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A REVIEW: CONTRIBUTION OF CTRTI TO SUSTAINABLE ENVIRONMENT

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ABSTRACT

The Central Tasar Research & Training Institute (CTRTI) in India is a pioneering institution dedicated to advancing sustainable practices within the tasar silk industry. This research paper explores CTRTI's comprehensive efforts towards environmental sustainability across biodiversity conservation, waste management, temperature regulation, and environmental impact mitigation. Through initiatives such as preservation of plant and insect species, promotion of sustainable practices, and innovative waste management strategies like vermicomposting and sericin extraction, CTRTI demonstrates a holistic commitment to ecological integrity. Furthermore, the institute's focus on temperature regulation through afforestation and agroforestry, coupled with soil management techniques, contributes to climate resilience and local microclimate regulation. CTRTI's dedication extends beyond operational activities to education and outreach programs, empowering stakeholders to adopt sustainable practices. This paper underscores CTRTI's pivotal role in driving positive environmental change within the sericulture industry and serves as a model for sustainability efforts worldwide.

Keywords: Sustainability, Environmental impact mitigation, Afforestation, Agroforestry, Sericin, Vermicomposting, Climate resilience.

Introduction

The Central Tasar Research & Training Institute (CTRTI) is a pivotal institution dedicated to the advancement and support of the tropical and temperate tasar sector in India. Established in 1964 under the auspices of the Central Silk Board, CTRTI holds a unique position as the sole institute globally focused on research and development activities in the Tropical Tasar Silk domain. Located in Ranchi, Jharkhand, India. CTRTI operates under Central Silk Board, Ministry of Textiles, Government of India, reflecting its strategic importance in the nation's sericulture landscape.

At the heart of CTRTI's mission is a steadfast commitment to innovation, education, and sustainable practices. This commitment is embodied through a comprehensive network comprising six Regional Sericulture Research Stations (RSRS), three Research Extension Centres (REC), one P4 Breeding Station, and one Raw Material Bank. These facilities serve as hubs of knowledge dissemination and technological advancement, providing stakeholders across the command states with state-of-the-art resources and expertise.

CTRTI's dedication to education and capacity building is exemplified through its Postgraduate Diploma in Sericulture (PGDS) program, a rigorous 15-months curriculum designed to equip students with comprehensive training in tasar silk cultivation and production. Moreover, the institute conducts an array of training programs and workshops, fostering a skilled workforce capable of driving sustainable growth and innovation within the sericulture industry.

With 85.3106619 acres of land in Ranchi, CTRTI demonstrates a commitment to sustainable land management and resource utilization. Within this expanse, 60.936187 acres are devoted to farming activities, featuring diverse plantations including Arjun, Asan, Jarul, Natural Sal Forest, and Quercus. These plantations not only support tasar silk production but also contribute to biodiversity conservation and ecosystem resilience.

Furthermore, CTRTI manages 27 plots dedicated to the cultivation of different food plants of tasar silkworms, complemented by a specialized gene bank and laboratory focused on tasar food plants. Beyond agricultural endeavours, CTRTI's infrastructure encompasses 24.3744749 acres of land housing administrative buildings, laboratories, training facilities, hostels, canteen, grainage houses, rearing houses, residential quarters, farmers' hostels, vehicle parking, natural Sal forests and other plantations. This integrated approach to land management underscores

Fig 1: Farm Layout

CTRTI's holistic commitment to sustainability (ctrti.res.in). This paper aims to provide a comprehensive information of CTRTI's contributions to environmental sustainability. By delving into the institute's initiatives spanning biodiversity conservation, waste management, temperature regulation, and environmental impact mitigation, this paper seeks to elucidate the pivotal role played by CTRTI in fostering a sustainable environment.

Fig. 2: Satellite image of main campus area and farm area of CTRTI (under the red line polygon)

Biodiversity Conservation:

The Central Tasar Research & Training Institute (CTRTI) plays a significant role in biodiversity conservation through various initiatives aimed at preserving and enhancing the flora and fauna associated with the tasar silk ecosystem.

1. **Preservation of Plant Species**:

- CTRTI manages extensive plantations encompassing diverse species crucial for the tasar silk industry. These plantations include Arjun (*Terminalia arjuna*), Asan (*Terminalia tomentosa*), Jarul (*Lagerstroemia speciosa*), Natural Sal Forest (*Shorea robusta*), Jamun (*Syzygium cumini),* Indian jujube (*Ziziphus mauritiana*) and Quercus plantations.
- These plant species not only serve as host plants for the tasar silkworms but also support a variety of other flora and fauna in the ecosystem. They provide habitat, food, and shelter for numerous organisms, contributing to overall biodiversity.
- The gene bank maintained by CTRTI further enhances biodiversity conservation efforts by preserving germplasm of various plant species. The gene bank contains species such as *Anogeissus latifolia*, *Terminalia belerica*, *Terminalia chebula*, *Terminalia myriocarpa*, *Lagerstroemia parviflora*, and *Lagerstroemia speciosa*.

Fig. Gene Bank of Tasar Food Plant

Plantation Under Gene Bank		
Species	**Common Name**	**Family**
Anogeissus Latifolia	Dhavda	Combretaceae
Terminalia arjuna	Arjun	Combretaceae
Terminalia tomentosa	Asan	Combretaceae
Terminalia belerica	Bahera	Combretaceae
Terminalia chebula	Harra	Combretaceae
Terminalia myriocapra	Hollok	Combretaceae
Lagerstroemia indica	Saoni	Lythraceae
Lagerstroemia parviflora	Siddha	Lythraceae
Lagerstoemia speciosa	Jarul	Lythraceae
Plantation in Farm Area		
Terminalia arjuna	Arjun	Combretaceae
Terminalia tomentosa	Asan	Combretaceae
Shorea robusta	Sal	Dipterocarpaceae
Lagerstroemia speciosa	Jarul	Lythraceae
Syzygium cumini	Jamun	Myrtaceae
Ziziphus mauritiana	Ber	Rhamnaceae
Quercus serrata	Konara oak	Fagaceae
Terminalia belerica	Bahera	Combretaceae
Terminalia chebula	Harra	Combretaceae
Anogeissus Latifolia	Dhavda	Combretaceae
Tectona grandis	Sagwan	Lamiaceae
Dalbergia sissoo	Sheesham	Fabaceae
Careya arborea	Kumbi	Lecythidaceae
Bombax ceiba	Semal	Malvaceae
Morus	Mulberry	Moraceae
Madhuca longifolia	Mahua	Sapotaceae
Mangifera indica	Mango	Anacardiaceae
Saraca asoca	Ashoka	Fabaceae

Delonix regia	Gulmohar	Fabaceae
Bauhinia variegata	Kachnar	Fabaceae
Plantation in Main Campus Area		
Shorea robusta	Sal	*Dipterocarpaceae*
Ziziphus mauritiana	Ber	*Rhamnaceae*
Phyllanthus emblica	Amla	*Phyllanthaceae*
Saraca asoca	Ashoka	Fabaceae
Azadirachta indica	Neem	*Meliaceae*
Lagerstroemia speciosa	Jarul	Lythraceae
Mangifera indica	Mango	Anacardiaceae
Arecaceae	Palm	*Arecaceae*
Thuja Orientalis	Morpankhi	*Cupressaceae*
Syzygium cumini	Jamun	Myrtaceae
Tamarindus indica	Imli	*Fabaceae*
Nauclea Parvifolia	Karam	*Rubiaceae*
Ficus religiosa	Peepal	*Moraceae*
Psidium guajava	Guava	*Myrtaceae*
Melia dubia	Malabar Neem	*Meliaceae*
Santalum album	Sandal	*Santalaceae*
Araucaria columnaris	Christmas tree	*Araucariaceae*
Artocarpus heterophyllus	Jackfruit	*Moraceae*

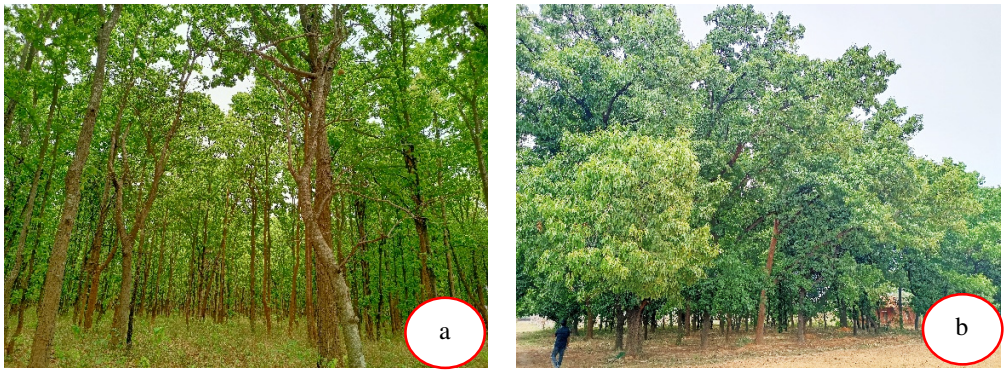

Fig 2: a: Natural Plantation of Sal, b: Plantation of *Quercus serrata* in farm area

2. **Protection of Insect Species**:

- In addition to preserving plant species, CTRTI's activities indirectly support the conservation of various insect species, including the tasar silkworm (*Antheraea mylitta*).
- Tasar silkworms depend on specific host plants for their survival and reproduction. By maintaining plantations of these host plants, CTRTI ensures the availability of suitable habitat for the tasar silkworms, thereby contributing to the conservation of this species.
- Moreover, the diverse plantations managed by CTRTI create microhabitats that support a wide range of insect species, including pollinators, predators, and decomposers. This contributes to the overall biodiversity of the ecosystem.

3. **Promotion of Sustainable Practices**:

- CTRTI advocates for sustainable land management practices that prioritize biodiversity conservation. This includes the use of organic farming methods, minimal pesticide use, and the preservation of natural habitats within agricultural landscapes.
- By promoting sustainable practices among tasar silk producers and stakeholders, CTRTI contributes to the conservation of biodiversity at the grassroots level, ensuring the long-term viability of the tasar silk industry while safeguarding ecological integrity.

Waste Management:

Waste management is a critical aspect of sustainable development, and the Central Tasar Research & Training Institute (CTRTI) has implemented various innovative strategies to effectively manage waste generated in the tasar silk production process.

1. **Production of Vermicompost:**

- CTRTI utilizes vermicomposting, a process that involves the use of earthworms to decompose organic waste materials, to produce nutrient-rich compost.
- Organic waste materials such as leftover tasar food plant leaves, cocoon shells, and other agricultural residues are collected and fed to earthworms.
- The earthworms digest the organic matter, breaking it down into compost that is rich in nutrients essential for plant growth.
- This vermicompost is then utilized as organic fertilizer in the cultivation of tasar host plants and other agricultural crops, promoting soil health and fertility (Vuković *et al.* 2021; Blouin *et al.* 2019; Manjunath *et al.* 2020)

2. **NADEP Compost:**

- CTRTI Ranchi promotes the Nadep composting method, an approach to sustainable waste management and organic fertilizer production.
- Nadep composting utilizes locally available organic materials like crop residues, weeds, and kitchen waste, making it suitable for small and medium-sized enterprises (SMEs) and individual farmers.
- The process involves layering these materials in a tank with cow dung slurry and dried soil, promoting biological degradation into nutrient-rich compost.
- Benefits of Nadep composting include reduced expenses on chemical fertilizers, improved soil fertility, and increased crop yield, conducive to organic farming practices.

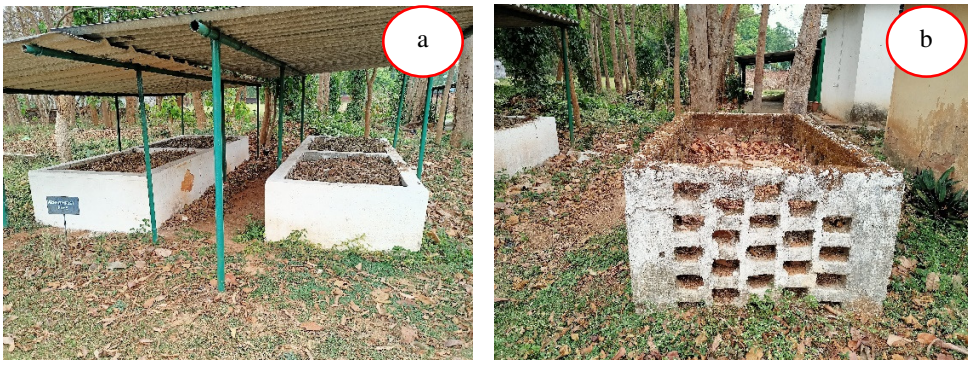

Fig. 3 : (a) Vermicompost (b) NADEP Compost

- By advocating for Nadep composting, CTRTI Ranchi contributes to waste reduction, soil health enhancement, and sustainable agriculture in alignment with the Swachh Bharat Mission (Kumar *et al.* 2011; Kumawat *et al.* 2017; Kumar *et al.* 2012; Verma *et al.* 2014).

3. Sericin extraction from Cocoon Cooked Waste Water:

- CTRTI utilizes cocoon-cooked waste water, a byproduct of the tasar silk reeling process, to produce sericin, a proteinaceous substance found in silk.
- The waste water from the cocoon cooking process is collected and processed to extract sericin using specialized techniques.
- Sericin has various industrial applications, including its use in cosmetics, pharmaceuticals, and textile industries, making it a valuable byproduct of the tasar silk production process (Li et.al. 2015; Capar 2012; Capar *et al.* 2008; Aramwit *et al.* 2012).

4. Cordyceps from Pupal Waste:

- CTRTI explores the potential of utilizing pupal waste, a byproduct of the tasar silk production process, for the production of Cordyceps, a valuable medicinal fungus.
- Pupal waste is collected and processed under controlled conditions to facilitate the growth of Cordyceps fungus.
- Cordyceps is known for its medicinal properties and is used in traditional medicine for various

health benefits, including boosting immunity and improving energy levels (Chaubey *et al*. 2019; Vishaka *et al*. 2021, Narzary *et al*. 2024).

5. Utilization of Waste Pupa for Fish Feed:

- CTRTI has developed fish feed from pupal waste, a byproduct of tasar silk production.
- Pupal waste, abundant in protein and essential nutrients, undergoes processing to create balanced fish feed.
- This initiative offers a sustainable and cost-effective alternative for aquaculture farmers.
- Commercialization of the fish feed product contributes to the sustainability of the tasar silk industry.
- It also supports the growth and development of the aquaculture sector (Vishaka *et al*., 2021).

Temperature Regulation:

The Central Tasar Research & Training Institute (CTRTI) plays a significant role in temperature regulation by:

1. Afforestation and Tree Plantation:

- CTRTI actively promotes afforestation and tree plantation efforts as part of its sustainable land management practices.
- The institute strategically plants a variety of tree species, including Arjun, Asan, Jarul, Natural Sal Forest, and Quercus etc. (Table) across its campus and farm areas.
- Trees play a crucial role in temperature regulation by providing shade and transpiring water vapour, thus cooling the surrounding environment.
- Trees act as natural windbreaks, reducing wind speed and maintaining more stable temperatures in the region.
- Vegetation, including trees, has a higher albedo compared to built surfaces like concrete and asphalt. This means that trees reflect more sunlight and absorb less heat, helping to mitigate the urban heat island effect and reduce local temperatures (Arora & Montenegro 2011; Shen *et al*., 2019).

2. Agroforestry:

- CTRTI promotes agroforestry systems that integrate trees with agricultural crops.
- Agroforestry practices enhance microclimate regulation by providing shade to crops and reducing soil erosion, contributing to temperature moderation (Liu *et al*., 2019; Pancholi *et al*., 2023).

3. Soil Management and Moisture Retention:

- CTRTI emphasizes soil management practices such as cover cropping and soil conservation techniques.
- Cover cropping helps maintain soil moisture and temperature by providing ground cover reducing evaporation and controlling the weed (Kaspar & Singer 2011; Kuo *et al*. 1997; Haramoto & Gallandt 2004, Fageria *et al*. 2005).
- Soil conservation measures prevent soil erosion and promote soil health, indirectly contributing to temperature regulation by maintaining stable soil conditions.

4. Research and Innovation:

- CTRTI conducts research on climate-resilient agriculture and innovative technologies for temperature regulation.
- The institute explores the use of drought-tolerant food plants varieties and CTRTI explores various methods to optimize water use and minimize water stress on plants.
- By fostering research and innovation in sustainable sericulture, CTRTI contributes to the development of effective strategies for temperature regulation and climate adaptation.

Environmental Impact Mitigation:

Central Tasar Research & Training Institute (CTRTI) contributes to air quality improvement, carbon sequestration, and other environmental impact mitigation efforts

1. Air Quality Improvement:

- CTRTI's afforestation and tree plantation initiatives play a significant role in improving air quality by sequestering atmospheric carbon dioxide and releasing oxygen through photosynthesis (FAO, 1985).
- The institute strategically plants a variety of tree species, including Arjun, Asan, Jarul, Natural Sal forest, Quercus etc. (Table) which act as natural air purifiers by filtering pollutants and particulate matter from the atmosphere.
- Trees also absorb harmful gases such as sulfur dioxide, nitrogen oxides, and ozone, thereby reducing air pollution levels and mitigating the adverse effects on human health and the

environment (Nowak *et al*., 2014; Beckett *et al*., 2000; Li *et al*. 2023).

- Additionally, CTRTI's promotion of agroforestry practices helps create green spaces that enhance air quality and contribute to the overall well-being of local communities.

2. Carbon Sequestration:

- CTRTI's tree plantation and agroforestry initiatives contribute to carbon sequestration, a process by which atmospheric carbon dioxide is absorbed and stored in biomass, soils, and other organic materials.
- Trees act as carbon sinks, absorbing CO_2 from the atmosphere during photosynthesis and storing it in their biomass, including roots, stems, branches, and leaves.
- Agroforestry practices, which integrate trees with agricultural crops and enhance carbon sequestration by increasing vegetation cover and organic matter in the soil.
- Through its sustainable land management practices, CTRTI helps mitigate climate change by sequestering carbon and reducing greenhouse gas emissions, thus contributing to global efforts to combat climate change and promote environmental sustainability (Lal, 2008; Lal *et al*., 2015; Bruce *et al*., 1999; Lal 2005).

3. Water Quality and Quantity Management:

- CTRTI's soil conservation measures, such as cover cropping, sunhemp and dhaincha are used for cover cropping which not only helps prevent soil erosion its also helps in nitrogen fixation and improves water quality by reducing sedimentation and runoff into water bodies.
- CTRTI, promotes water management techniques such as rainwater harvesting and water-efficient farming practices.
- Rainwater harvesting helps capture and store rainwater for agricultural and other uses, reducing reliance on groundwater and surface water sources.
- Water-efficient farming practices, such as conservation tillage, help minimize water wastage and improve water use efficiency in agriculture (Wang 2006; Babu *et al*., 2023; Deng *et al*., 2023).

4. Ecosystem Restoration and Biodiversity Conservation:

- CTRTI's extends support for afforestation, agroforestry, and habitat restoration initiatives contribute to ecosystem restoration and biodiversity conservation by creating and enhancing habitats for a variety of plant and animal species.
- The institute's gene bank of tasar food plants and research on endangered plant species help safeguard genetic diversity and preserve native ecosystems.
- CTRTI is also putting efforts to conserve important ecoraces of tasar silkworm in their ecological niche.

5. Education and Outreach:

- CTRTI conducts education and outreach programs to raise awareness about environmental issues and promote sustainable practices among stakeholders.
- Through workshops, training sessions, and community engagement activities, CTRTI empowers individuals and communities to take action towards environmental conservation and sustainability.

Fig. : Plantation in Main Campus area

Conclusion

In conclusion, the Central Tasar Research & Training Institute (CTRTI) stands as a beacon of sustainable practices and environmental stewardship in the realm of sericulture. Through its multifaceted initiatives spanning biodiversity conservation, waste management, temperature regulation, and environmental impact mitigation, CTRTI exemplifies a holistic approach to fostering a sustainable environment.

The institute's dedication to preserving plant species and protecting insect diversity not only sustains the delicate tasar silk ecosystem but also contributes to overall biodiversity conservation. By promoting sustainable land management practices and advocating for organic farming methods, CTRTI ensures the long-term viability of the tasar silk industry while safeguarding ecological integrity.

Furthermore, CTRTI's innovative waste management strategies, such as vermicomposting and sericin extraction, not only minimize environmental pollution but also generate valuable byproducts with industrial applications. The institute's efforts in temperature regulation through afforestation, agroforestry, and soil management contribute to climate resilience and local microclimate regulation.

Moreover, CTRTI's commitment to environmental impact mitigation extends beyond its research and operational activities to education and outreach programs aimed at raising awareness and empowering stakeholders to adopt sustainable practices.

In essence, CTRTI's contributions to environmental sustainability serve as a model for sericulture institutions worldwide, highlighting the crucial role of research and training institutes in driving positive environmental change while fostering economic growth and social development. As we navigate the challenges of the 21st century, the lessons learned from CTRTI's endeavors underscore the importance of integrating sustainability principles into every facet of our society for a prosperous and harmonious future.

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