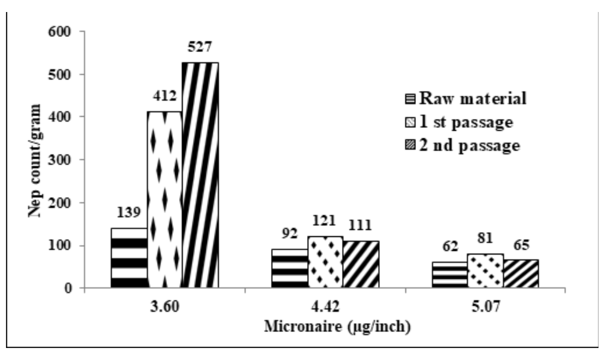

Figure 3 Cotton micronaire on nep count per gram

Maturity, or relative wall thickness, is a very important cotton fibre property, it being stated that no other fibre property has had so much effort devoted towards its measurement as this property results in the development and standardization of several different test methods.

Low cotton maturity (or high immaturity, i.e. relatively low wall thickness) is due to the normal wall-thickening process (deposition of secondary cellulose layers) being interrupted or slowed down during growth of the cotton seed hair, with the wall thickness generally less than the fibre diameter of mature cotton

Such interruption, or slowing down, could be due to a number of reasons, such as undeveloped seed-cotton bolls damaged by frost, bad weather, insects and drought stress, pre-mature opening, mineral deficiencies, plant diseases or injury to the foliage, stem or roots. Dead cotton refers to fibres that are extremely immature, i.e. where the secondary wall is completely missing, or has a thickness less than 20% of the total fibre diameter as shown in Figure 4.

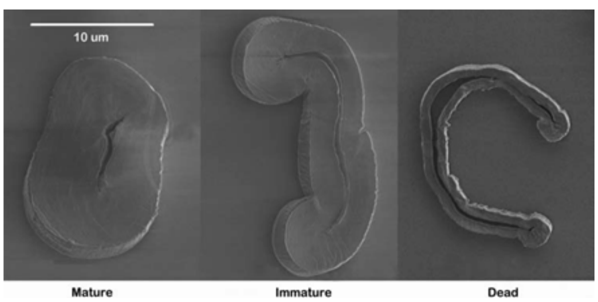

Figure 4 Images of mature, immature and dead cotton fibres.
Source: Obtained by means of a Hitachi S4300 SE/N Scanning Electron Microscope (CSIRO)

The parameter characterizing maturity co efficient also influences the nep number in cotton. Test results shows lower maturity cotton have higher nep in raw material and higher maturity co-efficient having lower nep content in raw material. During mechanical processing, fibres that have lower maturity co-efficient generate more nep count per gram in 1st passage and 2nd passage compared than those of higher maturity co-efficient.

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Immature fibres are responsible for most neps, since they are generally highly flexible and easily bend, buckle and entangle to form neps. Dead fibres are extremely flat and therefore do not absorb much dye, thus appearing duller or paler than mature fibres but generally acting as a highly reflective surface, producing what is referred to as shiny neps, a phenomenon first identified by Koechlin-Schouch on printed Calico in 1848 and studied by Crum in 1849. Crum found that the undyed portions (flecks or spots) on the fabric surface consisted of remarkably thin, flattened and transparent (i.e. immature) cotton fibres of greater ribbon width than normal fibres. Mean micronaire and maturity level of sample is given in Table 15.

The results show that, in the case of micronaire and maturity co-efficient, the nep increase after 1st passage lower with coarser micronaire & high mature cotton and higher with finer micronaire & low maturity cotton.

All cotton bolls contain fibres ranging in maturity, with at least 5% of the fibres generally being very immature and also referred to as thin-walled, or even as dead fibres. Normal commercial cottons contain about 25% immature fibres. Complaints are rare for cottons which have 10% or fewer immature fibres. Cottons with 20 to 25% or more immature fibres are generally susceptible

Table 15 Fibre properties of various cotton samples
(Grouping based on Micronaire and maturity co-efficient)

Micronaire (µg/inch)	2.5% length (mm)	Maturity co-efficient	Nep Count per gram			
			Raw Material	1st Passage	2nd Passage	% of increase 1st Passage
3.60 (3.02-3.96)	32.58 (29.54-39.10)	0.797 (0.764-0.862)	139 (97-171)	412 (163-864)	527 (162-1304)	196
4.42 (4.01-4.97)	30.59 (29.40-31.84)	0.833 (0.796-0.878)	92 (62-126)	121 (71-204)	111 (64-188)	32
5.07 (5.01-5.16)	31.01 (30.47-31.51)	0.861 (0.852-0.872)	62 (59-64)	81 (68-91)	65 (55-77)	31

to complaints due to excessive neps. The mean maturity co-efficient, mature fibre%, half mature fibres % and immature fibres% are given in the above table for the various fibre groups studied.

Fibre length

Cotton fibre length also influences nep levels, though next only to the properties related to fibre fineness and cross section. Fibre length can either be measured in single- fibre or fibre-beard form, the AFIS being the popular method in the case of single fibres and HVI in the case of fibre beards.

According to research carried out by various workers, there appears to be a tendency for nep formation to increase as staple length increases. In a large US study, conducted on cotton from the 1935 to 1937 crop years, it was found that there was a significant trend for the number of neps in the yarn to increase as the fibre length of the cotton increased (*r* = 0.67).

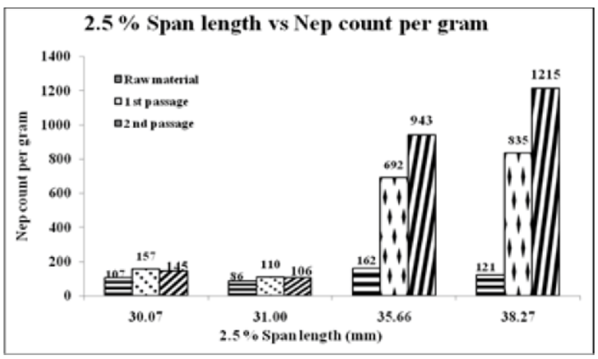


Figure 5 2.5% span length on nepping potential of cotton

The 2.5 % span length has influences the nep generation after mechanical processing of fibres. The figure 5 shows clearly when the fibre length increases the nep generation propensity is increased.

The result shows that increase in neps after 1st passage is lower in the shorter length group and very high in the longer length group as given in the Table 16.

Conclusion:

- Fibre length, fibre fineness and maturity co-efficient values have a greater corelation with the raw material nep count per gram
- The increase in neps after 1st passage is lower in the shorter length group and high in the longer length group.
- In case of micronaire and maturity co-efficient, the nep increase after the 1st passage in lower with coarser micronaire & high mature cotton and higher with finer micronaire & low maturity cotton

Guideline:

- o While selecting of bales for mixing (as per SITRA suggestion), the permissible limits for the critical difference are to be fixed based on the average of two samples
- o For 2.5 span length 5 combs/sample and critical difference(% of mean) should be within 3.6.
- o For micronaire value 5 plugs/sample and critical difference(% of mean) should be within 5.4
- o For maturity coefficient 600 fibres/sample and critical difference (% of mean) should be within 7

Future study:

- To study the effect of nep size and its distribution in the raw cotton, card sliver, comber sliver and finisher draw frame slivers used for spinning different counts of yarns
- To study the nepping propensity of cotton with regard to picking (1st and 2nd or 3rd pick)

Table 16 Fibre properties of various cotton samples (Grouping based on 2.5% span length)

2.5% length (mm)	Micronaire (µg/inch)	Maturity co-efficient	Nep Count per gram			
			Raw Material	1st Passage	2nd Passage	% of increase 1st Passage
30.07 (29.47-30.47)	4.19 (3.52-5.16)	0.819 (0.764-0.872)	107 (64-157)	157 (82-261)	145 (71-242)	47
31.00 (30.52-31.84)	4.53 (3.56-5.05)	0.837 (0.764-0.878)	86 (43-124)	110 (68-204)	106 (55-188)	28
35.66 (34.58 – 36.74)	3.18 (3.02-3.34)	0.801 (0.792-0.810)	162 (153-171)	692 (520-864)	943 (855-1030)	327
38.27 (37.44-39.1)	3.60 (3.23-3.96)	0.825 (0.788-0.862)	121 (97-145)	835 (823-846)	1215 (1126-1304)	590

A NOVEL APPROACH TO EVALUATE NEP REMOVAL IN CARDS

The primary objective of the carding process is to individualize the fibers by means of the carding action. During this process, the heavy trash particles are removed in the licker-in zone, entangled fiber neps and trash are removed in the carding zone. Carding is an ideal process to remove 70% to 80% of the feed neps (i.e. from chute/lap). In the carded yarn process, the removal of nep is not possible after carding and in the case of combed yarn process, removal of small neps in comber pose certain limitations.

In earlier days, the assessment of neps in the card sliver was practiced with Shirley nep template, manual counting and comparing the same with the available standards. This method is almost a subjective evaluation. Since 1982, instrumental evaluation of nep and trash was initiated by the cooperative efforts of USDA Agricultural Research Service at Clemson, SC and Schaffner Technologies. The current generation instruments measure the nep, nep size, trash, trash size, length, length distribution, etc.

Present scenario

Spinning mills are assessing the neps in both the feed and delivery material using Uster AFIS (Advanced Fibre Information System) that was what is popularly known as the single fibre measuring system. Based on the results, mills estimate the Nep Removal Efficiency % (NRE%), which is vital for evaluation of carding performance using the following formula:

$$\text{NRE\%} = \frac{\text{No. of infeed neps} - \text{No. of indel neps}}{\text{No. of infeed neps}} \times 100$$

The expected nep removal efficiency of the current generation cards is expected to be above 70%. The condition of critical components and settings are vital for achieving better NRE. Apart from this, the amount of feed neps also plays a major role. Now a days, mills are facing the problem of sudden spurt in yarn neps even after maintaining a better NRE. To analyse this phenomenon, a novel approach to evaluate the nep removal efficiency based on nep size is discussed below.

Critical Nep size

Critical Nep size is the nep size in card (or) combed sliver above which all the neps in the sliver will be measured as yarn neps when the yarn spun from the same sliver is tested on an evenness Tester. But the question arises as to what size of nep in the card sliver will have a direct bearing on yarn neps. The measurable neps protruding on the outside of the yarn body in each count varies based on the linear density. Since, the small neps are embedded in the yarn core, they are not necessarily detected by the yarn testing instruments. Large neps on the other hand are not enclosed in the yarn core and are therefore counted as neps in the yarn. The size of the fiber nep, which is measured by the yarn testing instruments named as critical nep size for that particular yarn count.

Figure 6 shows the critical nep size for ring yarns.

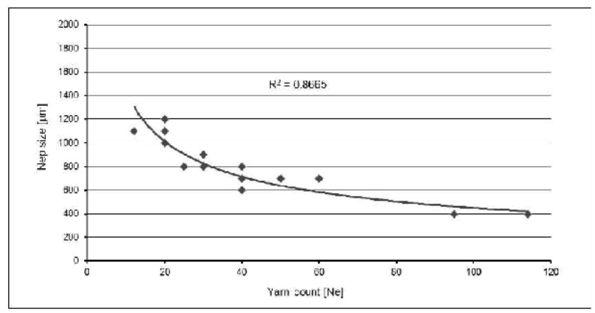


Figure 6 Critical nep size of Ring yarns

It may seen from the figure that in ring yarns, fiber neps size measured in feed material with a size above the curve will result in yarn neps for the corresponding yarn count. For example, the critical nep size in feed material for a ring yarn Ne 30 is 900 µm.

Generally, all fiber neps that are found in finisher draw frame sliver for yarn counts above Ne 60 will also transform into yarn neps. In these yarn counts, the yarn diameter is so small so that no fiber neps or trash particles can be enclosed in the yarn core. Thus, the sensitivity level set at the yarn testing instrument will always be exceeded, and a nep will be detected. Figure 7 shows the critical nep size for rotor yarns.

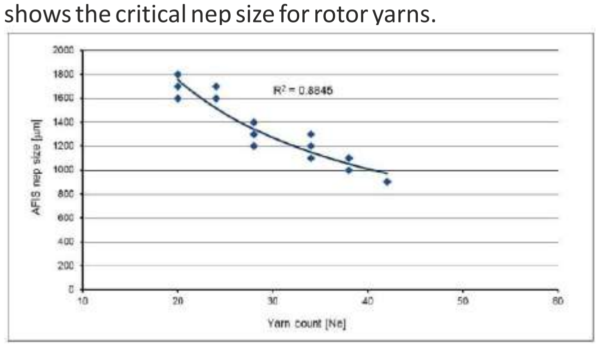


Figure 7 Critical nep size of rotor yarns

In the open-end spinning process, most of the fiber neps are embedded in the fiber material, resulting in very low numbers of neps assessed by the instrument in the yarn counts up to Ne 20. Therefore, these yarns could not be included in the data comparison as given in Figure 7. The curve of the critical nep size in finished sliver for rotor yarns is much steeper than the curve for ring yarns. For example, for a rotor yarn count Ne 30 the critical size is approx. 1200 µm and only 900 µm for a yarn count Ne 40 compared to 900 µm for a ring yarn Ne 30s and 750 µm for a ring yarn of Ne 40s. This proves that open-end rotor yarn is less susceptive to neps in fiber material prior to spinning stage than ring yarns. Fiber neps tend to be embedded in open-end rotor yarns.

Another characteristic of the open-end rotor spinning process is the additional cleaning feature in the spin box. Neps, seed coat neps, trash and dust particles can be extracted directly before the actual open end spinning process.

An earlier study of SITRA revealed that neps in yarn tally with neps in sliver up to Ne 50. In Ne 20 count, the neps in the yarn tallies with neps in sliver having size of 950 µm. and above (Figure 8). Similarly, in other counts also, i.e. in Ne 30, the neps in the yarn tallies with the size of sliver neps having 750 µm. and above, 550 µm. and above in Ne 40 and 450 µm. and above in Ne 50. For counts finer than Ne 50, neps per gram in yarn is much higher than the total neps per gram in sliver as measured by the AFIS instrument.

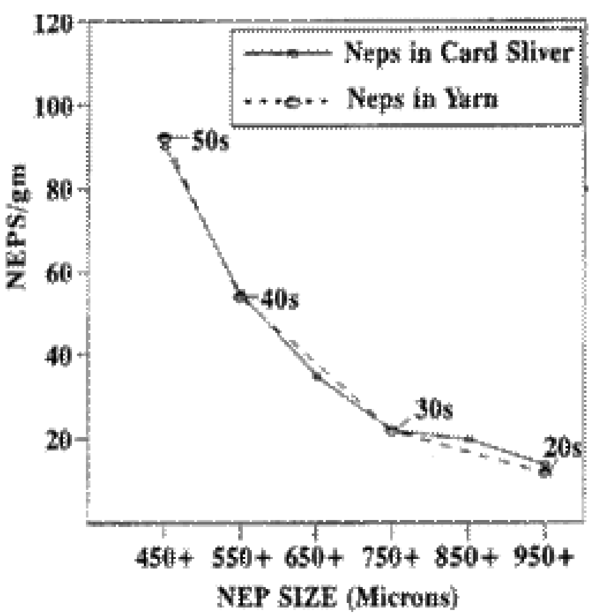


Figure 8 Neps in card sliver and yarn

Critical nep size (C.N.S.) is found to be inversely proportional to the count of yarn. This is due to the fact that in yarns, nep measurement is based on yarn diameter and yarn diameter is inversely proportional to yarn count. As a rough approximation, critical size of neps (in µm) in sliver is given by,

$$\text{C.N.S.} = \frac{22}{\text{Count of Yarn}} \times 1000$$

for counts in the range of 30s to 50s.

Case study

The importance of critical neps evaluation is explained with the help of the following case study.

The case study mill is facing the problem of higher neps in their yarn and are also facing the problem of low nep removal efficiency in the cards. Even, after increasing the waste in card and comber, the neps in the yarn remains same. The mill approached SITRA to find out the causes for the same. Subsequently, the critical nep size analysis was made for the feed and delivery sliver of the carding machine. The nep count and nep size details of the feed and delivery material (sliver) of carding machine are given in Table 17.

Table 17 Nep count and size in feed material and sliver

Particulars	Feed material	Card sliver
Total neps (count per gram)	276	138
Over all Nep removal efficiency %		50
Count per gram <750 µm.	178	119
Count per gram >750 µm.	98	19
Nep removal efficiency % for <750 µm.	-	33
Nep removal efficiency % for >750 µm.	-	81

It can be seen from the Table 17 that the average neps in card sliver is high at 138 and the average nep removal efficiency is also low at 50%. This NRE% is about 5-10% lower than the NRE % for regular mills. But, the nep increase in the yarn is many folds in their current process. A detailed analysis reveals the presence of large size neps in the sliver of above 750 microns size even after combing process. This may be the main reason for the increase in the yarn neps.

The ideal place to remove the larger size neps is the carding process. Hence, subsequently, trials were conducted in the carding machines with changes in the critical settings (cylinder to flat and cylinder to doffer) and keeping the other parameters constant. The nep count and nep size details of the feed and delivery material (sliver) of carding machine before and after the trials are given in Table 18 and Figure 9(a),9(b) &9©.

From the above figure the total nep count per gram in the feed material is 276 and its size ranges from 450 µm to 2250 µm. About 65% of the total neps lies in the range of 750 µm and 35% of the total neps lies in the range above 750 µm in feed material.

Before optimisation, about 86% of the total neps and after optimisation / process about 89% of the total neps lies within the 750 µm size range. Similarly, about 14% and 11% of the total neps in sliver lies in the nep size of above 750 µm for the before and after optimisation respectively. This clearly indicates the number of neps got reduced in the nep size of above 750 µm with optimisation of card setting.

Table 18 Nep count and size in feed material and sliver

Particulars	Feed material	Card sliver Before (Regular)	Card sliver After (Trial)
Total nep count per gram	276	138	84
Over all nep removal efficiency %		50	70
Nep count per gram <750 µm.	178	119	75
Nep removal efficiency % for <750 µm.	-	33	58
Nep count per gram >750 µm.	98	19	9
Nep removal efficiency % for >750 µm.	-	81	91

It can be seen from Table 18 that the neps per gram in card sliver has been reduced from 138 to 84 in the trial sliver. Nep removal efficiency (NRE%) also improved by 20 percentage points. In the trial material, neps in the nep size less than 750 µm got reduced by about 1.5 times and NRE improved by 25 percentage points.

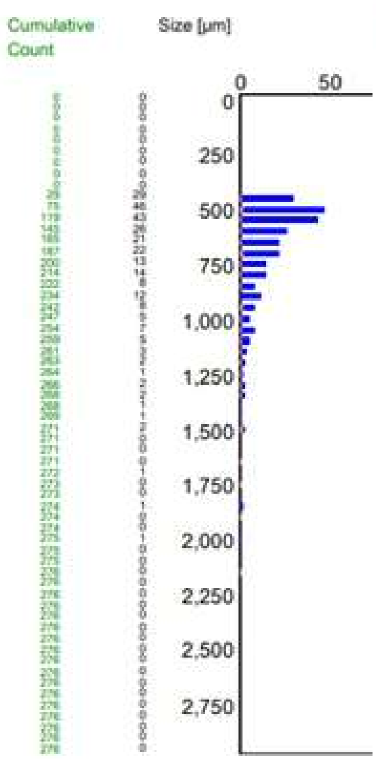


Fig. 9 (a) Feed material

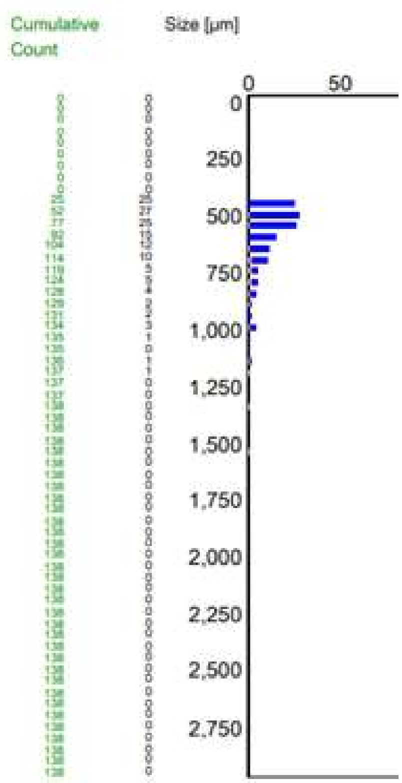


Fig. 9(b) Sliver (Before)

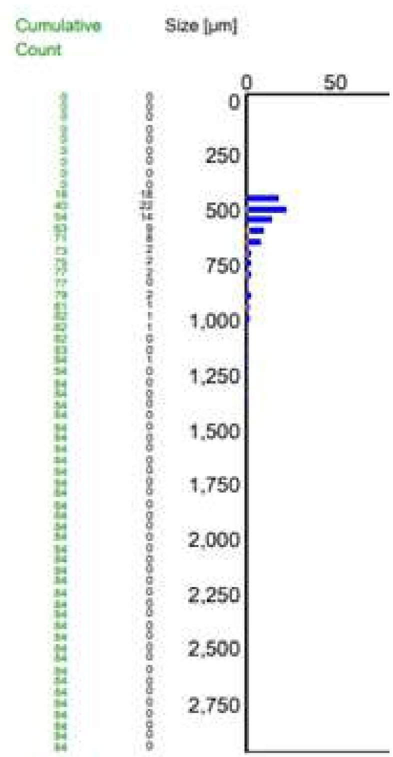


Fig. 9(c) Sliver (After)

Nep count Histogram

Similarly, there was a reduction of neps in the nep size >750 µm. by about 2 times and also an improved NRE% by 10 percentage points.

Yarn samples were produced from the above slivers in Ne 32s KH count and the yarn quality results are given in Table 19.

Table 19 Yarn quality results

Particulars	Regular	Trial
Unevenness (U%)	11.60	11.14
Thin -50%	3	2
Thick +50%	254	145
Neps +200%	640	261
Total Normal sensitive imperfections per km.	**897**	**408**
Thin places (-40%)	131	105
Thick places (+35%)	1166	792
Neps (+140%)	2125	1290
Total Extra sensitive imperfections per km.	**3422**	**2187**
Hairiness Index H	**4.25**	**3.85**
Yarn faults cleared/100 km.	**104.6**	**91.2**
Total classimat faults/100 km	**4937**	**2937**

It can be seen from the above table that, total normal sensitive imperfections per km reduced by about 50% and the total extra sensitive imperfections per km reduced by about 65% in the trial sliver material when compared with the regular sliver material. The reduction in the overall imperfections is mainly due to the reduction in yarn neps in all the classes followed by the reduction in thick places in the yarn. Similarly, yarn hairiness index (H) was also found to decrease by 9% in the trial process when compared with their regular process. In winding, the total yarn faults cleared was reduced by 13% in the trial process yarn sample and also the total online classimat faults were lower by about 40% when compared with the regular process material.

Conclusion

The following measures are suggested towards reducing neps in the yarn.

- Estimate the nep removal efficiency for the critical nep size for the yarn count spun.
- Analyse the neps having the size of above 750 µm. which are crucial in nature and ensure that their removal is above 85%.
- Check and ensure the critical settings in the cards are optimal in order to remove the large size neps from the feed.

OPERATIONAL STUDIES

COSTS, OPERATIONAL PERFORMANCE AND YARN QUALITY (36th STUDY):
Inter-mill survey of key factors (October-December 2021)

SITRA regularly conducts inter-firm surveys on commercial and operational factors in order to keep the mills informed about the industry trend and enable them to make decisions and necessary benchmarking. These inter-firm surveys also form a base for revising SITRA standards from time to time. Of the various inter-firm surveys being conducted by SITRA, the CPQ study continues to attract a large number of mills, particularly mills having multiple units (group mills), spread all over India. Many participants vouch that these studies have helped them to trim their input costs and improve their mill's performance. This clearly depicts the uniqueness and usefulness of this study.

SITRA has launched its 36th inter-mil study on Costs, operational performance and yarn quality, popularly called as "CPQ study", in January 2022. The above study covers data for the period October – December 2021. The soft copy of the questionnaire pertaining to the above study has been sent to more than 1000 spinning mills spread all over India. The mills that participate in the CPQ studies are being ranked based on their contribution (per spindle per year) that was earned by them during the period October – December 2021. Analysis of the 36th CPQ study has been completed and the reports have been dispatched to all the participant mills.

Table 20 shows the major findings of the study. The average contribution earned by the participant mill is at Rs 10660 per spindle per year, which amounts to about 25% of yarn sales. The average of the top 20% mills among the participants is noticed to be about three-fourths higher than the all mills' average, which is mainly due to the high yarn sales turnover (47% higher).

Table 20 Summary of the mills' performance in 36th CPQ study

Parameter		All mills' average	Top 20% mills' average
Yarn sale value (YSV)	- Rs/spindle/year	43440	63890
	- Rs/kg	374	349
Raw material cost (RMC)	- Rs/kg	212	200
	- Rs/spindle/year	26130	37980
	- As % of sales	58.8	58.3
Salaries & wages cost (SWC)	- Rs/spindle/year	3210	3260
	- As % of sales	7.4	5.1
Power cost (PC)	- Rs/spindle/year	3440	4180
	- As % of sales	8.5	6.6
Contribution*	- Rs/spindle/year	10660	18470
	- Rs/kg	102	107
	- As % of sales	25.3	30.0
Prodn. /spindle/8 hrs. (adj. to 40s) in grams		109	120
Spindle utilisation (%)		94.12	96.98
Average count (Ne)		44s	33s

'' Contribution = YSV – (RMC + SWC + PC)*

Raw material cost has accounted for about 60% of the total yarn sale value. Salaries and wages cost, in terms of Rs per spindle per year, is noticed to be almost the same in both all mills' average and Top 20% mills' average. Power cost average was at 8.5% of yarn sales in all mills' average. However in the Top 20% mills, due to high sales turnover, the same is noticed to be at 6.6% of yarn sales.

The overall ring frame production rate is about 6% lower than SITRA standard in all mills' average and in the case of Top 20% mills, the average production rate has excelled the standard by 3%. During the period October – December 2021, most of the mills have managed to maintain better spindle utilisation levels.

Table 21 shows the summary of the product diversification levels maintained by the mills during the period October – December 2021.

Table 21 Summary of the mills' performance in 36th CPQ study

Type of yarn	All mills' average	Top 20% mills' average
Export	23	40
Combed	68	84
Hosiery	31	56
Doubled		
- Ring	2	1
- TFO	8	9
- Eli-twist	1	1
Compact	49	51
Gassed	3	2
Slub	1	1
Core spun	1	1
Melange	1	-
100% cotton	81	73
100% non-cotton	7	3
Cotton/MMF blends	12	24

Table 20 shows that the proportion of compact yarn manufacturing which accounts for about one-half of the total production in both all mills' average and Top 20% mills. It is also interesting to note that during the period October – December 2021, the Top 20% mills have shifted their product-mix towards manufacturing cotton blended yarns.

Comparison with last study (October – December 2019)

Table 22 shows the comparison of the common mills that had participated in both the 35th and 36th CPQ studies. Between 2019 and 2021, totally 67 mills have participated in both the studies.

Parameters between the two studies

An analysis shows that in the 4th quarter of 2021, mills on the whole had registered about 2.5 times higher contribution when compared to the 4th quarter of 2019.

Table 22 Comparison of costs and operational

Parameter		Common mills' (67) avg.	
		35th study (Oct.–Dec.2019)	36th study (Oct.–Dec.2021)
Yarn sale value (YSV)	- Rs/spindle/year	27950	44010
	- Rs/kg	262	393
Raw material cost (RMC)	- Rs/kg	150	214
	- Rs/spindle/year	17200	25880
Salaries & wages cost (SWC)	- Rs/spindle/year	2580	2930
Power cost (PC)	- Rs/spindle/year	3320	3360
Contribution	- Rs/spindle/year	4850	11840
Prodn. /spindle/8 hrs. (adj. to 40s) in grams		107	110
Capacity utilisation (%)		93.6	94.8
Average count (Ne)		48s	46s

This is mainly due to an increase in yarn sale value and an increase in ring frame machine productivity. During the 4th quarter of 2021, the yarn sale value had registered an increase of 57% when compared to the same quarter of 2019. The raw material cost, had also witnessed an increase of 50% in terms of Rs per spindle per year and 43% increase with respect to Rs per kg of yarn. When compared to the 4th quarter of 2019, salaries and wages cost had increased by 14% in the 4th quarter of 2021. However, the power cost had increased only marginally among the common mills.

Further analysis shows that out of the 67 common mills, 97% of the mills (65 mills) registered an increase in the contribution (by Rs 7290 per spindle per year) with the increase ranging from Rs 340 to Rs 17560 between mills (Figure 10). The increase in the contribution in the 65 mills was mainly due to an increase in yarn sale value (by Rs 16,410 per spindle per year) which offsets the increase in input costs viz. RMC, salaries & wages cost and power cost (by Rs 9120 per spindle per year). Only 2 mills recorded a reduction in the contribution by Rs 1690 and Rs 3200 per spindle per year. In both the mills, yarn sale value had increased by Rs 3970 and Rs 4850 per spindle per year. Nevertheless, this increase could not offset the increase in input costs, in particular, the raw material cost (by Rs 6410 and Rs 7920 per spindle per year), thereby resulting in an overall drop in the contribution in these 2 mills.

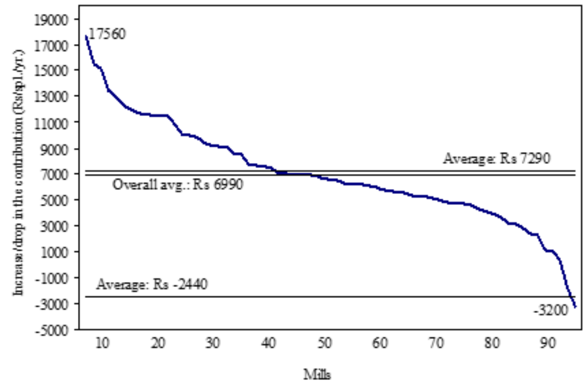


Figure 10 Differences in the contribution between the two studies (Q4 of 2019 and Q4 of 2021)

INTER-MILL STUDY ON FIBRE TO YARN CONVERSION COST: (OCTOBER-DECEMBER 2021)

This study is based on the conversion cost particulars that were collected from mills in the 36th CPQ (Costs, Operational performance and Yarn quality) study, covering the data for the fourth quarter of 2021 (October – December). Out of 103 mills that had furnished data in 36th CPQ study, slightly more than half of them had furnished the count-wise conversion particulars covering all the elements of cost. Remaining mills had not furnished the requested data. The data provided by the mills were scrutinised and wherever required, clarifications were obtained from them.

This report, being the tenth in the series, covers the conversion cost particulars of as many as 196 different counts and varieties of yarns. A detailed analysis has been made for 10 different counts for which 4 and above mills (in each count) had furnished the relevant data. In addition, the trend in the movement of conversion cost between 2010 and 2021 has also been covered.

Overall conversion cost in 2021

Table 22 shows the conversion cost particulars for 10 different counts and varieties of yarns.

It can be seen from Table 23 that the average conversion cost, in terms of per kilogram of yarn was found to increase as the count becomes finer, i.e. as low as Rs 43.9 in 20s CH to a high of about Rs 183.7 in 80s C-Comp. Counts. Between mills the conversion cost differ

Table 23 Count-wise conversion cost for the period October – December 2021

S. no.	Count	Conversion cost/kg of yarn (Rs)				Conv. cost/ kg/ count (Rs)	Conv. cost/ spl./ shift (Rs)[@]	No. of mills
		Avg.	Min.	Max.	Std. Dev.			
1.	40s K	90.3	75.7	100.8	8	2.26	9.8	6
2.	60s C	148.3	136.2	169.3	13	2.47	9.2	5
3.	40s C-Comp.	77.7	71.7	82.4	4	1.94	11.2	6
4.	50s C-Comp.	100.5	95.9	105.0	4	2.01	10.4	4
5.	60s C-Comp.	130.5	116.8	162.0	13	2.18	9.6	11
6.	80s C-Comp.	183.7	182.2	186.7	2	2.30	8.8	5
7.	20s CH	43.9	39.5	45.5	3	2.20	13.5	4
8.	24s CH	53.2	45.9	55.7	5	2.22	13.2	4
9.	40s CH-Comp.	72.3	66.6	83.5	7	1.81	11.4	5
10.	30s CH-Comp.-Ex.	55.5	44.7	65.9	8	1.85	13.1	5

'@' $\frac{\textit{Conversion cost/kg of yarn} \times \textit{Prodn./spl./8 hours (g)}}{1000}$

Table 24 Count-wise conversion cost and profit margin

S. no.	Count	Amount (Rs/kg of yarn)			As a % of YSP		
		NOV	Conver- sion cost (CC)	Net profit (NOV- CC)	NOV	Conver- sion cost (CC)	Net profit (NOV- CC)
1.	40s K	82.7	90.3	(-) 7.6	29.4	32.1	(-) 2.7
2.	60s C	177.4	148.3	29.1	43.6	36.5	7.2
3.	40s C-Comp.	134.2	77.7	56.6	38.4	22.3	16.2
4.	50s C-Comp.	225.1	100.5	124.7	52.7	23.5	29.2
5.	60s C-Comp.	225.5	130.5	94.9	49.6	28.7	20.9
6.	80s C-Comp.	304.9	183.7	121.1	54.4	32.8	21.6
7.	20s CH	92.6	43.9	48.8	30.7	14.5	16.2
8.	24s CH	103.4	53.2	50.4	33.1	17.0	16.1
9.	40s CH-Comp.	111.8	72.3	39.5	33.6	21.7	11.9
10.	30s CH-Comp.-Ex.	112.3	55.5	57.0	35.1	17.4	17.8

Note: (-) sign indicates loss

It can be seen from Table 24 that during October to December 2021, almost all the counts (except 40s K) had managed to earn profit ranging from 7% and 29% of yarn sale value. Compact warp yarns and hosiery yarns (both compact and non-compact) were found to be more beneficial during the above period.

Component-wise conversion cost

Tables 25 and 26 show the component-wise average conversion cost for all the 10 counts in terms of per kg of yarn and as a % of YSP respectively.

Table 25 Component-wise conversion cost per kg of yarn

S. no.	Count	YSP (a)	RMC (b)	Conversion cost							Net profit (a-b-c)
				SWC	Power	Stores & packing	Admn. OH	Int.	Dep.	Total (c)	
1.	40s K	281.1	198.4	25.0	29.0	6.7	10.4	12.2	7.0	90.3	(-) 7.6
2.	60s C	406.5	229.1	45.2	45.8	10.9	20.2	12.9	13.3	148.3	29.1
3.	40s C-Comp.	349.1	214.9	20.3	31.6	10.4	5.3	2.5	7.6	77.7	56.6
4.	50s C-Comp.	426.9	201.8	24.3	39.6	15.7	6.8	4.0	10.1	100.5	124.7
5.	60s C-Comp.	454.4	228.9	33.6	49.2	17.9	10.6	7.4	11.8	130.5	94.9
6.	80s C-Comp.	560.3	255.4	56.8	62.2	22.7	14.9	8.5	18.6	183.7	121.1
7.	20s CH	302.0	209.4	13.7	14.9	6.5	2.0	3.0	3.8	43.9	48.8
8.	24s CH	312.8	209.4	16.8	18.1	7.3	2.5	3.7	4.8	53.2	50.4
9.	40s CH-Comp.	332.5	220.7	21.3	27.4	9.0	1.5	5.1	8.0	72.3	39.5
10.	30s CH-Comp.-Ex.	319.6	207.3	9.6	20.6	8.5	3.5	3.7	9.6	55.5	57.0

Table 26 Component-wise conversion cost as a % of YSP

S. no.	Count	RMC (a)	Conversion cost							Net profit (100-a-b)
			SWC	Power	Stores & packing	Admn. OH	Int.	Dep.	Total (b)	
1.	40s K	70.6	8.9	10.3	2.4	3.7	4.3	2.5	32.1	(-) 2.7
2.	60s C	56.4	11.1	11.3	2.7	5.0	3.2	3.3	36.5	7.2
3.	40s C-Comp.	61.6	5.8	9.1	3.0	1.5	0.7	2.2	22.3	16.2
4.	50s C-Comp.	47.3	5.7	9.3	3.7	1.6	0.9	2.4	23.5	29.2
5.	60s C-Comp.	50.4	7.4	10.8	3.9	2.3	1.6	2.6	28.7	20.9
6.	80s C-Comp.	45.6	10.1	11.1	4.1	2.7	1.5	3.3	32.8	21.6
7.	20s CH	69.3	4.5	4.9	2.2	0.7	1.0	1.3	14.5	16.2
8.	24s CH	66.9	5.4	5.8	2.3	0.8	1.2	1.5	17.0	16.1
9.	40s CH-Comp.	66.4	6.4	8.2	2.7	0.5	1.5	2.4	21.7	11.9
10.	30s CH-Comp.-Ex.	64.9	3.0	6.4	2.7	1.1	1.2	3.0	17.4	17.8

Note: for Tables 25 and 26: (-) ve sign indicates net loss; SWC: Salaries and wages cost; OH: Overheads

An analysis of the data that is furnished in Tables 6 and 7 reveals the following.

- Component-wise conversion cost also showed an increasing trend as the count become finer. For example, the salaries and wages cost in 24s CH averaged at Rs 13.7 per kg of yarn where as in the fine counts (80s), it was almost 4 times higher at Rs 57 per kg of yarn. Similarly, the power cost which was around Rs 15 per kg of yarn in 24s count was also more than 4 times higher at about Rs 62 per kg of yarn for the 80s yarn.

- Another interesting observation is that amongst the 6 cost components, power cost was found to be the largest component with a share of 35% followed by salaries and wages cost (28%). The stores and packing materials cost stood at 3rd place (12%) followed by depreciation cost (10%), administrative overheads (8%) and interest (7%) (Figure 11.

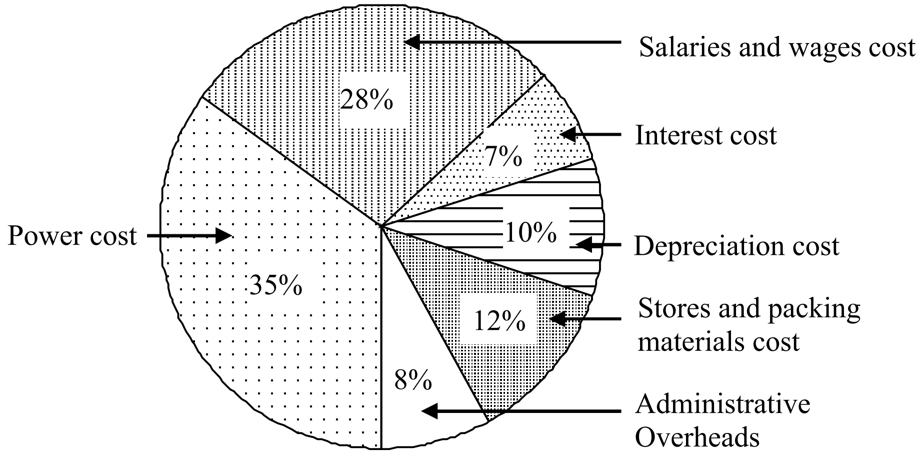


Figure 11 Share of component-wise conversion cost on the total cost

Trend in the movement of conversion cost between 2010 and 2021

The year-wise average conversion cost in terms of Rs/count/kg between 2010 and 2021 is shown in Table 27 along with the range.

Table 27 Average conversion cost between 2010 and 2021

Year	CPQ study no.	Conversion cost (Rs/count/kg)	
		Avg.	Range
2010	25	1.60	1.40 - 1.70
2013	29	2.10	1.85 - 2.30
2014	30	2.00	1.70 - 2.30
2015	31	2.00	1.70 - 2.30
2016	32	2.10	1.96 - 2.35
2017	33	1.98	1.66 - 2.23
2019	35	1.96	1.56 - 2.59
2021	36	2.12	1.81 – 2.47

The above table shows that between 2010 and 2013, the overall conversion cost had increased by about 30% and since then it was found to be hovering around Rs 2 per kg up to 2019. In 2021, the overall conversion cost had witnessed an increase of about 8% in comparison with the costs that prevailed in the year 2019.

The movement of conversion cost in terms of Rs per kg of yarn for 3 popular counts, for which there were sufficient representation of mills in all the 8 studies is shown in Figure 12.

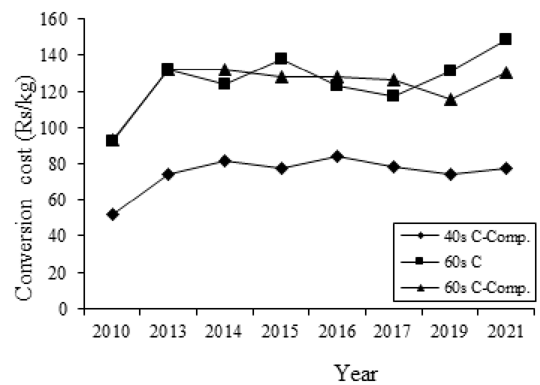


Figure 12 Movement of conversion cost between 2010 and 2021

The above figure shows that between 2010 and 2013, the conversion cost in terms of Rs/kg had witnessed an increase in the range of 18% to 43% between counts. An analysis of the component-wise conversion cost for the above counts during the period 2010 to 2019 shows that since 2013, the mills have been able to maintain the conversion cost at the minimum level (Table 28). But in 2021, the same has registered an increase of 5% to 13% in comparison with the costs that prevailed in the previous study (2019).

Table 28 Changes in the component-wise conversion cost between 2010 and 2021

(Rs/kg of yarn)

Year	Salaries & wages			Power			Stores & packing			Admn. O.H, Int. & Dep.			Total		
	40s C-Comp.	60s C	60s C-Comp.	40s C-Comp.	60s C	60s C-Comp.	40s C-Comp.	60s C	60s C-Comp.	40s C-Comp.	60s C	60s C-Comp.	40s C-Comp.	60s C	60s C-Comp.
2010	9.5	15.8	14.2	19.4	35.4	36.6	6.0	6.4	7.7	17.0	34.7	34.5	51.9	92.3	93.0
2013	12.3	27.3	23.0	32.0	54.3	55.0	7.7	10.1	12.3	22.0	40.3	41.5	74.0	132.0	131.8
2014	14.6	27.2	26.1	29.6	48.0	51.9	8.1	10.5	12.3	29.0	38.0	42.1	81.3	123.7	132.4
2015	12.0	28.6	22.9	32.7	58.2	54.5	6.6	10.8	12.9	26.0	40.2	37.2	77.3	137.8	127.5
2016	17.1	32.5	23.9	32.1	49.0	51.6	9.4	13.4	16.4	25.2	28.3	35.7	83.8	123.2	127.6
2017	14.8	28.9	31.6	28.3	41.2	47.2	9.9	11.1	15.1	25.3	35.7	32.0	78.3	116.9	125.9
2019	13.0	34.1	28.9	30.9	48.1	40.7	9.1	10.0	13.3	20.8	38.9	32.6	73.8	131.1	115.5
2021	20.3	45.2	33.6	31.6	45.8	49.2	10.4	10.9	17.9	15.4	46.4	29.8	77.7	148.3	130.5

A STUDY ON WORKER MANAGEMENT AND RETENTION IN SPINNING MILLS

Training and development of work force is a vital activity under Human Resource Management (HRM) towards achieving consistency in both productivity and quality of a product. Employees are the most important assets of a spinning mill and hence steps should be taken to retain them for long term planning of the mill's human resources. A spinning mill that invests its time and money on training & development of their employees and maintaining good HR welfare initiatives aimed at retaining talent can succeed in achieving higher profits. Training and development in the mill also ensures a perceptual shift in the employee's feeling regarding belongingness in the mill. Some of the measures towards retention should include focus on fulfilling the employee's need/demands regarding their food, safety, health & hygiene, morale and financial support.

In recent years, majority of the spinning mills are operating with migrant workers to maintain their capacity utilization. Irrespective of the nature of the employment, it becomes a herculean task for the spinning mills to retain their work force. In this regard, to understand the measures being taken by the spinning mills for retaining their workers, a survey was initiated along with the 36th CPQ study.

Out of 103 spinning mills that participated in the study, nearly two-thirds have provided their mill data regarding their manpower engagement system, trainer employment details and measures being taken towards workers' welfare. The analysis of the data is under progress and a comprehensive report shall be published at the earliest.

ONLINE SURVEY OF YARN SELLING PRICE AND RAW MATERIAL COST

SITRA had launched the monthly online survey on raw material cost (RMC) and yarn selling price (YSP) in April 2013. The objective of this survey is to help the mills to compare their RMC, YSP, Net output value (NOV), as well as yarn quality, production rate & yarn realization (pertaining to 10 counts in each mills) with other mills every month. This survey gives vital information about the trend in the movement of count-wise YSP and RMC between months for popular counts. For this survey, SITRA has created a dedicated web portal www.rmcysp.sitraonline.org.in, where the mills can register with SITRA to participate in this unique survey. SITRA has stuck to the timelines in all these surveys where the analysis report is uploaded on the website on the 21st of every month.

The participant mills enters their data on count-wise average RMC, YSP, yarn realisation and production per spindle pertaining to nealy 10 major counts in the web portal "www.rmcysp.sitraonline.org.in" between 1st and 7th of every month. Between 8th and 20th of every month, the entered data is critically scrutinized and analyzed. On 21st of every month, a survey report covering the data of all the participating mills on count-wise YSP and corresponding RMC, NOV, yarn quality, yarn realisation and production per spindle is being uploaded in the above web portal along with data base supported queries. Apart from the above, trend in the movement of average YSP, RMC and NOV of popular counts is being uploaded every month. The participant mill's can access this survey with their user name and password.

The findings of this survey report help mills to compare their RMC, YSP, net out-put value (NOV) as well as their yarn quality and productivity level with other mills every month. This unique survey covers almost 250 different counts and varieties of yarns in which the following parameters are being covered.

Ex-mill yarn selling price (YSP) (Rs/kg) Raw material cost (RMC) (clean material cost) (Rs/kg of yarn) Net output value (NOV) (Rs/kg of yarn & Rs/spl./8 hrs.) TCI (techno-commercial index) OTCI (overall techno-commercial index) RMC as a % of YSP Yarn realisation (%) Production/spindle (rotor)/8 hours (g)	Yarn quality - Count CV% - Strength CV% - CSP - U% - Imperfections/1000 m - Hairiness Index

Market Performance Evaluation Index (MPEI)

To suitably reflect the fluctuations/volatility in the commercial efficiency of spinning mills over a period, SITRA has developed a new index by name MPEI (Market Performance Evaluation Index) which clearly portrays the commercial trend of the cotton spinning industry. MPEI is an arithmetic index that is derived by having April 2013 as the base month and the base index set to 100 for that month. The calculation of MPEI is based on the average net output value (yarn selling price – clean raw material cost) in terms of Rs per kg of yarn for 12 popular counts which occupies a considerable proportion in the market share with a wide range. The popular counts that have been assumed to arrive at the MPEI are *40s K, 40s C, 60s C, 80s C, 100s C, 40s C-Comp., 50s C-Comp., 60s C-Comp., 80s C-Comp., 30s CH, 40s CH and 30s CH-Ex. counts*.

Trend in the movement of MPEI during the year 2021-22

The trend in the movement of MPEI for the period April 2021- March 2022 is shown in Figure 13.

MPEI for the year 2021-22 has started with a healthy value of 135 index points and was found to remain quite stable during the first quarter. This period is said to be most beneficial period as the MPEI stood at the highest level since the inception of the survey. However, by the end of the second quarter, the MPEI had reduced to 124 index points (August 2021). The third quarter was noticed to be the most volatile period as the MPEI in the months of October, November and December 2021 has varied widely by registering a value of 125, 135 and 117 index points respectively. In January 2022, the MPEI had gained about 10 index points increase in comparison with that of the previous month. However, this increase did not continue in the subsequent months. In February 2022, the MPEI was noticed to remain at 110 index points which is comparatively lower during the above period. In the next month, the MPEI had witnessed a further reduction of 9 points and remained at 101 index points in March 2022. This huge drop in MPEI in the 4th quarter is mainly because of substantial increase in the

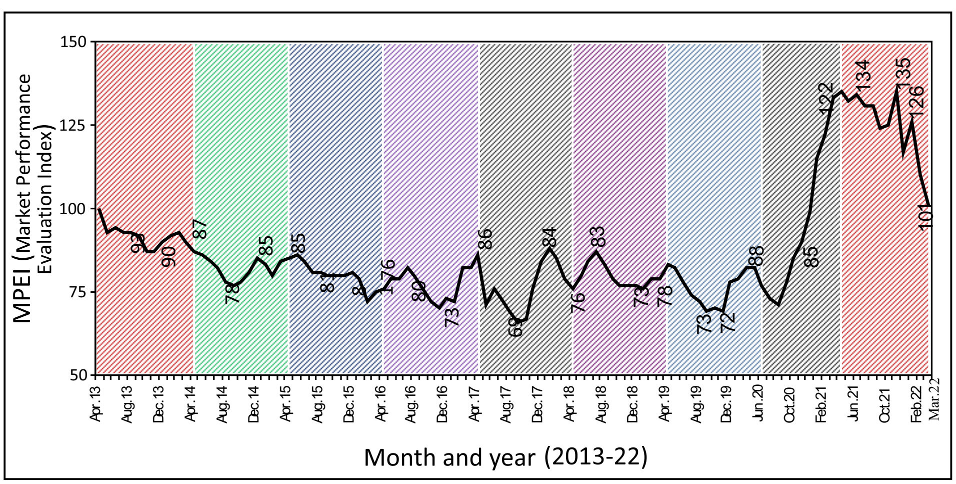


Figure 13 Market Performance Evaluation Index (MPEI)

raw material cost with almost stagnated trend witnessed in the yarn selling price between months.

Yarn selling price index (YSPI) and raw material cost index (RMCI).

The trend in the movement of MPEI is influenced by two major factors viz., the yarn selling price and the raw material cost. Hence, it is very much important to know about the trend in the movement of yarn selling price and raw material cost for the 12 popular counts that have been considered for the MPEI calculation. Like MPEI, the average yarn selling price and the average clean raw material cost for the above counts is set at the index level of 100 in April 2013.

The trend in the movement of yarn selling price index and raw material cost index during the period April 2021 – March 2022 is shown in Figure 14.

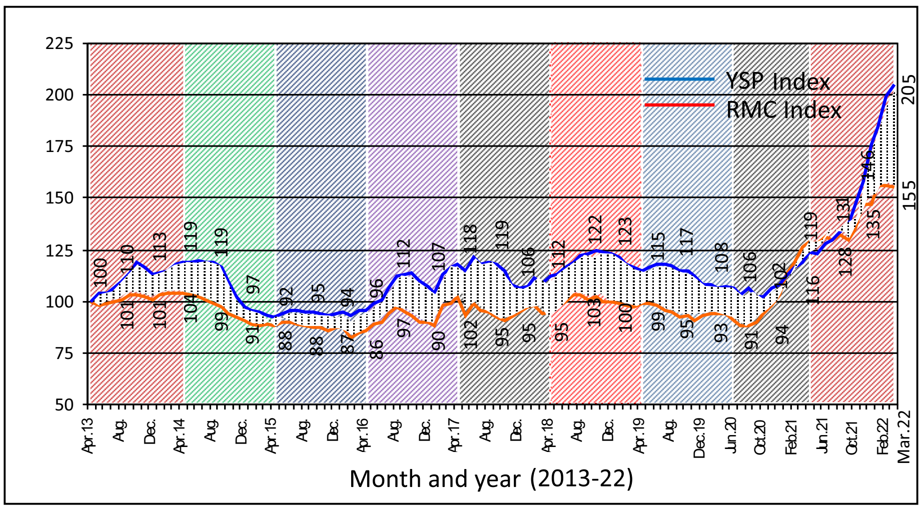


Figure 14 Yarn selling price index (YSPI) and Raw material cost index (RMCI)

The above figure shows that up to the end of 1st quarter, the yarn selling price index remained higher than that of the raw material cost index. In July 2021, both the yarn selling price and raw material cost remained at the same level (130 index points). However, since then, the raw material cost increases were comparatively higher than the increase in yarn selling price between months. On the whole, the raw material cost had registered an increase of 75 index points during the year 2021-22 i.e. from 124 index points in April 2021 to 199 index points in February 2022. The yarn selling price, on the other hand, witnessed an increase of only 27 index points during the above period thereby resulting in the overall reduction of MPEI during February 2022.

During March 2022, raw material cost index (RMCI) had registered a record high value of 205 index points. However, the yarn selling price index had reduced marginally by one index point (YSPI: 155), when compared with the index that prevailed in the previous month.

Raw material cost (RMC), yarn selling price (YSP) and net out-put value (NOV) of a few popular counts during the past 8 years (April 2013 – March 2022)

The trend in the movement of RMC, YSP and NOV of a few popular counts during the past 106 months (April 2013 to March 2022) is shown in Figures 15 to 23.

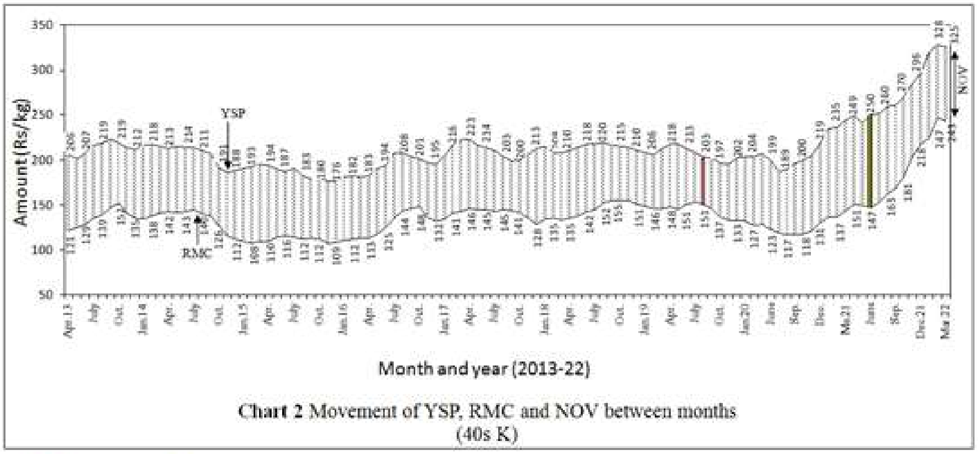


Chart 2 Movement of YSP, RMC and NOV between months (40s K)

Lowest NOV; Highest NOV

Figure 15 Movement of YSP, RMC and NOV between months (40s K)

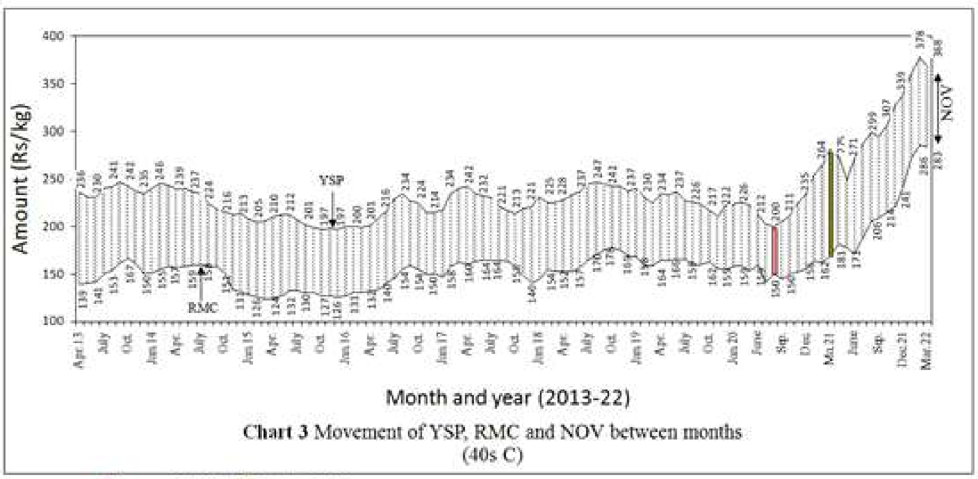


Chart 3 Movement of YSP, RMC and NOV between months (40s C)

Lowest NOV; Highest NOV

Figure 16 Movement of YSP, RMC and NOV between months (40s C)

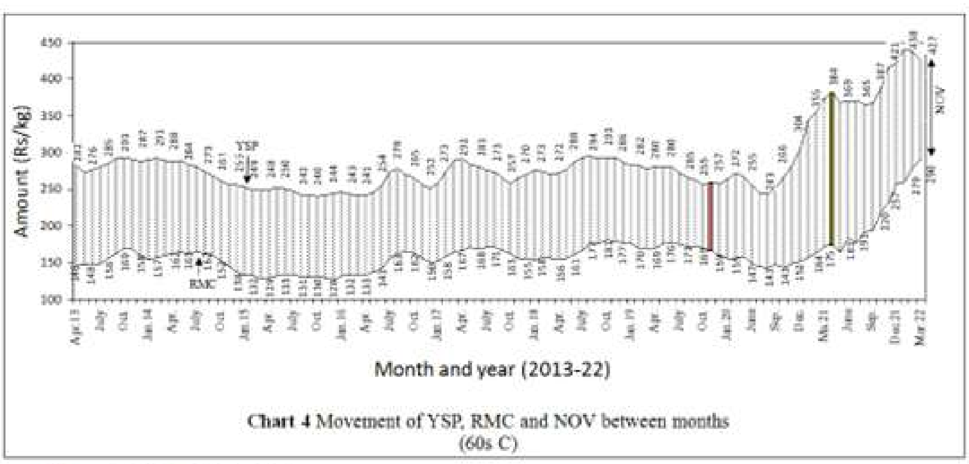


Chart 4 Movement of YSP, RMC and NOV between months (60s C)

Lowest NOV; Highest NOV

Figure 17 Movement of YSP, RMC and NOV between months (60s C)

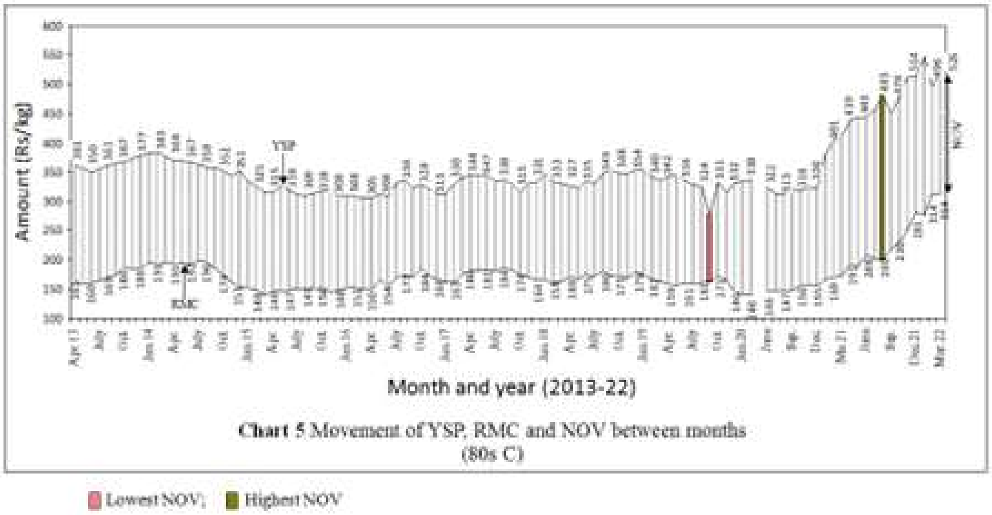


Figure 18 Movement of YSP, RMC and NOV between months (80s C)

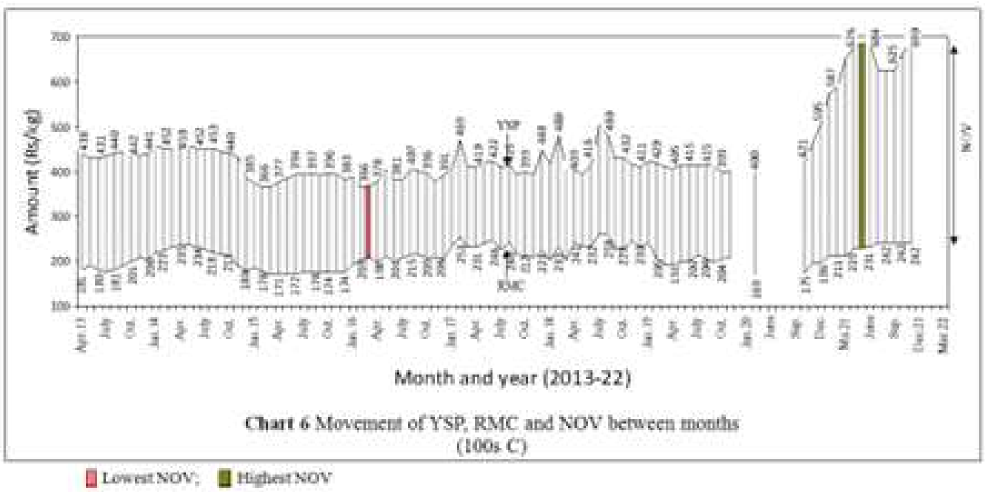


Figure 19 Movement of YSP, RMC and NOV between months (100s C)

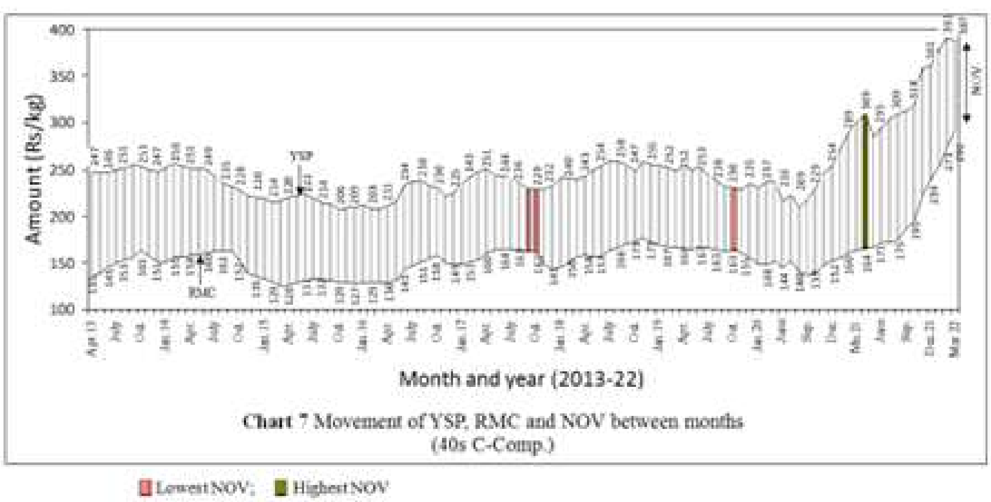


Figure 20 Movement of YSP, RMC and NOV between months (40s C-Comp.)

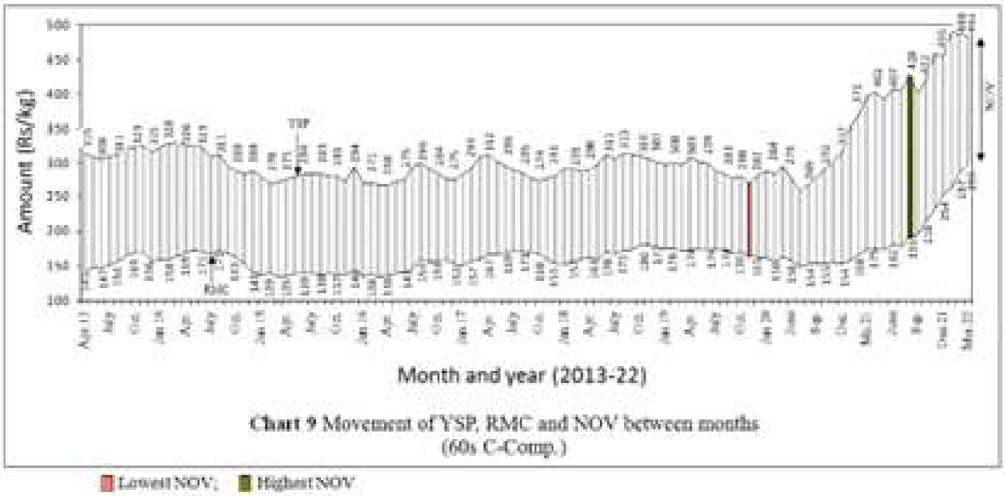


Figure 21 Movement of YSP, RMC and NOV between months (60s C-Comp.)

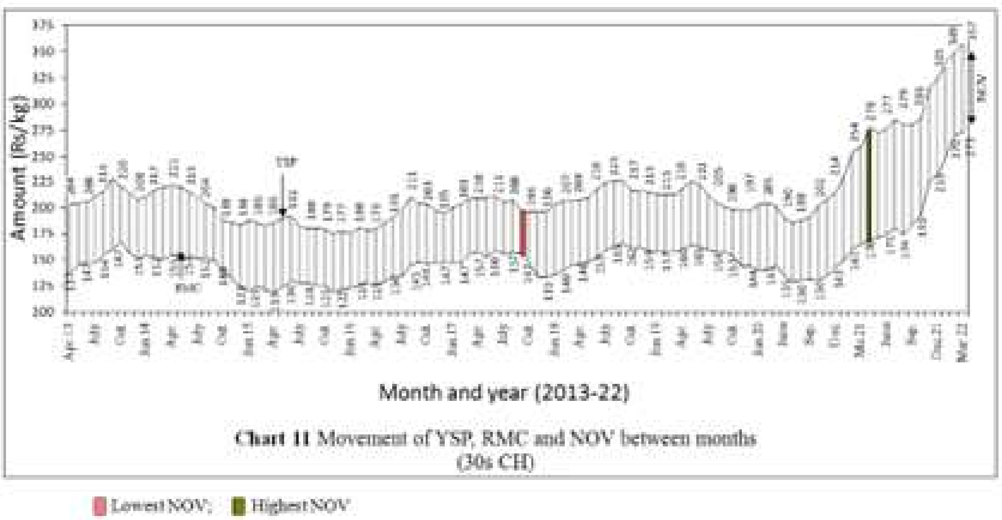


Figure 22 Movement of YSP, RMC and NOV between months (30s CH)

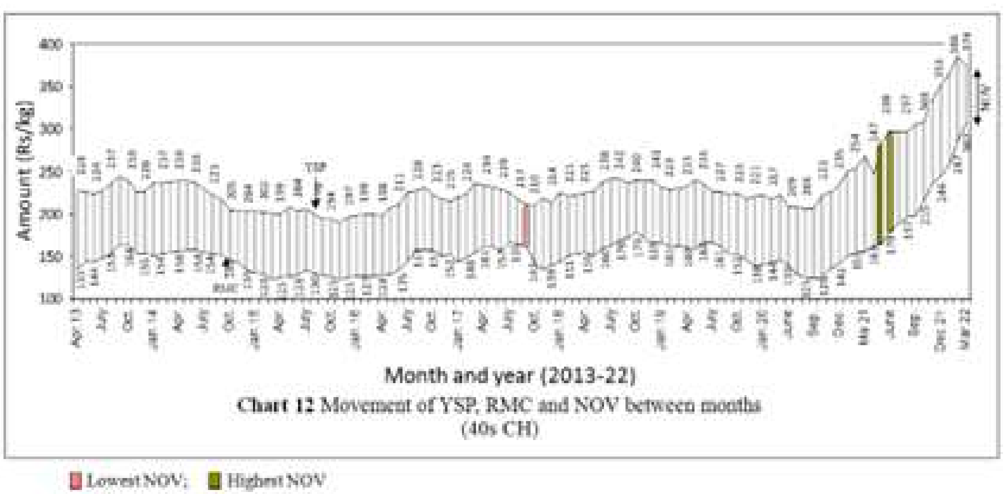


Figure 23 Movement of YSP, RMC and NOV between months (40s CH)

ENERGY MANAGEMENT

SITRA "OHTC Effis copy"

The OHTCs (Over Head Travelling Cleaners) assist textile mills in producing yarn with better quality and quantity. Spinning mills use 2 types of OHTCs and the models have been known to mills as bus-bar and belt driven OHTCs. In the bus-bar OHTCs either 1.5kW or 2.2 kW fan motor is used (3kW motor is used in looms OHTC). Spinning mills use belt driven models mostly with 1.5kW fan motor. Though the mills acquire advantages through OHTCs, they consume a good amount of energy too. A single window system to monitor and optimize energy use of OHTCs individually is essential in the present day context.

What is SITRA "OHTC Effis copy"

SITRA "OHTC Effis copy" is a web based OHTC controller unit having ICT (Information and Communication Technology) enabled devices/systems to monitor energy efficiency of OHTCs on-line.

Aim of the project

To optimize energy consumption of OHTCs using an advanced interactive web based control system.

Objectives of this project

- To design and develop a web based smart electronic control system for improvising the energy performance of OHTCs.
- To test the control system in the industrial environment.
- To evaluate overall effectiveness of the control system in improving the quality performance of OHTCs.
- To commercialize the product.

Scope of work

The project scope includes design and development of a master controller unit, mobile app and an algorithm software in addition to data acquisition system.

STUDY ON THE INTERRELATIONSHIP BETWEEN ENERGY PERFORMANCE OF NON PRODUCTIVE LOADS, MAGNITUDEOF FLUFF, FLY AND DUST DENSITY IN AIR IN SPINNING DEPARTMENT AND HEALTH HAZARDS – AN INTEGRATED APPROACH FOR OPTIMISATION

In today's highly competitive yarn market environment, spinning mills are under enormous pressure to reduce/optimise cost of production particularly in the area of power and labour. To minimize cost of energy component of production, some of the measures resorted to by some mills include optimising the speed of fans in humidification plants and running hours of overhead travelling cleaners (OHTCs) and optimising/minimizing lux levels. Since these measures are also related to/affect the performance parameters such as the number of air changes, machine cleaning efficiency, fluff density/pollution levels and human comfort, health/ efficiency or their willingness to work, some of the mills are reluctant to reduce excess humidification supply/exhaust capacities or OHTC utilisation levels losing opportunities for energy conservation / cost reduction based on subjective rather than objective judgment. The above factors are also greatly influenced by the count spun (fine, medium, coarse), compact/non compact, combed/carded and type of fibre (cotton or synthetic) and system maintenance. To avoid energy saving in one area/system at the cost of deterioration in the performance of an interdependent some other system, a clear understanding/establishment of the interrelationship between above ancillary systems and their performance and operating parameters is essential. This will pave the way for establishment of new standards which is unavailable at present in modern mills due to various resons.

Hence, in the first phase of the project, the interrelationship between performance/operating parameters of the above aspects will be established based on extensive measurements in different conditions to develop mathematical / empirical equations for a rational approach towards optimisation/energy saving and in the second phase, the scope for introducing new technologies in the respective areas for further improvement will be explored.

CHEMICAL PROCESSING

Antioxidant Cosmetotextiles: Durable Nano-encapsulated Vitamin E Finishes on Textile Fabrics and Its Controlled Release Study. (Funded by DST-WOSA)

In a project funded by DST – WOS 'A' under the "woman scientist" scheme of 3 years duration, an attempt has been made to develop Antioxidant cosmeto textiles for controlled release of Vitamin E for the likes of pre-term infants, patients having vitamin and immuno deficiencies.

During the year 2020-21, complete literature survey was carried out for the micro- and nano- encapsulation of vitamin E by various methods and the application of encapsulated vitamin E on cotton fabric. The raw materials and equipment were procured and characterization studies of raw materials were performed. Trolox Equivalent Antioxidant Capacity (TEAC) was evaluated for procured vitamin E and its derivative. Based on the anti-oxidant activity results, DL-α-tocopherol was chosen to prepare the nano-formulation. The Concentration of encapsulating agent, vitamin E (DL-α-tocopherol) and vegetable oil were optimized to achieve stable nano-emulsion. Prepared nano-emulsions were characterized by particle size analyzer and the results were reported in the previous year.

During the year 2021-22, characterization of prepared nano-formulation and application of nano-formulation on the fabric were performed and the results are as follows.

Characterization of prepared nano-emulsion by HR-TEM:

The prepared nano-emulsion was analyzed using HR-TEM to prove the encapsulation of vitamin E. Confocal microscopic analysis was also performed for the nano-emulsion by staining the protein using Nile Red dye.

The prepared nano-formulation with the particle size 1.73 nm was applied on the fabric by pad-cure method of application. Curing time and temperature were optimized to achieve better durability. The nano-formulation with cross linking agent and catalyst was applied on the fabric by 2 dip-2 nip method of padding and later cured at 50 °C for 20 minutes.

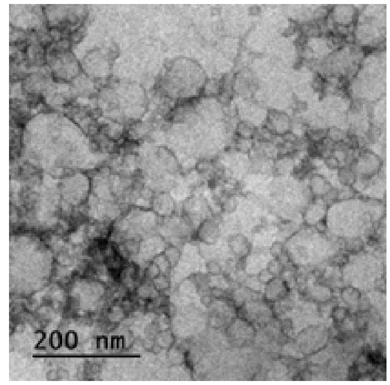


Figure 24 HR-TEM image of prepared nano-emulsion

Table 29 Fabric parameters

Parameter	Result	Parameter	Result
Fabric type	Woven fabric	Warp count	Ne 41.79
EPI (Ends per inch)	99	Weft count	Ne 79.36
PPI (Picks per inch)	84	GSM	86.69
Cover factor	19.58	Thickness	0.27 mm

Table 30 Optimization parameters for the application of nano-formulation on the fabric

S. No	Parameter	Time (minutes)	Temperature (°C)
1	Curing	20	50
2	Curing	10	100*

* Degradation of vitamin E was observed at 100 °C

Four different eco-friendly crosslinking agents CA1, CA2, CA3 and CA4, were used to incorporate the vitamin E finishes on the fabric. Among the four cross linking agents, CA1 showed better crosslinking which was confirmed by add-on %. The evaluation of durability of finishes by washing, rubbing and light are in progress.

Table 31 Cross linking agents used for the application on the fabric

S. No	Cross linker	Add-on (%)
1	CA1	3.83
2	CA2	2.96
3	CA3	3.13
4	CA4	1.27

Staining of fabric using Coomassie Brilliant Blue

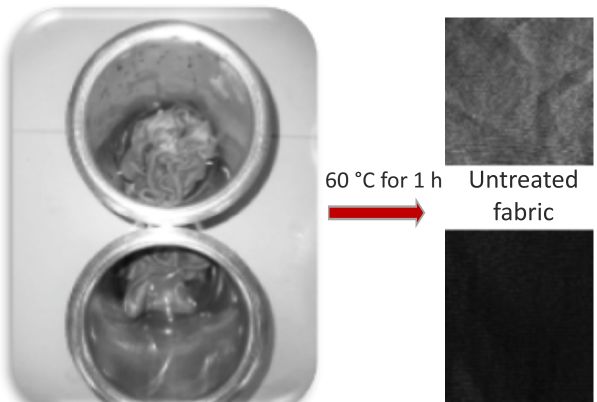


Figure 25. Staining of control and treated fabric using Coomassie Brilliant Blue

Nano-emulsion finishes on the fabric was confirmed by staining the fabric with Coomassie Brilliant Blue R250. Treated fabric and control (without protein finish) fabric were stained with Coomassie Brilliant Blue at 60 °C for 60 min. The samples were then washed several times with distilled water. Then, the samples were dried at room temperature. To evaluate the finishes on the fabric, the color absorption was calculated *via* Kubelka–Munk equation (K/S). The K/S value for control fabric was 1.44 and for nano-emulsion treated fabric it was 2.74 at 600 nm which is the absorbance maximum for bright blue colour of Coomassie Brilliant Blue dye. This value confirms the presence of protein based nano-emulsion on the fabric.

Surface characterization of nano-emulsion finished fabric

The surface morphology of control fabric (untreated fabric) and treated fabric with four different crosslinking agents were evaluated by FE-SEM, and EDX. The images indicate the presence of finishes on the fabric.

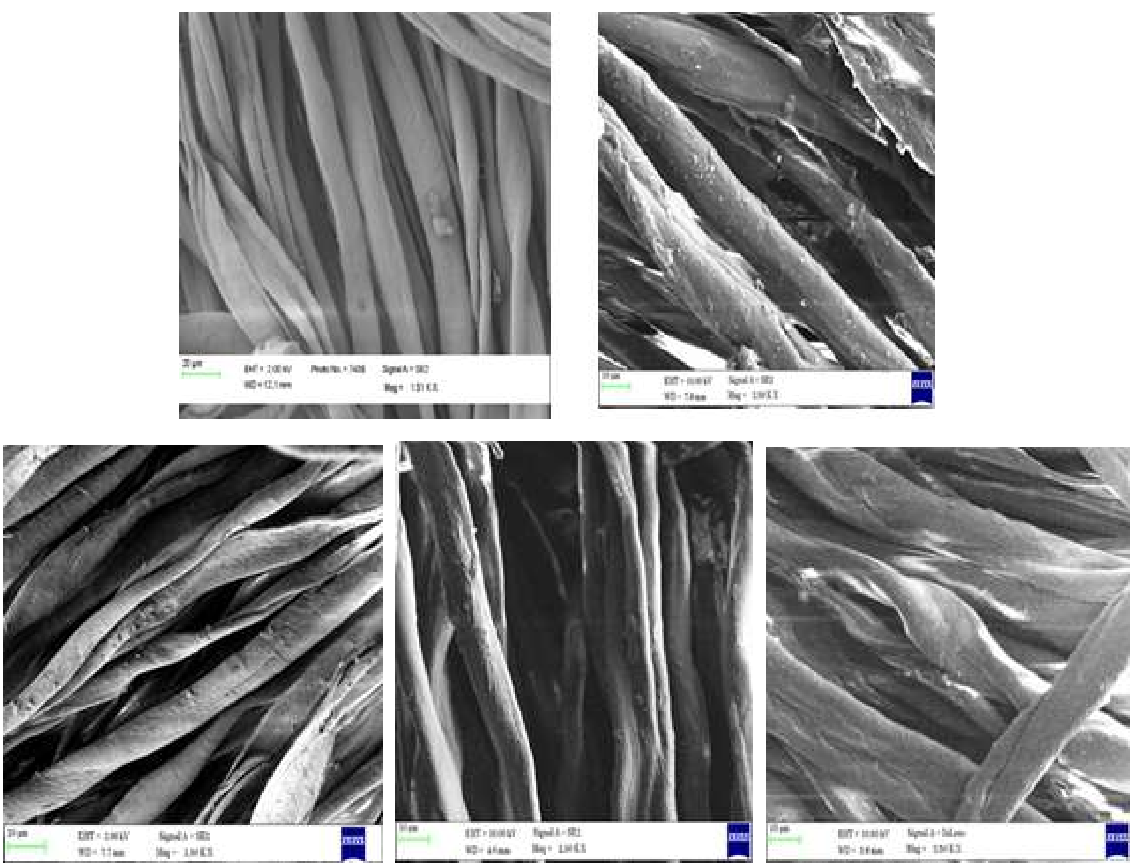


Figure 26 FE-SEM image of a) control b) with CA1 c) with CA2 d) with CA3 e) with CA4

The presence of more particles on the fabric surface using CA1 as a crosslinking agent (Figure 25b) indicates the better crosslinking of protein based nano-emulsion with the fabric

Cytotoxicity evaluation of prepared nano-formulation and treated fabric

The cytotoxicity of nano-formulation and nano-formulation treated fabric were evaluated as per ISO 10993:5 test on extract method. The nano-formulation showed slight toxicity against L929 cells and nano-formulation finished fabric showed no toxic reactivity after 24 h contact. Control gave none cytotoxic reactivity as expected.

Table 32 Cytotoxicity results

S. No	Description	Cytotoxicity (%)	Cell viability (%)
1	Nano - formulation	2	98
2	Treated fabric	0	> 99

Stability studies of prepared nano-emulsion

The stability studies were performed for the nano-formulation stored under refrigerated condition. The nano-formulation is stable for six months if it is stored at 4-8 °C. Further stability studies under ambient conditions are in progress.

Further the durability of vitamin E finishes on the fabric and release study by Franz-diffusion method are in progress.

Table 33 Stability study by HPLC

S. No	Temperature (°C)	Duration (in days)	Concentration (mg/L)
1	4-8	7	970.54
2	4-8	30	962.46
3	4-8	90	960.08
4	4-8	180	951.26
5	RT*	7	966.42

** RT – Room Temperature*

Characterization of natural dyes extracted from food processing waste materials

The current in-house study focuses on characterization of natural dyes extracted from two commercial food processing waste materials namely the spent coffee grounds and the roasted peanut skin. The dyes were applied on silk, cotton and nylon fabrics with and without the aid of mordants using two different baths, the water bath and the ultrasonic bath. This paper was published in Journal of Natural fiber journal in February 2022. (Journal Of Natural Fibers https://doi.org/10.1080/15440478.2021.1993506)

Materials & Methods

FTIR spectroscopy

The Diffuse Reflectance Infrared Fourier Transform Spectra (DRIFTS) were obtained using a Jasco FT-IR 4600 series with KBr pellet mode and a spectral window range of 4000–400 cm−1. Each KBr pellet was made with 3 mg of dye extract powder and 100 mg of potassium bromide. In particular, freshly produced KBr pellets were examined, with a total of 32 scans performed in a dry environment for each spectrum.

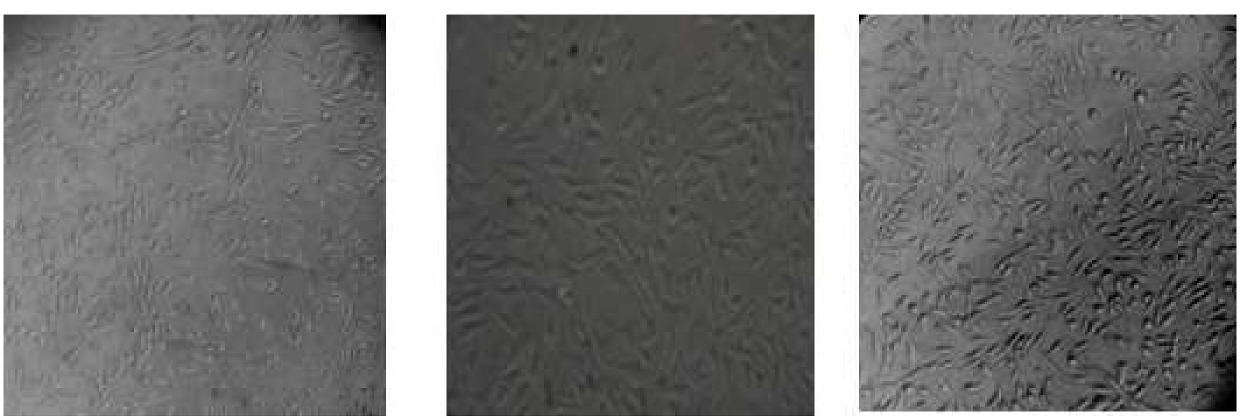


Figure 27 Cell viability images for a) control b) nano-formulation c) treated fabric

GC MS analysis

The dye extracts were analyzed using GC/MS (Agilent 7000 D GC/TQ) by DB 35-MS capillary standard nonpolar column using Helium gas at a flow rate of 1.0 mL/min, initial temperature of 70°C and increased to 260°C at the rate of 6°C to identify the compounds present. The dye was first dissolved in methanol solvent at a concentration of 1 mg/ml and then analyzed using GC/MS by scan mode and performed the library match to identify compounds.

Results & Discussion

FTIR spectroscopy

The FTIR spectra of the natural dyes extracted from the spent coffee grounds and roasted peanut skin are shown in Figure 28a and b respectively. The broad peak at 3402 cm^{-1} (spent coffee grounds dye) and 3420 cm^{-1} (roasted peanut skin dye) could be hydroxide (–OH) and amine function groups stretching frequency corresponding to phenols, carboxylic acid in Gallic acid-based tannins. The sharp peaks at 2919 cm^{-1} and 2926 cm^{-1} and weak peak at 2653 cm^{-1} may be C-H functional group stretching frequency corresponding to aldehyde and allylic respectively. The strong, sharp peak at 1626 cm^{-1} may be C = C function group stretching frequency corresponding to unsaturated alkene and aromatic ring system. The medium and weak peaks at 1383 cm^{-1} and 1314 cm^{-1} may be – CH_3 function group bending frequency and then 1132 cm^{-1} and 1119 cm^{-1} (Figure 28a and b) may be C–OH function group stretching frequency corresponding to phenols, carboxylic acid in Gallic acid-based tannins.

GC-MS analysis

The presence of color compounds in spent coffee grounds and roasted peanut skin were illustrated in the previous literature reports (Ana et al. 2012; Bae and Hong 2019; Elsorady and Ali 2018; Koh and Hong 2019; Ritu et al. 2018). Based on the literature reports GC MS analysis was performed with library match for the extracted dyes. The compounds present in the dyes and their chemical structure are shown in Tables 1 and 2. The active sites in the color compounds react with the mordant and the fiber molecule. The GC-MS spectra of the color compounds present in spent coffee grounds dye and roasted peanut skin dye extracts with library match. Melanoidins are dark brown natural coloring agents which are responsible for the color of coffee extract and they can absorb light at 420 nm. Coffee melanoidins are composed of different chemical species such as Galactomannans, Arabinogalactans, proteins, chlorogenic acids, and Maillard reaction products. Mordants assist binding of dyes to fabric by forming chemical bridge from dye to fiber thus improving the fixation of a dye along with increasing its fastness properties. 5,6,4′-trihydroxy-7,8-dimethoxy-flavone, a color component, Al^{3+} and cellulose were taken as an example to outline the reaction mechanism. Initially, the metal ion $Al3^{+}$ present in alum will make a co-ordination complex with cellulose. Then it will react with 5,6,4′-trihydroxy-7,8-dimethoxyflavone to form the co-ordination complex using the aromatic alcohol and keto group as reactive site as shown in Figure 29. The fibers made of proteins, such as silk, will make hydrogen bonding between the polypeptide linkages and the dye.

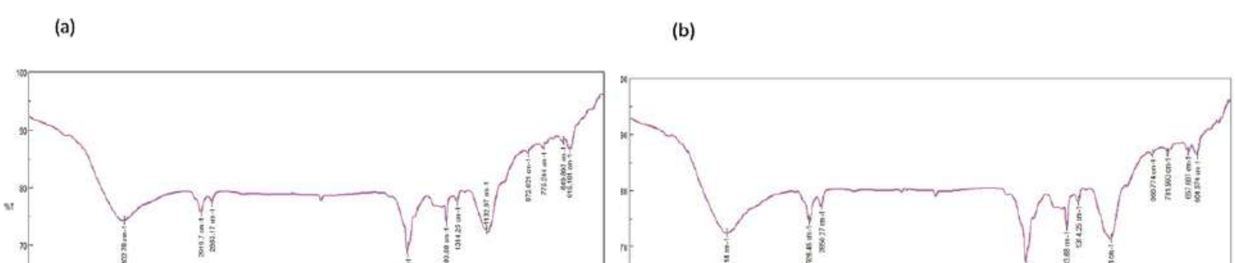
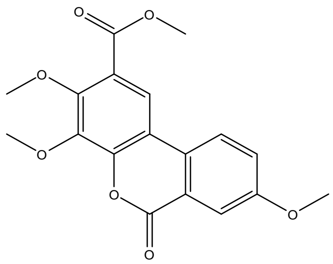
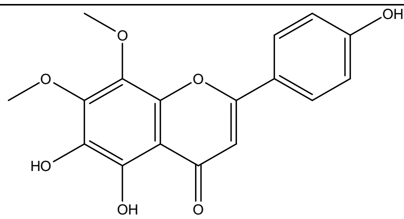


Figure 28 FTIR spectra of dyes extracted from (a) spent coffee grounds and (b) roasted peanut skin

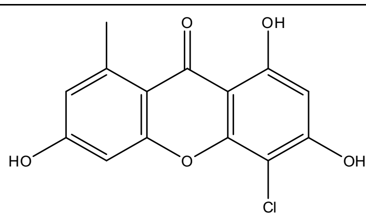
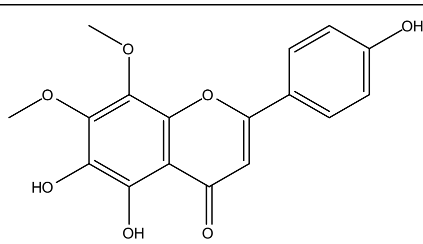
Table 34 Chemical structure of the dye compounds present in spent coffee grounds dye

S. No	Chemical Structure	Chemical name	Common name	Category
1		Benz[c]coumarin-3-carboxylic acid, 1,2,7- trimethoxy-, methyl(ester) (or) methyl 3,4,8-trimethoxy-6-oxo-6H-benzo[c]chromene-2-carboxylate	Coumaric acid derivative	Oxyaromatic acids
2		5,6,4'-Trihydroxy-7,8-dimethoxyflavone (or) 5,6-dihydroxy-2-(4-hydroxyphenyl)-7,8-dimethoxy-4H-chromen-4-one	mosloflavone	Flavanoids

Melanoidins are dark brown natural colouring agent which are responsible for the colour of coffee extract and they can absorb light at 420 nm. Coffee melanoidins are composed of different chemical species such as Galactomannans, Arabinogalactans, proteins, chlorogenic acids, and Maillard reaction products.

Groundnut peel colour compounds identified by GC MS

Table 35 Chemical structure of the dye compounds present in roasted peanut skin dye.

S. No	Chemical Structure	Chemical name	Common name	Category
1		9H-Xanthen-9-one, 4-chloro-1,3,6-trihydroxy-8-methyl- (or) 4-chloro-1,3,6-trihydroxy-8-methyl-9H-xanthen-9-one	Arthothelin	Xanthone
2		5,6,4'-Trihydroxy-7,8-dimethoxyflavone (or) 5,6-dihydroxy-2-(4-hydroxyphenyl)-7,8-dimethoxy-4H-chromen-4-one	mosloflavone	Flavanoids

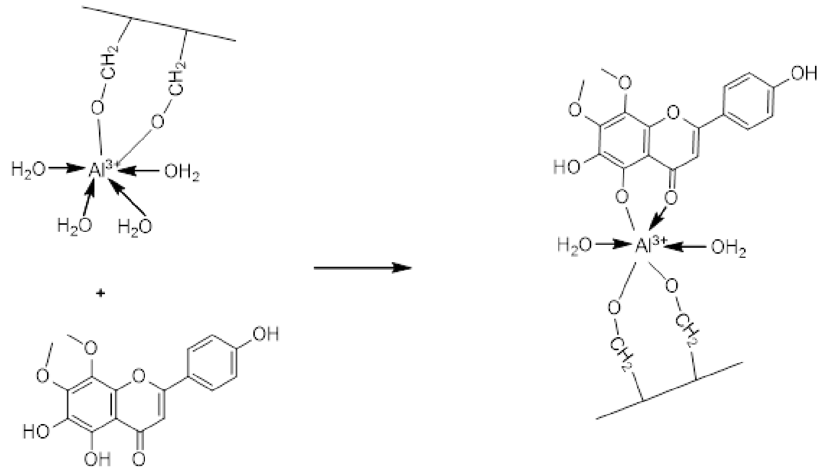


Figure 29 Interaction between the mordant, fabric and color compound

The interaction between mordant fabric and dye molecule are depicted in Figure29.

Decolourization of dye effluent water using eco-friendly nanoparticles

This is an in-house project to study the decolourisation efficiency of ecofriendly nanoparticles on textile dye effluent.

In textile dyeing mills, coloured wastewater is discharged in the form of high concentrations of dyes combined with various chemicals. Dyestuffs are in general difficult to dispose because their structures are complex and aromatic. It is a serious aesthetic issue as well as an ecological one when water resources are coloured.They reduce light penetration which adversely affects the photosynthetic activity of aquatic plants. Dye removal techniques include chemical coagulation, flocculation, chemical oxidation, photo chemical degradation, membrane filtration and aerobic and anaerobic biological degradation. All of these methods have some limitation and none of them are effective in completely removing dye from waste water.

Metal nanoparticles (Nps) are also used to decolourize the coloured effluents.Numerous applications are proven to be possible with ZnO Nps among the others because of its capability of absorbing light, transport charges, providing fast response, low cost and ease of use. In addition ZnO Nps are applicable in water purification, UV blocking, anti-bacterial, anti-fungal, self-cleaning, sun screening, food packaging, sterilizing environment, biomedical, cosmetics, photo-catalyst due to its unique physical and chemical properties i.e. high chemical stability, high electro chemical coupling coefficient, broad range of radiation absorptions, wide energy band gap(3.37eV), large excitation binding energy(60meV), high thermal and mechanical stability. Also, they exhibit excellent properties such as ease of synthesis, non-toxicity, controlled shape and size, presence of intrinsic and extrinsic at emission center, emitting different colours.

Most of the literature work highlighted the decolourization of direct dye solution, but the present work focused on photo catalytic degradation of dye using nanocomposite for the decolourization of dye effluent water. Initial trials were conducted for the colour removal of the dye solution using synthesized ZnO nanoparticles. The various parameters such as time, nanoparticle concentration, and Blue MR dye concentration were optimized for the effective decolourisation. In addition to colour removal, chemical oxygen demand (COD) and biological oxygen demand (BOD) reduction were also investigated.

MATERIALS

Zinc acetate dehydrate ($Zn(CH_3COO)_2.2H_2O$),zinc sulfate heptahydrate ($ZnSO_4.7H_2O$), Cetyltrimethylammonium bromide ($[(C_{16}H_{33})N(CH_3)_3]Br$, Oxalic acid $(COOH)_2$ and Sodium hydroxide (NaOH) were procured from local supplier to synthesize Nps.

METHODS

ZnO Nps synthesis

Different trials were performed to synthesise the Nps. The method of synthesis, time and temperature are the critical parameters which determine the size, shape and yield of the Nps. The table 36 describes the precursors and approach carried out to synthesize the Nps.

Table 36 Method and precursor for Nps synthesis

Trials	Precursors	Method
1	Zinc acetate	Sol-gel
2	Zinc acetate	Sol-gel
3	Zinc acetate	Calcination
4	Zinc sulphate	Calcination
5	Zinc acetate	Sol-gel

Sol- gel method is a wet chemical method which is used to produce various nanostructures, particularly metal oxide nanoparticles. In this method, the molecular precursor (Zinc acetate) was dissolved in water /alcohol. It was then continuously heated and stirred to obtain gel. The wet/damp gel was then dried and Nps were separated from the solvent using appropriate techniques. The synthesized Nps were then crushed and powdered. On the other hand, in the calcination process the precursor (Zinc acetate/ zinc sulphate) was heated at higher temperatures in order to convert into its oxide form. It was heated below its melting point in the absence of air or in a limited supply. Temperature and time were altered and optimized in order to yield Nps with the expected size and shape.

Preparation of Stock solution

The stock solution was made by 1000 ppm of reactive Blue MR dye. Different initial concentrations (20, 40, 60, 80, and 100 ppm) of dye solution was prepared to evaluate the decolourization process.

Advantage of using Nano composites for decolourization

Numerous chemical and physical processes are adopted for the decolourization of dye effluent, which work by direct precipitation and separation of pollutants, or elimination by adsorption on activated carbon or relevant materials. These techniques will displace the colour alone, and further treatments are necessary in order to separate the purified effluents or to regenerate the adsorbents. Hence, a new and different risk of pollution is becoming unanswerable. Alternatively, a photochemical approach has been adopted. Indeed, ultraviolet irradiation combined or not with oxidative agents such as ozone or hydrogen peroxide leads to a complete destruction of the pollutants, but the presence of intermediates arising from the photo degradation reaction could be more harmful than the pollutant itself. Such inconvenience can be avoided by using the photo catalytic degradation. In photo catalytic decolourization process, hydroxyl radicals ($OH^{\cdot}$) are generated when the photo catalyst is illuminated in the presence of water and air, these ultra-reactive species associated with oxygen are able to achieve a complete mineralization of organic pollutants into carbon dioxide, water and other nontoxic products. The main advantages of using Nano composites for decolourization process are the elimination of hazardous sludge formation and the reuse of photo catalyst.

RESULTS AND DISCUSSION

Nanoparticle Characterization

Among the five trials, Nps with small size was taken for the decolourisation process. The structure and morphology of the ZnO Nps is shown in the figure 1. The particle size of ZnO Nps as determined on FE-SEM was 68 nm.

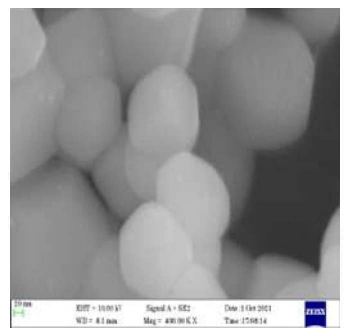


Figure 30 FE-SEM images of ZnO Nps

Influence of nanoparticles on degradation of Blue MR dye

The optical properties of the reactive blue MR dye were analyzed using a UV-Visible spectrometer. The absorbance of dye solution in water was observed at 600 nm to determine the concentration of dye present in the solution. The initial concentration of dye is 1000 ppm and after photo catalytic degradation the dye concentration was reduced to 56 ppm.

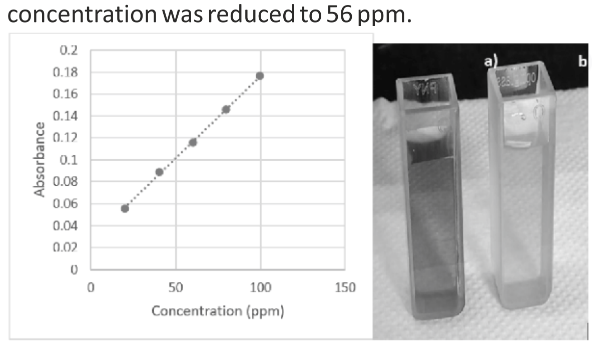


Figure 31 Calibration curve and a) initial b) degraded dye after photo catalytic degradation

Chemical Oxygen Demand (COD)

Dye reduction results reported in this study were based on the spectroscopic analysis of the dye solutions. COD value for treated effluent was 131 ppm while the same for untreated one was 249 ppm which was shown in the table 2. It can be inferred that ZnO nanoparticles not only eliminates the colour from the effluent but also reduces the COD indicating degradation of the dye.

Biological Oxygen Demand (BOD)

The reduction in BOD values for the effluent treated with ZnO Nps is listed in the table 36. Similar to COD, BOD also plays a major role in treatment of dye effluents. It was found to have 99ppm for dye effluent and it was reduced for the effluents treated with ZnO Nps.

Table 37 COD and BOD values

Parameters	Dye effluent	Dye effluent treated with ZnO Nps
COD (mg/L)	249	131
BOD (mg/L)	99	45

The effective decolourization can be achieved using nanocomposite treatment of dye effluent water. Further research on nanocomposite preparation and nanocomposite based decolourization are in progress.

Development of a process methodology for reuse of ginning cotton waste in the core layer of hygiene productd - An in-House Project

In today's scenario, efficient use of natural resources and the reuse of recoverable wastes play a vital role in maintaining the sustainability. SITRA has developed a process methodology for the reuse of ginning cotton waste in Hygiene core layers. The ginning cotton wastes generally comprise of short cotton fibres, dust, broken seed particles, etc. The shorter lengths of fibres mean that these fibres cannot be spun and converted into a yarn. Hence, SITRA has developed an optimized methodology for processing the ginning cotton wastes to make them suitable for use in Hygiene core layers. Further, the processed sample was characterised for various physical and chemical characteristics.

Ginning process is to clean the cotton fibre by removing the foreign matter and to separate seeds from the fibre. Ginning waste cotton contains more contaminated linters, burrs, short fibres and seed hulls. Presence of a high level of contamination in these fibres causes difficulty in getting better whiteness Index. In an ideal scenario, it is better to remove the contaminations such as dust, dirt, small linters, etc using openers and cleaners before the said material is taken for chemical processing. However, preliminary studies revealed that treating the said cotton wastes in opening and cleaning machines lead to further rupture of fibres and also significant weight reduction say to the tune of 30%. Hence, in this study the ginning cotton waste was directly taken up for processing without any mechanical pre-treatments.

Materials and Methods

Ginning waste was collected from well reputed spinning industry in Coimbatore. Chemicals were procured from local chemical suppliers. The collected ginning samples and processed samples were analysed for various physico-chemical parameters according to standardized test methods.

Ginning Waste

After Carding Sample

Chemicals: Below chemicals were procured from local distributors

- Caustic Soda
- Hydrogen peroxide
- Wetting Agent
- Demineralisation Agent
- Citric Acid – Neutralizing agent

Methodology for reuse of ginning cotton waste

During this study, an attempt has been made to develop a suitable processing methodology for bleaching of ginning cotton waste and characterize them for various physical and chemical properties required for hygiene core layers. The main function of the core layer obtained from waste cotton is to absorb and retain the fluids and to ensure the hygiene. The processed cotton waste should exhibit good absorbency and also comply with the respective requirements as stipulated by national and international standards, as the case may be.

S. No.	Process	Chemical Name	Quantity (%)	Water quantity (MLR)	Temperature (degree ° c)	Time (Mins)
01	Pre- Wetting	Non – Ionic Wetting agent	1%	1:15	40	30
		Demineralising Agent	2%			
02	Scouring & Bleaching - 1	Wetting agent	0.5 %	1:12	110	60
		Caustic soda	3 %			
		Peroxide 50 %	5 %			
		Peroxide Stabilizer	0.5 %			
03	Hot – Wash	----------------	-	1:12	90	15
04	Scouring & Bleaching - 2	Wetting agent	0.5 %	1:12	110	60
		Caustic soda	2 %			
		Peroxide 50 %	5			
		Peroxide Stabilizer	0.5			
05	Hot – Wash	-----------------	-	1:12	90	15
06	Neutralisation	Citric Acid	0.75	1:12	80	15
07	Cold - Wash	-----------------	------	1:12	Room	10
Total				87	_	205

Different permutations and combinations were tried for bleaching the given ginning cotton waste and the process parameters were optimized accordingly. The optimized process flow chart and the recipe used for each of the processes are listed below in detail:

Processed Sample

Bleached cotton

Bleached Cotton – Carding Sample

Results and Discussions

The bleached waste cotton obtained through the optimized process methodology was evaluated for various physical and chemical properties including free swell absorptive capacity, water holding capacity, etc. The findings are given below:

S. No.	Parameters	Results
01	pH	6.7
02	Moisture Content	8.7 %
03	Whiteness of Cotton	65
04	Sinking Test	03 sec

Free swell absorptive capacity

Free swell absorptive capacity test is intended to measure the ability of fibres to absorb and retain the liquids. The bleached samples were tested as per WSP 240.3-2011 test method.

Parameters	Results
Free Swell Absorptive Capacity	19 grams of water/gram of cotton

Chemical Tests

Hygiene Products must be free from chemicals. The bleached cotton waste samples processed through SITRA' optimized methodology was tested for different chemicals tests and the values are given below:

S. No.	Parameters	Test Method	Results
01	Free Formaldehyde, mg/L	(ISO 14184-1 : 2011)	ND(LOD16 mg/kg)
02	Releasable Formaldehyde	(ISO 14184-2 : 2011)	ND (LOD 16 mg/kg)
03	pH, of water used	(IS 1390 – 1983 RA 2013)	6.77
04	Oxidizing / Reducing agents	SITRA – In-house Method	Absent
05	Surface active agents	SITRA – In-house Method	Absent
06	Nonyl Phenol Ethoxylates (NPEO), mg/kg	(BS EN ISO 18254-1 :2016)	ND (LOD : 0.5)
07	Octyl Phenol Ethoxylates (OPEO), mg/kg	(BS EN ISO 18254-1 :2016)	ND (LOD : 0.5)
08	Nonyl Phenol (NP), mg/kg	(BS EN ISO 14362-1:2017)	ND (LOD : 0.5)
09	Octyl Phenol (NP), mg/kg	(BS EN ISO 14362-1:2017)	ND (LOD : 0.5)

ND – Not Detected

Bio-burden test

Bio-burden test is the measure of microbial contamination levels in a product. This method identifies the presence or absence of specified micro-organisms, providing complete robust test results. The testing was carried by the Aerobic Plate Count method and Yeast and Mould Count method for determining the bacterial and fungal Bio-burden respectively using the standard method ISO 11737. All Colony Forming Units (CFU) were counted including pinpoint size. Tested sample results are given below.

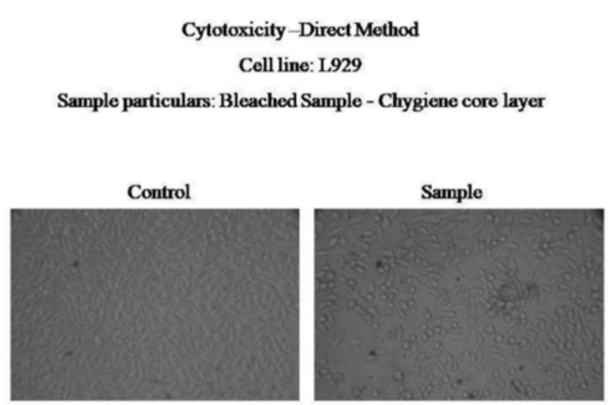
Test Parameter	Results
Total Bacterial Count	<100 CFU/g
Total Fungal Count	<100 CFU/g

Bacterial growth was analyzed after 24 hours of incubation and fungal growth was analyzed after 7 days of incubation. Tested sample had no bacterial and fungal growth.

Cytotoxicity test

The cytotoxicity test is one of the biological evaluation and screening tests that uses tissue cells in vitro to observe the cell growth, reproduction and morphological effects by medical devices. Cytotoxicity is preferred as a pilot project test and an important indicator for toxicity evaluation of hygiene products. Bleached waste cotton is tested in *Invitro* cytotoxicity direct method as per ISO 10993:5. Tested sample has acceptable limit of cytotoxic reactivity. Tested sample

Parameters	Results
Cytotoxicity (%)	26
Cell Viability (%)	74
Cytotoxic reactivity	Mild



Summary test results

The measured characteristics are summarized and the reports are given below:

S. No.	Parameters	Results
01	pH	6.77
02	Whiteness Index	65
03	Moisture Content (%)	8.7
04	Sinking time (Sec)	3
05	Free swell absorptive capacity test (grams/ gram	19
07	Chemical tests (Free HCHO, APEO, etc)	ND
08	Cytotoxicity test	Mild
09	Bio-burden test ➢ Total Bacterial Count (CFU/g) ➢ Total Fungi Count (CFU/g)	<100

ND – Not Detected

Findings

- Waste cotton was bleached with Hydrogen peroxide and the bleached waste cotton has more roughness. Water consumption is relatively more than what is used while treating virgin cotton fibres which are attributed to the contaminants present in the given sample.

- Prior opening and cleaning of the cotton waste gives better results in terms of better whiteness index and ease of processing.

- Bulk bleaching process can be done using High Temperature and High Pressure (HTHP) machines. Further reduction of water consumption may be achieved by conducting large scale trials on HT/HP processing machines.

- The bleached waste cotton, processed through SITRA's optimized process methodology, is free from chemicals, skin irritation components, bacterial, fungi and toxicity.

- We could utilize the waste cotton for hygiene core layer. The said bleached waste cotton absorbs the about 19 grams of water per gram of waste cotton.

MEDICAL TEXTILES

DEVELOPMENT OF BREATHABLE, REUSABLE AND OXO-BIODEGRADABLE COVERALL USING BIOCIDAL POLYESTER

(Funded by Board of Research in Nuclear Sciences (BRNS), Government of India
Collaborator: Bhabha Atomic Research Center, Mumbai, Government of India)

Corona virus (COVID-19) continues to pose a threat around the world, and health care providers are on the frontlines of battling this novel pandemic. Health care providers are extensively affected, and the pandemic will continue to inexplicably affect them if proper precautions are not taken. As a preventive measure, the use of personal protective equipment (PPE), such as face mask, coverall, gloves, shoe cover and goggles have been the first protective means that can prevent the spread of the virus. Though the available disposable coverall products are cheaper and lighter in weight, they offer least comfort to the wearer and are less effective against COVID-19 viruses. Hence, the access to an effective antiviral PPE for health care workers is a key concern. The present proposal is aimed at developing a leak protecting, biocidal, reusable and oxobiodegradable coverall using affordable raw materials to minimize the disease transmission and to combat COVID-19.

METHODS

The characterized nanoparticles (Nps), PCM and oxidizing agent were applied on the fabric by padding mangle. The fabric is then dried and cured in a curing chamber for a better binding of nanoparticles on to the fabric. The breathable film is then laminated onto the fabric using PUR lamination technology. The developed product was characterized for physical, chemical and biological properties as per IS 17423.

RESULTS AND DISCUSSION

Surface morphology of Nps treated polyester fabric

The presence of nanoparticles on the fabric surface indicates the finishing of the polyester material. The homogeneity of the nanoparticles on the fabric was assessed and confirmed by taking SEM images at various places of the sample. A homogeneous and the mono dispersed coating of nanoparticles were observed with the particles ranging from 35nm to 60nm

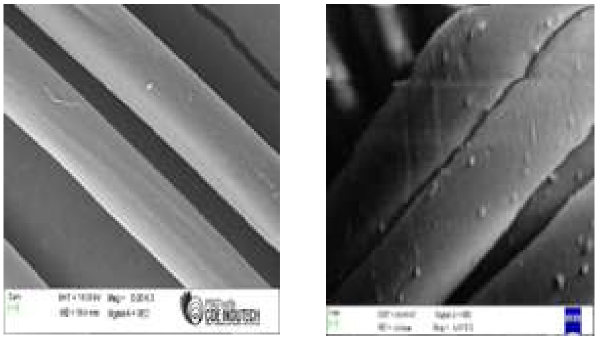


Figure 32 FE-SEM image of a) untreated b) Nps treated polyester fabric

Physical Characterization

The developed prototype coverall was characterized for various parameters such as SBPRT (ISO 16603), MVTR (ASTM E 96-95), tensile (ISO 7016 II), seam (ASTM D 751-06) and bursting strength (IS 1966-1) which is given in Table 37. The critical task is achieving the better results in barrier and moisture transfer properties simultaneously. The fabric should resist external agents like blood and bodily fluids but it should allow vapor from inside to move out. These were achieved for the final coverall product as per IS 17423. Moreover, the mechanical properties of the fabric such as tensile and bursting strength were achieved as per the standard which indicates the fabric was resistant against stress and strain. Also, the seam portion of the fabric showed improvised results against synthetic blood penetration and better seam strength.

Chemical Characterization

The Durability of nanoparticles on the fabric by washing was performed in accordance to AATCC 61 2A test protocol. The fabric was durable up to 15 washes without affecting the barrier and moisture transfer properties. For the quantification of Nps on the fabric, amount of Nps leached from the fabric and durability of Nps on the fabric were evaluated by ISO 17294 test method using ICP-MS. The biodegradability of the sample was assessed by burying the sample in soil under standard test conditions and tensile strength of the treated and control sample was performed at regular time intervals. The weight loss was found to be 14.93% for the oxidizing agent treated sample, which was buried in soil for one year (AATCC 30 Part 1).

Biological Characterization

Biological characterization was conducted at each level of product development. Initially, antibacterial activity of the Nps was confirmed through ASTM E 2149 method using *E.coli* as the test organism. Further, effective concentration of Nps to develop padding formulation was identified using *E.coli* at different concentrations and time intervals. Antibacterial, antiviral,ability to resist penetration of bacteria and virus, microbial cleanliness and biocompatibility was assessed in accordance to the requirement of IS 17423. Results of the studies confirm the material being biocidal with high resistance to viral / bacterial penetration..

Summary

- The coverall (Figure 33) with multi-functional properties such as breathable, anti-viral, reusable and oxo-biodegradable was developed successfully.
- Barrier properties were achieved as per the requirement without compromising the moisture vapor transport.
- Increasing the laundering cycles upto 15 washes did not show much reduction in the Nps present on the fabric thereby proving that 15 washes also did not change the barrier and comfort properties of the coverall.

Figure 33 Final prototype coverall

DESIGN AND DEVELOPMENT OF FACILE HIGH THROUGHPUT NEEDLE LESS ELECTROSPINNING SET UP ***(Funded by National Technical Textile Mission – MoT)***

Electrospinning is a widely used spinning technique which utilizes electrical forces to produce polymeric nanofibers. Owing to the salient features of nanofibers such as high surface area to volume ratio, smaller pore

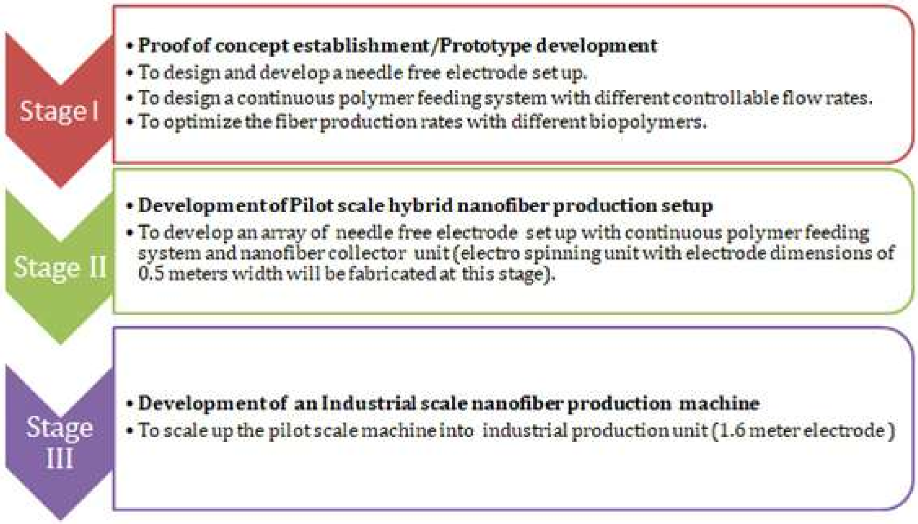
Table 38 Characterization of the final coverall

S.No	Parameters	Final	Requirement
1.	Bursting Strength		
	Dry (kPa)	1451	≥ 40
	Wet (kPa)	1422	≥ 40
2.	Seam strength		
	Dry (N)	134.17	≥ 20
	Wet (N)	122.68	≥ 20
3.	Tensile Strength		
	Warp (N)	831	≥ 20
	Weft (N)	652	≥ 20
4.	SBPRT	Pass(6 levels)	Pass(6 levels)
5.	MVTR ($g/m^2/24h$)	957.48	> 800
6.	Antiviral activity	99.9	>95
7.	Viral penetration resistance	Pass (6	Pass (6 levels)
8.	Dry microbial penetration	≤300	≤300
9.	Wet bacterial penetration Barrier index (I_B)	5.4	≥2.8
10.	Microbial cleanliness	<100	≤300
11.	Cytotoxicity	None	None

size with high porosity, strong mechanical property, malleability, and biomimetic nature of Extra Cellular Matrix (ECM), it is used in various applications such as nanocatalysis, tissue engineering scaffolds, protective clothing, filtration, optical, electronics, healthcare, defense & security and environmental engineering. Though electrospinning is a well-established and versatile technique, its utilization in industry is limited by low production rate. The production rate of conventional single needle electrospinning systems being very less, researchers have focused on multiple needle electrospinning and needle-less electrospinning mechanisms. With multiple needle electrospinning has some intrinsic problems including mutual interference of electric field and clogging of needles with polymer solution, focus is on needless electrospinning. In spite of enormous research work carried out in electrospinning, achieving an electrode with continuous jet stability, high throughput and nanofibers with precisely controlled diameter remains a challenge. Keeping the above-mentioned facts in mind, the present project proposal is aimed to develop a needless high throughput electrospinning set up. The Major advantage of the proposed set up is high productivity, versatility (applicable for both solvent as well as melt spinning), hybrid nanofibrous coating on single substrate and the set up is easy to construct.

Objectives

Objectives of the project was divided into three stages and is illustrated in next page



Work under progress and Findings

✓ Proto type machine has been successfully developed and trials have been conducted with different polymers.

✓ Defect free nanofibers with the fiber diameter of 200nm-700nm were produced.

Future work

Pilot scale machine with 500mm electrode width and commercial machine with 1.6 Meter width will be fabricated for hybrid nanofiber production.

FLUORESCENT TAGGED NANOPARTICLES – AN ALTERNATIVE TO BACTERIAL AEROSOLS IN BACTERIAL FILTRATION EFFICIENCY TEST

The main purpose of a medical face mask is to protect the patient from infective agents and additionally, to protect the wearer against the splashes of potentially contaminated liquids. Medical face masks may also be intended to be worn by patients and other persons to reduce the risk of infections through aerosols particularly in epidemic or pandemic situations. Bacterial Filtration Efficiency (BFE) instead measures the filtration efficiency of such masks using live bacteria (viable particles) that vary in size from 1 to 5 microns. This test is done as per the Indian and International standards namely IS 16288 and ASTM F 2101, EN 14683 respectively. Higher numbers of bacterial filtration efficiency percentage in this test indicates better barrier efficiency but the challenging organism used in this test is *Staphylococcus aureus* and we can get the test results in three days. In order to reduce the test duration, it is intended to use fluorescence nanoparticles, so that the test duration is reduced from 3 days to one day because there is no need of an incubation time (time required to grow colonies) and another advantage of using nanoparticles is to reduce the risk of using a pathogen.

As per the international standard specifications, facemask has to be tested for bacterial filtration efficiency, particulate filtration efficiency, differential pressure, and flammability. Among these test methods for surgical facemasks, bacterial filtration efficiency alone uses a pathogen and involves three testing days while other tests can be done in a single day and does not involve pathogens. Hence in this project, an attempt is made to derive an alternate method to assess the filtration efficiency of masks by the use of nanoparticles that mimic a BFE test which enables completion of the test in a single day.

Objectives, Materials and Methods

- Derivation of an alternative method for assessing the filtration efficiency of the mask.
- Optimization of the production parameters for nanoparticles tagged with fluorescence.
- To produce uniform-sized nanoparticles to replace bacterial aerosols
- To compare the efficiency of the developed method against the international standards of BFE.

Work done

Fluorescent tagged particles were prepared. It is being tested for bacterial filtration efficiency as per the international standard methods.

TRICOMPOSITE ANTIMICROBIAL BIOINK FOR 3D PRINTING OF HUMAN SKIN

India with the highest number of diabetes patients in the world. It requires advanced wound dressing for chronic non-healing ulcer. Out of 62 million diabetics in India, 25% is reported to develop diabetes foot ulcers (DFUs), of which 50% is expected to get infected, requiring hospitalization while 20% need amputation. DFUs contribute to approx. 80% of all non-traumatic amputations in India, annually (Ghosh and Valia, 2017). Though the available medical solutions such as skin grafting does assist healing of the ulcer, the result is not always successful and the patient in turn suffers by the wound created for skin grafting as well as by the foot ulcer. Moreover, the success rate of such skin grafting is reported to vary and is influenced by the age, glucose level, quantity and quality of cells in the skin graft, etc. Currently, dermagraft (Advanced BiohealingInc, Lojalla, CA, USA), Apligraft (Organogenesis, Canton, MA, USA), polylactin and collagen based scaffolds seeded with keratinocytes and/or fibroblasts are available to treat non-healing DFU in addition to standard therapy. These biological dressings, in spite of their efficiency in treating non-healing ulcer (NHU), find limited application in a developing country like India due to its exorbitant cost. Hence it is proposed to develop a skin construct using biopolymers to substitute imported graft, thereby benefitting the diabetes patients and health care professional to a large extent.

Objectives, Materials and Methods

a. Preparation / procurementand characterization of antimicrobial extract /nanoparticles.
b. Preparation and characterization of antimicrobial bioink.
c. Printing of scaffold using antimicrobial bioink.
d. Characterization of scaffold for its antimicrobial activity and biocompatibility.

Summary of the findings

- Antimicrobial extract was prepared and the nanoparticles were procured.
- The extract and the nanoparticles were characterized for their antimicrobial activity against multidrug resistant bacteria.
- Antimicrobial bioink was characterized for its antimicrobial activity, biocompatibility and printability.

Work under progress

- Printing of scaffold and its characterization

BIOMEDICAL APPLICATIONS OF NANOCELLULOSE EXTRACTED FROM TEXTILE WASTE

Industrial waste management is a key concern around the globe nowadays. In the textile industry, textile waste is produced in every phase of the textile manufacturing process like spinning, weaving, dyeing, finishing, and garment manufacturing. Textile waste which comes from the manufacturing of clothes and their eventual disposal in landfills is one of the fastest-growing waste streams in the world. Micro-dust is defined as too-short fiber (15-50mm) consisting of 50-80 %fiber fragments, leaf and husk fragments, and 10-25 % sand. The problems associated with micro-dust, have now assumed serious consideration since it has no resale value. Also, it pollutes the atmosphere and if not degraded properly leads to infectious diseases and the release of foul odor. However, most of them are disposed of by burning, which in turn increases the carbon dioxide level in the atmosphere which adds to global warming. Therefore, the effective utilization of the micro-dust waste to develop value-added products has gained momentum in recent years. Keeping the above mentioned facts in mind, the present research work is devoted to extract nanocellulose (NC) from the micro-dust waste collected from textile units and to use it for different biomedical applications.

Objectives

(i) To extract and characterize the NC from the micro dust by an eco friendly method
(ii) To surface modify the extracted NC (SNC) to induce hemostatic activity
(iii) To electrospun the extracted NC and SNC to produce nanofiber mat and to evaluate its wound healing efficacy.

Summary and findings

NC was successfully extracted from the microdust and the surface was modified by using oxidation process.The size of the extracted NC was found to be around 70nm -100nm. Surface functionalization was confirmed by FTIR. The surface modified nanocellulose (SNC) has the potential to clot the blood in 60 seconds. Further, NC and SNC were blended with Poly vinyl alcohol co ethylene (EVOH) to produce nanofiber mats. Surface morphology, porosity, biocompatibility of the mats were evaluated.

DEVELOPMENT OF BIOPOLYMER COATED TEXTILE SUBSTRATES FOR HEMOSTASIS

Rationale:

Uncontrolled hemorrhage is one of the major causes of death in military and civilian traumatic events. Excessive bleeding usually increases the risk of suffering hemorrhagic shock, coagulopathy, infection and multiple organ failures. Approximately 5 million people die every year around the world from accidental and non-accidental trauma, making trauma the leading cause of death in people under the age of 45. Since our body's natural response to injury is failure to control massive hemorrhage caused by major trauma or surgery, intervention of hemostatic agent is required. An ideal hemostatic agent should stop bleeding within 2 minutes of application, easy to use by the victim or medical persons, long shelf-life in extreme environmental conditions, light weight, durable, should not elicit adverse immune responses and inexpensive. In recent years, various hemostatic agents including Oxidized Regenerated Cellulose (ORC), Collagen microfiber, Hemcon, Quikclot, Combat gauze, Wound stat, Surgispon have been used. Though these products have been investigated and found to be relatively effective, none of the products meet all the requirements of an ideal hemostatic agent as mentioned above. Developing an inexpensive and more accessible hemostatic agent which can overcome the limitations of the existing is still a challenge to health care sector. Keeping the above-mentioned fact in mind, the present work is focusing on developing natural polymer, hemostatic agents coated textile substrates for profuse bleeding.

Objectives

- ✓ To prepare CMC hydrogel by using nontoxic cross linker.
- ✓ To optimize various parameters involved in hydrogel formation (cross linker concentration and time).
- ✓ To incorporate the hemostatic agent to prepare the hydrogel and to coat the hydrogel on to a textile substrate to form Hemostatic sponges.
- ✓ To evaluate the hemostatic potential of the developed substrates.

Summary and Findings

Hemostatic agent incorporated with stable hydrogel was successfully prepared and coated on the textile substrates. Coating uniformity and the incorporation of the hemostatic agent were confirmed by using FeSEM and FTIR. The developed hydrogel coated textile substrates showed higher swelling percentage and hemostatic activity.

POTENTIAL OF HERB AND ANTIBIOTIC COMBINATION TO COMBAT MULTIDRUG RESISTANT PATHOGENS

Today's microbial infections which are resistant to antibiotic drugs, have been the biggest challenges which threaten the health of societies. Despite the advancements of modern medicine, bacteria continue to pose one of the greatest risks to human health. Microbial infections are responsible for millions of death every year worldwide. The occurrence of the evolution of resistance has caused the existing antibacterial drugs to become less effective or even ineffective. MDR strains causing infection has been the global public health care challenge for more than fifty years. Herbal drugs alternatively can be used in combination with antibiotics with enhanced activity against bacterial infections. Herbal drugs may act synergistically with drugs to kill microbes, herbs may inactivate/destroy enzymes produced by bacteria to degrade antibiotics, herbal drugs may inhibit the action of efflux pumps making bacteria unable to remove antibiotics from their body, etc. The combined therapy has numerous benefits that include treatment of mixed infections, infection caused by specific causative organism, to increase antimicrobial activity, preventing the need for long term antibiotic use, thus preventing the emergence of multidrug resistant bacteria. The aim of this project is to evaluate the antimicrobial activity of some plant potentiators in combination with antibiotics against MDR strains.

Objectives, Materials and Methods

- Obtaining the Multi-drug resistant pathogens from clinical laboratories.
- Formulation of a suitable procedure for the extraction of the herbal phytochemicals.
- Investigation on the susceptibility of the MDR pathogens against a combination of herbal extracts and antibiotics.
- Deriving the minimum inhibitory concentration (MIC) for the combination of plant extracts and antibiotics.
- To substantiate the herb as potentiators using Efflux Pump Inhibition Assay.

Summary of the findings

In the present study, the sensitivity of the multi drug resistant bacteria had increased with the use of herb antibiotic combination. The study opens a window to look at the significant potential for the development of novel antimicrobial combinations of antibiotics and herbal antimicrobials. It may be an alternative method for the treatment of several diseases caused by multi-drug resistant bacteria.

TRANSFER OF TECHNOLOGY AND RESEARCH UTILISATION

SERVICES TO MILLS

The stability in the industry caused by the gradual weakening of the pandemic has also led to an improvement in the seeking of SITRA's services by the industry. As in the previous years, the range of services offered by SITRA continued to be effectively utilised. The services availed by the mills during 2021 - 22 are given in Table 39.

The recovery of mills since the onset of COVID-19 was witnessed in the stabilising of the services being utilised by the industry - both members mills as well as non-members.

Table 39 SITRA's services availed by textile mills during 2021 - 22

Type of service	Member units	Non members
Fibre, yarn and fabric testing (including PPE)	145	2920
Consultancy services	25	203
Surveys and Online studies	104	38
Training: Executives, supervisors and operatives	60	266
Accessories testing & instrument calibration	28	189

Testing of fibres, yarns and fabrics continued to the highly sought-after by mills during this year as well, with as many as 145 member mills, representing 77% of SITRA's membership, sending their samples for analyses (Table 40). Apart from the member units, as many as 2920 non-member units, also utilised this service. This included testing of samples under medical textiles as well. The total number of tests carried out during the year, including those under medical textiles, was 87220 (Table 40).

The "Rapid Conditioning System", established by SITRA some years back, to condition and prepare the pre-opened cotton fibres quickly for High Volume cotton testing ensures speedy testing of test samples, without in any way compromising on the test standards which insist on preconditioning of samples. Many mills have started using this facility to receive quick test reports for their fibre samples.

The "Costs, Operational Performance and Yarn Quality" study (CPQ) covering key areas of a mill's functioning, initiated by SITRA more than 2 decades back, has been receiving good appreciation from mills. During the year 2021-22, 103 mills availed this service.

The monthly online survey of raw material cost and yarn selling price, initiated by SITRA almost a decade back in April 2013, has been receiving good response from mills and during this year, on an average, 101 mills participated in the 12 surveys.

The training programmes offered for the managerial, supervisory and operative personnel were utilised by 60 (around 32%) of the member units and 266 non-member units also availed this service. Further details regarding the training programmes are given in the section under 'Training and development programmes and labour training'.

The consultancy services offered by different departments of SITRA for various operational and other technical/techno-economic problems were utilised by 33 (16%) member units and 117 non-member mills.

Table 40 Testing services offered by SITRA during 2021 - 22

Material	Commercial		Project and Others	
	Samples	Tests	Samples	Tests
Fibres	34439	45051	260	955
Yarns	11470	25021	245	554
Fabrics	1685	2384	51	90
Chemical testing	8444	10166	134	190
CoE tests	3862	4598	286	378
Total	59900	87220	976	2167

Some of the important assignments that were handled by SITRA during the year, are listed below.

- Technical audit of spinning mills
- Quality audit
- Performance audit
- Assessment of laboratories for compliance to ISO/IEC 1705:2005
- Compressor air flow study
- Water consumption audit and time study of soft flow dyeing machines
- Energy Audit
- Process optimisation and trouble shooting of dyeing units
- Synthesis of nanoparticles for hemostatic applications.
- Design and development of reusable coverall
- Working performance studies in weaving

Details of the individual consultancy services that were offered to the mills during the year are presented in Annexure V.

POWERLOOM SERVICE CENTRES

SITRA has set up powerloom service centres (PSCs) at various places of powerloom concentration with the objective of addressing the requirement of the decentralised powerloom sector. Since setting up of the first such center in Somanur 3 decades ago, six more centres have been established with the support of the Ministry of Textiles, Government of India. The 7 centres are located in Tamil Nadu at Karur, Komarapalayam, Palladam, Rajapalayam, Salem, Somanur and Tiruchengode. A textile service centre also functions at Chennimalai for the benefit of both handloom and powerloom units in the region, which is wholly managed by SITRA without MoT grants.

Various services have been offered by the PSCs which include interactive sessions with powerloom entrepreneurs under the TUF scheme, consultancy activities like cluster development programme, machinery buyer-seller meet, exposure visits with Association & Society members to best practices being followed at units at various places in India, entrepreneur development programmes, etc. Under the credit linked capital subsidy scheme many machinery inspections have been carried out. Weaving units are also continuously getting the service of the centers for various aspects like new project report preparation, machinery valuation, techno-economic viability study, project appraisal, textile extension study tour, etc. Many units that have installed rapier looms in recent years at places like Coimbatore, Erode, Namakkal and Salem have greatly benefitted from the various services offered by the centres.

The buyer-seller meets have also been ideal forums for manufacturers to market their wares and have also contributed to the huge volume of Indian poplin and cambric fabrics exported from these units.

The welfare schemes of the Govt. of India are given a push by the centres and one such is the Group Insurance scheme wherein workers engaged in weaving, twisting, warping and sizing units have been benefitted.

The various services rendered by these powerloom service centres are given in Table 41.

Table 41 Services rendered by the powerloom service centres (2021 - 22)

S. No.	Type of service	No. of services
1.	Consultations	27
2.	New designs development	296
3.	Yarn / cloth / chemical samples testing	34,914
4.	Training programmes (persons trained)	22 110
5.	Liaison / request visits	2,437
6.	Number of looms inspected	16,320
7.	Number of awareness programme*	27

** Seminars / TUF meetings / Talks*

Four PSCs of SITRA also have the CAD centres which function under SITRA's control without any financial assistance from the Ministry. The facility at these centres ensure creation of numerous designs quickly which can be varied or changed instantly depending upon the requirement of the customers. Computerised card punching, an intermediate technology, which will reduce the cost in both handloom and powerloom sectors, is also offered by the CAD centres. Table 42 depicts the various services of these centres that were utilised by the decentralised weaving sector.

Table 42 Services offered by the CAD centres during 2021 - 22

S.No.	Type of service	No. of services
1.	Designs development /graph printouts	402
2.	Training programmes (persons trained)	7 (54)

KNITTING DIVISION

Varied services are offered by the knitting division. Taking knitting trials and suitably advising the spinning mills to produce the required quality yarns is one such activity. Apart from this, the division also renders several other major services like testing the knitted fabric, technical consultations, identification of the causes for the defects, sample development, machinery valuation, etc., In addition to the above, the knitting department is conducting seminars focusing on the latest trends in the knitting industry and providing training at various levels. Karl Mayer warp knitting and warping machines are available at SITRA for mills/parties to develop samples as well as specific products in technical textile applications. Some of the testing carried out by the division during the year include Yarn count (72), Weight per unit area (36), Shrinkage and Spirality (16), Loop length (13), Compression Pressure Measurement (8) and Others (113).

The various services offered by the division in the year under review are given in Table 43.

Table 43 Services offered by the knitting division (2021 - 22)

S. No.	Type of service	No. of services
1	Testing	258
2	Samples knitting on FAK machine	831
3	Knitting performance of yarn	217
4	Other testing services	258
5	Fabric observation	925
6	Defect Analysis	1260
7	Consultancy	364

DEFECT ANALYSIS WING

A separate wing for "Defect Analysis" was established in the year 2016 at SITRA to enable mills to send their yarn and fabric (woven and knitted) samples for analysis of defects. Physical faults in fabrics like weave/knit faults as well as wet processing faults can be analysed. Based on the analyses carried out, mills receive reports indicating the maximum possible evidences for the root cause of the problem in the sample(s) sent for analyses.

Ø Defects analyses

The various defects that can be assessed include contamination, stain, shade variation- barre or bands in knitted and woven fabrics or patches, colouration effects, blend irregularities, stress failure, holes due to chemical, mechanical or biological damage, etc.

Ø Re-engineering and design evaluation

Mills can be guided on re-engineering and design evaluation of woven and knitted fabrics (Both warp and weft knitted fabrics).

Ø Sewability

Samples sent by mills would be evaluated for the performance of sewing threads / needles on different sewing machines that are available with SITRA at high stitches / min.

Ø Appearance / Performance of woven and knitted fabrics

Details of the running performance of the yarns during knitting and details of grey fabric appearance like thick places, thin places, long thin places, long thick places, slubs and contaminations using SITRA method as well as on a 4 Point System of inspection method.

During the year, 3,491 samples were tested for various parameters.

WEAVING CENTRE

The weaving centre at SITRA is equipped with a range of shuttleless weaving machines like Sulzer Projectile P700 HP, Picanol GTX Plus Rapier, Toyota JAT 710 Air-jet and Dornier LWV 4/E Air-jet machines. The objective is to provide the following services to the textile industry so as to make them competitive to meet the global competition.

- Preparation of project proposals, model project reports and technical feasibility study reports for weaving units.

- Entrepreneur Development Programme for new entrepreneur to start weaving units.
- Conducting weavers and maintenance training programmes on shuttleless weaving machines
- Consultancy services and liaison visits
- Product development and sample weaving
- Yarn performance study in shuttleless weaving machines
- Woven fabric defect analysis
- Management development programmes & Supervisory development programmes
- Training programme on fabric quality inspection and cloth analysis

The division was involved in offering technical consultancies to 11 mills, carrying out 16 sample weavings/product development and conducting 4 different training programmes wherein 26 entrepreneurs were trained.

TEXTILE CHEMISTRY DIVISION

SITRA's Textile Chemistry division, with nearly 4 decades of experience, has the skilled manpower and expertise in chemical processing, effluent treatment, chemical testing, consultancy, training, etc., to meet the ever increasing demands of today's industries. The laboratory accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL) and meets the requirements of ISO / IEC 17025:2017and its test reports are valid across the globe. The department's eco testing, water analysis and fibre & wet processing laboratories are equipped with State-of the-art testing equipment to carry out testing on various aspects namely,

- Textiles (Fibre, yarn and fabric)
- Textile accessories
- Technical textiles
- Medical textiles
- Bio-degradability of chemicals
- Packing materials
- Water (Drinking water, construction water, bore well water, mineral water, etc)
- Waste water / Effluent (general and as per TNPCB norms)
- Industrial water

The lab has increased the no. of parameters in the scope of accreditation by more than 67% compared to the previous cycle of accreditation which means increased range of testing of the products and improved recognition in the global market. Now, majority of the quality control tests required by buyers are included in the NABL scope of accreditation. Water testing to test drinking water, construction water, bore-well water, surface/river/ground water, water from purifiers, water from treatment plants, sewage water, effluent water, industrial water, etc. have also received NABL Accreditation in the year 2020. The lab is also equipped with facilities required to carry out the tests required for organic certifications like Eco mark in India, Global Organic Textile Standard (GOTS), Global Recycling Standard (GRS), etc. and pre-requisite testing for OekoTex certification. The lab also has facilities for carrying out testing of oils, wax rolls, packing materials, sizing ingredients, etc as per the requirements of the respective standards. The pre-requisite testing was done on fibre, yarn, fabric and garment samples for different mills/exporters to meet regulations for OEKO TEX certification.

The water lab has now facilities required to test most of the testing requirements of,

- Potable drinking water as per IS 10500: 2012
- Packaged drinking water as per IS 14543: 2016
- Water for textile industry as per IS 201:1992
- Laboratory grade water as per ISO 3696
- Packaged Natural Mineral Water as per IS 13428, etc.

Analytical Instruments

The lab is equipped with state-of the art instruments to test the harmful substances in the textile, residues in water, etc. The following are the major instruments available with the laboratory:

- High Performance Liquid Chromatography (HPLC – DAD / FLD)
- Liquid Chromatography with Mass Spectrometer Triple Quadrapole (LC-MS/MS)
- Gas Chromatography with Mass Spectrometer (GC-MS)
- High Performance Thin Layer Chromatography (HPTLC)
- Fourier Transform Infra Red Spectroscopy (FTIR)
- Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
- Gas Chromatography mass spectrometer – Triple Quadrapole (GC-MS/MS)
- Ion chromatography (IC)

Further, the lab is equipped with state-of-the art instruments viz., UV-Vis spectrometer, Atomic Absorption Spectrometer (AAS), Total Organic Carbon analyser (TOC), etc. for testing of eco parameters. The lab carries out testing of various samples as per national and international standard test methods such as AATCC, ASTM, IS, ISO, BS EN ISO, DIN, APHA, OECD, EN, etc.

The addition of state-of-the art GC-MS/MS (GC: 8890 B and MS: 7000 D) a couple of years back has helped the lab to carry out finite analysis such as Pesticides Residues in Textiles, drinking water, waste water, etc and Volatile Organic Compounds in Textile, water and food matrices, etc. Most of the eco parameters which are required for GOTS, Oeko-tex and water testing as per BIS can now be performed at SITRA.

Recent addition of Ion Chromatograph (IC)

During the year 2020-21, the lab has procured a new Ion chromatograph instrument (made in Switzerland) from Metrohm India Limited. With this, the lab is now equipped to test the entire range of anions in water and effluent samples. This instrument is particularly added to analyse the presence of Bromates and Bromides in drinking water, packaged drinking water, etc. It is heartening to note that SITRA now has the entire range of facilities to test packaged drinking water as per IS 14543 and is planning to get BIS recognition for its water testing lab as well.

The department conducts training programmes on various aspects of testing, quality control, general analysis, instrumental analysis to mill technicians, international participants, students, research scholars, etc. During the year 2021-22, the department conducted 5 different training programmes and a total of 142 persons were trained.

Staff of the department are also accredited by NABL as assessors to carry out assessment of testing laboratories as per ISO/IEC 17025 Standards. During the year, 5 assessments were carried out.

The division also offers consultancy services to processing mills on wide-ranging areas. During the year, 106 consultancies were offered to textile mills, Government bodies and chemical suppliers on various areas such as water consumption audits, technical troubleshooting, process optimization, technical feasibility study, dyeing with natural dyes, etc. Tamil nadu Pollution Control Board (TNPCB) has recognized SITRA's textile chemistry department for carrying out water consumption studies at processing units.

SITRA TEXTILE TESTING AND SERVICE CENTRE, TIRUPUR

SITRA had established a sample collection centre at Tirupur in the year 2005 with an aim to cater for the requirement of the knitting industry, textile processing units, export houses etc., in the region. SITRA has upgraded the centre into an extension service centre and has completed the process of setting up a laboratory with essential instruments for physical and chemical testing of knitted fabric / garments, water effluent, chemicals etc. For those high-end tests, samples collected at the centre are brought to SITRA and in many cases, results are reported to the customers within 24 hours, thus reducing considerably the turnaround time. During the year 2015, the centre had moved to a spacious building to accommodate more instruments. With addition of new instruments during the year, the centre is able to carry out testing for water / effluent testing, fibre identification & blend analysis, etc. The number of tests carried out by the centre during the year was 3027 which was more than 150 samples increase over the previous year (2877) tests and the number of samples transferred to SITRA was 984 which was more than 79 samples increase over the previous year (905) tests.

SITRA TEXTILE TESTING AND SERVICE CENTRE-CHENNIMALAI

SITRA has established a Testing and Service Centre at Chennimalai to address the requirements of handloom and power loom weavers and textile processing units in SIPCOT. Units in the vicinity like Perundurai, Erode, etc., also benefit from the facility. The Centre carries out testing of testing Yarn CSP, fabric analysis for design, identification of fibre, blend analysis, etc., while for the high-end tests, samples are collected at the centre and brought to SITRA and in many cases, results reported to the customers within 24 hours. The number of tests carried out by the centre during the year was 1039 samples.

CENTRE OF EXCELLENCE FOR MEDICAL TEXTILES

The Centre of Excellence for medical textiles was established at SITRA under Mini Mission I of Technology Mission on Technical Textiles (TMTT), promoted by Office of the Textile Commissioner, Ministry of Textiles, Government of India during the year 2010. The centre is actively involved in various activities such as prototype development, pilot scale production, testing and evaluation, training and seminars, standards formulation, incubation services, information resources, research and development, technical consultancy and Detailed Project Reports for new ventures. It has technical collaboration with various reputed institutes in India and abroad.

The centre has been equipped with several high-tech testing instruments for measuring various parameters for medical textile products. It has also developed many equipment on its own like the Synthetic Blood Penetration Resistance Tester (SBPRT), Bacterial Filtration Efficiency tester, compression bandage pressure measurement system and Particulate Filtration Efficiency tester. SITRA is involved in the testing of PPE since Feb, 2020 to assist the Goverment of India and the manufacturers with the selection of right fabric for the development of PPE to combat COVID 19. In the initial stages of the pandemic, SITRA was the only lab approved by Ministry of Textiles, Govt. of India for testing and certification of PPE. During the year, the Coe-Physics laboratory tested 1747 samples.

The centre's activities also include development of many medical textile products like Bifurcated vascular graft, 3D compression bandages for Lymphedema, spunlace non-woven wound dressings for malodour wounds, breathable surgical gowns treated with nano finishes, barbed - bi-directional surgical sutures, hospital bed linens with enhanced thermal properties for coma patients, hernia mesh, clinical heart patch fabrics, insole liner for diabetic shoes, etc. During the year, the centre developed wet wipes of different types, curcumin loaded wood pulp and chitosan coated gauze for different customers.

The department had prepared several DPRs as part of its activity to help new entrepreneurs in setting up of technical textile units. It was involved in the development of specifications / standards, apart from the development of prototypes. During the year, 26 such prototypes were developed. The department also offered consultancies on 3 different assignments.

Another activity of the department includes training of personnel from industry as well as fresh entrepreneurs on avenues in medical textiles. During the year, the department trained 279 persons under 11 different programmes.

Formulation of standards for various medical textile products in another mandate for the division. The division is actively in collaboration with the Bureau of Indian Standards,(BIS) in the formulation of many standards of medical textile products.

Staff of the department are also registered with the Bharathiar University, Coimbatore to guide students for their M.Phil and Ph.D. in Medical Textiles.

SITRA participated in conferences organized by various associations towards dissemination of the services offered by the division and to encourage entrepreneurs in both Medical and Technical Textiles fields.

Microbiology and Bio-tech Laboratories

Towards providing diversified services under chemical testing, SITRA had started the microbiology testing facilities as an extension of its chemical laboratory in the year 2009. This NABL accredited laboratory is now under the CoE-Meditech and is well equipped to test samples as per international test standard of ASTM, AATCC,APHA and IS and has the facility to test samples for bacterial filtration efficiency, anti-bacterial activity assessment of textile materials : parallel streak method, anti-bacterial finishes on textile materials: assessment of testing for antibacterial activity and efficacy on textile products, anti-fungal activity, assessment on textile materials: mildew and rot resistance of textile materials, anti-microbial activity assessment of carpets, determining the anti-microbial activity of immobilized anti-microbial agents under dynamic contact conditions, anti-microbial susceptibility tests, methods of sampling and microbiological examination of water, heterotrophic plate count, ETO Sterilization, resistance of materials used in protective clothing to penetration by blood-borne pathogens using Phi X174 bacteriophage penetration as a test system, textile fabrics-determination of antibacterial activity-Agar diffusion plate test and determining the activity of incorporated anti-microbial agent(s) in polymeric or hydrophobic materials. During the year 2019-20, a total of 1209 samples (including food) were tested by the microbiology laboratory , 486 samples by the biotech laboratory and 705 samples by the Polymer laboratory.

TEXTILE ACCESSORIES TESTING

SITRA offers testing service to evaluate the quality of spinning and weaving accessories / spares as per BIS standards. Moreover, training is imparted to the mill technicians on aspects like evaluation of quality characteristics, sampling procedures, etc. A total of 1,097 samples from 229 units covering various accessories like carton boxes, paper cones, rings & travellers, tubes, paper cores and kraft papers, etc., were tested during the year under review as per BIS standards. The numbers tested during the year has shown a drop compared to the previous year.

CALIBRATION AND PERFORMANCE CERTIFICATION FOR INSTRUMENTS

Calibrating testing equipment and maintaining their reports is a requirement as per quality systems like ISO and TQM. Many mills are seeking SITRA's help to get a "Calibration Certificate" for their textile testing and quality control instruments. SITRA's certificates are rated as equivalent to the national standards of the National Physical Laboratory (NPL), New Delhi. SITRA also undertakes the tasks of testing the performance of instruments developed by SITRA and manufactured by its licensees. During the year under review, as many as 270 spinning, weaving and knitting units availed the service of SITRA to receive calibration certificates for 9768 textile testing and quality control instruments.

SITRA CALIBRATION COTTONS

SITRA has been involved in the supplying calibration cottons to help mills in calibrating their High Volume Testing equipments. Currently available cottons include LL5 (Long), SL5 (Short), LM4 (Low Mic) & HM4 (High Mic). The response to the cottons continued to be good this year as well with enquiries from mills all over India, and about 99 packets being sold.

TRAINING SERVICES

1. Staff Training

During the year under review, SITRA offered 11 different training programmes which include 9 functional programmes, 1 international training and training batches under medical textiles wherein a total of 1105 persons were trained. The details of the various programmes are given in Table 44.

Table 44 SITRA's training and development programmes (2021-22)

S.no.	Name of the programme	Duration (in days)	Number of		
			A	B	C
1.	Webinar on “Maintenance Management in Modern Spinning Machinery"	1	1	89	128
2.	Webinar on "“Evaluation of Single Yarn Strength (UTR&UTJ) and Implications of Yarn Quality on Post Spinning Operations	1	1	94	126
3.	Webinar on ‘Defect Analysis in Woven & Knitted fabrics’	1	1	92	137
4.	Webinar on “Polyester- An Engineered Fiber”	1	1	65	76
5.	Webinar on AFIS Testing Programme	1	1	95	129
6.	Training Programme on Technical Training for Sales Eexecutives of M/s. Grasim Industries	1	1	1	25
7.	Training programme on ‘Healthcare Safety Practices’ for Indian Chamber of Commerce German	1	1	30	250
8.	Training programme on “Industrial Energy Auditing” for students of Tamil Nadu Agricultural University (TNAU), Cbe.				
9.	Webinar on “Classimat Faults”	1	1	60	95
10.	Training programmes in medical textiles	1-10	16	106	128
11.	ITEC International Training Programme on “Textile Testing and Quality Control”	10	1	5	11
	Total	**-**	**25**	**-**	**1105**

Note: *A - Batches* *B - Orgnisations* *C - Participants*

A. Functional Programmes

Webinars under the series "Maintenance Management in Modern Spinning Machinery"

The importance of an effective maintenance system cannot be overlooked in any textile mill because it plays such an important role in the effectiveness of manufacturing. With an aim to create awareness on modern maintenance practices to textile technicians, SITRA organised a series of Webinars under the series – Maintenance Management in Modern Spinning Machinery.

Webinar on "Evaluation of Single Yarn Strength (UTR & UTJ) and Implications of Yarn Quality on Post Spinning Operations".

SITRA organised a Webinar on "Evaluation of Single Yarn strength (UTR & UTJ) and implications of yarn quality on post spinning operations" on 31st August, 2021. The technical session was handled by Mr.Murali Ganesh, Product Support Manager, USTER Technologies, India who dealt elaborately the salient aspects technicians need to take note of in the said Uster equipment towards quality management. Positive feedbacks were received from many of 126 participants who took part in the webinar.

Webinar on "Defect analysis in Woven and Knitted Fabrics".

Understanding defects in knitted fabrics requires a critical examination of the source of defect in the fabric's characteristics right from its fibre stage. An orientation on the various defects in fabrics which include contamination, stain, shade variation-barre or bands or patches, colouration effects, blend irregularities, stress failure, holes due to chemical, mechanical or biological damage, etc., were highlighted during a webinar organised by SITRA on 18th October 2021. C lose to 140 participants attended the webinar.

Webinar on "Polyester - An Engineered Fibre "

With a view to encourage more and more spinning mills, which have conventionally been spinning cotton, to diversify in polyester and its blends, SITRA organised a Webinar on "Polyester - An Engineered Fibre " during November 2021. Seventy eight participants attended the webinar which covered topics such as manufacturing sequence of polyester fibre, properties of polyester fibre and their influence on yarn quality and some practical hints on processing of polyester fibre and its blends in short staple spinning system.

Webinar on "AFIS Testing for Quality Enhancement in Cotton Processing

The quality of yarns depends on a multiplicity of factors, and spinners face the challenge of understanding and interpreting those factors to achieve the best quality-productivity balance. Machine settings, production rates and waste levels are all dependent on key fiber parameters being measured and reported as accurately as possible. Hence, it is essential to understand the results of AFIS testing instrument for determining processing options.

Highlighting the above aspects, SITRA conducted a webinar with a technical specialist from USTER providing the necessary technical inputs. The webinar was held in December 2021 and witnessed a participation of close to 130 technicians from the industry.

Technical Training for M/s. Grasim Industries

At the request of M/s. Grasim Industries, Mumbai, SITRA conducted a series of online training sessions for their technical sales employees with an aim to sensitize them on various key issues in spinning mills that require attention and are considered crucial when they address their customers. The trouble shooting mechanisms for addressing/solving these issues were also dealt with in detail during the contact sessions. Twenty sales executives attended the online sessions held from December, 2021.

Training programme on Industrial Energy Auditing for students of Tamil Nadu Agricultural University (TNAU), Coimbatore

Under request from the Energy and Environmental Engineering department of Tamil Nadu Agricultural University (TNAU), Coimbatore, SITRA conducted a two-day training programme on Industrial Energy Auditing for the final year students of B.Tech course. Concepts of energy auditing in various industries, energy savings in primary and ancillary machinery, specific energy consumption for industries were some of the topics that were covered during the two days programme that was held on 19th and 20th March 2021.

Training programme on Healthcare Safety Practices during Covid 19 in Textile Industry for Indian Chamber of Commerce German

At the request of Textile Skill Council, New Delhi, SITRA conducted a series of online training sessions for the supervisors, fitters and operatives of textile industry with an aim to create awareness amongst the personnel working in the textile industry about COVID-19 and the precautions to be taken in the present scenario when the pandemic is on the wane. Verified Information about Covid-19, identifying sources and risks of Covid-19 infections, preventive and reactive measures against Covid-19 cases, the transmission routes, risk group under the virus infection were some of the topics discussd during the webinar. Two hundred fifty participants attended the online sessions held from February 22 - 24, 2022.

Webinar on "Classimat Faults – Analysing and interpreting test results for enhancing quality of yarns".

SITRA organised a Webinar on "Classimat Faults – Analysing and interpreting test results for enhancing quality of yarns" on 25th March, 2022. The technical session was handled by Mr.Murali Ganesh, Product Support Manager, USTER Technologies, India who dealt Understanding the new system of classification of contamination in yarn in addition to yarn fault classification, Predicting the outliers in yarn, Optimization of clearer setting using Clearing Index. Positive feedbacks were received from many of 95 participants who took part in the webinar.

B. International Training Programme

International training, a regular feature of SITRA's training activity since 1974, and more than 1690 participants from 69 countries have so far been benefited out of SITRA's expertise in textiles. The participants taking part in such programmes are sponsored by the Ministries of External Affairs and Economic Affairs, Govt. of India, under their sponsoring schemes viz., ITEC (Indian Technical and Economic Co-operation Plan).

Considering the COVID-19 pandemic, the scheme was temporally withheld last year and this year, the Government offered institutes the Online programmes under specific schemes for select countries. Accordingly, the 69th batch of SITRA's International Training Programme was an eITEC Training Programme, conducted for the officials of Mekong Gamga Cooperation (MGC) countries which includes countries like Myanmar, Cambodia, Laos, Vietnam, etc. Textile testing and quality control course was offered and 11 participants from 2 members counties namely Vietnam and Myanmar participated in the programme that was held from March 22 to April 2, 2021.

2. LABOUR TRAINING

SITRA has been regularly conducting training programmes for the textile mill workers for the past 36 years. Many mills have utilized SITRA's services in this area this year as well, with as many as 99 shop floor workers being trained during the year. All the training programmes (6 batches) were organized at mills' premises in the respective regional languages (Table XX).

Pre-employment training and retraining programmes for textile workers

Three out-station and four local mills availed SITRA's training services for their workers. Seventy operatives in spinning and autoconer departments were trained in 4 batches. The training programmes were conducted in Tamil.

Table 45 Training programmes offered for shop floor workers in 2021-22

S. no.	Type of programme	Number of		
		Mills	Batches	Partici-pants
1.	Operatives training	4	4	70
2.	NBCFDC	2	2	29
	Total	6	6	99

Training under National Backward Classes Finance Development corporation(NBCFDC)

The National Backward Classes Finance & Development Corporation (NBCFDC), under the Ministry of Social Justice and Empowerment, Government of India aims to improve and develop the economic activities for the members of Backward Classes living below the poverty line by offering assistance to institutions by leveraging their strength to enhance the skill of individuals under different job roles in various sectors. Two outstation mills availed SITRA's services to train their operatives under the scheme. Totally, 29 operatives were trained in 2 batches for a period of 38 days for the tenting jobs in spinning and autoconer. The training programmes were conducted in Tamil.

ANCILLARY SERVICES FOR TEXTILE MILL OPERATIVES

1. Online Assessment of Trainers/Assessors

The Textile Sector Skill Council (TSC) under the National Skill Development Council (NSDC) has recognized and certified training personnel of SITRA as Master Trainers eligible to conduct TOTs for trainers who train persons in textile mills for various job roles. Master trainers are also eligible to conduct assessment of the trainers. Post-COVID-19, TSC has created protocols and guidelines for carrying out online assessment of trainer on both domain and other skills. Under request from TSC, SITRA conducted online assessments for 17 trainers/assessors on the job roles of ring frame tenter, autoconer tenter, weaving operative and knitting operative.

2. Aptitude tests for selection of operatives

Since the jobs in textile mills are mostly semi-skilled, repetitive and monotonous, it is of utmost importance to select only those individuals who would have these characteristics and would desire to do these jobs. By doing so, mills can not only ensure more productivity but also greater commitment and involvement amongst the employees.

SITRA's aptitude tests are exclusively designed to meet the specific requirements of assessing the ability or aptitude of employees to do the expected activities in the various departments of a textile mill. These tests are being effectively used by around 220 member mills for the selection of employees and they are appreciative of the effectiveness of these tests. The tests measure whether an individual has the capacity or latent ability to learn and perform a given job if adequate training is provided. The use of aptitude tests is advisable for fresh applicants who have little or no experience and may be used by the mills interested in selecting employees for whom training will result in greater performance. The tests are designed to cover the operatives for preparatory, spinning and weaving departments. Most of the jobs in these departments involve I) Visual acuity eg., ability to note end breakages, ii) Two hand coordination for working at machines eg., operations like piecing and knotting, iii) Finger dexterity eg., operations like piecing and knotting iv) Eye and hand coordination for operating the state-of-the-art machines and v) quick reaction time to respond to emergencies at the work place. All these psychophysical attributes are measured by using the three tests in the SITRA Aptitude Test Kit.

Since 2005, SITRA has included another sub-test to the Kit - colour blindness. Many times, it is observed that operatives suffering from colour blindness are unable to distinguish the subtle differences in colour variations as also identify the basic colour combinations. In order to ensure the best fit of operatives with the job, it is essential to screen out persons with this defect. During the year 2021-22, 9 aptitude test kits were purchased by the textile mills.

3. Multimedia DVDs on work methods

SITRA had earlier come out with a CD, for the benefit of spinning mill operatives, providing the work methods for spinning mill operatives. Modernisation has brought in many new machinery in the industry and it was pertinent that SITRA come out with a revised version in line with the times. Hence, a new version of multimedia training materials, in DVD format, was released by SITRA some years back. Like the earlier version of VCDs released by SITRA, this DVD version also will serve as a handy tool for spinning mills to educate operatives on the right ways and means of working in spinning mills. All departments from mixing to reeling are covered. The highlight of the DVD is the option available to users to select any of the 5 languages voice-over namely, Tamil, Telugu, Malayalam, Kannada and Hindi. An English version of the DVD is also available separately.

Departments covered: Mixing, blowroom, carding, combing, drawing, speedframe, ring spinning, open end spinning, manual cone winding, auto cone winding, ring doubling, two for one twisting and reeling.

During the year 2021-22, 3 DVDs were purchased by the textile mills.

MOUs SIGNED

During the year, Memorandums of Understanding / Agreement were signed with the following organisations/ Institutions/agencies:

a) **CRODA India Company Pvt. Limited,** Mumbai, a Company engaged in the business of manufacturing, sales and marketing of a wide range of speciality chemicals and products catering to diverse industries such as personal care, health care, home care, textiles, fibres, polymer additives, polymers & coatings, agrochemicals and lubricants, for a research tie-up for development of novel bio-based micro-encapsulated robust PCMs along with bio-based cross linker systems for use in Fibre and Fabric applications.

b) **ZDHC Foundation India,** Mumbai - an international foundation with the objective of joint working to help industrial houses achieving greener solutions in industrial production.

c) **Vellore Institute of Technology (Fashion Institute of Technology-VFIT),** Chennai, - an educational institution to achieve mutual benefit through scholarly interactions, student training, co-operative research and other forms of academic collaboration.

d) Sri Krishna Arts and Science College, Coimbatore, - a NAAC accredited institution students and faculty training and internships and to develop entrepreneurs to avail the incubation facilities of SITRA's Coe-Meditech.

e) JD Institute of Fashion Technology, Bengaluru, - for conducting training programmes and workshops on a regular basis for their students.

Non-disclosure agreements (NDAs) have also been signed with the following instutitons/organisations for specific working on various projects/testing/ equipment designs.

a) GCL International Limited, - a company with experience in techniques, methods and systems in textile testing, to carry out the necessary tests / analysis on specific tests complying to ISO/IEC 17025 accreditation standard.

b) Circular Systems S.P.C., Los Angeles, California 90014, United States of America. - for carrying out dedicated research projects in the area of mechanical processing of textile material.

c) Premier Evolvics Pvt. Ltd., - a leading player in the field of quality testing, online clearing and monitoring products for the textile industry, for business alliance/relationship towards development and commercialization of a needleless electro spinning setup achieving high throughput nano-fibres.

COMMERCIAL AGREEMENT SIGNED

a) Agreement with M/s. MAK India Ltd., for commercialization of SITRA's development

SITRA has synthesised a cationising chemical and has successfully developed a single step pre-treatment cum cationisation process methodology for dyeing of cotton fabrics. The developed methodology is suitable for salt free dyeing of cotton fabrics for a wide range of shades and depths.

SITRA has granted a license to M/s. MAK India Ltd. (MIL) to use this technology for commercial manufacture of the salt-free dyeing chemical. MIL has traveled along with SITRA in this journey by establishing and standardizing the enrichment process that would be suitable for commercial production by fabricating a pilot vessel and carrying out pilot industrial trials and providing necessary support towards incorporating various modifications as and when necessary. The licence would be valid for a period of 10 years of which the initial 5 year would be an exclusive one and the next 5 year will be non-exclusive.

COMMUNICATION

Felicitation by BIS

Bureau of Indian Standards, Coimbatore Branch Office felicitated SITRA with a memento during the "BIS 75th Foundation Day celebrations" held at SITRA on 06.01.22 for SITRA's contribution to the quality standards of products and its active participation on various sectional committees of BIS for drafting the standards.

Library

SITRA library has a large collection of books and periodicals and has been a happy hunting ground for book enthusiasts who include technicians from member mills as well as students from colleges and universities. With easing of restrictions, many visitors visited the library during the year for utilising its rich collection of books and journals. One hundred and eighty three publications have been added to the existing book bank and SITRA right now has 25486 active publications on various technical subjects, apart from textiles and management. SITRA has also been receiving 104 Journals on varied aspects on textiles and allied disciplines.

Visitors

Dignitaries from various walks and industries, from India and abroad visited SITRA during the year. This included, among others, Mr. V.Senthil Balaji, Hon'ble Minister for Electricity & Prohibition and Excise, Govt. of Tamil Nadu. Mr. R.Gandhi, Hon'ble Minister of Handlooms and Textiles, Govt. of Tamil Nadu, Mr Mahesh, IAS, Secretary, Govt. of Puducherry, Dr. M. Vallalar, IAS, Commissioner, Commisionerate of Textile, Govt. of Tamil Nadu, Mr. T.P. Rajesh IAS, Commissioner, Commisionerate of Handlooms, Govt. of Tamil Nadu, Dr. Rossitza Krueger, Project Head, DeutscheGesellschaft für Internationale Zusammenarbeit (GIZ), Mr. Jayakumar, General Manager, Cotton Corporation of India. The details of visitors are given in Annexure II.

Publications

SITRA brought out during the year, 18 publications which included 12 online reports, 5 focus and 1 Etech letter (SITRA news publication) (Annexure III).

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SITRA scientists published 8 research papers in technical journals and presented 12 papers in conferences and seminars (Annexure VI).

ANNEXURE I

THE STAFF

DIRECTOR
Dr.Prakash Vasudevan, M.Sc. (Textile Engineering), Ph.D (Leeds)

SPINNING

Deputy Director and Head of Division:
(Addl. incharge of Weaving & Knitting division)
Mr.D.Jayaraman, M.Tech.

Senior Scientific Officers:
Mr. R.Soundararajan, B.E.
Mr. S.Balamurugan, M.Tech.

Scientific Officer:
Mr. V.Vijayajothi, M.Tech.

WEAVING AND KNITTING

Senior Scientific Officer:
Mr. S.Sounderraj, M.Tech.

Scientific Officer:
Ms.C.Vanithamani, B.Tech.

LIAISON AND CONSULTATION

Principal Scientific Officer & Head of Division:
Mr. J.Sreenivasan, M.Tech.

Senior Scientific Officers:
Mr. N.K.Nagarajan, M.Tech., MBA.
Mr. P.Subash, M.Tech.
Mr. N.Ravichandran, M.Tech.

Scientific Officers:
Mr. G.Santhana Krishnan, M.Tech.
Mr. Sambhaji Shivaji Chavai, M.Tech.

TEXTILE PHYSICS

Head-in-Charge of Division:
Dr. V.Thanabal, M.Tech., Ph.D.

Principal Scientific Officer:
Dr. R.Pasupathy, M.Tech., M.B.A., A.M.I.E, Ph.D

Scientific Officers:
Mr. M.Kumaran, M.Tech.
Mr. G.Selvaraj, B.Sc.

TEXTILE CHEMISTRY

Principal Scientific Officer & Head of Division :
(Addl. incharge of CoE- Medical Textiles division)
Mr. S.Sivakumar, M.Tech., D.T.P

Scientific Officer:
Ms. S.Kowsalya, M.Tech.

TEXTILE ENGINEERING & INSTRUMENTATION

Principal Scientific Officer & Head of Division:
Mr. M.Muthukumaran, B.E.

Senior Scientific Officers:
Mr. M.Muthuvelan, B.E., PGDBA., M.B.A., M.Phil (Mgmt).
Mr. N.Vasanthakumar, B.Sc., A.T.I.

Scientific Officers:
Mr. G.Ilango, DME.
Mr. S.Chandirasoodan, M.Tech.

TRAINING

Scientific Officer:
Mr. K.V.Vaidhyanathan, B.Tech.

CENTRE OF EXCELLENCE FOR MEDICAL TEXTILES

Senior Scientific Officers:
Dr. E.Santhini, M.Sc., M.Phil., Ph.D.
Dr. R.Radhai, M.Sc., M.Phil., Ph.D.

Scientific Officers:
Mr. D.Veerasubramanian, M.Tech.
Dr. L. Amalorpava Mary, Ph.D.

BUSINESS DEVELOPMENT MANAGER
Mr. R.Indrajith. M.Tech.

ADMINISTRATION

Principal Scientific Officer & Administrative Officer :
(Addl. incharge of Training division)
Dr. K.Sajjan Rao, M.Sc., Ph.D.

Principal Officer & Head - Finance and Cost Accounts:
Ms. K.Vadivazhaki, B.Com., A.C.A.

Principal Scientific Officer - IT:
Ms. R.Suganthi, M.Sc., M.C.A., M.C.S.D., Net 07, OCA & OCP.

Senior Officer - Stores:
Mr. M.Babu, B.E.

Officer & Secretary to Director:
Ms. N.Saradha Jayalakshmi, M.Sc., M.B.A.

Officer - Accounts:
Ms. K.Prabha, M.Com., PGDCA

ANNEXURE I (Contd..)

THE STAFF

Total staff strength as on 31st March 2022		*Powerloom service centres (Govt. sponsored)*	
Officers	*:....................32*	*Officers*	*:.......................3*
Scientific/Technical assistants	*:....................29*	*Scientific/Technical assistants*	*:....................25*
Administrative staff	*:....................11*	*Skilled/Semi skilled*	*:.......................2*
Skilled/Semi skilled & maintenance services	*:....................11*	***Total..:***	***...................30***
Technical assistants on contract	*: 3*		
Total	***:....................86***		

ANNEXURE II VISITORS

Mr. V.Senthil Balaji, Hon'ble Minister for Electricity & Prohibition and Excise, Govt. of Tamil Nadu.

Mr. R.Gandhi, Hon'ble Minister of Handlooms and Textiles, Govt. of Tamil Nadu.

Mr Mahesh, IAS, Secretary, Govt. of Puducherry.

Dr. M. Vallalar, IAS, Commissioner, Commisionerate of Textile, Govt. of Tamil Nadu.

T.P. Rajesh IAS, Commissioner, Commisionerate of Handlooms, Govt. of Tamil Nadu.

Dr. Rossitza Krueger, Project Head, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

Mr. Shivaprasad Shetty, Consultant for the ELS cotton study, Cotton Corporation of India.

Mr. Jayakumar, General Manager, Cotton Corporation of India.

ANNEXURE III

SITRA PUBLICATIONS DURING 2021 - 2022

1. Focus:

How can a participant mill analyse and monitor its techno - commercial performance with the help of SITRA monthly online surevey? - *J.Sreenivasan, N.K.Nagarajan & Sambaji.*

An energy efficiency evaluation study on the IE3 motors - *M.Muthuvelan & B.Harishankar.*

Comparison of first phase of cotton fiber seasons 2022 and 2021 - *V.Thanabal & P.Suganthi.*

Effect of sliver compactness on winding clearer cuts in 100% polyester yarns - a case study - *D.Jayaraman & N.K.Nagarajan.*

Effect of apron surface modification in ring spinning on yarn quality - *D.Jayaraman & S.Balamurugan.*

2. SITRA eTech letter:

1 Issue

3. Other Publications:

Annual report 2020-21

12 Online Technical Reports

ANNEXURE IV

SITRA DEVELOPMENTS

1. Machinery

Storage positive feed system for knitting machines
High speed reeling machine
High production cutting machine
High speed blending draw frame single delivery machine
"Spinfan" system for fancy yarns
SITRA - VOLKA ring frame
"Enerspin" drive system for ring spinning & doubling frames
SITRA "miniSPIN" - Miniature spinning plant for test runs
SITRA ENERCONER - Energy efficient drive control system for automatic cone winding machines
Energy and production information system for ring spinning frames "SITRA EnerInfosys"
Ener TFO
SITRA CIM
SITRA Microcontrol
Weavability Tester
High performance jute flyer spinning frame - SITRA Jute Flyspin
Micro controller based energy saving & information system for air compressors used in textile mills - SITRA PCRA ENERCOMP
SITRA PCRA Climocontrol

2. Fibre and Yarn Testing Instruments

Fibre bundle strength tester
Trash separator
Electronic twist tester
Electronic lea strength tester
Semi - Automatic twist tester
Motorised twist tester
Nep counter
SITRA motorised multi-board yarn appearance winder
Electronic load indicator for conventional lea strength tester (ELCONLEA)
SITRA rapid sample conditioner
SITRA- ABRATEST - Yarn abrasion resistance tester
Single yarn strength tester
Schnidt model yarn tension meter
Roving strength tester

3. Others

SITRAlised energy saving spindle tapes
SANTIMIT
Weft feeler mechanism to stop the loom for pirn changing
Energy efficient fans - SITRA excel fan
Infra colour dyeing machine
Shore hardness tester
Cyberscan bench top PH meter
Fabric stiffness tester
Drapemeter
Fabric thickness tester
MRG crimp tester
Fabric elongation tester
Fabric roughness/friction tester
UV Photocatalytic reactor
Self anchor suturing machine
CSP system and fabric strength tester
Fabric winding mechanism for powerlooms
Arterial prosthetic graft
SITRA pneuma kit
SITRA motor relay tester
Lab fabric dyeing machine
Soxhlet extraction mantles
Microprocessor based electronic balance
Launderometer
Crease recovery tester
Perspirometer
SITRA Enercool
Fabric compression tester
SITRA's Bacterial Filtration Efficiency Tester
SITRA's blood penetration resistance tester
SITRA's viral penetration resistance tester

SITRA may be contacted for the addresses of the Licensees

ANNEXURE V

LIST OF STUDIES / SERVICES RENDERED TO MILLS

Mills utilised SITRA's services and expertise for a wide range of their requirements. Some of the studies/services attended during 2021-22 were:

Water consumption audits (90), Sample Weaving – Product Development (16), Ad-hoc Technical problem solving (16), Annual cousultancy for compressors (10), Process optimization and trouble shooting at Tirupur dyeing units (10), Energy Audits (8), Assessment of laboratories for NABL accreditation purpose (5), Compressor Study (4), Machine audit (4), Quality study (3), Humidification Plant study (3), Technical consultancy (4), Productivity improvement study (2), Warping breaks reduction study (2).

Apart from the above, the following studies were also undertaken:

Comparative study between dyeing & sizing of yarn in hank form viz-a-vis in cheese form, Study on Water consumption, conservation and productivity, Development of undercast pads with improved frictional properties, Power study, Electrical system study, Consultancy for BNPM, Development of dry comber flow measurement, Efflux Pump Inhibitory Analysis In Multidrug Pathogens, Synthesis of nanoparticles for hemostatic applications, Design and development of reusable coverall, Compressed Air Audit, Work assignment study, Air consumption on weaving machines, Technology transfer of the outcome of a research project, Humidification Plant study, Air Audit, Trouble shooting of ETP operation, Process optimization in dyeing etc.

ANNEXURE VI

PAPERS PUBLISHED IN JOURNALS AND PAPERS PRESENTED IN CONFERENCES

PAPERS PUBLISHED IN JOURNALS

J.Sreenivasan, N.K.Nagarajan and Sambhaji S Chavai	"Production pattern and product diversification in spinning mills"	Vol. 15, Issue 2, March - April 2021
V Thanabal	An investigation on the coir spinning process	Spinning Textiles, Volume 16 (6), Nov - Dec, 2021.
Santhini. et.al	Development and characterization of triclosan coated heat and moisture exchange filter for ventilation therapy	IJFTR, 47(1): 87-95, 2022. IF: 0.65.
	Development and characterization of gelatin-based herbal hydrogels for managing infected wounds	IJFTR, 47(1): 59-69, 2022. IF: 0.65.
	Development and assessment of biologically compatible anterior cruciate ligament using braided ultra-high molecular weight polyethylene	Journal of Biomedical Materials Research. 2021;1–13. IF: 3.368.
Sivakumar, Subramaniam; Veerasubramanian, Doraisamy; Sripriya, Gopalakrishnan; Muthuukumar, R Rajendran	Application of comfort index for evaluating tactile and thermo-physiological comfort properties of surgical gowns	IJFTR, Vol.47(1), PP: 146 – 153.
E.Santhini, R. Parthasarathy, M.Shalini, S.Dhivya, L. Amalorpava Mary, V. Vijaya Padma	Bio inspired growth factor loaded self assembling peptide nano hydrogel for chronic wound healing	International Journal of Biological Macromolecules, 197(1): 77-87, 2022. IF: 6.953
N. Sudhapriya. et.al	Ecofriendly dyeing of textiles with natural dyes extracted from commercial food processing waste materials.	Journal of natural fibers (Published online 19th February 2022)

PAPERS PRESENTED IN SEMINARS /CONFERENCES

S. Sivakumar	A study on the salt-free dyeing of textile materials and the physio-chemcial properties of the resultant effluent	International Conference on Sustainable Water (ICSW) 2022 organised by KPR Institute of Engineering and Technology, Coimbatore on 22 & 23 .3. 2022.
S. Sivakumar	Introduction to Medical Textiles	Awareness workshop on medical textiles organised by SIDRI, Govt of Tamilnadu on 14th July, 2021
N. Sudhapriya	World Nano Congress on Advanced Science & Technology – WNCST 2021	Centre for Nanotechnology Research, Vellore Institute of Technology (VIT), Vellore.

ANNEXURE VI (Contd.)

PAPERS PUBLISHED IN JOURNALS AND PAPERS PRESENTED IN CONFERENCES

PAPERS PRESENTED IN SEMINARS /CONFERENCES

D.Jayaraman	Yarn contraction for 100% polyester yarn	SITRA's 33rd Technological Conference, 29th December 2021
	Studies on combing efficiency in modern combers	
	Effect of apron surface modification in ring frame on yarn quality	
J.Sreenivasan	Commercial performance of spinning mills during the last decade	
M.Muthuvelan	Mapping the energy use in spinning mills	
V.Vijayajothi	A study on effect of modified cots and top roller load on yarn quality in ring frame	
N.Sudhapriya	Antioxidant Cosmetotextiles: Durable Nano-encapsulated Vitamin E Finishes on Textile Fabrics	
Muthukumar	Development of comfort index paradigm for textile structures	

LECTURES DELIVERED

M.Muthukumaran	"Industrial Energy Audit & Energy Conservation Measures"	AICTE Training & Learning Academy sponsored FDP for Agricultural Engineering College & Research Institute, TNAU, Coimbatore held on 29.10.2021.
	"Conservation of Energy"	Training programme for "Promotion of Energy Audit and conservation of Energy" (PEACE) scheme on 11.03.2022 organized by District Industries Centre (DIC), Coimbatore.
R.Radhai	Innovation in Medical Textiles – Scope and Opportunities	Post Graduate & Research Department of Microbiology in association with Institution Innovation Council, Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai on 9th Dec, 2021.

ANNEXURE VII

MEMBERS OF COUNCIL OF ADMINISTRATION

Elected members

1. Mr.Sanjay Jayavarthanavelu, Chairman & MD, Lakshmi Machine Works Ltd., Coimbatore (Chairman)
2. Mr.E.Sathyanarayana, Managing Director, Sree Sathyanarayana Spinning Mills Ltd., Tanuku (Vice-Chairman)
3. Mr. S.Dinakaran, Joint Managing Director, Sambandam Spinning Mills Ltd., Salem.
4. Mr. Durai Palanisamy, Managing Director, Shri Cheran Synthetic India Ltd., Pallipalayam
5. Mr. Gopinath Bala, Managing Director, Sri Venkatalakshmi Spinners (P) Ltd., Udumalpet.
6. Mr. Prashanth Chandran, Managing Director, Precot Ltd., Coimbatore.
7. Dr. K.V.Srinivasan, Managing Director, Premier Mills Pvt. Ltd., Coimbatore.
8. Dr. S.K. Sundararaman, Executive Director, Siva Texyarn Ltd., Coimbatore
9.. Mr. Thyagu Valliappa, Executive Director, Sree Valliappa Textiles, Ltd, Bangaluru
10. Mr. J.Thulasidharan, Managing Director, The Rajaratna Mills Ltd., Coimbatore.

Permanent Members

11. The Managing Director, National Textile Corporation, Southern Regional Office, Coimbatore.
12. The President, Madura Coats Pvt. Limited, Bengaluru.
13. The Wholetime Director, The Lakshmi Mills Co. Ltd., Coimbatore.

Directors of the Textile Research Associations of India

14. Dr. T.V.Sreekumar, Director, The Bombay Textile Research Association, Mumbai.
15. Dr. Arindam Basu, Director General, Northern India Textile Research Association, Ghaziabad.
16. Shri Pragnesh Shah, Director, The Ahmedabad Textile Industry's Research Association, Ahmedabad.
17. Dr. Prakash Vasudevan, Director, The South India Textile Research Association, Coimbatore.

Scientific / Technical Members

18. Dr. A.N.Desai, Retd. Director, The Bombay Textile Research Association, Mumbai.
19. Dr. J.Srinivasan, Professor and Head, Dept. of Fashion Technology, Kumaraguru College of Technology, Coimbatore.

Representative of the Government of Tamil Nadu

20. The Commissioner of Handlooms and Textiles, Govt. of Tamil Nadu, Chennai.
21. The Commissioner of Textiles, Govt. of Tamil Nadu, Chennai.

Representative of the Tamil Nadu Handloom Weavers' Co-operative Society Ltd., Chennai.

22. The Managing Director, The Tamil Nadu Handloom Weavers' Co-operative Society Ltd., Chennai.

Representative of the Southern India Mills' Association

23. Chairman, The Southern India Mills' Association, Coimbatore.

Special invitees

1. The Chairman, Confederation of Indian Textile Industry, New Delhi.
2. The Director, Central Leather Research Institute, Chennai (CSIR representative).
3. The President, Dyers Association of Tirupur.
4. Mr. Raja M. Shanmugam, President, Tirupur Exporters Association, Tirupur.
5. Mr. Suresh Manoharan, Executive Director, Best Color Solutions (I) Pvt. Ltd., Tirupur.
6. Sri Harish Kapil Kumar, Technical Director, Sri Kumaran Mills Pvt. Ltd.
7. Mr. Rohit Rajendran, Executive Director, Premier Spg&WvgMills Ltd.

ANNEXURE VIII

MEMBERS OF SUB-COMMITTEES

(A) Finance and machinery sub-committee

Shri Sanjay Jayavarthanavelu	Lakshmi Machine Works Ltd., Coimbatore.
Shri E.Sathyanarayana	Sree Satyanarayana Spinning Mills Ltd, Tanuku.
Dr. K.V.Srinivasan	Premier Mills Pvt. Ltd., Coimbatore.
Dr. Prakash Vasudevan	Director, SITRA, Coimbatore.

(B) Staff and awards sub-committee

Shri Sanjay Jayavarthanavelu	Lakshmi Machine Works Ltd., Coimbatore.
Dr. K.V.Srinivasan	Premier Mills Pvt. Ltd., Coimbatore.
Shri J.Thulasidaran	The Rajaratna Mills Ltd., Palani.
Dr. Prakash Vasudevan	Director, SITRA, Coimbatore

ANNEXURE IX

MEMBERS OF RESEARCH ADVISORY COMMITTEE

Members

1. Shri Sanjay Jayavarthanavelu, Chairman cum Managing Director, Lakshmi Machine Works Limited, Coimbatore (Chairman)
2. Shri E.Sathyanarayana, Managing Director, Sathyanarayna Spinning Mills, Tnuku.
3. Dr. Prakash Vasudevan, SITRA, Coimbatore (Director)
4. Dr. T.V.Sreekumar, Director, The Bombay Textile Research Association, Mumbai.
5. Dr. Arindam Basu, Director General, Northern India Textile Research Association, Ghaziabad.
6. Dr. Pragnesh Shah, Director, The Ahmedabad Textile Industry's Research Association, Ahmedabad.
7. Shri. S. Dinakaran, Joint Managing Director, Sambandam Spinning Mills Ltd., Salem.
8. Shri. Gopinath Bala, Technical Director, Sri Venkatalakshmi Spinners Pvt. Ltd., Udumalpet.
9. Shri J.Harish Chandravel, Executive Director, Ram Narayana Mills Limited, Coimbatore.
10. Shri. M.Muthupalaniappa, Vice President (Technical), representing Mr. T.Kannan, Thiagarajar Mills Ltd., Madurai.
11. Shri.Prashanth Chandran, Joint Managing Director, Precot Ltd, Coimbatore.
12. Dr. K.V.Srinivasan, Premier Mills Private Limited, Coimbatore.
13. The Chairman & Managing Director, National Textile Corporation Ltd., New Delhi.
14. The Chairman, The Southern India Mills Association, Coimbatore.
15. The Commissioner of Handlooms and Textiles, Govt. of Tamil Nadu, Chennai.
16. The Director, Central Leather Research Institute, Chennai.

Invitees

1. Dr.R..Adivarekar, Professor and Head-Department of Fibres and Textile Processing Technology, Institute of Chemical Technology (formerly U.D.C.T), Mumbai.
2. Dr.J.Angayarkanni, Head, Dept, of Microbiology,Bharathiar University, Coimbatore
3. Shri K.Balasanthanam, MD, Kongoor Textile Process, Tirupur.
4. Mr. B.M.Bhoopathi, CEO, DAT, Tirupur.
5. Mr.N.Deivasigamani, Techical Committee member, DAT, Tirupur
6. Mr.C.B.Bhaskaran, MD, Angerialayam CETP,
7. Dr.V.Chandrasekaran, Vice-President (Technical), Adwaith Textiles Limited, Coimbatore.

3. Dr. V.R.Giridev, Professor and Head, Dept. of Textile Technology, AC College of Technology, Anna University, Chennai.

9. Shri Joga Rao, President (Operations), Sree Satyanarayana Spinning Mills (P) Ltd., Tanuku
10. Shri Kanthimathinathan, President, Rajapalayam mills Limited, Rajapalayam.
11. Mr.T.Kumar, Executive Director, Precot Ltd., Coimbatore-18.
12. Dr.N.N. Mahapathra, Business Head(Dyes), Shree PushkarCehmicals & Fertilizers Ltd., Mumbai.
13. Dr.R.Rajendran, Associate Professor, Dept. of Microbiology, PSG College of Arts & Science, Coimbatore.
14. Dr.M.Senthil Kumar, Associate Professor, PSG College of Technology, Coimbatore
15. Shri S.Shyamsundar, Head - Technical, Precot Limited
16. Mr.K.Sudhakaran, M.D., Confident Dyeing, Tirupur.
17. Dr.J.Srinivasan, Professor, Dept of Fashion Technology, Kumaraguru College of Technology, Coimbatore.
18. Dr.A.Shanmugavasan, MD, KOB Medical Textiles, Palladam
19. Dr.V.Subramaniam, Director, Dept. of Textile Technology, Jaya Engineering College, Chennai.
20. Dr.Uma Krishnan, Associate Dean, SASTRA, School of humanities and sciences .
21. Dr. V.Vijaya Padma, Professor, Department of Biotechnology, Bharathiar University, Coimbatore.

ANNEXURE X

COMMITTEES IN WHICH SITRA STAFF REPRESENTED

Chairman, Hosiery Sectional Committee, TXD10, Bureau of Indian Standards, New Delhi.

Chairman, Medical Textiles Committee TxD36, Bureau of Indian Standards, New Delhi.

Member, Advisory Committee for AIC NIFT TEA incubation centre for Textiles and Apparels.

Co-opted member of Governing Committee, NIFT - TEA.

Member, Sub-committee for manpower planning for the textile engineering industry constituted by India ITME Society, Mumbai..

Member, TX 0I & TX 05 Committees, Bureau of Indian Standards, New Delhi.

Expert member, Board of Studies (BoS) in Textile Technology, Bannari Amman Institute of Technology (Autonomous), Sathyamangalam.

Member, Board of Studies in Textile Technology, PSG College of Technology, Coimbatore.

Member, Council of National Jute Board, Kolkata.

Member, All India Powerloom Board, Ministry of Textiles, Government of India, New Delhi.

Member, Advisory Committee & member, Staff Selection Board, Textile Technology Department, Kumaraguru College of Technology, Coimbatore.

Member, Council of Administration and member of Advisory committee for strategic planning and Co-Chairman of technical Committee, SIMA Cotton Development & Research Association.

Member, Cotton Advisory Board, Ministry of Textiles, Govt. of India.

Member, Cotton Development & Research Association, New Delhi.

Member, Board of Examiners of Indian Institute of Handloom Technology, Salem.

Member, CII, Southern Region, Textile Sub-committee.

Member, Confederation of Indian Industries (CII), Coimbatore zone.

Supervisor, Ph.D & M.Phil. Programmes (Textile Technology), Anna University, Chennai.

Member, Board of Studies (BoS) in Textile Technology (TT) Karpagam University, Coimbatore.

Member, Board of Governors, Sardar Vallabhbhai Patel International School of Textiles and Management, Coimbatore.

Member, Cotton Selection/Purchase Committee, KVIC, Chitradurga.

Member, Technical Sectoral Expert Committee of Textile Sector under PAT Scheme of Bureau of Energy Efficiency (BEE), New Delhi.

Member Board of Studies (Bos) in Psychology, Bharathiar University, Coimbatore; PSG College of Arts & Science, Coimbatore; Govt. Arts College, Coimbatore; Sri Krishna College of Arts & Science

Member, Board of Studies (BoS) in Textile Technology and Textile Chemistry departments of Anna University, Chennai.

Member, Textiles Speciality Chemicals and Dyestuffs Sectional Committee, TXD 07, Bureau of Indian Standards, New Delhi.

Member of the Syllabus Sub Committee for Faculty of technology – Master of technology (Textile Chemistry) for Anna University, Chennai.

DST SEED Project advisory committee for Kumaraguru College of Technology, Coimbatore

Technical committee for tender and purchase of Yarn yeing and stenter machinery for Tamilnadu Co-operative Textile Processing Mils, Erode

Technical committee for establishing a new processing unit at Nadukani Kannur by Department of Handlooms and Textiles, Kerala.

Member, Board of Studies in Biochemistry and Bio technology departments, Bharatiar University, Coimbatore.

Member Board of Studies in Department of Biochemistry, Dr. NGP College of Arts and Science, Coimbatore.

ANNEXURE XI

SITRA MEMBER MILLS

Full Members

1 Acsen Tex P. Ltd.
2 Adwaith Textiles Limited
3 Amaravathi Spinning Mills
4 Amarjothi Spg. Mills Ltd.
5 Anna Co-op. Spg. Mills Ltd.
6 Annamalaiar Mills Private Ltd.
7 B K S Textiles Private Limited
8 B R T Spinnerrs Limited
9 Best Cotton Mills (P) Ltd
10 Cardwell Spinning Mills Limited
11 Chenniappa Yarn Spinners (P) Ltd
12 Chida Spg. Mills (P) Ltd.
13 Coimbatore Polytex Private Ltd.
14 D B V Cotton Mills (P) Ltd.
15 Eastman Spinning Mills (P) Ltd.
16 Emperor Textiles (P) Ltd
17 Ennar Spinning Mills (P) Ltd
18 G T N Industries Ltd
19 Ganesh Spintex pvt ltd
20 Gopalakrishna Textile Mills Pvt. Ltd
21 Harshini Textiles Ltd
22 Hindustan Cotton Spinning Mills
23 Jai Sakthi Mills
24 Jay Textiles -Unit II (Super Sales India Ltd.)
25 Jayalakshmi Textiles Private Limited
26 Jayavarma Textiles (P) Ltd - Unit 2
27 JVS Exports
28 K K P Spinning Mills Ltd
29 Kallam Spinning Mills Ltd
30 Kaveri Yarns and Fabrics Ltd.
31 Kayaar Exports Private Limited
32 Kesharinandan knit fabrics P Ltd
33 L S Mills Ltd.
34 Lakshmi Machine Works Ltd.
35 Madura Coats Private Limited (4)
36 MAG Solvics (P) Ltd
37 Mallur Siddeswara Spg. Mills Pvt. Ltd.
38 Maris Spinners Ltd.
39 Marudhamalai Sri Dhandapani Spinning Mills
40 Narasu's Spg. Mills
41 National Textile Corporation (TN&P) Ltd. (16)
42 Prabath Spinner India (P) Ltd
43 Prachidhi Spinners Pvt. Ltd,
44 Precot Ltd. (6)
45 Premier Mills Private Ltd.
46 Premier Spg. & Wvg. Mills Ltd.
47 S C M Textile Spinners
48 S P Spinning Mills Ltd.
49 S.A. Aanandan Spinning Mills (P) Ltd
50 S.P Apparels - Spinning Unit
51 Sahana Textiles
52 Salona Cotspin Limited
53 Sangeeth Textiles Ltd.
54 Saravana Polythreads (P) Ltd
55 Sarmangal Synthetics Limited
56 Saurer Textiles Solution-CBE
57 Selvaraja Mills Pvt. Ltd.
58 Senthilkumar Textile Mills Private Limited, Erode
59 Seyadu Spinning mills
60 Shanmugappriya Textiles Ltd.
61 Shiva Mills Limited
62 Shiva Tex Yarn Limited-Coimbatore
63 Shri Cheran Synthetics India Ltd
64 Shri Govindaraja Mills Ltd,- B Unit
65 Shri Ramalinga Mills Ltd.
66 Shri Santhosh Meenakshi Textiles Private Limited
67 Shri Siddhivinayaga Tex India Pvt Ltd -Dindigul
68 Soundararaja Mills Ltd.
69 Southern Spinners and Processors Limited
70 Sowmiya Textiles Private Ltd
71 Sree Ayyanar Spg. & Wvg. Mills Ltd - Unit I (2)
72 Sree Narasimha Textiles (P) Ltd.
73 Sree Satyanarayana Spg. Mills Ltd.
74 SRG Apparels
75 Sri Gomathy Mills Private Limited
76 Sri Kannapiran Mills Ltd.
77 Sri Kannattal Mills P. Ltd.
78 Sri Karthikeya Spg. & Wvg. Mills Ltd.
79 Sri Kumaraguru Mills Ltd
80 Sri Kumaran Mills Limited.
81 Sri Lakshmi Saraswathi Textiles (Arni) Ltd. (2)
82 Sri Mahasakthi Mills Ltd
83 Sri Muni Pachaiyappan Textiles (P) Ltd.
84 Sri Nachammai Cotton Mills Ltd.
85 Sri Ramakrishna Mills (CBE) Ltd.
86 Sri Ranga Textiles (P) Ltd.
87 Sri Saravana Mills Pvt Ltd-Dindigul
88 Sri Selvabathi Mills Pvt Ltd-Coimbatore
89 Sri Shanmugavel Mills Pvt. Ltd.
90 Sri Sharadhambika Spintex P.Ltd
91 Sri Sivajothi Spg Mills P Ltd
92 Sri Sundhareswara Mills-Pollachi
93 Sri Varadaraja Textiles Ltd.
94 Sri Vasudeva Textiles Limited Unit II
95 Sri Venkatalakshmi Spinners (P)Ltd.
96 Sri Vignesh Yarns (P) Limited
97 Super Spg. Mills Ltd.
98 T T Limited-(Unit Tirupathi Spinning Mills)
99 The Banhatti Co-op. Spg. Mills Ltd.
100 The Bharathi Co-op. Spg. Mills Ltd.
101 The Kadri Mills (CBE) Ltd. (8)
102 The Lakshmi Mills Co.Ltd. (3)
103 The Palani Andavar Mills Ltd.
104 The Puducherry Co-op. Spg. Mills Ltd.
105 The Pudukkottai District Co-op Spg Mills Ltd
106 The Rajaratna Mills Ltd. (2)
107 The Ramanathapuram District Co-operative Spg Mills
108 The Southern Textile Ltd
109 The Tamilnadu Handloom Weavers' Co-op.Society Ltd
110 The Tamilnadu Textile Corporation Ltd
111 Tirupur Textiles Private Ltd. (3)
112 Veejay Lakshmi Engineering Works Ltd
113 Veejay Syntex Pvt. Ltd.
114 Vijay Velavan Spinning Mills (P) Ltd
115 Vishnu Lakshmi Mills (P) Ltd
116 Viswabharathi Textiles Ltd.

Associate Members

1 Br.Sheshrao Wankhede Shetkari Sahakari Soot Girni Ltd
2 Eurotex Industries & Exports Ltd.
3 Ginni International Limited
4 Gloster Jute Mills Ltd
5 Gujarat Heavy Chemicals Ltd. Unit : Sree Meenakshi Mills (2)
6 Indocount Industies -Kolhapur
7 JP MODATEX LLP-SILVASSA

Note: Figures in brackets indicate number of units

ANNEXURE XI (Condt..)

SITRA MEMBER MILLS

8 Kangwal Textile Company Limited,
9 Loyal Textile Mills Ltd.
10 Maharaja Shree Umaid Mlls Ltd
11 Nagammal Mills Ltd.
12 Nagreeka Exports Ltd.
13 P B M Polytex Ltd. (2)
14 Pee Vee Textiles Limited
15 Pratibha Syntex Limited
16 Rajapalayam Mills Ltd.
17 Reliance Industries Ltd.
18 Rieter India (P) Ltd
19 RSB Cottex
20 Sambandam Spg Mills Ltd.
21 Shetkari Sahakari Soot Girni Ltd.
22 Siddhi Industries Limited
23 Sree Valliappa Textiles Ltd.
24 Sri Jayajothi & Co Ltd
25 Sudiva Spinners Private Limited
26 Sumicot Limited
27 The Suguna Mills Pvt. Ltd.
28 Thiagarajar Mills Ltd. (2)
29 Vardhaman Yarns & Threads Limited
30 Vippy Spinpro Ltd
31 Voltas Ltd.

TSC Members

1 A.R.Appasamy
2 Aarthi -A1 Traders
3 Anishkumar Spinning Mill
4 Anithaa Weaving Mills Pvt Ltd
5 Dhanalakshme Textiles
6 Eluru Jute Mill
7 Golden Fashions India Pvt Ltd
8 J.G. Hosiery Pvt Ltd
9 Jacquard Fabrics India Pvt Ltd
10 Jayanthi Textile Products
11 K G Denim Limted
12 Kanakalakshmi Mills Pvt Ltd
13 Kikani Exports Pvt Ltd
14 Lakshmi Spinners
15 Medisafe Global Solutions-Bangalore
16 Muthu Spinning Mills Private Limited
17 Nilgiri Textiles Pvt Ltd
18 Prathishta Weaving and Knitting Co Ltd.
19 Precission Fabrics India Private Limited
20 Ramakrishnaa Processing Mills
21 Renaissance Incorporations
22 Rimtex Engineering Pvt Ltd
23 S.N.N Textiles Private Limited
24 Shree M.T.K Textiles Private Limtied
25 Siruvani Yarns
26 SMBS Cotton Spinners
27 Sre Venkatachalapathy Textiles
28 Sreedhara Textiles Private Ltd
29 Sri Amman Textiles
30 Sri Choleeswara Spg Mills
31 Sri Jagannatha Spinners Pvt Ltd
32 Sri Jothi Textiles
33 Sri Murugan Textiles
34 Sri Palani Andavar Textiles
35 Stalwart Sourcing Solutions
36 Techno Electronics and Instruments
37 V.Thangavel And Sons Private Limited
38 Veejay Terry Products Ltd
39 Veen Farm and Field Agro Products Pvt Ltd

FINANCIAL STATEMENTS
AS ON
31st MARCH 2022

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

COIMBATORE - 641 014

Independent Auditor's Report

To
The Members of The South India Textile Research Association

Report on the Audit of the Financial Statements

Opinion

1. We have audited the accompanying financial statements of The South India Textile Research Association ("the Association"), which comprise the Balance Sheet as at March 31, 2022 and the Statement of Income and Expenditure for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

2. In our opinion and to the best of our information and according to the explanations given to us the aforesaid financial statements give a true and fair view of the financial position of the Association as at March 31, 2022 in conformity with the accounting principles generally accepted in India:

   (a) in the case of the Balance Sheet, of the state of affairs of the Association as at March 31, 2022; and

   (b) in the case of the Income and Expenditure Account, of the Excess of Income over Expenditure for the year ended on that date.

Basis for Opinion

3. We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those standards are further described in the Auditor's responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Association in accordance with the Code of Ethics issued by ICAI and we have fulfilled our other ethical responsibilities in accordance with the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Responsibilities of Management and Those Charged with Governance for the Financial Statements

4. Management of the Association is responsible for the preparation of these financial statements that give a true and fair view of the state of affairs and results of operations of the Association in accordance with the accounting principles generally accepted in India. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

5. In preparing the financial statements, management is responsible for assessing the Association's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Association or to cease operations, or has no realistic alternative but to do so.

6. Those charged with governance are responsible for overseeing the Association's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

7. Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists.

Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

8. As part of an audit in accordance with SAs, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

   (a) Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.

   (b) Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Association's internal control.

   (c) Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.

   (d) Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Association's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report.

9. We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

Report on Other Requirements

10. Further, we report that:

   (a) We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of our audit.

   (b) In our opinion, proper books of account have been kept by the Association so far as appears from our examination of those books.

   (c) The Balance Sheet and Statement of Income and Expenditure dealt with by this Report are in agreement with the books of account.

For P N Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration Number: 003328S

sd/-
Pon Arul Paraneedharan
Partner
Membership Number: 212860
UDIN: 22212860AQTNGD5340

Coimbatore
August 29, 2022

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
BALANCE SHEET AS AT 31ST MARCH 2022

Amount in "Rs."

Particulars	Schedule No.	2021-22	2020-21
LIABILITIES			
Corpus/Capital Fund	1	2,92,45,968	2,87,92,408
Capital Grant from Ministry	2	39,78,15,615	39,76,85,194
Reserves and Surplus	3	77,59,84,215	73,88,24,938
Current Liabilities and Provisions	4	3,39,38,659	2,88,52,024
TOTAL (A)		**1,23,69,84,457**	**1,19,41,54,564**
ASSETS			
Fixed Assets - Net Block	5 & 6	56,98,93,760	57,35,60,466
Investments	7	59,70,85,035	52,74,94,341
Sponsored Projects - Grant Receivable	8	1,72,52,165	1,63,01,493
Current Assets, loans, Advances etc	9	5,27,53,497	7,67,98,264
TOTAL (B)		**1,23,69,84,457**	**1,19,41,54,564**

"Vide our report of even date"

For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration No:003328S
Sd/- Pon Arul Paraneedharan
Partner
M.No:212860

Place : Coimbatore
Date : 29-08-2022

Sd/- Sanjay Jayavarthanavelu (Chairman)
Sd/- E Sathyanarayana (Vice Chairman)
Sd/- Dr. Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2022

Amount in "Rs."

Particulars	Schedule No.	2021-22	2020-21
INCOME			
Income from Services	10	8,67,42,555	15,50,17,034
Membership/Ministry Contribution	11	2,65,40,338	1,78,98,843
Sponsored Projects - Overhead Recoveries	12	10,87,661	5,37,481
Interest Income	13	77,24,736	54,63,075
Other Income	14	94,73,584	82,92,911
Changes in Inventories	15	(9,64,804)	1,52,150
TOTAL (A)		**13,06,04,070**	**18,73,61,494**
EXPENDITURE			
Establishment Expenses	16	9,28,02,321	8,50,30,949
Administrative Expenses	17	1,74,40,886	1,68,33,307
Repairs and Maintenance	18	78,02,232	91,91,284
Stores Consumed	19	83,11,045	55,25,118
Finance Charges	20	30,583	26,977
Sponsored Projects - SITRA Contribution	21	8,763	15,02,230
Depreciation	22	99,67,685	97,81,602
TOTAL (B)		**13,63,63,516**	**12,78,91,467**
Balance being excess of Income over Expenditure for the year		(57,59,446)	5,94,70,027
Appropriated from Research & Development Reserve		64,664	1,28,084
Appropriated from Infrastructure Dev. & Maintenance Reserve		13,79,158	15,00,619
Appropriated from Staff Benefit Reserve (Payment of Terminal Benefits & Exgratia)		50,97,327	33,50,083
Paid from Sitra Employee Gratuity Scheme		29,08,470	26,20,487
Appropriated from Depreciation Reserve		12,55,398	20,98,479
Balance Surplus		**49,45,571**	**6,91,67,779**
Transfer to Staff Benefit Reserve		22,00,000	65,00,000
Transfer to Research & Development Reserve		-	1,50,00,000
Transfer to Depreciation Reserve Fund		-	2,40,00,000
Transfer to Infrastructure Devel. & Maintenance Reserve		24,00,000	1,50,00,000
Transfer to General Reserve		**3,45,571**	**86,67,779**

"Vide our report of even date"

For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration No:003328S
Sd/- Pon Arul Paraneedharan
Partner
M.No:212860

Place : Coimbatore
Date : 29-08-2022

Sd/- Sanjay Jayavarthanavelu (Chairman)
Sd/- E Sathyanarayana (Vice Chairman)
Sd/- Dr. Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year ended 31.03.2022

Amount in "Rs."

Schedules	2021-22	2020-21
Sch - 1		
Corpus/Capital Fund		
Contribution from Member Mills	2,87,92,408	2,85,78,448
Add: Received during the year	4,53,560	2,13,960
Total	**2,92,45,968**	**2,87,92,408**
Sch - 2		
Capital Grant from Ministry		
Cotton Textile Fund Committee	12,53,791	12,53,791
Council of Scientific and Industrial Research	22,69,513	22,69,513
MOT/DST/DRDO/Others	12,04,33,926	12,03,09,015
Ministry of Textiles - Sponsored CAD Centre	48,82,780	48,82,780
Ministry of Textiles - Centre of Excellence - Meditech	21,01,85,777	21,01,80,267
MOT/Office of the Textile Commissioner - PLSC	5,87,89,828	5,87,89,828
Total	**39,78,15,615**	**39,76,85,194**
Sch - 3		
Reserves & Surplus		
General Reserve	24,20,66,394	27,39,66,455
Asset Stabilisation Reserve	5,23,45,679	1,91,64,676
Research and Development Reserve	13,49,49,817	12,72,09,344
Infrastructure Development and Maintenance Reserve	9,16,75,680	8,47,65,309
Staff Benefit Reserve - SITRA	4,06,84,553	3,95,90,313
Staff Benefit Reserve - PLSC	76,87,012	65,85,816
Depreciation Reserve Invt.Interest	19,75,75,859	17,98,97,361
PLSC/CAD Centre Reserve	89,99,221	76,45,664
Total	**77,59,84,215**	**73,88,24,938**
Sch - 4		
Current Liabilities & Provisions		
Current Liabilities		
Unspent grant		
Unspent grant - SITRA	57,10,453	19,96,538
Unspent grant - COE	-	1,42,179
Advance from Debtors	90,90,534	1,10,09,843
Creditors for Purchases & Capital Goods	9,67,942	15,56,436
Creditors for Expenses	15,05,930	39,41,505
Total (A)	**1,72,74,859**	**1,86,46,501**
Provisions		
Provision for Expenses -SITRA	1,30,36,654	47,97,737
Provision for Expenses - COE	15,93,748	43,54,786
Provision for Expenses - PLSC	20,33,398	10,53,000
Total (B)	**1,66,63,800**	**1,02,05,523**
Total (A + B)	**3,39,38,659**	**2,88,52,024**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year ended 31.03.2022

Amount in "Rs."

Schedules	2021-22	2020-21
Fixed Assets		
Sch - 5		
Gross Assets		
Lands	7,83,712	7,83,712
Building - SITRA	3,87,24,226	3,87,24,225
Building - COE	8,51,76,526	8,51,76,526
Plant and Machinery	18,71,43,249	18,23,98,614
Furniture & Fittings	80,70,032	80,70,032
Computer & Accessories	1,33,31,291	1,23,76,100
Library	34,96,878	33,38,826
Vehicle	15,89,106	15,69,606
Total	**33,83,15,020**	**33,24,37,641**
Sch - 6		
Fixed Assets under Sponsored Projects		
The South India Textile Research Association	7,40,24,073	7,38,99,162
Integrated Skill Development Scheme	2,42,91,138	2,42,91,138
Centre of Excellence - Meditech	22,73,07,341	22,73,07,341
Powerloom Service Centre	5,98,55,104	5,96,40,203
Total	**38,54,77,656**	**38,51,37,844**
Total Gross Block	**72,37,92,676**	**71,75,75,485**
Accumulated Depreciation		
Depreciation Reserve - Building	2,10,33,029	1,93,11,879
Depreciation Reserve - Computer & Accessories	40,84,724	37,17,151
Depreciation Reserve - Furniture And Fixtures	37,55,184	35,21,442
Depreciation Reserve - Plant & Machinery	11,54,99,721	10,88,41,140
Depreciation Reserve - Vehicles	7,08,019	6,42,011
Depreciation Reserve - Library	17,70,443	14,97,077
Depreciation Reserve - ISDS	70,47,796	64,84,319
Total	**15,38,98,916**	**14,40,15,019**
Net Block	**56,98,93,760**	**57,35,60,466**
Sch - 7		
Investments		
Depreciation Reserve Investment - SITRA	24,98,51,474	23,78,39,625
Research and Development Reserve Investment	10,34,92,825	9,84,28,011
Infrastructure Development & Maintenance Reserve Investment	7,94,39,571	7,28,66,789
Staff Benefit Reserve Investment - SITRA	2,58,52,102	1,93,33,536
Staff Benefit Reserve Investment - PLSC	32,08,272	30,63,160
General Reserve Investment - SITRA	12,19,22,946	8,83,15,607
General Reserve Investment - PLSC	1,33,17,845	76,47,613
Total	**59,70,85,035**	**52,74,94,341**
Sch -8		
Sponsored Projects - Grant Receivable		
As per Schedule	1,72,52,165	1,63,01,493
Total	**1,72,52,165**	**1,63,01,493**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year ended 31.03.2022

Amount in "Rs."

Schedules	2021-22	2020-21
Sch - 9		
Current Assets, loans, Advances etc		
Sundry Debtors		
Sundry Debtors	51,57,673	78,04,305
Total	**51,57,673**	**78,04,305**
Inventories		
Raw Materials	6,17,089	14,40,480
Finished Goods	2,12,017	11,76,821
Total	**8,29,106**	**26,17,301**
Cash & Bank Balances		
Cash on Hand	65,177	90,768
Cash at Bank	19,63,878	43,01,243
Cash at Bank Sponsored Project	68,32,057	30,49,820
Total	**88,61,112**	**74,41,831**
Loans & Advances		
Deposits - Others	46,42,314	38,57,660
Interest Receivable	1,71,26,019	3,26,45,197
Advances for Purchases and Others	33,13,797	83,62,080
Prepaid Expenses	16,49,001	13,26,140
Balance with revenue authorities (GST)	21,75,468	28,36,649
Tax Deducted at Source	89,99,007	99,07,100
Total	**3,79,05,606**	**5,89,34,827**
Grand Total	**5,27,53,497**	**7,67,98,264**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Income and Expenditure Account for the year ended 31.03.2022

Amount in "Rs"

Schedules	2021-22	2020-21
Sch - 10		
Income from Services		
Testing and Investigation Fee	8,42,95,469	15,37,50,003
HRD Education Receipts	21,76,664	10,29,961
Publication Income	2,70,422	2,37,070
Total	**8,67,42,555**	**15,50,17,034**
Sch - 11		
Membership/Ministry Contribution		
From Ministry of Textiles	2,00,00,000	1,20,00,000
From Membership Contribution	62,19,913	56,00,063
From Technical Service Card Membership Fees	3,20,425	2,98,780
Total	**2,65,40,338**	**1,78,98,843**
Sch - 12		
Sponsored Projects - Overhead Recoveries	10,87,661	5,37,481
Total	**10,87,661**	**5,37,481**
Sch - 13		
Interest Income		
Interest Income from Investment and Advances	77,24,736	54,63,075
Total	**77,24,736**	**54,63,075**
Sch - 14		
Other Income		
Rent Receipts	12,15,719	11,34,483
Miscellaneous Income	55,82,576	34,09,358
Allocation of Expenses incurred by SITRA for PLSC	8,60,438	8,85,841
Allocation of Expenses incurred by SITRA for COE	18,14,851	28,63,229
Total	**94,73,584**	**82,92,911**
Sch - 15		
Changes in Inventories		
Closing Stock of Finished Goods	2,12,017	11,76,821
Less:Opening Stock of Finished Goods	11,76,821	10,24,671
Total	**(9,64,804)**	**1,52,150**
Sch - 16		
Establishment Expenses		
Salary and Other Allowances	8,38,59,139	7,74,07,291
Payment towards Terminal benefits	39,05,797	33,02,782
Sitra Contributory PF and other Funds	62,18,608	53,03,344
	9,39,83,544	8,60,13,417
Less: a) Allocated to Ministry Sponsored Projects	11,47,842	8,19,503
b) Allocatd to Internal Project from Research & Development Reserve	33,381	68,500
c) Allocated to SAMARTH	-	94,465
Total	**9,28,02,321**	**8,50,30,949**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Income and Expenditure Account for the year ended 31.03.2022

Amount in "Rs"

Schedules	2021-22	2020-21
Sch - 17		
Administrative Expenses		
Travelling Expenses	11,07,003	12,40,871
Printing & Stationery	6,75,011	7,88,275
Publication Expenses	1,14,741	2,76,927
Postage, Telegrams and Telephone Charges	13,62,852	12,53,756
Journals and Periodicals	6,00,854	7,36,750
Electricity Charges	63,23,353	57,94,895
Less: Solar Energy Consumption	(10,22,596)	(9,20,393)
Insurance	7,71,634	7,47,909
Rent, Rates and Taxes	7,13,006	9,52,745
Advertisement Charges	80,385	1,44,827
Training Course Expenses	1,09,658	80,916
Conferences, Seminars and Meetings	1,16,838	54,242
Professional Charges	16,94,744	15,71,554
Office Expenses	6,96,856	5,18,149
Testing expenses	14,36,487	3,03,111
Inhouse Project Others	8,45,209	1,28,084
Allocation of Expenses incurred by SITRA for COE	18,14,851	28,63,229
Provision for Doubtful Debts & Bad Debts Written off	-	2,97,460
Total	**1,74,40,886**	**1,68,33,307**
Sch - 18		
Repairs & Maintenance		
Maintenance of Motor Cars and Vehicles	35,783	45,713
Maintenance of Machinery	57,81,191	64,71,703
Maintenance of Building & Staff Quarters	17,03,111	26,47,379
Maintenance of Furniture and Office Equipments	2,82,147	26,489
Total	**78,02,232**	**91,91,284**
Sch - 19		
Opening Stock of Rawmaterials	14,40,480	9,41,643
Add: Purchase of Consumables	59,72,007	58,27,371
Less: Closing Stock of Rawmaterials	6,17,089	14,40,480
Project Expenses	15,15,647	1,96,584
Total	**83,11,045**	**55,25,118**
Sch - 20		
Finance Charges		
Bank Charges and Commission	30,583	26,977
Total	**30,583**	**26,977**
Sch - 21		
Sponsored Projects - SITRA Contribution	8,763	15,02,230
Total	**8,763**	**15,02,230**

Place : Coimbatore

Date : 29-08-2022

"Vide our report of even date"

For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration No:003328S

Sd/- Pon Arul Paraneedharan
Partner
M.No:212860

Sd/- Sanjay Jayavarthanavelu (Chairman)
Sd/- E Sathyanarayana (Vice Chairman)
Sd/- Dr. Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2021 - 2022

Schedule 22

DEPRECIATION FOR THE YEAR 2021- 2022

Amount in "Rs."

S.No.	Name of the Asset	COST				DEPRECIATION				WDV	
		Value as on 01.04.2021	Additions During 2021-2022	Deletion During 2021-22	Value as on 31.03.2022	Depreciation As on 01.04.2021	Deletion During 2021-22	Depreciation for the year 2021-22	Depreciation As on 31.03.2022	Closing W.D.V As on 31.03.2022	W.D.V As on 31.03.2021
1	Land	7,83,712	-	-	7,83,712	-	-	-	-	7,83,712	7,83,712
2	**Library**										
	Library	32,72,182	1,45,045	-	34,17,227	14,91,302	-	2,69,914	17,61,216	50,68,670	51,93,539
	ISDS - Library	34,12,659	-	-	34,12,659						
3	**Building**										
	Building	**3,65,92,715**	-	-	3,65,92,715	1,12,84,395	-	4,28,877	1,17,13,272	2,58,82,620	2,63,11,497
	Building WIP	-	-	-	-						
	ISDS - Building Renovation	10,03,177	-	-	10,03,177						
	Auditorium	18,93,967	-	-	18,93,967	2,41,016	-	26,943	2,67,959	16,26,008	16,52,951
	Dining Shed WIP	-	-	-	-						-
	Staff Quarters	2,37,543	-	-	2,37,543	1,20,797	-	1,903	1,22,700	1,14,843	1,16,746
	COE Building	8,51,76,526	-	-	8,51,76,526	76,65,671	-	12,63,427	89,29,098	7,62,47,428	7,75,10,855
4	**Furniture**										
	Furniture - Sitra	50,96,331	-	-	50,96,331	29,35,290	-	1,53,998	30,89,288	44,56,720	46,10,718
	ISDS - Furniture	24,49,677	-	-	24,49,677						
	Sitra Furniture at PLSC	27,685	-	-	27,685	18,708	-	300	19,008	8,677	8,977
	COE Furniture & Fixtures	26,17,044	-	-	26,17,044	4,99,997	-	70,709	5,70,706	20,46,338	21,17,047
5	**Machinery**										
	Machinery	15,90,57,243	50,00,490	3,86,354	16,36,71,379	8,56,58,370	83,789	59,60,669	9,15,35,250	11,26,90,805	11,39,53,549
	Machinery WIP	-	-	-							
	Sponsored Projects - Assets	4,05,54,676	-	-	4,05,54,676						
	Machinery-SISPA	3,17,252	12,380		3,29,632	1822	-	16,441	18,263	3,11,369	3,15,430
	Sitra Machinery at PLSC	4,33,949	-	-	4,33,949	2,60,532	-	8,931	2,69,463	1,64,486	1,73,417
	Depreciation Reversal - PLSC	-	-	-	-	1,91,56,113	-	-	1,91,56,113	(1,91,56,113)	(1,91,56,113)
	CoE Building Electrical Equipments	1,31,46,233	-	-	1,31,46,233	26,26,746	-	3,51,351	29,78,097	1,01,68,136	1,05,19,487
6	**ISDS Assets**										
	ISDS - Machinery	1,34,70,102	-	-	1,34,70,102	50,00,122	-	4,36,204	54,36,326	80,33,776	84,69,980
	ISDS-PSC-Machinery	36,00,001	-	-	36,00,001	13,61,572	-	1,15,279	14,76,851	21,23,150	22,38,429
	ISDS - Machinery Phase II	3,55,523	-	-	3,55,523	1,22,625	-	11,994	1,34,619	2,20,904	2,32,898
7	**Computer**										
	Computer - Sitra	97,14,081	6,61,071	-	1,03,75,152	37,15,724	-	3,50,937	40,66,661	63,08,491	59,98,357
	ERP WIP	23,37,570	3,45,300	51,180	26,31,690	-	-	-	-	26,31,690	23,37,570
	Computer-SISPA	3,24,449	-		3,24,449	1,427	-	16,636	18,063	3,06,386	3,23,022
8	**Vehicles**										
	Motor Cars	13,78,119	19,500	-	13,97,619	5,85,049	-	56,497	6,41,546	7,56,073	7,93,070
	Motor Cycles & Scooters	1,91,487	-	-	1,91,487	56,962	-	9,511	66,473	1,25,014	1,34,526

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2021 - 2022

DEPRECIATION FOR THE YEAR 2021 - 2022

Schedule 22

Amount in "Rs."

S.No.	Name of the Asset	COST				DEPRECIATION				WDV	
		Value as on 01.04.2021	Additions During 2021-2022	Deletion During 2021-22	Value as on 31.03.2022	Depreciation As on 01.04.2021	Deletion During 2021-22	Depreciation for the year 2021-22	Depreciation As on 31.03.2022	Closing W.D.V As on 31.03.2022	W.D.V As on 31.03.2021
9	**COE Assets**										
	CoE Equipment Electrical General	16,25,755	1,18,122	-	17,43,877	2,55,844	-	47,749	3,03,593	14,40,284	13,69,911
	Machinery	78,18,179	-	-	78,18,179	8,81,714	-	3,57,228	12,38,942	65,79,237	69,36,465
	Furniture & Fixtures	3,28,972	-	-	3,28,972	67,447	-	8,735	76,182	2,52,790	2,61,525
	Library	66,645	13,006	-	79,651	5,775	-	3,452	9,227	70,424	60,869
	Sponsored Projects -Assets										
10	UNDP Jute Project Machinery	1,32,01,739	-	-	1,32,01,739	-	-	-	-	1,32,01,739	1,32,01,739
11	Assets under Sponsored Projects - SITRA	2,01,42,747	1,24,911	-	2,02,67,658	-	-	-	-	2,02,67,658	2,01,42,747
12	Assets under Sponsored Projects - COE	22,73,07,341	-	-	22,73,07,341	-	-	-	-	22,73,07,341	22,73,07,341
13	Assets under Sponsored Projects - PLSC	5,96,40,204	2,14,900	-	5,98,55,104	-	-	-	-	5,98,55,104	5,96,40,204
	Total	**71,75,75,485**	**66,54,725**	**4,37,534**	**72,37,92,676**	**14,40,15,020**	**83,789**	**99,67,685**	**15,38,98,916**	**56,98,93,760**	**57,35,60,466**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2021 -2022

Schedule 8 & 21

Financial Status of Sponsored Projects : 01/04/2021 - 31/03/2022

Amount in "Rs."

Sl. No	Name of Sponsored Project	Opening Balance 2021-22		Receipts			Expenditure as at 31.03.2022 Recurring & Non Recurring			Total Expenditure as at 31/03/2022	Refunded/ Transfer	Balance as at 31/03/2022			
												IA / SITRA		MOT	
		Industry	Ministry	MOT/IA Contribution	Revenue/ Appropriation	Total Receipts	Industry	SITRA	MOT			Unspent	Due	Unspent	Due
1	**Ministry of Textile Sponsored Research Projects**														
a	Development of Special wound care Dressing made of PVA/ chitosan	-	(36,205)	-	-	(36,205)	-	-	-	-		-	-	-	(36,205)
b	Design and Fabrication of an Instrument to Evaluate Resistance of Medical Face Masks to Penetration by High Velocity Stream of Blood from a Punctured Wound	-	(13,97,446)	-	1,018	(13,96,428)	-	-	-	-	7,341	-	-	-	(14,03,769)
c	Design and fabrication of an instrument to evaluate the characteristics of fluid handling capacity of wound care dressings	-	(15,00,511)	-	395	(15,00,116)	-	-	-	-	1,591	-	-	-	(15,01,707)
d	Development of a Heat and Moisture Exchange Filter	-	(14,42,792)	-	960	(14,41,832)	-	-	-	-	614	-	-	-	(14,42,446)
e	Development of Indigeneous Viral Barrier Fabric		(11,55,002)	-	789	(11,54,213)	-	-	-	-	3,038	-	-	-	(11,57,251)
f	Development of a Anterior Cruiate Ligaments (ACL) using Textile Matrices	-	(14,60,206)	-	1,010	(14,59,196)	-	-	-	-	2,804	-	-	-	(14,62,000)
g	Development of Nanoparticle based transdermal patches of selected cardiovascular drugs	-	(12,97,943)	-	934	(12,97,009)	-	-	-	-	7,240	-	-	-	(13,04,249)
h	Polyester Vascular Graft Implant-Process Optimization and Production Scale up	-	(18,20,338)	-	3,568	(18,16,770)	-	-	-	-	5,842	-	-	-	(18,22,612)
i	Development of Eco Clothing by greener reduction process of Natural Indigo Dye	-	(5,18,240)	-	4	(5,18,236)	-	-	-	-	35	-	-	-	(5,18,271)
j	Design and Development of facile high throughput needleless electro spinning set-up	-	-	58,00,000	1,11,244	59,11,244	-	-	19,14,387	19,14,387	-	-	-	39,96,857	-
		-	**(1,06,28,683)**	**58,00,000**	**1,19,922**	**(47,08,761)**	**-**	**-**	**19,14,387**	**19,14,387**	**28,505**	**-**	**-**	**39,96,857**	**(1,06,48,510)**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2021 -2022

Financial Status of Sponsored Projects : 01/04/2021 - 31/03/2022

Schedule 8 & 21 Amount in "Rs."

Sl.No.	Name of Sponsored Project	Opening Balance 2021-2022	Receipts		Expenditure Recurring		Capital -	Total Expenditure As At 31/03/2022	Refunded/ Transfer to Reserve	Balance as at 31/03/2022			
			Funds Received during the year	Revenue / Appropriation	IA	MOT	MOT			IA / SITRA Unspent	IA / SITRA Due	MOT Unspent	MOT Due
1	Ministry sponsored powerloom service centre receipts	-	1,14,00,000	-	87,87,977	1,14,00,000	-	2,01,87,977	-	-	-	-	-
2	Samarth - Scheme for capacity building in Textile Sector - Phase I	(9,64,226)	-	-	-	2,84,830	-	2,84,830	-	-	-	-	(12,49,056)
	Samarth - Scheme for capacity building in Textile Sector - Phase II	-	13,44,960	-	-	5,56,850	-	5,56,850	-	-		7,88,110	-
3	**CoE Projects**							-					
i	Office of the Textile Commissioner							-					
	a) Development of Collagen coated hernia	(2,40,000)	-	-	-	-	-	-	-	-	-	-	(2,40,000)
	b) Development of Moppings pads using non woven & Woven structure	(2,40,000)	-	-	-	-	-	-	-	-	-	-	(2,40,000)
ii	Design & Development of an instrument to assess the puncture resistance of surgical material by using sharp edged puncture	(7,63,093)	-	458	-	-	-	-	-	-	-	-	(7,62,635)
iii	Development of nanofibrous membrane for wound healing by controlled release of Indian Honey & Curcumin	(1,99,810)	-	78	-	-	-	-	843	-	-	-	(2,00,575)
iv	Dev of Total Comfort Index paradigm for textile structures	(29,78,907)	-	293	6,481	6,11,880	-	6,18,361	9,444	-	-	-	(35,99,938)
v	Development of Leukodepletion Filter - Sree Chitra Tirunal Institute	1,07,326	-	1,410	805	1,07,931	-	1,08,736	-	-	-	-	-
vi	Medical Textile products identified by INMAS for wound healing and radio protective equipment based on textiles - DRDO	34,853		3,951	-	-	-	-	38,804	-	-	-	-

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
Schedules to Balance Sheet for the year 2021-2022
Financial Status of Sponsored Projects : 01/04/2021 - 31/03/2022

Schedule 8 & 21

Amount in "Rs."

Sl.No.	Name of Sponsored Project	Opening Balance 2021-2022	Receipts		Expenditure Recurring		Capital -	Total Expenditure As At 31/03/2022	Refunded/ Transfer to Reserve	Balance as at 31/03/2022			
			Funds Received during the year	Revenue / Appropriation	IA	MOT	MOT			IA / SITRA Unspent	IA / SITRA Due	MOT Unspent	MOT Due
4	**SITRA DST & Inhouse Project**												
i	Durable Non-Fluorinated Functional Textiles using Fumed Silica Sols	(2,45,890)	-	340	-		-	-	-	-	-	-	(2,45,550)
ii	High Productivity hand operated charkhas development - KVIC	4,83,765	-	12,536	-	1,31,040	-	1,31,040	-	3,65,261	-	-	-
iii	Dev of Cost effective and better fastness dyeing methods for production of Kovai Kora Cotton sarees - Dept of Handlooms &	(40,884)	-	276	-	-	-	-	-	-	-	-	(40,608)
iv	Antioxidant Cosmetoextiles durable non encapsulated Vitamin E Finishes on Textile fabrics and its controlled release study	9,03,359	6,00,000	16,959	-	9,43,134	-	9,43,134	16,959	-	-	5,60,225	
v	Dev of breathable resuable and oxo-biodegradable coverall using biocidal Polyester	6,09,414	5,17,035	16,038	1,477	10,42,869	1,24,911	11,69,257	-	-	-	-	(25,293)
		(35,34,093)	1,38,61,995	52,339	87,96,740	1,50,78,534	1,24,911	2,40,00,185	66,050	3,65,261	-	13,48,335	(66,03,655)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Centre of Excellence Medical Textiles
Balance Sheet as at 31st March 2022

Annexure

Amount in "Rs."

31.03.2021	LIABILITIES		31.03.2022	31.03.2021	ASSETS		31.03.2022
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
	CAPITAL GRANT				**FIXED ASSETS**		
21,38,45,815	Contribution from Ministry-Opening	21,40,95,257		22,73,07,341	- Ministry Grant		22,73,07,341
2,43,932	Additions during the year		21,40,95,257	98,39,550	- Others	99,70,678	
				12,10,779	Less: Accumulated Depreciation	16,27,943	83,42,735
-	Interest Opening balance	-		23,59,36,112			
33,106	Add: Earned during the year	11,242			**CURRENT ASSETS**		
33,106		11,242		30,29,241	Sundry Debtors		5,27,045
9,644	Less: Refund to MoT	5,087		15,100	Loans & Advances		15,100
23,462	Transfer to Various Grant	6,155	-	28,00,179	Advances for Purchases & others		3,60,328
-				9,52,050	Bank Balance		1,65,158
				74,09,013	Branch and Divisions		22,73,665
1,42,179	Unspent Grant		-	12,15,547	Balance with revenue authorities		9,20,582
				2,12,270	Prepaid Expenses		2,49,916
	RESERVES & SURPLUS			30,24,426	Investment		1,35,35,115
1,84,47,618	Depreciation Reserve	1,84,47,618					
1,54,71,256	Appropriation for Capital Expenditure	1,55,89,378			**Inventories**		
7,79,409	Staff Benefit Reserve	19,34,985		14,40,480	Raw Material		6,17,089
80,00,372	Research & Development Reserve	80,00,372		11,76,821	Finished Goods		2,12,017
95,43,937	Infrastructure Devl. & Maint Reserve	115,43,937					
7,80,377	General Reserve	16,75,595	5,71,91,885		**SITRA - RESERVE ADJUSTMENT**		
				1,46,67,699	Asset Stabilization Reserve	1,47,85,821	
	CURRENT LIABILITIES:			4,98,200	SITRA Group Gratuity Scheme	4,98,200	1,52,84,021
45,01,465	Advance from Customers	17,82,017					
25,77,597	Creditors for Purchases & Capital Goods	1,88,903		44,21,810	Sponsored Projects - Grant Receivable		50,43,148
2,49,200	Creditors for Expenses	1,450					
22,15,791	Provision for Expenses	15,93,748	35,66,118				
27,67,98,948	**Total**		**27,48,53,260**	**27,67,98,948**	**Total**		**27,48,53,260**

"Vide our report of even date"

For P.N.Raghavendra Rao & Co
Chartered Accountant
Firm Registeration No:003328S
Sd/- Pon Arul Paraneedharan
Partner
M.No:212860

Place : Coimbatore
Date : 29/08/2022

Sd/- Sanjay Jayavarthanavelu (Chairmar
Sd/- E Sathyanarayana (Vice Chairman)
Sd/- Dr. Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Centre of Excellence Medical Textiles

Annexure

Income & Expenditure Account for the year ended 31st March 2022

Amount in "Rs."

31.03.2021 Rs.	EXPENDITURE	Rs.	31.03.2022 Rs.	31.03.2021 Rs.	INCOME	31.03.2022 Rs.
10,24,671	To Opening Stock of Finished Goods		11,76,821			
1,01,37,060	Establishment Expenses	91,38,655		8,96,22,192	Testing & Investigation Fees	1,59,78,851
2,06,32,419	Salary for Lockdown period transfer from SITRA	-				
3,98,545	Payment towards Terminal benfits	-		1,24,826	HRD Education Receipts	6,83,796
3,11,68,024		91,38,655				
4,63,411	Less : Allocated to Sponsored Projects	5,91,437		18,00,000	Ministry Contribution	30,00,000
3,07,04,613			**85,47,218**	66,118	Sponsored Projects - Overhead Recoveries	3,44,264
7,080	Training Course Expenses		6,125			
1,18,103	Travelling Expenses		48,482	1,18,684	Interest Income	1,97,608
9,41,643	Opening stock - Rawmaterials	14,40,480				
17,98,701	Add: Stores Consumed-Raw Material	14,77,519		11,76,821	Closing Stock of Finished Goods	2,12,017
14,40,480	Less: Closing Stock of Raw Materials	6,17,089				
12,99,864			**23,00,910**			
13,81,863	Stores Consumed		5,94,058			
1,77,068	Building Repairs & Maintenance		1,28,356			
27,45,696	Maintenance of Machinery		5,29,420			
2,37,812	Printing & Stationery		85,804			
2,52,671	Office Expenses		2,27,812			
9,18,355	Electriciy Charges		10,57,787			
1,49,196	Insurance		2,12,270			
2,36,399	Postage & Telephone charges		1,42,116			
1,96,560	Professional Fees		73,890			
1,68,558	Testing Expenses		11,16,950			
28,63,229	Allocation of Expenses incurred by SITRA for COE		18,14,851			
15,01,499	Sponsored Projects - IA Contribution		7,286			
3,15,814	Depreciation		4,17,164			
4,86,09,590	Excess of Income over Expenditure Income for the year c/o		**19,29,216**			
9,29,08,641	**Total**		**2,04,16,536**	**9,29,08,641**	**Total**	**2,04,16,536**

INCOME & EXPENDITURE APPROPRIATION ACCOUNT

31.03.2021 Rs.		Rs.	31.03.2022 Rs.	31.03.2021 Rs.		31.03.2022 Rs.
4,92,32,613	**Excess of Income Over Expenditure for the year c/o**		**23,29,216**	**4,86,09,590**	Excess of Income over Expenditure for the year b/f	**19,29,216**
15,00,000	Transfer to Staff benefit Reserve	2,00,000				
1,00,00,000	Transfer to Reserach & Development Reserve	-		3,80,610	Paid from Sitra Employee Gratuity scheme Fund-SITRA	-
1,90,00,000	Transfer to Depreciation Reserve Invt.Interest	-				
1,05,00,000	Transfer to Infrastructure & Maintenance Reserve	20,00,000		2,42,413	Appropriated from Staff Benefit Reserve-SITRA (Exgratia and Encashment Salary)	4,00,000
82,32,613	Transfer to General Reserve	1,29,216				
4,92,32,613			**23,29,216**	**4,92,32,613**		**23,29,216**

"Vide our report of even date"

Place : Coimbatore
Date : 29/08/2022

For P.N.Raghavendra Rao & Co
Chartered Accountant
Firm Registeration No:003328S
Sd/-Pon Arul Paraneedharan
Partner
M.No:212860

Sd/- Sanjay Jayavarthanavelu (Chairmar
Sd/- E Sathyanarayana (Vice Chairman)
Sd/- Dr. Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Ministry of Textiles Sponsored Powerloom Service Centres

BALANCE SHEET AS AT 31st March 2022

Annexure

Amount in "Rs."

31.03.2021	LIABILITIES		31.03.2022	31.03.2021	ASSETS		31.03.2022
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
	CONTRIBUTION FROM GOVERNMENT AND GOVERNMENT DEPARTMENTS	5,87,89,828		5,99,12,808	**FIXED ASSETS (AT COST)**		6,01,27,709
5,87,89,828	Add: Interest received from MOT funds	-	5,87,89,828	76,47,613	**Investments**		1,33,17,845
					ADVANCES AND DEPOSITS		
55,42,865	**PLSC/CAD CENTRE - GENERAL RESERVE**		66,81,522	11,63,782	Sundry Deposits	11,63,782	
				95,610	Advances for Purchase & Others	1,03,167	12,66,949
	STAFF BENEFIT RESERVE APPROPRIATION FOR TERMINAL BENEFITS						
1,23,97,055	**Opening Balance**	34,12,216					
(36,59,314)	Less: Excess Provision Reversed	-			**CURRENT ASSETS**		
25,00,000	Add: Transfer of Balance Surplus	10,00,000		46,875	Cash on Hand	35,698	
-	Less: Staff Terminal Benefit Apportioned for the year	-					
(78,25,525)	Less: Amount transferred to LIC Group Gratuity Scheme	(1,42,361)	42,69,855				
34,12,216							
				19,23,715	Cash at Bank	12,70,933	
	PSC RESERVE APPROPRIATION FOR CAPITAL EXPENDITURE						
18,73,570	Opening Balance	21,02,799					
2,29,229	Add: Current year Utilisation	2,14,900	23,17,699				
21,02,799				27,606	Sundry Debtors	3,67,579	
				3,13,981	Branches & Divisions	-	16,74,210
	CURRENT LIABILITIES						
70,000	Creditors for Purchases and Capital Goods	70,000					
11,79,789	Provision for Expenses	20,33,398					
34,493	Advances Received from Customers	27,778					
-	Branches and Divisions	21,96,634	43,27,810				
7,11,31,990	**Total**		**7,63,86,713**	**7,11,31,990**	**Total**		**7,63,86,713**

-

Place : Coimbatore
Date : 29-08-2022

"Vide our report of even date"
For P.N.Raghavendra Rao & Co
Chartered Accountant
Firm Registeration No:003328S
Sd/-Pon Arul Paraneedharan
Partner
M.No:212860

Sd/- Sanjay Jayavarthanavelu (Chairman)
Sd/- E Sathyanarayana (Vice Chairman)
Sd/- Dr. Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
Ministry of Textiles Sponsored Powerloom Service Centres

Income & Expenditure Account for the year ended 31st March 2022

Annexure

Amount in "Rs."

31.03.2021	EXPENDITURE		31.03.2022	31.03.2021	INCOME		31.03.2022
Rs.			Rs.	Rs.		Rs.	Rs.
1,14,89,077	Salaries	1,25,31,543		1,14,00,000	Revenue Grant from Ministry		1,14,00,000
5,89,881	Less: Samarth Scheme	4,56,258	1,20,75,285				
1,08,99,196							
36,78,296	General office expenses	31,96,045		1,60,43,123	Income from Services		1,07,69,219
-	Less: Samarth Scheme	32,289	31,63,756				
33,67,259	Rent, Rate & Taxes	38,84,695					
3,17,467	Less: Samarth Scheme	-	38,84,695				
30,49,792							
				2,19,015	Interest on Bank and other deposits		3,72,314
1,44,066	Spares, store & Consumables		79,287				
12,24,841	AMC/Maintenance of Equipement	9,96,169					
-	Less: Samarth Scheme	11,215	9,84,954				
86,65,947	Excess of Income over Expenditure for the year c/o		**23,53,557**				
2,76,62,138	**Total**		**2,25,41,533**	**2,76,62,138**	**Total**		**2,25,41,533**
				86,65,947	Excess of Income over Expenditure for the year b/f		23,53,557
86,65,947	**Balance Surplus**		**23,53,557**				
25,00,000	Transfer to Staff Benefit Reserve - PLSC	10,00,000					
61,65,947	Transfer to PLSC/CAD Centre Reserve	13,53,557					
86,65,947			**23,53,557**	**86,65,947**			**23,53,557**

Place : Coimbatore

Date : 29-08-2022

"Vide our report of even date"
For P.N.Raghavendra Rao & Co
Chartered Accountant
Firm Registeration No:003328S
Sd/-Pon Arul Paraneedharan
Partner
M.No:212860

Sd/- Sanjay Jayavarthanavelu (Chairman)
Sd/- E Sathyanarayana (Vice Chairman)
Sd/- Dr. Prakash Vasudevan (Director)