

# Himalayan Pine Fiber Canvas Manufacturing Unit



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## Converting Pine Needles and Pine Wood Fiber into Eco-Friendly Canvas Fabric

### 1. Introduction

Uttarakhand, popularly known as Devbhoomi, possesses vast forest resources dominated by Chir Pine (locally called Cheed). Pine forests cover large areas of mid-hill districts such as Almora, Pauri Garhwal, Tehri, Nainital, and Uttarkashi. Every year, massive quantities of fallen pine needles (Pine Litter) accumulate on forest floors. These dry needles are highly inflammable and are one of the primary causes of recurring forest fires in the state. While traditionally treated as waste biomass, pine needles and pine wood fibers possess strong cellulose content, making them suitable for fiber extraction and eco-textile applications.

The proposed project aims to establish a Himalayan Pine Fiber Canvas Manufacturing Unit in Uttarakhand that will convert pine needles and pine wood pulp into durable, eco-friendly canvas fabric. This innovative enterprise integrates forest waste management, rural livelihood generation, sustainable textile manufacturing, and green product innovation into a scalable MSME model.

The unit will manufacture canvas fabric suitable for:

Eco-friendly bags

Tents and tarpaulins

Artist canvas sheets

Footwear lining

Upholstery backing

Industrial covers

Sustainable fashion accessories

The project aligns with:

Forest fire mitigation policies

Circular economy principles

Sustainable textile innovation

Rural employment generation

Green entrepreneurship under MSME schemes

This enterprise transforms a forest hazard into a value-added commercial product.

## 2. Industry Overview

The global canvas and heavy fabric industry is experiencing transformation due to growing environmental concerns and the shift toward biodegradable materials. Conventional canvas is primarily manufactured using cotton or synthetic polyester blends. However, cotton cultivation requires high water consumption, and synthetic materials contribute to microplastic pollution.

There is rising demand for:

- Sustainable textiles
- Plant-based fibers
- Recycled biomass materials
- Eco-friendly fashion products
- Sustainable industrial fabrics

India's textile industry is one of the largest in the world, and the technical textile segment is growing rapidly. Pine fiber-based canvas presents a niche yet high-potential segment under sustainable textiles.

**Table: Market Opportunity Analysis**

Parameter	Current Scenario	Opportunity for Pine Canvas
Raw Material	Cotton & Synthetic	Abundant Pine Biomass
Sustainability	Water Intensive	Forest Waste Utilization
Fire Risk	Not applicable	Reduces Forest Fire Hazard
Competition	Conventional Fabrics	Niche Eco Segment

Parameter	Current Scenario	Opportunity for Pine Canvas
Market Trend	Shift to Green Products	Strong Positioning Advantage

### 3. Vision and Objectives

#### Vision

To establish Uttarakhand as India's leading producer of sustainable pine fiber-based canvas fabric while promoting forest fire mitigation and rural livelihoods.

#### Objectives

- Utilize 2,000–5,000 tons of pine biomass annually within 5 years
- Establish decentralized pine needle collection networks
- Develop a branded eco-canvas product line
- Achieve ₹20–25 Crore turnover within 5 years
- Create 300+ direct and 1,500+ indirect jobs

#### Strategic Objectives Table

Objective	Target	Timeline
Biomass Utilization	1,000 Tons	3 Years
Revenue Target	₹25 Crore	5 Years
Direct Employment	150+	3 Years
Export Entry	Trial Shipments	5 Years
Brand Development	National Eco-Brand	3 Years

### 4. Raw Material Availability in Uttarakhand

The primary raw material includes:

- Pine Needles (Chir Pine – *Pinus roxburghii*)
- Pine Wood Waste
- Natural binders

- Organic dyes
- Cotton reinforcement fibers (optional blending)

Pine forests are widely spread across:

- Almora
- Pauri Garhwal
- Tehri Garhwal
- Nainital
- Uttarkashi

#### Supporting Table: District-wise Pine Biomass Potential

District	Estimated Annual Pine Litter (Tons)	Collection Potential (%)
Almora	80,000	20%
Pauri	75,000	18%
Tehri	60,000	15%
Nainital	50,000	15%
Uttarkashi	45,000	12%

Even 10–15% structured collection can sustain a large-scale unit.

## 5. Manufacturing Process – Detailed Technical Explanation

The manufacturing of Himalayan Pine Fiber Canvas is a structured, multi-stage industrial process that transforms forest biomass into high-strength woven fabric suitable for commercial applications. The process combines mechanical, chemical, and textile engineering operations to ensure fiber durability, flexibility, tensile strength, and long-term usability. Each stage is critical in determining the final quality of the canvas.

The complete manufacturing chain is described in detail below:

### A. Pine Needle Collection & Sorting

The process begins at the forest level with organized collection of fallen pine needles from forests dominated by *Pinus roxburghii*. Collection is carried out manually by trained rural workers or through light mechanical rakes to avoid soil contamination. Only dry, mature, and fibrous needles are selected. Fresh green needles are avoided due to higher moisture and resin content.

At the primary aggregation center, the collected biomass is:

- Spread on sorting platforms
- Manually inspected to remove stones, twigs, soil, bark pieces
- Graded based on length and dryness

Sorting improves fiber consistency and reduces mechanical damage during extraction.

**Operational Objective:**

Ensure uniform raw material quality and reduce impurities before processing.

**B. Cleaning & Dust Removal**

Pine needles typically carry dust, forest debris, and micro-particles. Proper cleaning is essential to protect downstream machinery and improve fiber purity.

The cleaning stage involves:

- Air-blowing systems for dust removal
- Rotary drum cleaning machines
- Water washing (if required)
- Drying under controlled airflow

After washing, needles are dried to 8–12% moisture content using hot air chambers. Controlled drying prevents fungal growth and enhances fiber strength.

**Technical Importance:**

Reduces contamination and improves fiber bonding in later stages.

**C. Mechanical Fiber Extraction**

Pine needles contain cellulose fibers embedded within lignin and resin. Mechanical extraction involves separating usable fiber strands from the outer structure.

The steps include:

- Feeding dried needles into shredding machines
- Crushing and splitting through fiber decorticators
- Mechanical beating to loosen fibrous strands

The output is coarse pine fiber bundles. At this stage, fibers are stiff due to high lignin content.

**Output:**

Coarse, semi-separated pine fiber suitable for softening treatment.

**D. Chemical or Enzymatic Softening**

Raw pine fibers are rigid and brittle. To convert them into textile-grade fibers, lignin reduction and softening are required.

Two methods are used:

### **A. Chemical Softening**

- Mild alkaline treatment (low concentration sodium hydroxide)
- Controlled heating
- Washing and neutralization

### **B. Enzymatic Treatment (Eco-Friendly Option)**

- Application of natural cellulase enzymes
- Biodegradable treatment tanks
- Lower environmental impact

This process:

- Reduces lignin content
- Enhances flexibility
- Improves tensile strength
- Increases spinnability

### **Environmental Note:**

Effluent treatment systems must be installed to recycle process water.

### **C. Pulping & Fiber Refining**

In this stage, softened fibers undergo refining to achieve uniform thickness and improved bonding capability.

Operations include:

- Mechanical refining in pulping drums
- Fiber length standardization
- Removal of residual non-fibrous matter
- Moisture conditioning

The fiber is now softer, finer, and suitable for blending.

### **Key Outcome:**

Textile-grade pine fiber with controlled fiber length and reduced brittleness.

### **D. Blending with Natural Reinforcement Fibers**

Pure pine fiber may lack elasticity and tensile strength required for heavy canvas. Therefore, blending is done with:

- Cotton fiber
- Hemp fiber

- Jute fiber
- Banana fiber (optional)

Blending ratios vary based on end-use:

<b>Application</b>	<b>Pine %</b>	<b>Reinforcement %</b>
Industrial Canvas	60	40
Eco Bags	50	50
Artist Canvas	40	60
Tent Fabric	65	35

Blending ensures:

- Improved flexibility
- Enhanced durability
- Better weaving compatibility
- Increased tear resistance

Blending is done in fiber mixing machines for uniform distribution.

### **E. Spinning into Yarn**

The blended fiber mass is converted into yarn through textile spinning operations.

The spinning process includes:

- Carding – Aligning fibers
- Drawing – Improving uniformity
- Roving – Forming loose strand
- Ring spinning – Final yarn formation

The yarn thickness depends on canvas type. Heavy-duty canvas requires thicker yarn (lower count), while artist canvas requires finer yarn (higher count).

### **Quality Parameters Checked:**

- Yarn tensile strength
- Twist per inch
- Evenness

- Moisture content

### **F. Weaving on Industrial Looms**

The yarn is woven into canvas fabric using power looms or shuttle looms. Canvas is typically woven using:

- Plain weave
- Duck weave
- Basket weave

Plain weave is most common for heavy-duty applications.

The weaving process determines:

- Fabric thickness
- Strength
- Texture
- Breathability

Loom speed and tension are carefully monitored to avoid breakage due to pine fiber stiffness.

#### **Output:**

Unfinished raw pine fiber canvas fabric.

### **G. Canvas Finishing (Coating / Strengthening)**

The woven fabric undergoes finishing treatments to enhance functionality and durability.

Finishing options include:

- Water-resistant coating
- Wax treatment
- Natural resin coating
- Fire-retardant treatment
- Anti-fungal treatment

Eco-friendly finishing agents are preferred to maintain sustainability standards.

Finishing improves:

- Weather resistance
- Abrasion resistance
- Tear strength
- Surface smoothness

## **H. Drying & Quality Testing**

After coating, the fabric is dried in controlled temperature chambers.

Quality tests conducted include:

- Tensile strength test
- Tear resistance test
- Shrinkage test
- Water absorption test
- GSM (grams per square meter) measurement
- Flexibility test

Defective rolls are rejected or reprocessed.

This ensures standardized industrial-grade production.

## **I. Cutting & Packaging**

Finished canvas rolls are:

- Trimmed for uniform width
- Cut into sheets or rolls
- Inspected for defects
- Packed in moisture-resistant wrapping

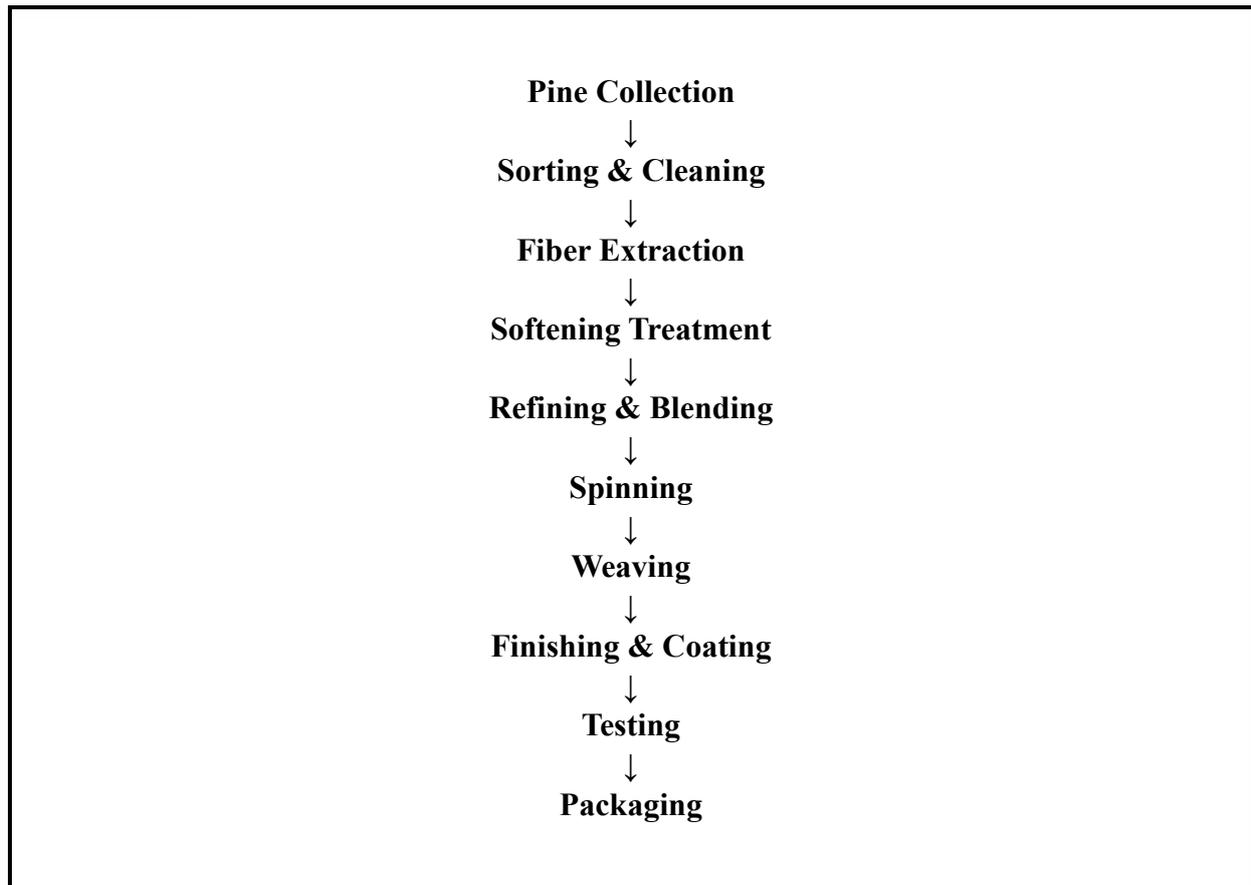
Packaging includes:

- Bulk industrial rolls
- Retail folded packs
- Customized cut sizes

Each batch is labeled with:

- GSM rating
- Blend ratio
- Manufacturing date
- Batch number

## Integrated Manufacturing Flow



### Technical Advantages of This Process

1. Converts forest fire-prone biomass into high-value textile.
2. Reduces dependency on water-intensive cotton.
3. Encourages decentralized rural raw material collection.
4. Enables scalable MSME textile manufacturing.
5. Supports circular economy and green industry principles.

## 6. Machinery Requirement

The unit will require mechanical and textile processing equipment.

**Supporting Table: Machinery & Cost Estimate**

Machinery	Quantity	Estimated Cost (INR)
Pine Needle Shredder	2	12,00,000
Fiber Extraction Machine	2	18,00,000
Pulping Unit	1	25,00,000
Fiber Refining Unit	1	15,00,000
Spinning Machine	4	40,00,000
Industrial Looms	6	60,00,000
Finishing & Coating Unit	1	22,00,000
Drying Chamber	1	10,00,000
Testing Equipment	1 Set	8,00,000

**Total Machinery Investment Approx.: ₹2.10–2.50 Crore**

## 7. Infrastructure Requirement

The project will require:

- 10,000–15,000 sq. ft. industrial shed
- Raw material storage
- Production floor
- Finishing section
- Testing lab
- Administrative office

### Infrastructure Allocation Table

Section	Area Required
Raw Material Storage	3,000 sq ft
Fiber Processing	3,500 sq ft
Weaving Section	4,000 sq ft
Finishing Unit	2,000 sq ft
Office & Lab	1,500 sq ft

## 8. Manpower Requirement

The project requires skilled textile technicians and semi-skilled rural workers.

### Supporting Table: Staffing Plan

Position	No.	Annual Cost (INR)
Plant Manager	1	12,00,000
Textile Engineer	2	18,00,000
Machine Operators	12	36,00,000
Fiber Processing Workers	20	48,00,000
Quality Control Staff	3	12,00,000
Accounts & Admin	3	10,00,000
Marketing Executives	4	20,00,000

Total Direct Employment: 45–50 persons (Initial Phase)

## 9. Business Model

The unit will operate under a hybrid B2B and B2C model.

Revenue Streams:

- Bulk canvas supply to bag manufacturers
- Supply to tent manufacturers
- Direct-to-consumer eco-bag brand
- Industrial contracts
- Export orders
- Government procurement

### Revenue Structure Table

Revenue Source	Projected Contribution Year 5
B2B Industrial Supply	50%
Eco-Bag Retail Brand	20%
Institutional Sales	15%
Export Sales	10%
Specialty Artist Canvas	5%

## 10. Financial Structure

### Project Cost Summary

Component	Amount (INR)
Land & Building	1.50 Crore
Machinery	2.30 Crore
Pre-operative Expenses	40 Lakhs

Component	Amount (INR)
Working Capital	1.80 Crore
<b>Total Project Cost</b>	<b>6.00 Crore (Approx.)</b>

Break-even expected within 3–4 years depending on capacity utilization.

## 11. Revenue Projection (10-Year Outlook)

Year	Revenue (Crore)	Net Profit (Crore)
Year 1	4	-0.5
Year 3	12	2.0
Year 5	25	6.5
Year 10	80+	20+

## 12. Sustainability Impact

Environmental Benefits:

- Reduction in forest fire risk
- Pine litter management
- Carbon footprint reduction
- Biodegradable textile alternative
- Reduced cotton water dependency

### Sustainability Table

Initiative	Impact
Pine Biomass Use	Fire Prevention
Eco Processing	Low Chemical Waste
Rural Collection Network	Livelihood Support

Initiative	Impact
Natural Dyes	Reduced Toxic Effluent

### 13. Risk Analysis

Risk	Mitigation
Fiber Strength Limitation	Blend with cotton/hemp
Seasonal Collection Variability	Storage Planning
Market Acceptance	Strong Eco Branding
Technical Challenges	R&D Collaboration

### 14. 3-Year, 5-Year & 10-Year Growth Plan

#### 3-Year Plan

- Establish plant
- Secure industrial buyers
- Achieve 60% capacity utilization

#### 5-Year Plan

- Launch branded eco-products
- Enter export markets
- Expand capacity

#### 10-Year Plan

- Establish multiple district collection hubs
- Develop advanced technical textiles
- Position Uttarakhand as Pine Fiber Textile Hub

### Growth Flow Chart



## 15. Employment Generation Potential

### Direct Employment

Year	Direct Jobs
Year 1	50
Year 3	120
Year 5	220
Year 10	500+

### Indirect Employment

Parameter	Year 5
Pine Collectors	800+
Transport Workers	150
Packaging Units	200
Rural Aggregators	100

Total Employment Impact by Year 10: 2,000+ livelihoods

## 16. Sustainability Features of the Himalayan Pine Fiber Canvas

### Manufacturing Unit

The Himalayan Pine Fiber Canvas Manufacturing Unit is fundamentally designed as a circular economy and green industrial model that integrates environmental conservation, social inclusion, and long-term economic sustainability. The project not only manufactures eco-friendly textile products but also addresses critical ecological challenges in Uttarakhand's fragile Himalayan ecosystem.

The sustainability features are categorized under Environmental, Social, Economic, and Institutional Sustainability Dimensions as explained below.

#### A. Environmental Sustainability

##### 1. Forest Fire Mitigation

Uttarakhand's pine forests, dominated by *Pinus roxburghii*, accumulate large quantities of dry pine needles annually. These needles are highly inflammable and are one of the primary contributors to seasonal forest fires.

By creating structured collection networks for pine litter:

- The project reduces combustible biomass load.
- Fire intensity and spread risk decreases.
- Forest regeneration improves.
- Soil biodiversity is protected.

#### **Environmental Impact:**

Direct reduction in forest fire vulnerability across mid-hill districts.

##### 2. Waste-to-Value Conversion

Pine needles are traditionally treated as waste biomass with little economic value. This project transforms:

Forest Waste → Industrial Raw Material → Marketable Canvas Product

This conversion:

- Promotes circular economy principles
- Minimizes raw material wastage
- Encourages resource efficiency
- Prevents uncontrolled biomass burning

### 3. Reduced Dependence on Cotton

Conventional canvas production relies heavily on cotton, which:

- Requires high water consumption
- Uses chemical fertilizers and pesticides
- Contributes to soil degradation

Pine fiber canvas reduces dependence on water-intensive cotton cultivation.

#### **Sustainability Benefit:**

Lower water footprint per meter of canvas produced.

### 4. Biodegradable & Eco-Friendly Textile

Unlike synthetic polyester-based canvas:

- Pine fiber canvas is biodegradable
- Does not release microplastics
- Has lower carbon footprint
- Is compostable under controlled conditions

This supports sustainable fashion and green industrial textile segments.

### 5. Eco-Friendly Processing

The project emphasizes:

- Enzymatic softening instead of heavy chemical treatment
- Effluent treatment plant (ETP) installation
- Water recycling systems
- Natural dye usage
- Low-emission drying systems

**Result:** Reduced chemical discharge and controlled industrial pollution.

#### **Supporting Table: Environmental Sustainability Measures**

Initiative	Sustainability Outcome
Pine Litter Collection	Reduced forest fire risk
Biomass Utilization	Waste-to-value conversion
Reduced Cotton Use	Lower water footprint

Initiative	Sustainability Outcome
Biodegradable Fabric	Reduced plastic pollution
Effluent Treatment	Controlled water pollution
Natural Dyes	Lower chemical toxicity

## B. Social Sustainability

### 1. Rural Livelihood Generation

Pine needle collection provides income to:

- Forest fringe communities
- Women Self-Help Groups (SHGs)
- Small rural collectors
- Marginal farmers

Each ton of pine collected generates direct rural income.

#### **Social Impact:**

Income diversification for hill communities.

### 2. Women Empowerment

In many hill districts, pine needle collection and sorting can be organized through women-led SHGs.

Benefits include:

- Financial independence
- Skill development
- Local employment opportunities
- Reduced seasonal migration

### 3. Reduced Migration

By creating village-level economic opportunities:

- Rural youth are less likely to migrate
- Local employment strengthens community stability
- Micro-enterprise networks emerge

#### 4. Skill Development & Capacity Building

The project includes:

- Fiber processing training
- Textile operation training
- Quality testing skill development
- Entrepreneurship exposure

This enhances human capital in rural and semi-urban areas.

#### Supporting Table: Social Sustainability Indicators

Social Dimension	Impact
Women SHG Participation	Inclusive employment
Rural Income Diversification	Reduced dependency on agriculture
Skill Development	Workforce enhancement
Migration Reduction	Community stability

#### C. Economic Sustainability

##### 1. Long-Term Raw Material Availability

Pine trees shed needles annually, ensuring:

- Continuous renewable raw material supply
- No deforestation required
- Sustainable harvesting cycle

Unlike timber-based industries, this model does not require tree cutting.

##### 2. Diversified Revenue Streams

The project produces:

- Industrial canvas
- Eco-bags
- Tent fabric
- Upholstery base cloth

- Export-grade sustainable textiles

Multiple market channels ensure long-term financial resilience.

### 3. Scalable Production Model

The manufacturing process:

- Can be expanded modularly
- Supports cluster-based collection
- Enables decentralized procurement

This reduces operational risk and improves long-term profitability.

### 4. Export Potential

Global demand for sustainable textiles is increasing. Pine fiber canvas can cater to:

- European eco-markets
- Sustainable fashion brands
- Outdoor equipment manufacturers

Export diversification enhances economic stability.

#### Supporting Table: Economic Sustainability Factors

Economic Driver	Sustainability Impact
Renewable Raw Material	Long-term viability
Product Diversification	Revenue resilience
Export Potential	Foreign exchange earnings
MSME Scalability	Controlled expansion

## D. Institutional & Policy Sustainability

### 1. Alignment with National Missions

The project supports:

- Atmanirbhar Bharat
- MSME Promotion
- Startup India
- Forest Fire Management Programs

- Circular Economy Framework

## **2. Collaboration with Forest Department**

Structured agreements for pine litter collection:

- Prevent illegal extraction
- Ensure sustainable harvesting
- Maintain ecological balance

## **3. Carbon Reduction Contribution**

By:

- Reducing forest fires
- Lowering synthetic textile production
- Promoting biodegradable alternatives

The project contributes to climate change mitigation efforts.

## **E. Carbon & Ecological Footprint Advantage**

### **Carbon Impact Areas**

- Reduced burning of pine litter
- Reduced synthetic fiber production
- Localized supply chains
- Lower transportation emissions

### **Water Impact Areas**

- Less water than cotton processing
- Water recycling systems
- Rainwater harvesting (optional inclusion)

## Integrated Sustainability Flow



### Long-Term Sustainability Vision (10-Year Outlook)

- Establish district-level pine aggregation hubs
- Develop 100% enzyme-based processing
- Achieve Zero Liquid Discharge system
- Introduce solar-powered production units
- Develop carbon credit eligibility framework

## 17. Conclusion

The Himalayan Pine Fiber Canvas Manufacturing Unit represents a transformative green enterprise model that integrates forest management, textile innovation, circular economy principles, and rural employment generation into a commercially viable MSME structure. By converting forest waste into high-value industrial canvas fabric, the project addresses environmental challenges while unlocking new economic potential for Uttarakhand's hill districts.

Technically feasible, financially scalable, environmentally responsible, and socially inclusive, this project can position Uttarakhand as a pioneer in pine-based sustainable textiles in India. Over the next decade, it has the potential to evolve into a national eco-brand while significantly contributing to forest fire mitigation, rural income enhancement, and green industrial development.

## Disclaimer

Only a few machine manufacturers are mentioned in the profile, although many machine manufacturers are available in the market. The addresses given for machinery manufacturers have been taken from reliable sources, to the best of knowledge and contacts. However, no responsibility is admitted, in case any inadvertent error or incorrectness is noticed therein. Further the same have been given by way of information only and do not imply any recommendation.