RESEARCH & DEVELOPMENT ACTIVITIES

As a policy matter, the aim for NITRA's research and development activities is to help the industry. So, at NITRA, ideas for most of the R & D projects are conceived only after interaction with the industry. Need based projects are earmarked for carrying out research and special emphasis is given to those projects which have industry acceptance as well as commercial viability.

In the year 2020-21, NITRA worked on nine projects. Out of which three have been successfully completed during the period whilst work is in progress for the six projects.

Work done in the area of R&D during the year 2020-2021 is categorized as below:

1. GOVERNMENT SPONSORED PROJECTS

1.1 Completed projects

(i) Project title : Setting up of Common Effluent Treatment Plant (CETP) -150 KLD at Ajrakhpur, Bhuj (Sponsored by Ministry of Textiles, Govt. of India)

Objectives :
- Environment protection
- Ground water saving
- Energy conservation through reduction in ground water lifting
- To increase investment opportunity
- Creation of employment opportunities through overall business growth

Scope of work :
- Preparation of DPR with detailed BOQ
- Preparation of drawings, tendering & tender evaluation
- Supply, construction, installation of all civil units as per the design and drawing
- Supply & installation of electro-mechanical equipment as per the design and specification
- Piping work and Hydraulic testing
- Setting-up of testing lab
- Commissioning of CETP and performance analysis
- Training of manpower
- 6 months hand holding

The foundation stone of the Common Effluent Treatment Plant (CETP) was laid on March 18, 2017 by Union Textile Minister Smt. Smriti Zubin Irani.

Research Outcome :
- Detailed project report (DPR) has been prepared, contract awarded through tendering
- Prepared environmental impact assessment report
- Environmental clearance (EC) obtained
- Consent to Establish (CTE) has been granted by the Gujarat Pollution Control Board

- Electromechanical work including fabrication of tanks have been completed
- Civil work completed
- Project is completed
- Pictures of CETP Bhuj are shown in Fig.1 to Fig.4

Fig.1: Reaction Tank & Settler-1

Fig.2: Secondary Clarifier and MBBR cum Aeration Tank

Fig.3: Secondary Clarifier & Settler-2

Fig.4: Washing of clothes with treated water

1.2 Ongoing projects

(i) Project title : New Approaches to Reduce Water Consumption in Textile Wet Processing (Sponsored by Ministry of Textiles, Govt. of India)

Objectives :

- To conduct preliminary trials to test suitability for various dyes, used for textile material
- Designing and fabrication of equipment for dyeing and standardization
- Conducting dyeing trial on various types of textile materials
- To compare dyed material out of new approach and conventional dyeing method in terms of quality and consumption of water

Progress of work :

- Water conservation/consumption study has been carried out in various mills
- Various approaches of dyeing are being tested to conserve water
- Brief of approaches adopted are given below:

Approach-1: Exploring Possibilities of Dyeing Cotton Hank Using Soft Flow Dyeing Machine

Cotton dyeing is one of the most water consuming processes in dyeing industry; major load on ETP is only due to cotton treatment. Conventional cabinet Hank dyeing machine consume water in the range of 1:15 to 1:20 MLR. The salt, soda and other chemicals auxiliaries are used as per the MLR of machine. If MLR is high, the consumption of chemicals will also on higher side. It was thought to use soft flow dyeing machine for dyeing cotton hank so the MLR can be reduce to 1:6 to 1:10. It will not only reduce consumption of water but also reduce chemical auxiliaries consumption and load on ETP. Also provide an option to the dyer having soft flow dyeing machine to dye yarn in hank form. Some of the dyeing trials taken using soft flow dyeing machine to dye cotton yarn in hank form are given below in the Table-1:

Table 1 : Results of some of the Dyeing trials

Trial	Material to liquor ratio	Total water consumption (liter/kg)	Observation
Trial 1	1:15	161	Even shade, high entanglement
Trial 2	1:10	107	Even shade, high entanglement
Trial 3	**1:8**	**88.5**	**Achieved even dyeing**
Trial 4	1:7	77.5	Due to poor liquor circulation dyeing was uneven, entanglement

This study shows (Trial 3) that cotton hank can be dyed in soft flow dyeing machine using 1:8 MLR as shown in Fig.5 and Fig.6 below:.

Fig.5: Soft flow dyeing machine used for cotton hank dyeing

Fig.6 : Dyed Cotton hanks

Approach-2: Dyeing Cotton Fabric in Solid Shade Using Disperse Dye

To dye cotton fabric, reactive dye is one of the best suitable methods. It also gives good fastness properties as required. For cotton dyeing with reactive dye requires 5 to 6 washes after dyeing to remove the unfixed dye. Due to high colour discharge and chemical in effluent it increases the load on ETP and cost of treatment. In this approach we have tried to develop a solid shade using disperse dye on cotton fabric.

In disperse dyeing the amount of color and chemical in effluent is comparatively less than reactive dye. It also saves time during dyeing and required less number of washes to remove unfix dye. The lab trials results are shown below in Fig.7 below:

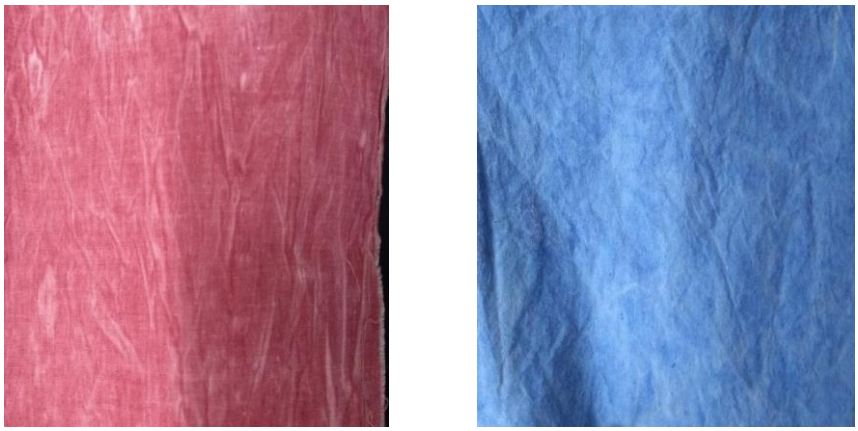

Fig.7 : Cotton Fabrics dyed in solid shades using disperse dye

Approach-3: Creating Denim Effect using Disperse Dye on Cotton Fabric

Denim industry is one of the most water consuming industry. Mostly vat and sulphur dyes are used to produce denim fabric. It has a limitation to produce different shades. In this approach we use **Pad-Cure-Dyeing** method to produce denim effect using **Disperse dye** on different twill fabric. Result are shown in Fig.8 below:

Fig.8 : Cotton Fabrics having denim effect created by using disperse dye

Approach-4: Fabrication of Hank Dyeing machine working in low material to liquor ratio

Under this approach a pilot model hank dyeing machine is fabricated. With this machine, yarn in hank form can be dyed in 1:8 MLR. The trials on this machine are still going on (see Fig.9).

Fig.9 : Pilot model Hank Dyeing Machine

(ii) Project title : Development of value added product from different Fibres in Himalayan Region (Sponsored by Ministry of Textiles, Govt. of India)

Objectives :

- To standardize a method for extraction of fibers from Pine Needles, Indian Flax, Nettle etc.
- Development of machines for extraction of fibres
- To produce yarn with pure fibres and blends by optimizing mechanical parameters
- To develop various kinds of fabric utilizing those yarns
- To develop final value added products / home textile using these fabrics

Progress of work :

- Cultivation of flax fibres has been done
- Extraction of fibre from Pine leaves has been standardized
- Machinery manufacturer has been identified and purchase process has been completed
- A patent has been obtained regarding extraction of textile grade fibre obtained from pine needles
- Products have been developed (Refer Fig.10)


Fig.10 : Some of the value added products developed

Background:

High level of poverty in hills persists due to low employment opportunities. Average monthly income of agricultural households in Uttarakhand is around Rs.4,700/- per month as compared to around Rs.8,800/- per month in neighboring Himachal Pradesh.

Considerable migration of people from hills to plains in search of livelihood affecting development of hills. As per report of Economic times (06.05.2018) approx 4 lakh people have migrated in past 10 years from their native villages of Uttarakhand. Problem is that opportunities available in this region is not exploited.

The fact is that Himalayan region has been bestowed with enormous nature's fibre wealth, including pine needles. These have been used by the locals for their needs. These natural fibres can be exploited to improve the livelihood of hill people. But on the other hand the most negative and damaging impact is that many times, pine needles (perul), lying in the Himalayan region in abundance, catch fire and become highly combustible after these get dry. And this leads to a forest fire causing huge losses to the people living in the region. So its better to exploit the use of natural fibres to bring the happiness to the hill people by upbringing their livelihood and earnings. Considering this need, NITRA got involved in development of value added products using the fibres extracted from Pine needles and from different other fibrous plants, which are available or can be grown in Himalayan region such as Ramie (Boehmeria Nivea), Flax (Linum usitatissimum) and Hemp (Cannabis sativa), pine needle etc. It has been observed that the products developed from these fibres have very high domestic and export demand. Indigenous flax fibres have very good probability of replacing flax fibres which are imported from European countries. Huge demand of high value garments produced from flax fibres can be a boost for the local people of Himalayan region.

Experiments were carried out for exploring the possibilities of using natural fibres abundantly available in Himalayan region. Brief details of experiments are given below.

Experimental work:

The pine needles were collected from the ground of Almora, Uttarakhand and neighbouring areas where Pine forests are abundantly available. Those needles were brought to NITRA, Ghaziabad and extraction of fibres was attempted. Various chemical combinations were tried to get the best textile grade fibres. Sodium hydroxide (NaOH) solution was used for preliminary treatment and then Aluminium chloride ($AlCl_3$) solution was used for final treatment. After a number of trials, optimum time, temperature and concentration(gpl) were finalised. Then the fibres were extracted by mechanically rubbing the treated leaves and dried.

For producing Indian Flax proper seeds were required. It was observed that Central Research Institute for Jute & Allied Fibres (CRIJAF) under ICAR had undertaken some trials and they have developed a variety of JRF2 which gives good result in Indian atmosphere. But large scale trials were not been taken for commercialization. NITRA procured seeds from them and planted in around 7 acres of land during 2017-18. Five acres of land was at G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand and around 2 acres of land was at NITRA, Ghaziabad. The sowing time was November end to beginning December 2017 and the plants were harvested during April, 2018. Fibres were extracted after retting and scutching was done.

Results & Discussion:

The properties of the extracted pine needle fibres were assessed. These are shown in Table-2 “Physical properties of Pine needle fibres”. As the fibres have low tenacity value it was blended with cotton fibre and yarns were spun. The SEM photographs of the cross section of the pine needle fibres and longitudinal structure have been shown in Fig.11 to Fig.14. Both Fig.11 and Fig.12 show the cross-sectional view of pine needle fibres at different magnifications. The figures show a hollow structure which is different from conventional natural fibres used in common. The Fig.13 and Fig.14 show the longitudinal view of pine needle fibres which are not fully cylindrical and somehow looks rough. It was observed that it has high moisture regain value (around 12%). It is expected that this hollow structure will result in products with high thermal resistance value and good water absorbency.

Table 2: Physical Properties of Pine needle fibres

Parameters	Pine needles
Tenacity (g/den)	1.10
Min.	0.32
Max.	3.63
Average	1.10
CV%	66.80
Elongation%	5.94
Min.	0.80

Max.	10.10
Average	5.94
CV%	41.25
Count (Denier/Ne)	87.69/60.61
Bundle strength (g/tex)	5.64
Elongation%	6.9

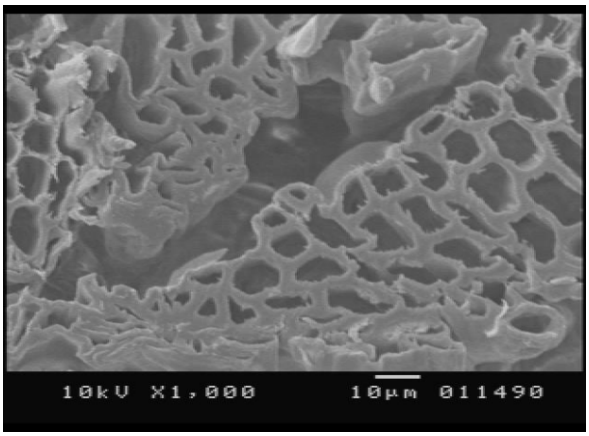

Fig. 11

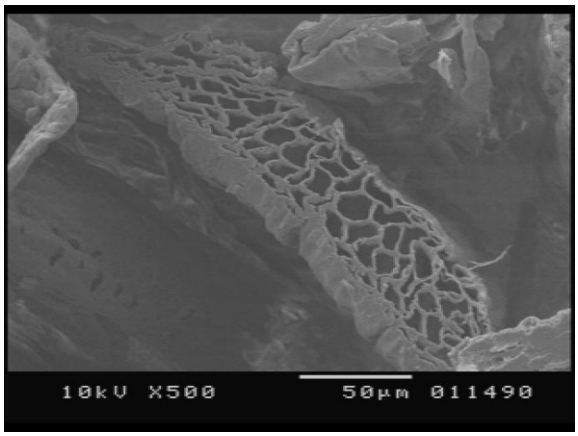

Fig. 12

Fig.11 and Fig.12 show the cross-sectional view of pine needle fibres at different magnifications.

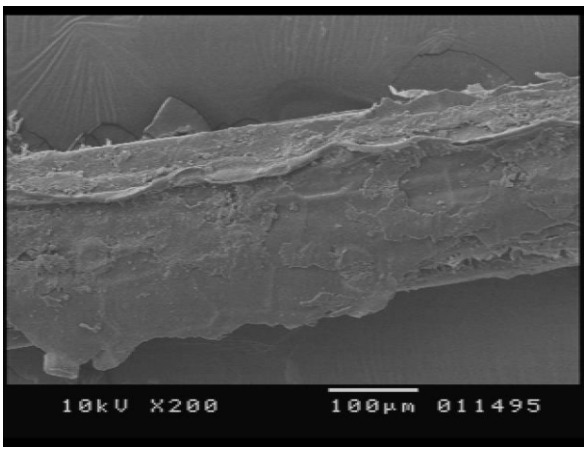

Fig. 13

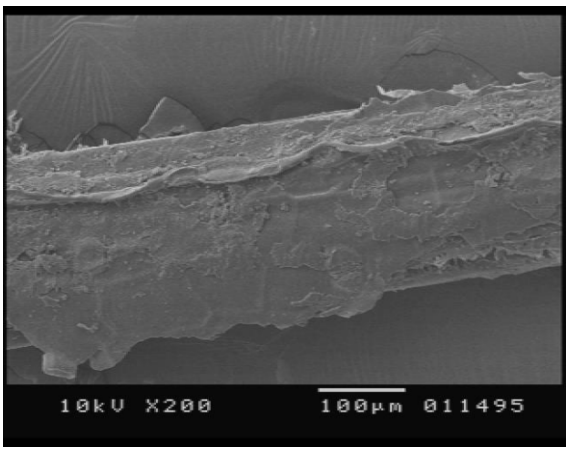

Fig. 14

Fig.13 and Fig.14 show the longitudinal view of pine needle fibres.

The flax fibres, produced in India, were assessed for their various properties and the same were compared with the some of the European flax, sourced from a commercial fabric manufacturer. The SEM photographs of the flax fibres are shown in Fig. 15 to 18. Both Fig.15 and Fig.16 show the cross sectional view of the flax fibres and different magnification. It can be seen that the fibres are mature and similar to available fibres elsewhere. The Fig.17 and Fig.18 show the longitudinal view of Indigenous flax fibres at different magnifications. The properties are shown in Table-3. It can be seen from the Table that there is no significant difference in properties of these fibres. However, single

fibre tenacity of Indian flax is lower than imported fibre, but the bundle strength of Indian fibre is higher. The appearance shows small difference and the Indian variety looks little harsher. This may be the reason for having higher bundle strength as compared to the bundle strength of imported fibres.

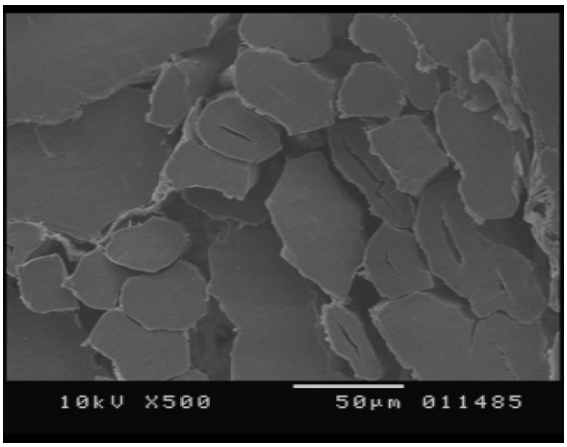

Fig. 15

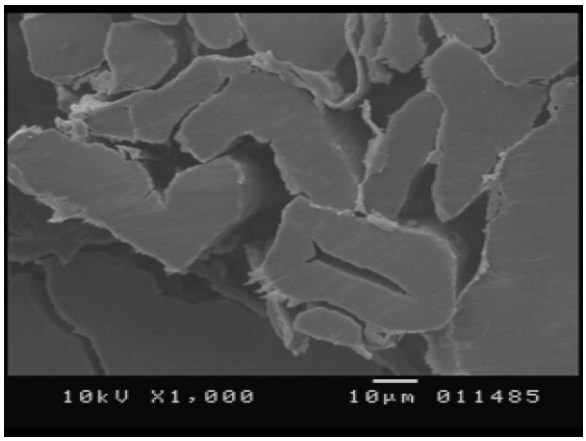

Fig. 16

Fig.15 and Fig.16 show the cross sectional view of the flax fibres and different magnification.

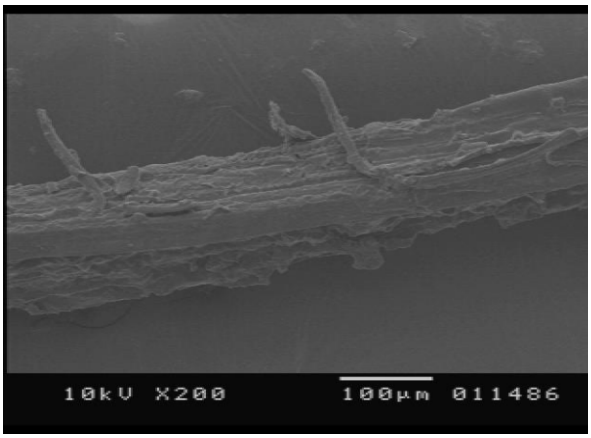

Fig. 17

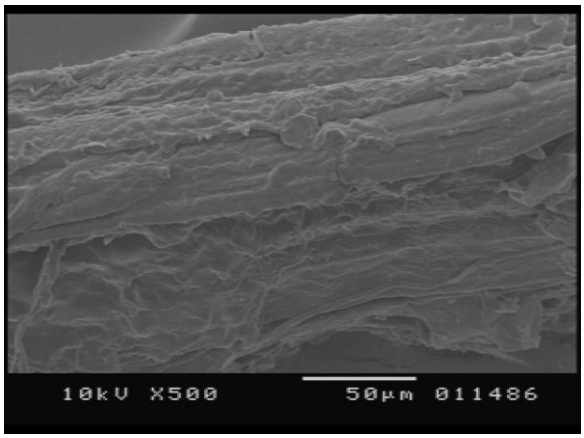

Fig. 18

Fig.17 and Fig.18 show the longitudinal view of Indigenous flax fibres at different magnifications

Table 3: Physical Properties of Flax fibres

Parameters	Indian flax	Imported flax
Tenacity (g/den)	3.43	4.18
Min.	0.56	0.86

Max.	7.34	7.19
Average	3.43	4.18
CV%	48.77	42.05
Elongation%	2.11	2.26
Min.	0.70	0.70
Max.	4.50	4.40
Average	2.11	2.26
CV%	41.38	35.12
Count (Denier/Ne)	40.81/130.24	38.52/137.98
Bundle strength (g/tex)	63.49	40.82
Elongation%	0.61	0.75

The pine needle fibres (PNF) have been blended with cotton in different ratios and it was found difficult to spin yarn as the percentage of PNF fibres increases. Also it is observed that there is preferential loss of PNF in carding, resulting in less PNF percentage in resultant yarn. The yarns with 70:30 Cotton: PNF (actual in yarn stage) was successfully spun and yarns were sized and woven into fabrics using loom. The fabrics have unique look and it will be useful to produce home textiles and apparels.

The Indian flax fibres were processed in very small scale in a commercial company in Eastern India which is the leader in flax processing. The fabric produced in small scale was found as good as that of produced from imported flax fibre. This preliminary small scale trial showed that yield is much lower (to the extent of 50%) during spinning operation. This is due to improper extraction of fibre and scutching of Indian flax fibre. The scutching was done using crude manual method which needs to be improved to get better yield of yarn from fibre.

Findings of experiment:

The results show that there is a very good possibility of producing high value textile products using Pine needles which are abundantly available as plant waste and can help improve the economy of Himalayan region. Also it will help in reduction of forest fire which is the cause of huge loss of human and animal life.

Flax fibre produced in India can replace the use of imported flax fibre, thereby, reducing import and generating income for the people living in the Himalayan region.

(iii) Project title : Development of air cleaner home textiles to reduce Indoor air pollution (Sponsored by Ministry of Textiles, Govt. of India)

Objectives :

- Understanding nature of air pollutions in the indoor places using primary and secondary data and preparing research design
- To evaluate various finishing chemicals/materials having characteristics to absorb/reduce air pollution
- To select suitable fabrics and apply selected finishing chemicals using various techniques
- To evaluate finished fabrics for various physico-chemical and performance properties
- To take field trial of developed fabric in actual practice and modify, if required

Progress of work :

- Details of air pollutants present in indoor air using primary and secondary data has been collected
- Identification of finishing chemicals required to reduce indoor pollution are going on through available sources
- Procurement of some finishing chemicals has been done
- Application of various finishing chemicals on fabric has been done.
- Preliminary trial of application of finishing chemicals was done.
- Identified some other's substances in respect to absorb air pollutant gases. Trials are under process with these substances.
- Preliminary testing has been done using different methods.
- Fabrication of testing instrument for pollution absorbing textile has been completed (Refer Fig.19)
- Air quality monitoring system has been procured
- Design of pollution absorption box (a part of instrument) finalized and ordered for fabrication

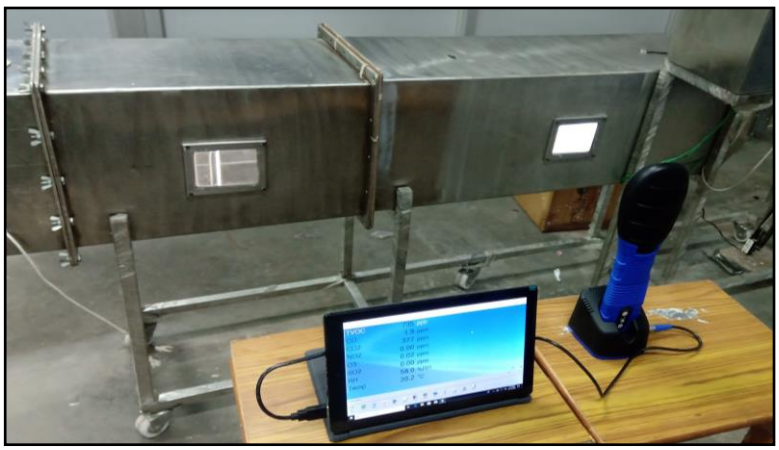

Fig.19: Fabricated Testing Instrument

(iv) Project title : Development of regenerated cellulosic fibres from Indian bamboo (Sponsored by Ministry of Agriculture & Farmers Welfare, Govt. of India)

Objectives :

- To collect data of all bamboo species available in India
- To collect bamboo of each species available in different part of India
- To Extract fiber from each type of collected bamboo
- To compare and study fiber property of each specie of bamboo fiber including silica content
- To develop a process for removing silica from extracted fiber
- Product development from the extracted fiber

Progress of work :

- Data regarding the bamboo production in different states of India and regarding bamboo varieties has been collected
- Pulping unit has been setup
- Bamboo pulping has been done
- Microbiological analysis of bamboo chips and bamboo pulp has been done.
- Bamboo of different varieties procurement is in progress for comparative study and to find the optimum one for fiber
- production from Indian varieties
- Wet spinning system has been procured
- Wet spinning machine commissioning is in progress
- Refer Fig.20 to Fig.25

PULPING

Fig.20: Bamboo

Fig.21: Bamboo Cutter

Fig.22: Digester

Fig.23: Beater

Fig.24: Refiner

Fig.25: Wet Spinning Machine

2. INDUSTRY SPONSORED PROJECTS

2.1 Completed Project:

(i) Development of coat combat disruptive

(ii) Development of technical textile products in the field of feminine hygiene

2.2 On-going Projects:

(i) Development of FR knitted fabric for anti-flash hood for Indian Navy

(ii) Development of antibacterial and antifungal properties in cotton and lotus fabric

3. PROPOSED PROJECTS

(i)	**Project title**	**:**	To develop protective work-wear for sewage and sanitary workers
	Sponsoring Agency	**:**	Department of Science & Technology, Govt. of India
(ii)	**Project title**	**:**	Development of low cost and handy indigenous device for textile fiber and small irregular shape density measurement
	Sponsoring Agency	**:**	Department of Science & Technology, Govt. of India
(iii)	**Project title**	**:**	Socio economic development of SC/ST by providing training, technology and market to convert local resources to industrial products
	Sponsoring Agency	**:**	Department of Science & Technology, Govt. of India
(iv)	**Project title**	**:**	Development of Manhole Cover and Drainage Cover slab using agricultural waste
	Sponsoring Agency	**:**	Department of Science & Technology, Govt. of India
(v)	**Project title**	**:**	Development of indigenous bacterial filtration efficiency tester for surgical face mask
	Sponsoring Agency	**:**	Department of Science & Technology, Govt. of India
(vi)	**Project title**	**:**	Development of NCI (Natural Compression Imprint) Machine for Textile Substrate
	Sponsoring Agency	**:**	Department of Science & Technology, Govt. of India