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 2021-22, NITRA worked on eight projects. Out of which five have been successfully completed during the period whilst work is in progress for the three projects.

Work done in the area of R&D during the year 2021-2022 is categorized as below:

1. GOVERNMENT SPONSORED PROJECTS

1.1 Completed 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

Research outcome :

- Water conservation/consumption study has been carried out in various mills
- Various approaches were used to dye textile materials to conserve water
- A water saving hank dyeing machine for dyeing textile yarns has been designed and developed
- Patent has been filed for the development of water saving hank dyeing machine
- Project has been completed and report has been sent to Ministry of Textiles, Govt. of India

A brief write-up of various approaches adopted is 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 the dyeing industry. As the consumption of water is very high in cotton dyeing, the load for treatment of effluent on ETP is also very high. The conventional cabinet Hank dyeing machine consumes water in the range of 1:15 to 1:20 MLR. The salt, soda. and other chemical auxiliaries are used as per the MLR of the machine. If MLR is high, the consumption of chemicals will also be on the higher side. It was thought to be used on soft flow dyeing machine for dyeing cotton hank so the MLR can be reduced to 1:6 to 1:10. It will not only reduce consumption of water but also reduce chemical auxiliaries' consumption and load on ETP. 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.1 and Fig.2.

Fig.1: Soft flow dyeing machine used for cotton hank dyeing

Fig.2 : Dyed Cotton hanks

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

To dye cotton fabric, reactive dye is one of the popular class of dyes. It also gives good fastness properties as required. Cotton dyeing with reactive dye requires 5 to 6 washes after dyeing to remove the unfixed dye. Due to high colour discharge and chemicals in effluent, it increases the load on ETP and the 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 colour and chemicals in the effluent is comparatively less than in dyeing with reactive dye. It also saves time during dyeing and required less number of washes to remove unfixed dye. The dyed sample developed in the lab trials are shown below in Fig.3:

Fig.3 : 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 (Indigo) 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 fabrics. Results are shown in Fig.4.

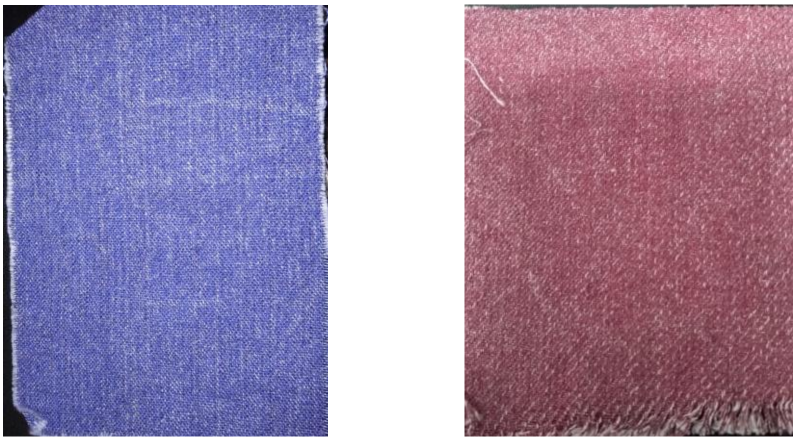

Fig.4 : Cotton Fabrics having denim effect created by using disperse dye

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

Under this approach, a pilot model hank dyeing machine is developed (shown in Fig.5). With this machine, yarn in hank form can be dyed in 1:8 MLR. A patent has been filed for this machine.

Fig.5 : Pilot model of newly developed 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

Research outcomes

- Cultivation of flax fibres has been done
- Extraction of fibre from Pine leaves has been standardized
- The machines identified for the project has been erected & commissioned at NITRA premises
- Machinery manufacturer has been identified and purchase process has been completed. Machinery procured is shown in Fig. 6
- A patent has been filed regarding extraction of textile grade fibre from pine needles
- Natural long fibre pilot plant consisting of Hackling Machine, Draw Frames, Speed Frames and Wet Spinning Ring Frames has been established and started
- Project has been completed and report has been sent to the Ministry of Textiles, Govt. of India
- Products have been developed (Refer Fig.7)

Fig.6 : Machinery procured

Fig. 7 : Some of the value added products developed

Background:

Life in hills is not easy-going due to limited sources of income. As a result of the same there is considerable migration of people from hills to plains in search of livelihood. 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.

In fact the Himalayan region has been bestowed with enormous nature's fibre wealth, including pine needles. These have been used by the locals for their general needs. The pine needles (perul), falling down on the earth in abundance, are highly inflammable when dry and catch fire leading to forest fires causing huge losses to the eco-system.

NITRA took an initiative to extract textile grade fibre from Pine needles and other such resources to develop value added products using these extracted fibres such as Ramie (Boehmeria Nivea), Flax (Linumusitatissimum) and Hemp (Cannabis sativa), etc. It has been observed that the products developed from these fibres have very high probability of domestic and export demand. Indigenous flax fibres have quite satisfactory properties and can reduce / replace import of flax fibres from European countries.

Experimental work:

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

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. 8 to Fig.11. Both Fig.8 and Fig.9 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.10 and Fig.11 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

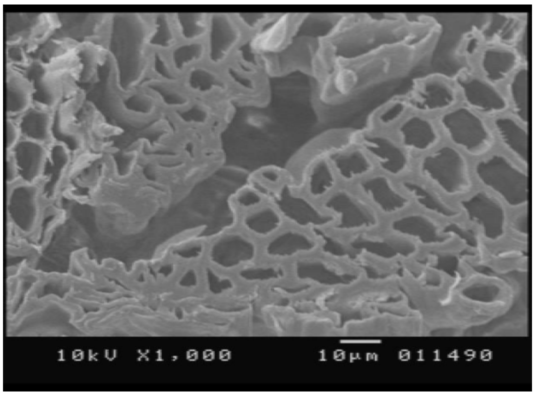

Fig.8

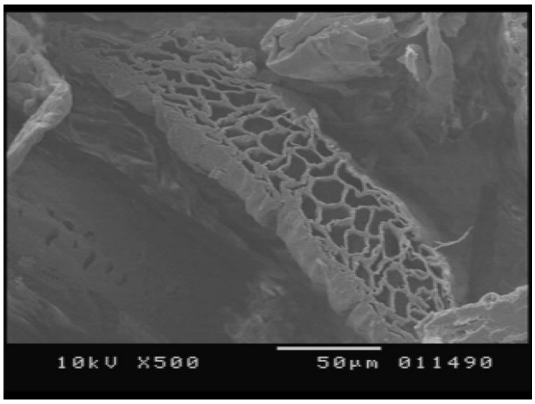

Fig.9

Fig.8 and Fig.9 show the cross-sectional view of pine needle fibres at different magnifications

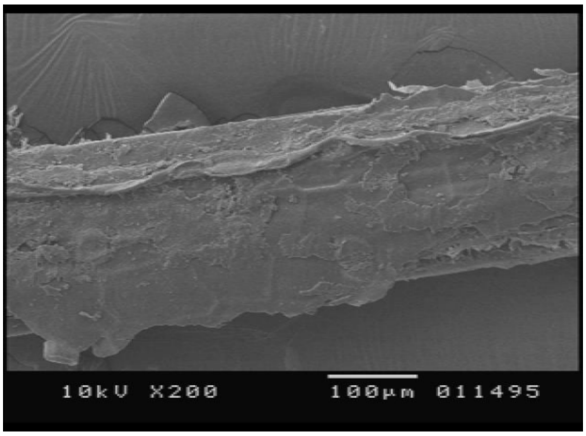

Fig. 10

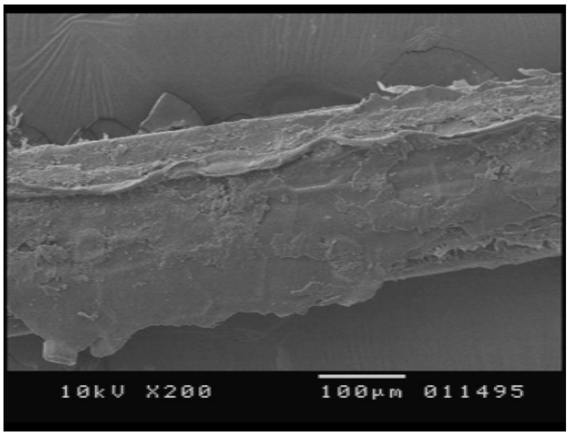

Fig. 11

Fig.10 and Fig.11 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. 12 to 15. Both Fig.12 and Fig.13 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.14 and Fig.15 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.

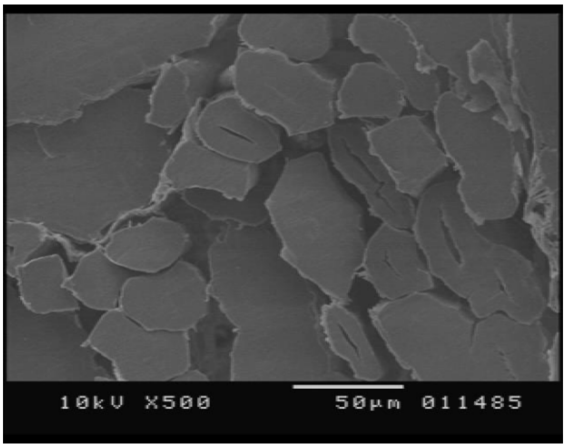

Fig. 12

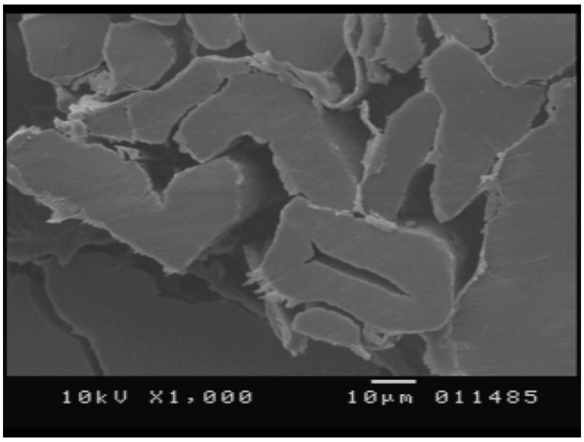

Fig. 13

Fig.12 and Fig.13 show the cross sectional view of the flax fibres and different magnification.

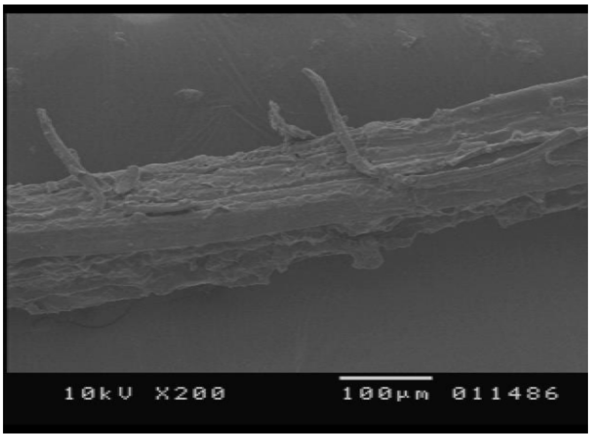

Fig. 14

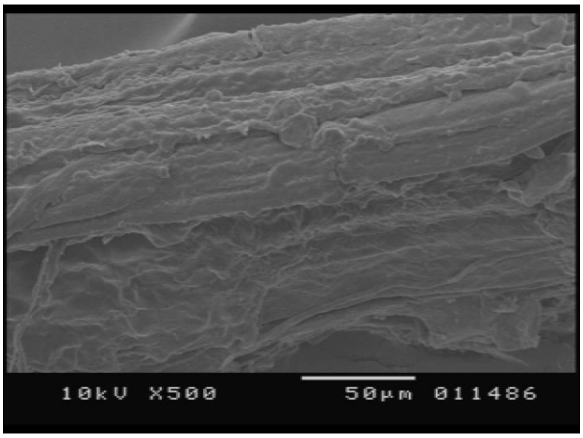

Fig. 15

Fig.14 and Fig.15 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

Research outcome :

- Detailed information of the air pollutants present in indoor air using primary and secondary data has been collected
- Identification of finishing chemicals required to reduce indoor pollution have been identified and procured
- Application of various finishing chemicals on fabric has been done.
- Trials of application of finishing chemicals have been done in large scale.
- Studies have been completed with identified chemicals which were used in different concentrations.
- Evaluation of treated fabric samples have been done for adsorption of air pollutant gases. Results have been encouraging.
- An apparatus to determine Air Pollutant Gas Adsorption Capability of Fabric has been designed and developed and patent has been filed (Refer Fig. 16).
- Project has been completed and report has been sent to Ministry of Textiles, Govt. of India.

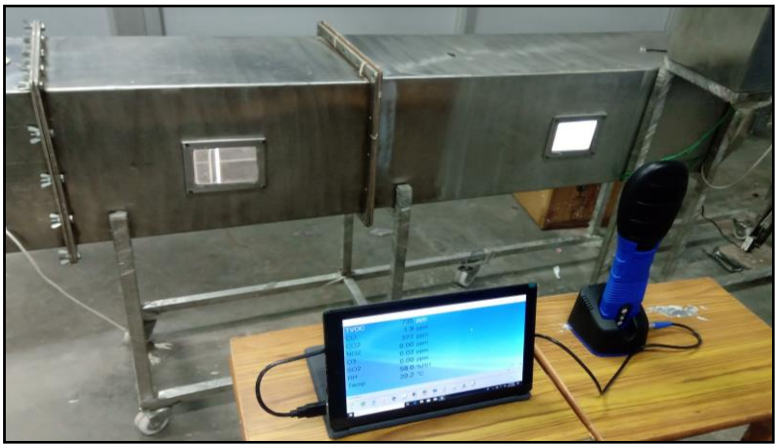

Fig.16: An apparatus to determine Air Pollutant Gas Adsorption Capability of Fabric

1.2 Ongoing projects

(i) 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 has been done and comparative study to find the optimum one for fiber production from Indian varieties has been done.
- Wet spinning machine has been commissioned.
- Developed regenerated fibres have been evaluated for chemical and physical properties.
  Refer Fig.17 to Fig.20.

Name of bamboo species		Name of bamboo species	
Bambusa Vulgaris		**Bambusa Tulda**	
Bambusa Balcooa		**Dendrocalamus Strictus**	

Fig. 17: Species of bamboo procured from Uttrakahd and Assam

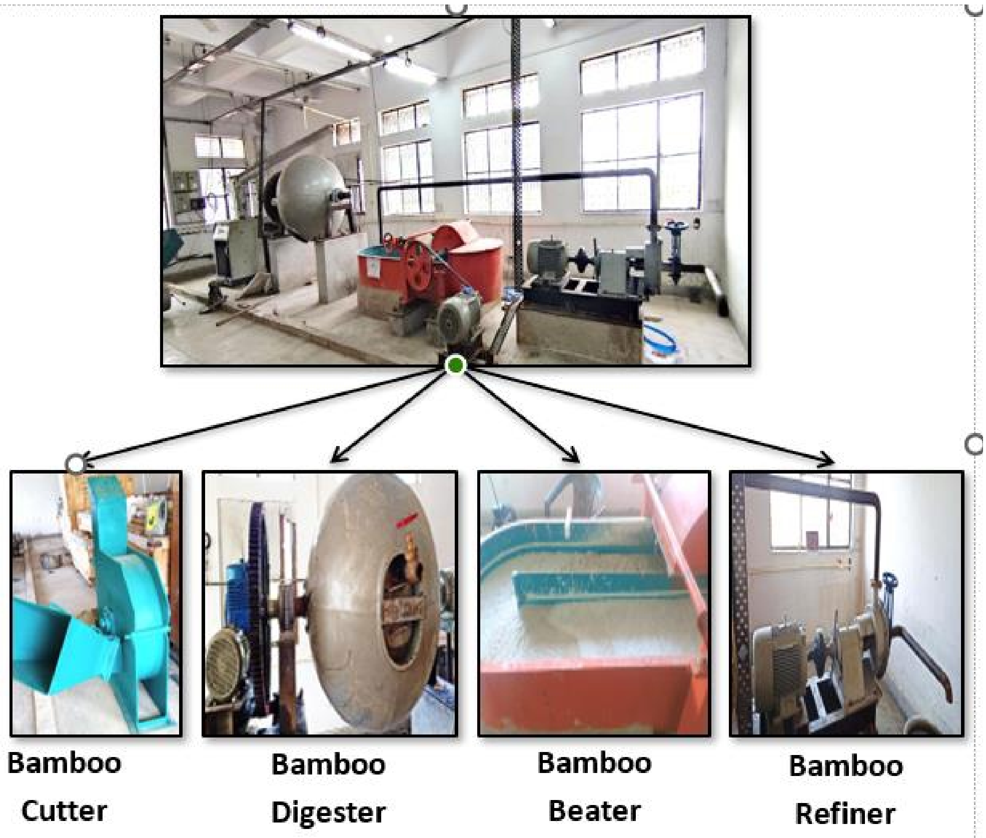

Fig.18: Pulping unit at NITRA

Fig.19: Wet Spinning Machine

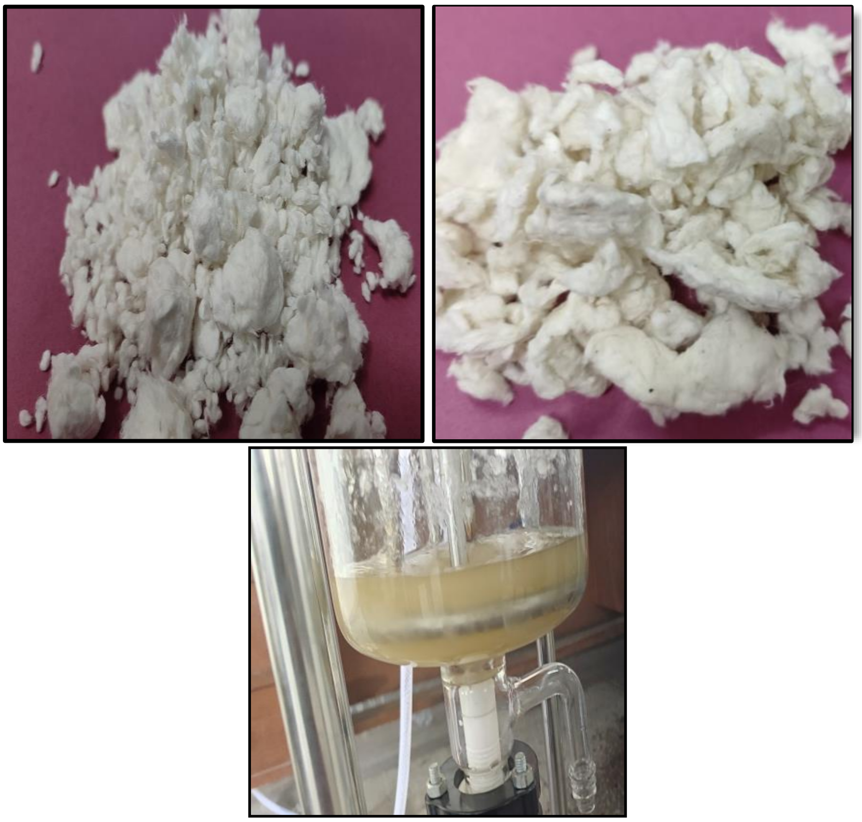

Fig. 20: Dissolvable bamboo pulp

(ii)	**Project title**	:	Development of a molten metal splash resistance unique Jute blended work wear for steel foundry workers
	Objectives	:	• To develop or procure Jute and its blended fabrics having various weaves and weight • To finish these fabrics with durable FR chemicals and their analysis • To determine chemical, mechanical and safety performance properties • To compare existing work-wear fabric with newly developed fabric for safety performance and other properties • Techno-commercial feasibility through field trials in the user industry
	Progress of work	:	• Review of literature • Procurement of yarn & chemicals • Procurement of various softeners, Flame-Retardant chemicals • Procurement of Existing FR protective fabric

(iii) Project title : Development of Jute composite for automotive acoustic insulation and other uses (Sponsored by National Jute Board, GoI)

Objectives :

- To design and develop composite material for automotive acoustic insulation
- To conduct trials in real life situation
- To standardize fibre component and process parameters for this specific use
- To attempt for use of jute non-wovens and composites in other automotive parts

Progress of work:

- Samples collected from the used vehicles and automotive workshops.
- Technical publications and literature related to acoustic textiles and automotive textiles were reviewed.
- Discussion with our industry partner for the initial development of the samples.
- Samples were tested for sound absorption and other physical characteristics such as weight per unit area, tensile properties etc.
- Preliminary samples have been developed.

2. INDUSTRY SPONSORED PROJECTS

2.1 Completed Project

(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

Submitted to National Technical Textile Mission, Ministry of Textiles, Govt. of India:

Project titles:

- Cellulose based indigenous high Clo value and low density surface modified natural fibre for developing thermal layers of extreme cold weather clothing
- Development of Bio degradable and Sustainable Disposable Sanitary Napkin
- Development of indigenous Basalt fibre for high performance applications

Submitted to Deptt. of Science & Technology, Govt. of India:

Project title:

- Socio-economic development of SC/ST by providing training, technology and market to convert local resources to industrial products