



India Achieves 20% Ethanol Blending in Petrol

For Prelims: [Ethanol Blending Programme](#), [Pradhan Mantri JI-VAN Yojan](#), [Carbon monoxide \(CO\)](#), [Hydrocarbons](#), [Flex-Fuel Vehicles](#)

For Mains: Ethanol Blending and Energy Security, Socio-economic and Environmental Impact of Biofuel Promotion.

[Source: DD](#)

Why in News?

India has reached a significant milestone in clean energy by **achieving 20% ethanol blending in petrol in 2025 under the [Ethanol Blending Programme \(EBP\)](#).**

- This rapid progress underlines the country's commitment to energy security, rural income enhancement, and environmental sustainability.

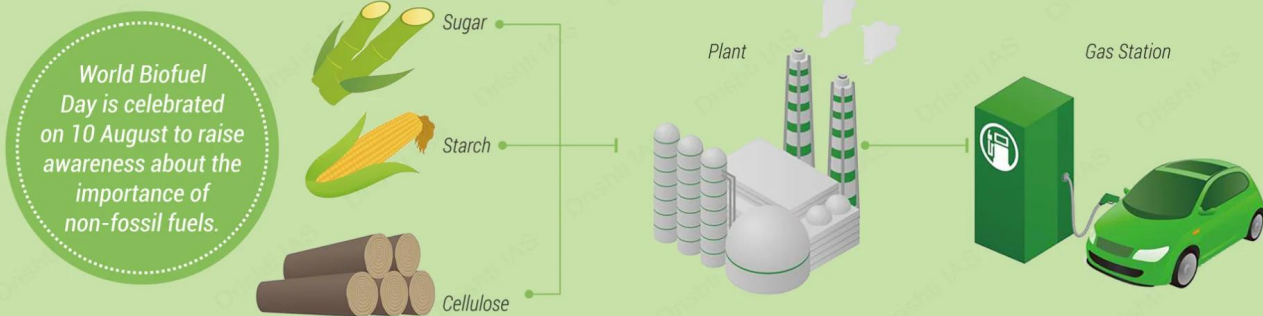
ETHANOL AS A FUEL

About Ethanol

- One of the principal biofuels
- Also called ethyl alcohol (C_2H_5OH)

Produced

- Naturally by fermentation of sugar (or corn, rice etc)
- By petrochemical processes (ethylene hydration)



Ethanol Blending

Blending ethanol with petrol to burn less fossil fuel while running vehicles.

Blending Target

- 20% ethanol blending in petrol (E20) by 2025

Currently, ethanol makes up 10% of the petrol used in vehicles.

Significance

- Reduce oil imports
- Equivalent efficiency at a lower cost than petrol
- Burns completely and cleaner than petrol
- Ethanol produced from farm residue to boost farmers' income

Challenges in Success

- High land requirement for sugarcane (+ consequent food prices issue)
- High water requirement of biofuel crops

Related Initiatives

- Roadmap for Ethanol Blending in India (Report by NITI Aayog) (2021)
- E100 Pilot Project (Network for production and distribution of ethanol) (2021)
- Pradhan Mantri JI-VAN Yojana (to boost 2G ethanol projects) (2019)
- The National Policy on Biofuels (2018)

What are the Key Factors Behind India's Ethanol Blending Success?

- Policy and Regulatory Framework:** The [National Policy on Biofuels \(2018, amended in 2022\)](#) advanced the 20% ethanol blending target from 2030 to **2025-26**.
 - The policy promotes use of diverse feedstocks: **sugarcane, molasses, corn, damaged food grains, agricultural residues, and even waste biomass**.
 - Flexibility in feedstock choice ensures stable supply and minimizes competition with food security.
 - The **EBP Programme** was institutionalized with regular monitoring and updates.
 - The **National Biofuel Coordination Committee (NBCC)** oversees feedstock use based on surplus declarations.
 - The [Pradhan Mantri JI-VAN Yojana](#) encourages production of advanced biofuels from **agricultural and forestry residues**, industrial waste, and algae, expanding the biofuel ecosystem.
- Infrastructure and Pricing Reforms:**

- **Ethanol Interest Subvention Schemes (EISS):** Financial support (2018–2022) to set up molasses- and grain-based ethanol plants.
- **Long-Term Offtake Agreements (LTOAs):** The LTOAs signed by Public Sector Oil Marketing Companies (OMCs) ensured steady demand, timely payments, and market stability for Dedicated Ethanol Plants (DEPs).
- **Administered Pricing Mechanism:** Assured pricing for ethanol under the EBP Programme, encouraging private participation.
- **GST Reduction:** Reduction of [Goods and Services Tax \(GST\)](#) on ethanol from **18% to 5%** helped **lower production costs and encouraged higher ethanol production** and blending.
- **Amendments to Industries (Development & Regulation) Act, 1953:** Facilitated smooth **interstate and intrastate movement** of ethanol.

What are the Socio-Economic and Environmental Impacts of Ethanol Blending in India?

Socio-economic Impacts

- **Enhanced Farmer Income and Rural Prosperity:** Ethanol procurement till 2025 earned farmers Rs 1.18 lakh crore and distilleries Rs 1.96 lakh crore.
 - New agro-processing and distillery jobs boosted rural employment in states like Uttar Pradesh, Maharashtra, and Bihar.
- **Foreign Exchange Savings and Energy Independence:** India saved Rs 1.36 lakh crore in forex by cutting [crude oil imports](#).
 - Ethanol Blending reduced India's oil import dependency, which is important for managing [trade deficits](#) and geopolitical risk.
- **Promotion of 'Make in India' and Self-Reliance:** Ethanol Blending strengthens domestic energy infrastructure and fosters the bio-economy, aligning with [Atmanirbhar Bharat](#) goals.
- **Price Stabilization and Crop Diversification:** Absorption of **surplus sugarcane and food grains** (e.g., broken rice, maize) stabilizes farm gate prices.
 - Facilitates crop diversification through incentives for non-food feedstocks like sweet sorghum, corn, and biomass.

Environmental Impacts

- **Reduced Greenhouse Gas (GHG) Emissions:** Approx. **700 lakh tonnes of CO₂ emissions avoided** (till 2025), aiding India to reach [Paris Agreement](#) targets.
 - Reduction in vehicular emissions of [carbon monoxide \(CO\)](#), [hydrocarbons](#), and particulate matter with E10–E20 blends.
- **Lower Air Pollution in Urban Areas:** Blended fuel burns more completely, reducing tailpipe pollutants, significant for **air-quality** challenged cities like Delhi and Kanpur.
- **Waste-to-Wealth Utilization:** Conversion of **damaged grains, molasses, crop residues, and agricultural waste** into ethanol reduces landfill burden and methane release, aligns with [circular economy](#) principles.

What are the Challenges in Deeper Ethanol Integration in India?

- **Feedstock Concerns and Food Security:** Ethanol from food crops (sugarcane, rice, maize) may pressure **food supplies**, and in 2024-25 [India became a net importer of maize](#) to meet ethanol demand.
- **Water Scarcity:** Ethanol production is **water-intensive**, grain-based units use 8–12 litres of water per litre of ethanol.
 - Sugarcane and molasses add to high water use, deforestation, and waste. Distilleries release **vinasse**, a toxic wastewater that can pollute rivers.
- **Climate Sensitivity:** Ethanol production depends heavily on climatic conditions affecting crop yields (e.g., droughts, unseasonal rains).
 - Intensive mono-cropping for ethanol production, driven by profitability, may reduce soil

fertility and alter land-use patterns, posing a threat to biodiversity.

- **Industrial Pollution Concerns:** Ethanol distilleries are classified as "**red category**" industries due to their high pollution risk.
 - They emit harmful chemicals like **acetaldehyde, formaldehyde, and acrolein, which can cause respiratory issues and cancer.**
 - In Andhra Pradesh, many units got environmental clearance without public hearings or proper assessments, and are often set up near residential areas.
- **Infrastructure and Logistics Gaps:** Ethanol infrastructure like pipelines, storage, and inter-state coordination needs upgrades.
 - Blending remains uneven across OMCs and states, with rural areas lacking facilities, raising safety and quality concerns.
 - Most existing vehicles in India are **E10-compatible**, E20 leads to marginal fuel efficiency loss unless engines are retuned.
 - Scaling beyond E20 will require industry-wide transition to **Flex-Fuel Vehicles (FFVs)** and fuel distribution upgrades.
- **Second and Third Generation Ethanol Technology:** Still underdeveloped in India, it needs large-scale investment and viability demonstration.

How could India Scale Beyond E20 While Ensuring Sustainability?

Strategy Area	Actionable Measures
Feedstock Diversification	<ul style="list-style-type: none">▪ Support algae-based ethanol (3G Ethanol) under PM JI-VAN Yojana as a greener, waste-to-fuel option.▪ Encourage drought-resilient, low-water crops like sorghum for sustainable biofuel production.
Technology Transition	<ul style="list-style-type: none">▪ Mandate FFV production, offer Production Linked Incentive (PLI) schemes and lower GST benefits to automakers, and scale up ETHANOL100 - compatible fuel stations.
Infrastructure Expansion	<ul style="list-style-type: none">▪ Build pipelines, blending terminals, and green logistics to cut emissions under the National Logistics Policy (NLP 2022).
Environmental Integrity	<ul style="list-style-type: none">▪ Mandate effluent treatment, recycled water use, reinstate public hearings for environmental clearances, and implement carbon, water, and land-use audits with water budgeting in ethanol-producing states.

Conclusion

India's early achievement of the E20 target marks a significant pivot toward renewable energy and rural prosperity. Going forward, strategic foresight and inclusive policy design will be crucial in **advancing ethanol blending beyond 20%, without compromising food security or environmental resilience.**

Drishti Mains Question:

India has achieved its E20 ethanol blending target. Discuss the factors behind this success and its implications for energy security and rural economy.

UPSC Civil Services Examination, Previous Year Questions (PYQ)

Prelims

Q. Given below are the names of four energy crops. Which one of them can be cultivated for ethanol? (2010)

- (a) Jatropha
- (b) Maize
- (c) Pongamia
- (d) Sunflower

Ans: (b)

Q. According to India's National Policy on Biofuels, which of the following can be used as raw materials for the production of biofuels? (2020)

1. Cassava
2. Damaged wheat grains
3. Groundnut seeds
4. Horse gram
5. Rotten potatoes
6. Sugar beet

Select the correct answer using the code given below:

- (a) 1, 2, 5 and 6 only
- (b) 1, 3, 4 and 6 only
- (c) 2, 3, 4 and 5 only
- (d) 1, 2, 3, 4, 5 and 6

Ans: (a)

Mains

Q. "Access to affordable, reliable, sustainable and modern energy is the sine qua non to achieve Sustainable Development Goals (SDGs)". Comment on the progress made in India in this regard. (2018)

1,000 Years of Rajendra Chola I's Maritime Expedition

For Prelims: Thiruvallangadu Inscription, Battle of Kandalur Salai, Cholas, [Pandyas](#), Cheras, [Chalukyas](#), Nagapattinam, [Local Self-Government](#), [Brihadeshwara Temple](#), [Dravidian Temple Architecture](#), [UNESCO](#), Gangaikonda Cholapuram, Airavateshvara Temple, Dakshina Meru, [Mural Paintings](#), [Bharatanatyam](#), [Nataraja Statue](#)

For Mains: Contribution of Chola dynasty in Indian history, Art & Architecture of Chola dynasty.

[Source: IE](#)

Why in News?

The **Prime Minister** visited **Gangaikonda Cholapuram** in **Ariyalur district, Tamil Nadu**, during the **Aadi Thiruvathirai festival**, and the **Brihadisvara Temple** ([UNESCO World Heritage Site](#)).

- He highlighted the **Chola Empire's democratic traditions**, and released a **commemorative coin** marking **1000 years of Rajendra Chola I's Gangetic expedition**.
 - The **Aadi Thiruvathirai Festival** commemorated 1,000 years of Rajendra Chola I's legendary maritime expedition to Southeast Asia and also marked the rich **Tamil Shaiva Bhakti tradition**.

What are the Key Facts About Rajendra Chola I?

- **About: Rajendra Chola I (1014 to 1044 AD)**, son of Rajaraja Chola I, was one of the greatest rulers of the **Chola Empire**.
 - He was the **first Indian king to lead overseas military expeditions**, extending Chola influence across **South and Southeast Asia**.
- **Titles and Legacy:** He assumed titles like **Gangaikonda Cholan** (after defeating the Palas in Bengal) and **Kadaram Kondan** (after naval victories in the Srivijaya Empire), **Pandita Cholan**, and **Mudikondan**.
 - Founded a new capital, **Gangaikondacholapuram**, to commemorate his northern conquests.
 - Built **Brihadisvara Temple (Gangaikondacholeeswaram)** and **Chola Gangam Lake (Ponneri)** in present-day **Ariyalur, Tamil Nadu**.
- **Military and Naval Prowess:** He reasserted control over **Chera** and **Pandya** regions; defeated **Jayasimha II** of Western Chalukyas, **Tungabhadra River** became the northern frontier.
 - His conquests included **Sri Lanka, Maldives, Nicobar, Lakshadweep, Kedah, Tambralinga, and Burma**, establishing one of India's earliest **blue-water navies**.
- **Trade, Culture, & Administration:** Under his rule, **Tamil merchant guilds** like *Manigramam* and *Ayyavole* thrived, fostering **trade and cultural exchange** with China and Southeast Asia.
 - Promoted **Shaivism**, patronized **Chidambaram's Nataraja Temple**, yet maintained religious **tolerance** toward **Vaishnavism** and **Buddhism**.

Chola Dynasty

- One of the three major **Tamil dynasties**, alongside **Cheras and Pandyas**, and among the longest-ruling powers in South India.
- Founded by **Vijayalaya Chola** in the 9th century AD after defeating the Pallavas.
- The empire expanded across **South India, Sri Lanka, and parts of Southeast Asia**.
- It reached its peak under **Rajaraja Chola I and Rajendra Chola I**, known for military conquests and administrative excellence.
- Declined with the resurgence of the Pandyas in the 13th century.
- **Key Rulers:**
 - **Vijayalaya Chola:** Founder, captured Tanjore.
 - **Aditya Chola I:** Defeated Pallavas, annexed Tondaimandalam.
 - **Parantaka Chola I:** Won battles, forged alliances, but suffered defeat at Takkolam.
 - **Rajaraja Chola I:** Built Brihadeeswara Temple, expanded empire.
 - **Rajendra Chola I:** Continued Rajaraja's legacy, including naval conquests.
 - **Kulothunga Chola I:** Strengthened administration, promoted trade.
 - **Rajaraja Chola II:** Marked the decline of the Chola Empire.

Read More:

- [Chola Dynasty](#)
- [Raja Raja I and Chola Administration](#)



What are the Key Features of Chola Administration & Architecture?

Chola Administration

- **Centralised Monarchy with Decentralised Governance:** The **Chola Empire** maintained a **centralised monarchy**, headed by king and supported by a structured **ministerial council**, with high officials called **Peruntaram** and lower ones as **Siruntaram**.
 - Capitals like **Tanjore** and **Gangaikondacholapuram** symbolised imperial power, and **royal tours** helped improve governance.
- **Provincial and Local Administration:** The empire was divided into **Mandalams** (provinces), **Valanadus**, **Nadus** and **Urs** (villages).
 - Towns or **Nagarams** were run by merchant guilds (**Nagarattar**), while **Nattar** governed

Nadus and **Periyannattar** managed Valanadus. **Local self-governance** was strong, especially at the village level.

- **Village Self-Governance & Early Democratic Practices:** Village assemblies- **Sabhas** (Brahmin villages) and **Urs** (non-Brahmin villages) had real power over revenue, justice, irrigation, and temples.
 - A unique **Kudavolai system (palm-leaf ballot)**, where the names of eligible candidates were placed in a pot and drawn by a child in public ensured **transparent village elections**.
 - **Eligibility to contest** included **owning tax-paying land ($\geq \frac{1}{4}$ veli)**, being aged **30-70**, local residency, and knowledge of **Vedas or administration**.
 - **Disqualifications** included **alcoholism, crime, unpaid debts, kinship with officials, or prior misconduct**.
 - **Accountability** was ensured through **annual audits**.
 - However, the system excluded **women, landless labourers, and lower castes**, reflecting its **hierarchical and non-inclusive** nature.
- **Revenue Administration:** The **revenue system** was managed by a department called **Puravuvarithinaikkalam**, with **land surveys and classification**.
 - **Temple lands** and **Ur Nattam** (residential zones) were tax-free. The **main source of revenue** included **land revenue (1/6th of produce)**, paid in cash or kind.
 - Other taxes included tolls, **customs, profession tax, marriage dues, salt pans**, etc. **Kulottunga I** abolished tolls and earned the title "**Sungam Tavirtta Cholan**".
 - Expenditure included **royal court, army, irrigation, roads, canals**.
- **Military Administration:** Cholas maintained a strong **4-fold army: Infantry, Cavalry, Elephants, Navy** and key forces included **Kaikkolaperumpadai** (royal army) and **Velaikkarar** (bodyguards).
 - Training was held at **Kadagams** (cantonments). The **navy** was powerful, securing **Bay of Bengal dominance** and influence in **Sri Lanka and Southeast Asia**.
- **Trade and Economic Administration:** Internal trade was organized via powerful merchant guilds like **Manigramam, Ayyavole, and Nanadesis**.
 - **Urban merchant bodies (Nagarams)** played a role in civic and economic governance.
 - Chola ports like **Puhar** supported flourishing **maritime trade** with **West Asia, China, and Southeast Asia**.
 - **Exports** included textiles, spices, gems and **imports** included luxury items, horses. **Urban guilds (Nagarams)** aided civic governance.

Chola Art and Architecture:

- The **Dravidian style** of temple architecture reached its **peak under the Cholas**.
 - The defining feature is the **Vimana** (tower over the sanctum). Temples typically included components like **vimana, arddhamandapa, mahamandapa, and Nandimandapa** (pavilion for Nandi).
- Early examples include temples at **Narthamalai, Kodumbalur, and Srinivasanallur**. Major temples like the **Brihadisvara Temple in Thanjavur** (by Rajaraja I), **Gangaikondacholapuram** (by Rajendra I), **Airavatesvara Temple (Darasuram)**, and **Kamaharesvara Temple (Tribhuvanam)** show their architectural brilliance.
- Chola temples like **Tanjore** and **Gangaikondacholapuram** are adorned with **large, finely executed sculptures**.
 - The **Chola bronze sculptures**, especially the image of **Nataraja (dancing Shiva)**, are globally renowned for their **aesthetic beauty, grace, and craftsmanship**.
- **Chola paintings** were found on temple walls at **Narthamalai and Tanjore**, reflecting both religious and secular themes.

Brihadeeswarar Temple (Gangaikonda Cholapuram Temple) Ariyalur

- Built by **Rajendra Chola I (1014 to 1044 AD)** to commemorate his **Gangetic expedition**, this temple marked the **shift of Chola capital** from Thanjavur to **Gangaikonda Cholapuram**, which remained the **imperial seat until 1279 AD**.
- Dedicated to **Lord Shiva**, the temple (Gangaikondacholisvarar) reflects **refined Dravidian architecture**, surpassing even the earlier **Brihadisvara Temple** built by his **father Rajaraja**.

Chola I, symbolising both **military glory and religious devotion**.

- The annual **Aadi Thiruvathirai festival** celebrates Rajendra's **birth star (Thiruvadhirai)** with **Therukoothu performances** and ceremonial offerings, reflecting the dynasty's **cultural legacy**.
- Supported by inscriptions from **1027 & 1068 AD** and the **Esalam copper plates (1036 AD)**, the temple received sustained royal patronage under Chola rulers like **Virarajendra**.
- It was declared a **UNESCO World Heritage Site in 2004**, along with the **Airavatesvara Temple at Darasuram**. **Thanjavur temple** was earlier included in **1987**, all together forming the **Great Living Chola Temples**.



Drishti Mains Question:

Examine the architectural contributions of the Chola dynasty, particularly the Dravidian temple style. How did these architectural achievements reflect the empire's cultural and religious values?

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims

Q. The Nagara, the Dravida and the Vesara are the (2012)

(a) three main racial groups of the Indian subcontinent

(b) three main linguistic divisions into which the languages of India can be classified

(c) three main styles of Indian temple architecture

(d) three main musical Gharanas prevalent in India

Ans: (c)

Mains

Q: (a) Discuss the Tandava dance as recorded in the early Indian inscriptions.

(b) Chola architecture represents a high watermark in the evolution of temple architecture. Discuss. (2013)

Q. Indian philosophy and tradition played a significant role in conceiving and shaping the monuments and their art in India. Discuss. (2020)

Mission for Cotton Productivity

For Prelims: Mission for Cotton Productivity, Textile Vision 2030, "5F" approach, [Bt \(Bacillus thuringiensis\) cotton](#), [Bollgard-II](#), [PM MITRA Scheme](#), [Cotton Corporation of India \(CCI\)](#), [Digital Agriculture Mission 2021-25](#), [Cott-Ally Mobile App](#)

For Mains: Need of the Mission for Cotton Productivity, Government initiatives for the Development of Cotton Sector.

[Source: PIB](#)

Why in News?

To strengthen India's **textile value chain** and enhance global competitiveness, the Government has launched the '**Mission for Cotton Productivity**' in line with the **Vision 2030** for the **textile industry**.

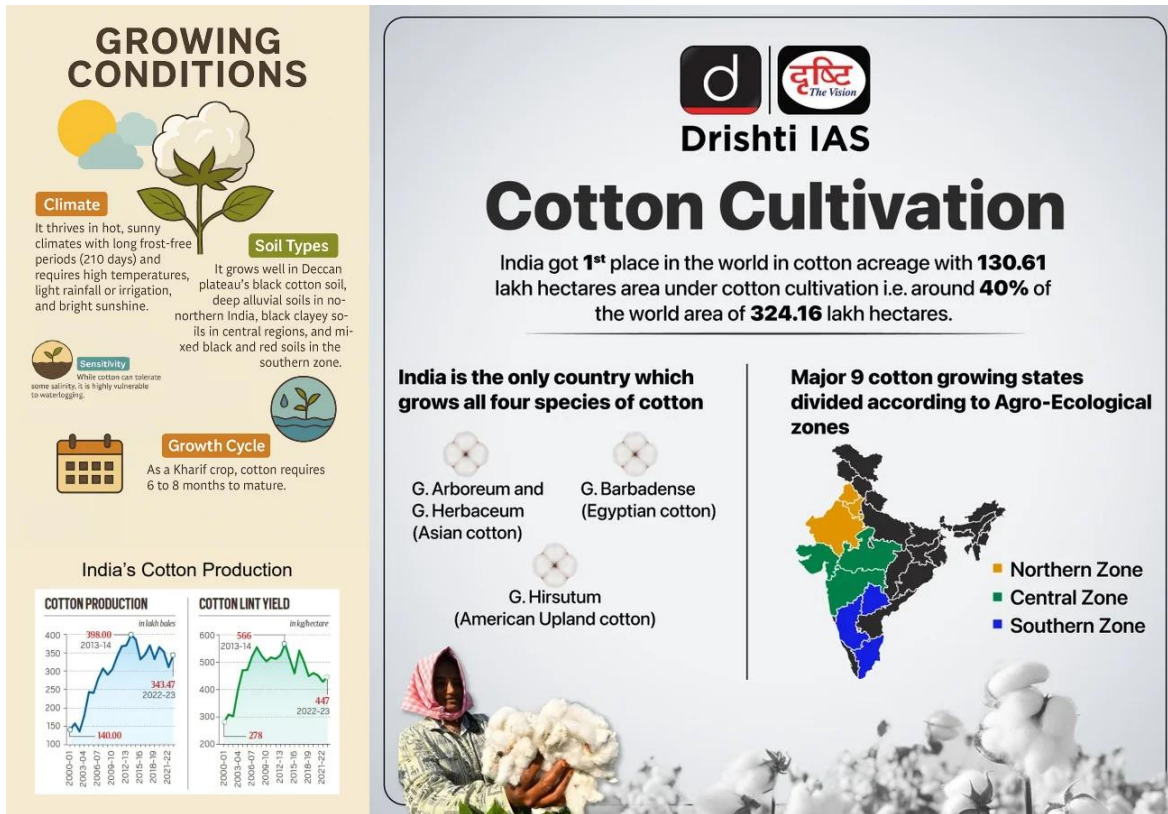
- **Textile Vision 2030 for India** aims at positioning India as a global textiles manufacturing hub by building a **USD 250 billion** textile industry and achieving **USD 100 billion** in global textile exports by 2030.

What is the Mission for Cotton Productivity?

- **About:** It is a **five-year initiative** launched by the **Government of India** in the [Union Budget 2025-26](#) to significantly **enhance cotton production** in the country.
 - It will provide scientific and technological support to cotton farmers, aligning with the Government's 5F vision- **Farm to fibre, fibre to factory, factory to fashion, fashion to foreign** for the textile sector.
 - It seeks to increase farmers' incomes while ensuring a consistent supply of high-quality cotton, vital for revitalizing India's traditional textile industry.
 - The **Department of Agricultural Research & Education (DARE)** is the **nodal agency** for implementing the mission, with the **Ministry of Textiles** as a key partner.

▪ Key Objectives:

- **Enhance cotton productivity** by adopting **advanced scientific methods** and developing **climate-smart, pest-resistant, and high-yielding varieties**, including **Extra Long Staple (ELS) cotton**.
 - **ELS cotton** is known for its **long fibers, superior strength, softness, and durability**.
- Utilize **advanced breeding techniques** and **biotechnology tools** to improve fibre quality.
- Equip farmers with **cutting-edge technology** to build resilience against **climatic and pest-related challenges**.



What are the Reasons Driving the Need for Mission for Cotton Productivity?

- **Low Productivity:** India ranks **1st globally in cotton acreage**, with **130.61 lakh hectares** under cultivation, accounting for **40% of the world's total cotton area (324.16 lakh hectares)**.
 - However, in terms of **productivity**, India stands **39th in the world**, with an average yield of just **447 kg/ha**.
- **Rising Dependence on Imports:** Cotton imports surged from **USD 518.4 million** in 2023-24 to **USD 1.04 billion** in 2024-25, while exports fell from **USD 729.4 million** to **USD 660.5 million**.
- **Stagnation after Success:** Despite the success of **Bt (*Bacillus thuringiensis*) cotton** and **Bollgard-II technologies**, India has not approved any new **genetically modified (GM) cotton variants** since 2006.
- **Infestation:** The decline in **cotton production** is mainly due to the **increased infestation of pink bollworm (PBW)**.
 - Initially, **Bt cotton** offered effective pest control, but over time, **PBW developed resistance to Bt proteins**.
- **Missed Opportunities in Global Markets:** Countries like the US and Brazil, with robust biotech adoption, are capturing the export space once dominated by India.

What are the Key Factors that Influence Cotton Cultivation in India?

- **About Cotton:** Cotton is a fluffy staple fiber that grows in a boll around its seeds.
 - In northern India, cotton is planted between April and May, while in the southern regions, the season is delayed due to monsoon patterns.
- **Production:** India leads the world in cotton acreage, accounting for around 40% of global cotton cultivation. The major cotton-producing regions in India are:
 - India ranks **second globally in cotton production**, with an estimated output of 343.47 lakh bales (5.84 MMT) in 2022-23, contributing to 23.83% of global cotton production.
 - India ranks **39th in global cotton yield**, lagging behind countries like the USA, China, and Brazil.
 - India is the **second-largest cotton consumer globally**, accounting for **22.24% of world consumption in 2023**. Less than 10% of India's cotton consumption is imported by the textile industry.
- **Key Factors Influencing its Cultivation:**
 - Cotton can tolerate **temperatures** up to **43°C** but temperatures below **21°C** are detrimental.
 - Cotton requires **210 frost-free days and 50 to 100 cm of rainfall** for optimal growth.
 - Warm days and cool nights with large diurnal temperature variations during the fruiting period promote better boll and fiber development.
 - Cotton is grown in various soil types, including well-drained deep **alluvial soils** in the northern region, **black clayey soils in the central region**, and **black and mixed soils in the southern zone**.
 - Cotton is semi-tolerant to salinity and sensitive to waterlogging, preferring light, well-drained soils that retain moisture.

India's Initiatives For Development of the Cotton Sector

- [Cotton Development Programme Under the National Food Security Mission \(NFSM\)](#)
- [PM MITRA Scheme](#)
- [Cotton Corporation of India \(CCI\)](#)
- [MSP for Cotton](#)
- [The Kasturi Cotton Bharat programme](#)
- [Cott-Ally Mobile App](#)

What Steps are Needed to Make India Self-reliant in Cotton?

- **Accelerate R&D and Biotech Approvals :** Fast-track approval of **next-generation GM cotton** (Bt 3.0, herbicide-tolerant traits, RNAi technology) to combat **pink bollworm (PBW) resistance**.
 - Brazil and the US have adopted advanced biotech traits, boosting yields beyond 1,500 kg/ha.
- **Promote Extra Long Staple (ELS) Cotton:** **Premium MSP**, contract farming models, and cluster-based approaches are essential to boost ELS cotton adoption and enhance export competitiveness.
 - [Agricultural Export Policy \(2018\)](#) emphasized production of export-oriented varieties.
- **Integrated Pest and Farm Management :** Scale up [Integrated Pest Management \(IPM\)](#) and **area-wide PBW eradication** using **pheromone traps, sterile male techniques, and crop rotation**.
 - [ICAR](#)-CICR's **PBW management protocols** have shown success in Maharashtra.
- **Enhance Market and Export Competitiveness:** Brand "**Kasturi Cotton India**" to promote premium quality and sustainability in global markets.
 - Set up **cotton quality testing hubs** and encourage **cluster-based textile parks** ([PM-MITRA](#)).

- **Digital Cotton Ecosystem : AI-driven pest alerts, remote sensing for yield monitoring, and blockchain for traceability** can modernize the cotton value chain.
 - [Digital Agriculture Mission 2021-25](#) advocates the use of emerging technologies in agriculture.
- **Climate-Smart Cotton Cultivation : Adopt micro-irrigation, organic farming, and precision nutrient management to improve yields and lower input costs.**
 - [Ashok Dalwai Committee](#) recommends **climate-resilient practices** to address water stress.

Conclusion:

If implemented with urgency and scientific rigour, the Mission can **lift yields, cut import dependence, revive exports, raise farmer incomes, and green the cotton value chain**, directly advancing [SDG-2](#) (Zero Hunger & productivity), [SDG-8](#) (Decent Work & growth), [SDG-9](#) (Innovation).

Drishti Mains Question:

Mission for Cotton Productivity is a strategic initiative to boost India's textile value chain. Discuss the key objectives and implementation strategy of this mission in the context of Textile Vision 2030.

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims:

Q. Which of the following activities constitute real sector in the economy? (2022)

1. Farmers harvesting their crops
2. Textile mills converting raw cotton into fabrics
3. A commercial bank lending money to a trading company.
4. A corporate body issuing Rupee Denominated Bonds overseas.

Select the correct answer using the code given below:

- (a) 1 and 2 only
- (b) 2, 3 and 4 only
- (c) 1, 3 and 4 only
- (d) 1, 2, 3 and 4

Ans: (a)

Mains:

Q. Analyse the factors for highly decentralized cotton textile industry in India. (2013)

International Tiger Day 2025

[Source: IE](#)

Why in News?

International Tiger Day (also known as **Global Tiger Day**) on 29th July raises awareness about tiger (*Panthera tigris*) conservation and also highlights the **Amur tiger (*Panthera tigris altaica*)**, the world's largest wild cat.

History of International Tiger Day

- Global Tiger Day was instituted at the **2010 Saint Petersburg Tiger Summit, Russia** where 13 tiger-range countries, including India, Bhutan, Nepal, Malaysia, and Bangladesh came together in response to the sharp decline in tiger populations.
 - The summit launched the **Tx2 initiative**, aiming to double the wild tiger population by 2022.

How has India Contributed to the Conservation of Tigers?

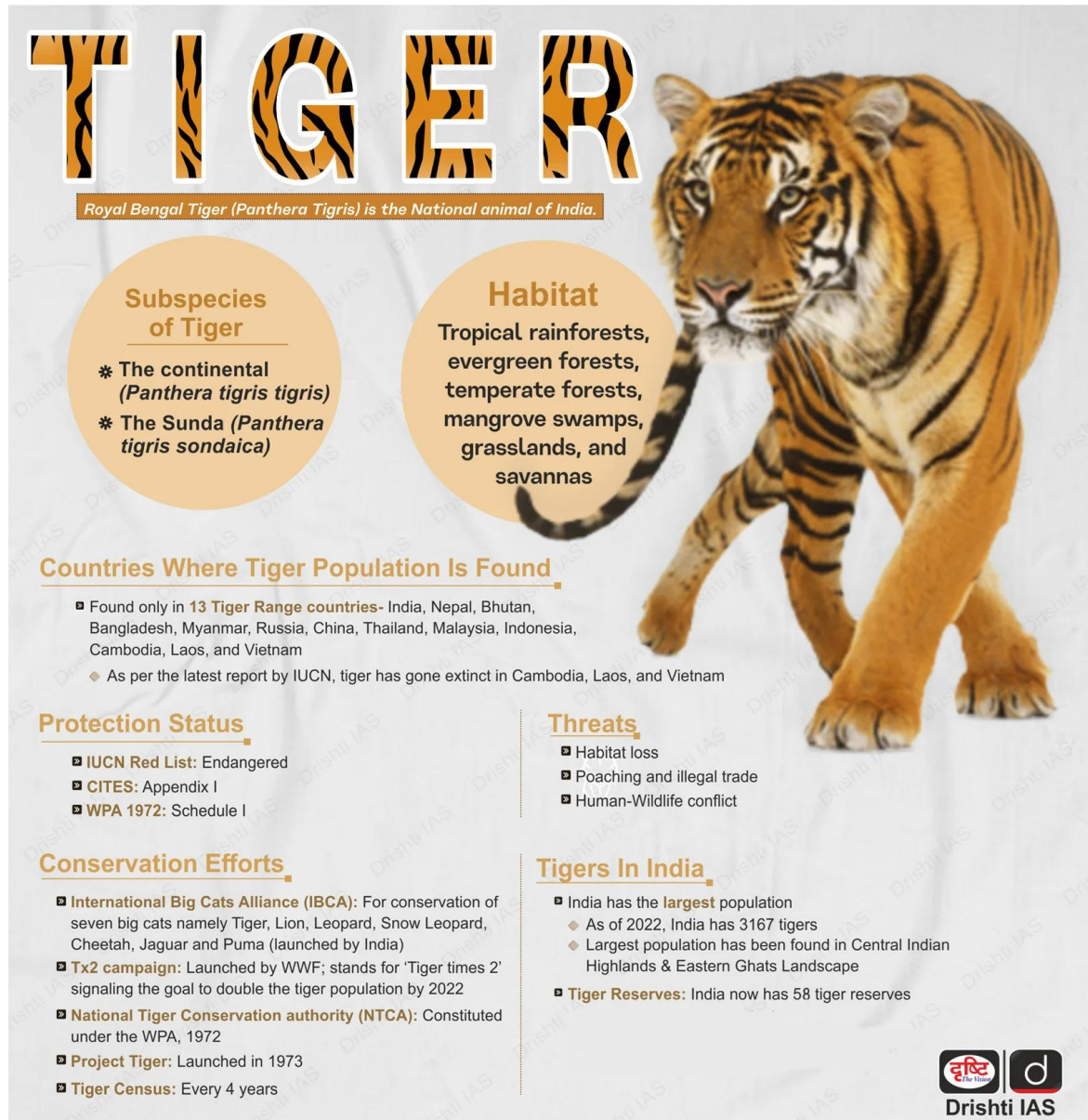
- **Need for Conservation:** In the early 1900s, India had around 1 lakh tigers. By 1972, the number had dropped sharply to just 1,827.
 - Alarmed by this, India launched **Project Tiger in 1973** to protect Bengal tigers (*Panthera tigris tigris*) and their habitats.

Project Tiger

- **About:** It is a **Centrally Sponsored Scheme**, provides **60% Central Assistance to most states for non-recurring expenses and 50% for recurring costs**, with states matching the rest.
- **Primary Aim:** Ensure a viable population of Bengal tigers in natural habitats.
- **Key Steps Taken:** Establishment of **tiger reserves** with a **core-buffer** strategy to **protect habitats in core zones** while allowing sustainable human activities in buffer zones.
 - The **National Tiger Conservation Authority (NTCA)** set up under the **Wildlife Protection Act, 1972**, oversees Project Tiger and conducts the **national tiger census every four years (last census done in 2022)**.
- **Progress:** Launched in 1973 with 9 reserves, Project Tiger now covers over 50 reserves across 18 states, spanning about 2.2% of India's land.
 - Tiger numbers rose from 1,827 in 1973 to an estimated 3,682 (avg) with an upper limit of 3,925 as per 2022 data.
 - **Madhya Pradesh has the largest tiger population**, followed by Karnataka, Uttarakhand, and Maharashtra.
 - Reserves with the highest tiger numbers are **Corbett** (Uttarakhand), **Bandipur** (Karnataka), **Nagarhole** (Karnataka), and **Bandhavgarh** (Madhya Pradesh).
 - **Nagarjunsagar-Srisailem Tiger Reserve (Andhra Pradesh)** is the largest tiger reserve in India
 - India now hosts around 75% of the world's tiger population. The population has **more than doubled in the last two decades**, with a growth rate of **6.1% per year**.
 - The Project Tiger and Project Elephant Scheme has been merged from FY 2023-24 and is now **known as Project Tiger & Elephant**.
- **Iconic Figures:**
 - **Machli (T-16)** a famous tigress from **Ranthambore**, often called the '**Queen Mother of Tigers**' and '**Tigress Queen of Ranthambore**.' She became the **poster face of Project Tiger**.
 - **Kailash Sankhala**, known as the **Tiger Man of India**, was the first director of Project Tiger.
- **Cultural Significance:** The **Royal Bengal Tiger is India's national animal** and is deeply rooted in Indian mythology and pride.

Amur Tiger

- The Amur tiger, or **Siberian tiger** is the **largest tiger subspecies and the biggest wild cat on Earth**.
- Native to **Russia's Far East**, it's adapted to harsh winters with thick fur and body fat. Solitary and territorial, it preys on wild boar, deer, and sometimes bears. It faces threats like **poaching and habitat loss**.
- In the Russian Far East, indigenous groups like the **Udeghe, Nanai**, and **Oroch** spiritually revere the **Amur tiger**, seeing it as a forest guardian.
 - This mirrors tiger-linked beliefs in South Asia, like **Bon Bibi in the Sundarbans**.



The infographic features a large tiger illustration on the right side. The word 'TIGER' is written in large, stylized letters with a tiger stripe pattern. Below it, a caption states: 'Royal Bengal Tiger (Panthera Tigris) is the National animal of India.' The infographic is divided into several sections with orange circular highlights for 'Subspecies of Tiger' and 'Habitat'. It lists countries where tigers are found, their protection status, threats, conservation efforts, and their status in India. Logos for 'Drishhti IAS' are visible in the bottom right corner.

TIGER

Royal Bengal Tiger (*Panthera Tigris*) is the National animal of India.

Subspecies of Tiger

- * The continental (*Panthera tigris tigris*)
- * The Sunda (*Panthera tigris sondaica*)

Habitat

Tropical rainforests, evergreen forests, temperate forests, mangrove swamps, grasslands, and savannas

Countries Where Tiger Population Is Found

- Found only in 13 **Tiger Range countries**- India, Nepal, Bhutan, Bangladesh, Myanmar, Russia, China, Thailand, Malaysia, Indonesia, Cambodia, Laos, and Vietnam
- ◆ As per the latest report by IUCN, tiger has gone extinct in Cambodia, Laos, and Vietnam

Protection Status

- IUCN Red List: Endangered
- CITES: Appendix I
- WPA 1972: Schedule I

Threats


- Habitat loss
- Poaching and illegal trade
- Human-Wildlife conflict

Conservation Efforts

- **International Big Cats Alliance (IBCA)**: For conservation of seven big cats namely Tiger, Lion, Leopard, Snow Leopard, Cheetah, Jaguar and Puma (launched by India)
- **Tx2 campaign**: Launched by WWF; stands for 'Tiger times 2' signaling the goal to double the tiger population by 2022
- **National Tiger Conservation authority (NTCA)**: Constituted under the WPA, 1972
- **Project Tiger**: Launched in 1973
- **Tiger Census**: Every 4 years

Tigers In India

- India has the **largest** population
 - ◆ As of 2022, India has 3167 tigers
 - ◆ Largest population has been found in Central Indian Highlands & Eastern Ghats Landscape
- **Tiger Reserves**: India now has 58 tiger reserves


Drishhti IAS

Tiger Reserves in India



UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. Among the following Tiger Reserves, which one has the largest area under “Critical Tiger Habitat”? (2020)

- (a) Corbett
- (b) Ranthambore
- (c) Nagarjunasagar-Srisailem
- (d) Sundarbans

Ans: (c)

Q. Consider the following protected areas: (2012)

1. Bandipur
2. Bhitarkanika
3. Manas
4. Sunderbans

Which of the above are declared Tiger Reserves?

- (a) 1 and 2 only
- (b) 1, 3 and 4 only
- (c) 2, 3 and 4 only
- (d) 1, 2, 3 and 4

Ans: (b)

Indian Railways Tests First Hydrogen-Powered Coach

[Source: IE](#)

Why in News?

[Indian Railways](#) has successfully tested its **first hydrogen-powered coach** at the Integral Coach Factory (ICF) in Chennai, as part of its “Hydrogen for Heritage” initiative.

- The project involves converting two 1600 HP diesel power cars into **Hydrogen Fuel Cell** systems and setting up a 3,000 kg hydrogen refuelling station at **Jind, Haryana**.
- The design and testing are being carried out by the [Research Designs and Standards Organisation \(RDSO\)](#).

What are the Key Benefits of Hydrogen as a Power Source?

- **High Energy Density and Versatility:** Hydrogen possesses one of the **highest energy-to-weight ratios** among known fuels, making it exceptionally well-suited for heavy-duty transportation sectors.
 - Furthermore, it **is versatile** and can be used in **fuel cells**, **internal combustion engines**, or as a feedstock in industrial processes.
- **Zero Emission Energy Carrier:** When used in fuel cells, **hydrogen emits only water vapor as a byproduct**, making it a critical enabler of clean mobility and industrial decarbonization.
- **Supports Renewable Energy Integration:** Hydrogen acts as an **energy storage vector**, allowing excess electricity from intermittent **renewable sources** (like **solar and wind**) to be stored in the form of hydrogen via electrolysis.
 - This helps in **grid stabilization, peak shaving, and achieving round-the-clock (RTC) power supply**—a key requirement for energy reliability and sustainability.
- **Decarbonization of Hard-to-Abate Sectors:** **Green hydrogen** enables deep decarbonization of hard-to-abate sectors such as **steel manufacturing, cement production, oil refining, fertilizers, and chemical industries**, where direct electrification is either technically or economically unfeasible.

Note: Hydrogen is central to India's strategy to achieve energy independence and **Net Zero emissions by 2070**. India's **National Green Hydrogen Mission** aims to make the country a global hub for green hydrogen production and export, positioning India as a key player in the emerging hydrogen economy.

- **Hydrogen Fuel Cell:** It is an electrochemical device that converts **chemical energy of hydrogen into electricity through a reaction with oxygen**, with water and heat as the only by-products.
- **Applications of Hydrogen Fuel Cell:**
 - **Transportation:** Powering cars, buses, trucks, trains, and drones.
 - **Stationary Power:** Backup and off-grid power for homes, businesses, and data centers.
 - **Portable Power:** Charging laptops, phones, and equipment in remote areas.
 - **Industrial Use:** Forklifts, cranes, and machinery in warehouses and factories.
 - **Space Exploration:** Powering spacecraft (e.g., NASA uses hydrogen fuel cells particularly in their crewed space missions like the **Apollo**).

What are the Key Technological Developments in Indian Railways?

- **Artificial Intelligence & Automation**
 - **'Gajraj' Elephant Detection System:** AI-based tool using optical fiber to detect elephant movement near tracks.
 - **AI in Namo Bharat (RRTS) Trains:** AI-enabled security surveillance and automated schedule optimization.
- **Rail Safety Technologies**
 - **Kavach (Automatic Train Protection):** Prevents signal passing at danger (SPAD) and over-speeding.
 - Uses RFID to apply brakes automatically.
 - Certified at **SIL-4 level**, error probability: 1 in 10,000 years.
 - **Ultrasonic Flaw Detection (USFD):** Detects rail cracks and flaws to prevent derailments.
 - Used for real-time track condition monitoring.
- **Signalling & Interlocking Systems**
 - **Electronic Interlocking (EI):** Widely adopted to reduce human error and automate signal control.
 - **Automatic Block Signalling (ABS):** Railway signaling system that allows for increased train traffic on high-density routes by **enabling multiple trains to operate simultaneously in the same direction**.
- **Sustainability:**
 - **Bio-toilets:** **Bio-toilets** in Indian Railways use **anaerobic bacteria** to decompose human waste in a sealed biodigester tank, converting it into **water and gases**.

- **Developed by DRDO**, these systems prevent open discharge on tracks, improving hygiene and reducing corrosion.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Q. With reference to bio-toilets used by the Indian Railways, consider the following statements: (2015)

1. The decomposition of human waste in the bio toilets is initiated by a fungal inoculum.
2. Ammonia and water vapour are the only end products in this decomposition which are released into the atmosphere.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

Ans: (d)

The Preah Vihear and Prasat Ta Muen Thom

Source: IE

Thailand and Cambodia have called a **ceasefire** after clashes near **Preah Vihear and Prasat Ta Muen Thom in the Southeast Asian Emerald Triangle**, a region long disputed due to colonial-era borders and cultural claims.

- **Southeast Asian Emerald Triangle:** It refers to a geographically sensitive area where the **borders of Thailand, Cambodia, and Laos meet**, known for its dense **forests** and ancient temples.
- **Preah Vihear:** It is a **Hindu shrine** dedicated to Lord Shiva, located in Cambodia, along the **Thailand-Cambodia border** in the **Dangrek Mountains**.
 - The temple was built around the 11th century by the **Khmer kings Suryavarman I and II**, it is now a **UNESCO World Heritage Site**.
 - The **International Court of Justice (ICJ)** ruled in 1962 (reaffirmed in 2013) that the temple belongs to Cambodia. However, **Thailand has rejected the ICJ's jurisdiction**, keeping tensions alive.
- **Prasat Ta Muen Thom:** It is a 12th-century temple dedicated to Lord Shiva, later adapted for Buddhist use. It is part of a temple group that includes **Prasat Ta Muen (a pilgrim rest house) and Prasat Ta Muen Tot (a hospital shrine)**.
 - Built by Khmer kings **Udayadityavarman II and Jayavarman VII**, the complex reflects **Angkorian architecture**.



Read more: [Angkor City in Cambodia](#)

India's First Private Test Facility for Heavy Water

Source: [IE](#)

TEMA India, a firm based in Mumbai, has opened India's first private facility for testing **heavy water upgrade equipment**, marking a new phase of public-private collaboration in the [nuclear sector](#).

- The facility will **manufacture and test distillation columns** used to upgrade **depleted heavy water (D_2O)** essential for [Pressurised Heavy Water Reactors \(PHWRs\)](#).
 - Usually, [Bhabha Atomic Research Centre \(BARC\)](#) handles the testing, but this move to the private sector aims to **cut project timelines by 1-2 years**.
- **Heavy Water (D_2O)**: Also known as **deuterium oxide**, it consists of two deuterium atoms and one oxygen atom and it is **not radioactive**.
 - Deuterium, a **heavier stable isotope of hydrogen**, present in hydrogen and hydrogen bearing compounds like water, hydrocarbons, etc.
 - Nuclear reactors use heavy water during **construction and refueling**. It acts as both

a **coolant and a moderator in nuclear fission** and must be 99.9% pure.

- During operation, the heavy water gets **depleted and is upgraded through distillation** to restore its purity and maintain efficient reactor performance.
- **India is the largest global producer of heavy water.**
- **India's Nuclear Power:** The nuclear power contributes about 3% to the total electricity generated in the country. India currently has **24 operational reactors** (with an installed capacity of 8,780 MW), with plans to reach **22.4 GW by 2032** and **100 GW by 2047**.

Read more: [India's Nuclear Energy Roadmap](#)

Veer Parivar Sahayata Yojana 2025

Source: [HT](#)

The [National Legal Services Authority \(NALSA\)](#) launched the **Veer Parivar Sahayata Yojana 2025**, a nationwide **legal aid scheme** dedicated to **soldiers, veterans, and their dependents**.

- **Objective:** It aims to provide **free legal aid, advice, and support** to **army and paramilitary personnel and their families**, acknowledging their unique service-related constraints.
 - It will enable **online application filing, video consultations, and dispute resolution through e-Lok Adalats** and online mediation.
- **Pan-India Reach:** The scheme is designed to operate **across all Indian states** ensuring **inclusive national coverage**.
- **Constitutional Basis:** It is rooted in [Article 39A](#) of the Constitution, ensuring **equal justice and legal aid**.
- **Legal Aid Infrastructure:** NALSA will set up **legal aid clinics** at the **district, state, and national levels**.

NALSA

- **About:** NALSA is a statutory body established in **1995** under the **Legal Services Authorities Act, 1987**.
 - It **monitors and evaluates legal aid programs**, ensuring **legal services** for eligible groups like **Women, Children, SC, ST, EWS, Industrial Workers, Persons with Disabilities, and Transgender Individuals**, as per **Section 12 of the Act**.
- **Tiered Structure:** Legal Services Institutions have been established at **all levels**, ranging from **Taluk Courts to the Supreme Court**.

Read More: [Supreme Court Legal Services Committee](#)