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GIST OF YOJANA

Topic : New Frontiers of Freedom

FREEDOM TO INNOVATE

Historical Context : Innovation has been central to human progress, from stone tools and agriculture to industrial, digital and AI revolutions. India's civilisational heritage includes pioneering contributions in mathematics, astronomy, metallurgy, medicine and education through centres like Nalanda and Vikramashila.

Constitutional Ethos : Freedom to innovate is seen as an extension of constitutional rights such as equality (Art. 14), dignity and life (Art. 21), education (Art. 21A) and the duty to develop scientific temper (Art. 51A). It involves the ability to create, solve problems and convert indigenous wisdom into globally relevant solutions.

Policy Push & Funding :

- Union Budget 2025–26 allocated ₹ 20,000 crore for R&D in emerging tech (AI, quantum computing, biotech, semiconductors, clean energy).
- ₹ 10,000 crore Deep-Tech Fund, 10,000 new PM Research Fellowships.
- Creation of Anusandhan National Research Foundation (ANRF) with a ₹ 50,000 crore mandate for inclusive R&D during 2023-28.
- RDI Scheme with ₹ 1 lakh crore corpus to boost private-sector innovation financing.

Grassroots Innovation : National Innovation Foundation supports rural and traditional knowledge-based technologies, filing 1,400+ patents and facilitating 120+ tech transfers. Unnat Bharat Abhiyan links academic institutions with rural development needs.

Digital Public Infrastructure : Platforms like Aadhaar, UPI, DigiLocker, ONDC, and India Energy Stack are enabling inclusive entrepreneurship, MSME participation, transparent energy distribution, and rural digital empowerment.

Sectoral Advances :

- **Health :** Ayushman Bharat Digital Mission (70 crore ABHA IDs), Pharmaceutical Research Incentive Programme, ICMR Action Plan.
- **Agriculture :** Agriculture 4·0 with drones, IoT, AI tools; schemes like ARYA, RKVY-RAFTAAR, Agri-Tech Innovation Hubs.
- **Deep Tech :** Atal Incubation Centres, ATL labs, National Quantum Mission, NM-ICPS.

Global Recognition : India ranks 39th in Global Innovation Index 2024, 6th in patent filings, 49th in Network Readiness Index; third-largest startup ecosystem with 1·57 lakh DPIIT-recognised startups and 100+ unicorns.

Civilisational Shift : Innovation is becoming people-driven, decentralised, and inclusive, blending grassroots ingenuity with high-tech research, aligned with the vision of Viksit Bharat@2047 and Aatmanirbharta.

PEOPLE'S PADMA

The Padma Awards have evolved to honour grassroots changemakers, reflecting inclusivity and recognition of ordinary citizens making extraordinary contributions.

Shri Pandi Ram Mandavi : Tribal Instrument Maker and Wood Carver from Narayanpur, Chhattisgarh; awarded Padma Shri for promoting *Gond Wood Crafts* and creating the bamboo wind whistle 'Sulur' or *Bastar flute*.

- Born in 1957, learnt Muria woodcraft from his father.
- Crafted combs, flutes, swords, battle axes, bows and walking sticks, each telling the story of Muria traditions.
- Advocated for Muria Wood Art nationally, trained artisans, organised workshops and preserved intangible tribal heritage.
- Recognised with multiple awards for safeguarding and promoting Bastar's cultural legacy.

Dr. Venkappa Ambaji Sugatekar : Gondhali Folk Singer from Bagalkot, Karnataka; awarded Padma Shri for preserving *Gondhal folk music* for over seven decades.

- Born in 1943, began singing at age 10, mastered 1,000+ songs and 150 mythological stories by memory.
- Trained over 1,000 students free of cost, ensuring generational continuity of the art form.
- Performed extensively across Karnataka, blending devotional music, storytelling and cultural narratives.
- Called a 'Cultural Torch Bearer' by the Prime Minister; recipient of 30+ awards for cultural preservation.

Both awardees exemplify how Padma Awards now celebrate cultural custodians at the grassroots, reinforcing the importance of protecting intangible heritage for future generations.

INDIA'S WAR AGAINST TERRORISM

1. Shift to Proactive Strategy

- **Post-April 2025 Pahalgam attack :** Launch of Operation SINDOOR targeting terror hubs in Pakistan & PoJK.
- **Precedents** : 2016 Surgical Strikes; 2019 Balakot Airstrike.
- **Message :** Terror facilities across borders are legitimate targets; Pakistan's nuclear deterrence narrative rejected.

2. Strengthening the Domestic Counter-Terrorism Framework

- **Post-2008 Reforms :** Multi-Agency Centre (MAC) for intelligence coordination. National Investigation Agency (NIA) for specialised terror cases. National Intelligence Grid for real-time data sharing.
- **Legal Measures :** PMLA Amendment Rules (2023) to choke terror financing. FATF-compliant frameworks to track illicit money flows.
- **Operational Focus :** Disruption of narco-terror networks. Counter-infiltration operations along LoC/IB. Neutralisation of 'hybrid' militants in J&K.

3. Tackling Radicalisation and Recruitment

- Online propaganda and extremist narratives as primary tools.
- Lone-wolf incidents (*e.g.*, Udaipur, Amravati) highlight new challenges.
- NIA & state agencies running deradicalisation and recruitment disruption programmes.

4. International Cooperation and Diplomacy

- **Platforms :** G20, UNSC, FATF, *No Money for Terror* conference.
- **Focus Areas :** Drone-based attacks; Cryptocurrency & darknet financing.
- **Bilateral Collaborations :** intelligence sharing, extraditions.
- Push for Comprehensive Convention on International Terrorism (CCIT) still blocked by lack of global consensus.

5. Evolving Nature of Pakistan's Proxy War

- Shift from mass-casualty urban terror to low-intensity proxy attacks post-2019.
- Use of groups like TRF & PAFF to mask direct involvement.
- Continued emphasis on 'a thousand cuts' doctrine.

Conclusion

India's CT posture now combines military strikes, intelligence reforms, financial crackdowns, and global engagement to dismantle terror ecosystems and reinforce national security.

SANSKRIT IN CONTEMPORARY TIMES

1. Essence and Relevance

- Sanskrit is more than a language—it is a worldview, intellectual tradition and cultural bridge.
- Despite being over 3 millenia old, it retains and is regaining significance in the digital and global age.
- Offers ancient wisdom to address modern dilemmas.

2. Cultural and Civilisational Role

- Core of India's civilisational heritage—medium of Vedas, epics, arts and sciences.
- Connects philosophical, artistic and ritual traditions.
- Not only India's legacy—impact visible across Asia via Buddhism and cultural exchange.

3. Precision and Technology Potential

- Panini's Aṣṭādhyāyī offers ~4,000 precise rules, akin to algorithms.
- Structure admired by linguists and computer scientists.
- Potential applications in AI, NLP and computational linguistics.

4. Breadth of Knowledge

- Beyond religion, it covers poetry, drama, medicine (*Āyurveda*), astronomy (*Sūrya Siddhānta*), governance (*Arthaśāstra*).
- Relevance in health, sustainability, and integrated knowledge systems.

5. Modern Academia and Digital Initiatives

- Sanskrit is taught globally (Harvard, Oxford, Kyoto, etc.).
- NEP 2020 promotes Sanskrit education in India.
- Digital projects like Sanskrit WordNet, Digital Corpus of Sanskrit and GRETIL make texts widely accessible.

6. Popular Revival

- Spoken Sanskrit movement via *Samskrita Bharati* through workshops, camps, media.
- Global interest from Kerala to California through Sanskrit newspapers, theatre, YouTube.

7. Global Influence

- Influences in Southeast, Central and East Asia.
- Key to an authentic understanding of Yoga, Ayurveda, and philosophical terms like *dharma* and *karma*.

8. Challenges

- Elitist image and caste association.
- Outdated teaching methods.
- Lack of trained scholars and manuscript preservation.
- Need to connect with modern contexts.

9. Way Forward

- Curriculum reform to include contemporary relevance.
- Interdisciplinary integration with sciences, ecology, and ethics.
- Public engagement via media and translation.
- Institutional funding, digitisation and inclusivity.

10. Conclusion

- Sanskrit offers clarity, harmony and universal wisdom in a chaotic age.
- Revival seen in India, Europe and Nepal through conferences, research and community efforts.
- Engaging with Sanskrit connects humanity to deeper cultural and philosophical roots while serving present and future needs.

SANSKRIT KNOWLEDGE SYSTEMS : NEP 2020 INSIGHTS

NEP 2020 elevates Sanskrit from a purely classical subject to an active, interactive tool for safeguarding India's intellectual heritage and civilisational values. It recognises Sanskrit as vital to India's philosophical, scientific and cultural traditions, integrating it into mainstream education.

Sanskrit as the Language of Indian Knowledge Systems : Sanskrit, historically the foremost language for documenting India's philosophical, scientific, and cultural wisdom, is central to Sanskrit Knowledge Systems (SKS), which include philosophy, mathematics, medicine, music, poetics, architecture, linguistics, etc. NEP 2020 positions it as a bridge between ancient and modern knowledge.

Reflections from NEP 2020 : Sanskrit literature surpasses Latin and Greek combined in scope and diversity. The policy sees Sanskrit as vital for interdisciplinary learning, cultural preservation and India's aspiration to be a global knowledge leader.

Reclaiming Ancient Intellectual Traditions : Ancient Indian education integrated intellectual, ethical, emotional and spiritual growth, aiming for self-realisation (Moksha). NEP 2020 draws on this tradition to promote transformative, humanistic education.

Integration of Sanskrit into School Education : Sanskrit is included in the three-language policy and offered at all school levels. NEP recommends innovative, experiential teaching, Simple Standard Sanskrit (SSS), and Sanskrit Through Sanskrit (STS) for natural learning, along with phonetics and pronunciation training to revive oral traditions.

Sanskrit and Multidisciplinary Higher Education : Sanskrit will be mainstreamed in higher education through interdisciplinary integration with mathematics, astronomy, yoga, linguistics and more. New research centres and collaborations with fields like AI and ecology are envisioned.

Preserving Multilingual and Classical Traditions : Alongside Sanskrit, NEP 2020 supports other classical languages like Tamil, Telugu, Kannada, Malayalam, Odia, Pali and Prakrit, emphasising their role in India's civilisational unity.

Ethics, Values and Sanskrit Texts : Sanskrit works like the Panchatantra and Jataka will be used to instil ethics such as ahimsa, seva, satya, and democratic values. The approach uses storytelling and experiential learning for moral and civic development.

Reviving Teacher Education in Sanskrit : To address teacher shortages, NEP proposes a four-year integrated B.Ed. programmes combining Sanskrit mastery with modern pedagogy, digital literacy and inclusive education methods.

Fostering National Identity and Global Citizenship : Sanskrit promotion aligns with NEP's aim to nurture Bharatiyata—an inclusive Indian identity—while making India a global knowledge superpower.

Challenges and Forward Path : Challenges include curriculum standardisation, social perceptions and rural resource gaps. However, NEP's structural reforms—covering curriculum, teacher training, and technology—promise to make Sanskrit a vital part of India's educational and intellectual fabric.

FREEDOM OF GOOD HEALTH

From Policy to People : The Evolution of Ayushman Bharat

Ayushman Bharat, a flagship healthcare reform, aims to ensure financial, social and institutional protection for all citizens. Rooted in the 2017 National Health Policy, it evolved into four pillars—Ayushman Arogya Mandir (AAM), Pradhan Mantri Jan Arogya Yojana (PM-JAY), Ayushman Bharat Digital Mission (ABDM), and Pradhan Mantri Ayushman Bharat Health Infrastructure Mission (PM-ABHIM)—addressing access, digital empowerment and infrastructure.

AB PM-JAY : Financial Assurance with Dignity : Offers cashless, paperless health coverage up to ₹ 5 lakh per family annually, benefiting over 41 crore citizens and preventing medical bankruptcy. It covers diverse procedures, ensures portability, and has inclusive outreach for women and transgender individuals.

Building the Foundation for Resilient Care : AAM and PM-ABHIM strengthen physical infrastructure, disease surveillance, emergency care, and local service delivery, integrating with ABDM for connected healthcare.

ABDM : Empowering Citizens through Digital Health Infrastructure : ABHA IDs, registries for professionals and facilities, and digital gateways ensure secure, portable health data. Innovations like 'Scan & Share' streamline hospital processes, saving time and resources.

Synergy in Motion : One Health Ecosystem : The four pillars work together to provide preventive, curative, and participatory healthcare, ensuring portability, accessibility and dignity across India.

The Road Ahead : Ayushman Bharat is central to Viksit Bharat @2047, focusing on integration, last-mile reach, AI-driven healthcare, and sustaining public trust.

EMPOWERING THE FARMERS

Farmers' Income Security – Multi-pronged Strategy

India has achieved self-sufficiency in major food grains and is striving for oilseed self-reliance. Policies now focus on treating farmers as agri-entrepreneurs and ensuring income security through higher productivity, reduced cultivation costs, fair prices, post-harvest value addition, diversification, product differentiation, risk mitigation, and adoption of technology.

Modernising Farms with Agri Infrastructure : The ₹ 1 lakh crore Agriculture Infrastructure Fund has sanctioned over ₹ 56,300 crore for over 92,000 projects, creating 9 lakh jobs. Mechanisation, subsidised inputs and protection from rising fertiliser costs have reduced farmers' burdens. MSP for 22 crops is fixed at least 1·5 times cost, backed by robust procurement.

Role of FPOs : 10,000 Farmer-Producer Organisations are driving crop diversification, technology adoption and value addition. They enhance bargaining power, enable cluster-based farming, reduce transport costs and improve price realisation.

Digital Agriculture Mission : Agri Stack provides geo-referenced land records, farmer IDs and digital crop surveys to streamline access to loans, procurement, subsidies and advisories. Over 6·5 crore farmer IDs have been created, enabling transparent, Aadhaar-linked services.

SATHI Portal : Ensures seed quality and traceability from breeder to retail level, empowering farmers to make informed seed purchases.

Technology for Sustainable Agriculture : Digitisation, AI, and precision technologies are enabling timely, location-specific decisions, boosting incomes while ensuring food, nutritional and environmental security.

FREEDOM WITH A STEEL RESOLVE

Ancient and Medieval Legacy

- India is renowned for wootz steel, produced in centres like Golconda, Mysore, Gwalior and Thanjavur.
- Used for high-quality arms—Tipu Sultan's curved sword, Rani Lakshmibai's weapons.
- Iron-cased rockets by Tipu Sultan & Hyder Ali (1780) displayed advanced metallurgy.

Decline and Early Modern Transition

- Traditional charcoal-based methods are limited by local ore and fuel exhaustion.
- Raniganj coalfield discovery (1815) enabled coke-based iron production.
- Railways spurred demand for large-scale steelworks in the mid-19th century.

Industrial Beginnings

- Rich hematite deposits in Odisha were found (1903–04).
- First Indian steel plant at Jamshedpur (1908); first ingots rolled in 1912.

Role in Freedom Struggle

- Steel arms and ammunition were used in Kakori Train Robbery (1925) and the Chittagong Arms Raid (1930).

Growth and Legacy

- Steel demand surged during World Wars I & II.
- From 1 million tonnes in 1947 to the 2nd largest crude steel producer today.

August 2025

GIST OF KURUKSHETRA

Topic : AgriTech

AGRICULTURE 4·0 : TOWARDS AGRI-TECH REVOLUTION

India has the potential to transform agriculture into a growth powerhouse by adopting digital technologies such as AI, blockchain, IoT, big data analytics, and robotics, improving farmer incomes and ensuring food security through precision agriculture, reduced wastage, climate resilience, better market linkages and improved farm economics.

Challenges in Indian Agriculture

- **Employment & GDP :** 42·3% workforce, 18·2% GDP contribution.
- **Issues :** Low productivity, high monsoon dependence, small holdings (89·4% < 2 ha), lower yields than the global average, 52% rain-fed farming, post-harvest losses, and livestock sector constraints.
- **Climate Risks** – Increased vulnerability due to climate change impacts.

Idea of Digital Agriculture

Two Paradigms :

1. SmartFarm Digitisation : Direct on-farm deployment of IoT-based sensors, drones, automated irrigation, mobile platforms; improves precision, resource efficiency and climate resilience.

2. SmartAgriSphere Digitisation : System-level solutions like satellite-based monitoring, blockchain-enabled supply chains, weather forecasting, digital market access, credit & insurance platforms.

SmartFarm Digitisation :

- **Technologies :** AI, drones, remote sensing, blockchain for precision farming.
- **Benefits :** Climate-smart practices, reduced pest damage, better water management.
- **Water Concerns :** Overuse of groundwater (70–80% farmers), depletion (17% over-exploited).
- **Sensors :** For irrigation, soil nutrients, fertiliser application, weed mapping.
- **Smartphones :** For field monitoring, GPS mapping, plant diagnostics.
- **Labour Issues :** Tech reduces labour dependency; need for skilling in tech use.

SmartAgriSphere Digitisation :

- **Blockchain :** Ensures traceability, boosts exports.
- **Digital Platforms :** Direct farmer-buyer linkages, AI advisories for weather & pests.
- **Geo-tagging and Remote Sensing :** For soil, crop health and pest monitoring.
- **Livestock Sector :** Tracking health & productivity, automation for quality assurance.
- **Fisheries Sector :** Weather updates, mapping fishing zones and sustainable fishing.
- **Smart Warehousing :** Sensor-based storage monitoring (nascent adoption in India).

Agri Stack India : Comprehensive Agriculture Management System (CAMS)

- **Purpose :** Data-driven decision-making & policy planning.
- **Components :** Farmer identity (Aadhaar-linked), land records, soil health, crop data, weather alerts, market prices, credit & insurance records, scheme integration.
- **Features :** Real-time dashboards, personalised advisories, strong data protection.

Way Forward

Key Areas to Strengthen :

- Rural digital infrastructure (high-speed internet, power supply).
- Affordability of tech solutions.
- Regulations for drones, AI and cyber-security.
- Training and Capacity Building for farmers, especially women, tribal communities and landless workers.
- Extension services to evolve with digital tools.

Government Initiatives and Opportunities

- **Schemes :** PM-KISAN, Digital India, KCC, Soil Health Cards, PMFBY.
- **Infrastructure :** Broadband to 2·5 lakh villages.
- **Institutional Support :** ICAR institutes, agri universities, KVKs, PACS, FPOs.
- **International Year of Cooperatives (2025) :** Opportunity to promote digital cooperatives.

Conclusion

Agriculture 4·0 is not just technology adoption but a nationwide movement to empower every farmer, strengthen rural communities and build climate-resilient agricultural systems. With coordinated efforts, India can emerge as a global leader in agri-tech innovation.

CONSERVATION AGRICULTURE : PRACTICES AND PERSPECTIVES

From Green Revolution to Conservation Agriculture

The 1960s Green Revolution made India food-secure but led to soil degradation, water stress and air pollution by the late 1980s. This prompted the development of sustainable, eco-friendly practices under the concept of *Conservation Agriculture (CA)*.

Sustainability is the Key

FAO defines CA as a system ensuring food security, profitability and natural resource protection. Key principles :

1. Minimum Soil Disturbance : Zero tillage (ZT) and direct seeding to prevent erosion and maintain organic matter.

2. Permanent Organic Soil Cover : Mulching for moisture retention, temperature control and biodiversity.

3. Crop Diversification : Crop rotations to improve soil health and reduce pests.

Zero-Tillage : A Game Changer

ZT eliminates ploughing, allowing direct sowing into fields with residues. Machines like Zero-Till Seed-cum-Fertilizer Drill enable efficient sowing. Benefits include reduced costs, less water use and residue management, especially in rice-wheat belts.

Research, Support and Adoption

ICAR and global bodies (CIMMYT, IRRI, BISA) promote CA through schemes like NICRA and CSISA. The government supports machinery subsidies but lacks a dedicated CA policy.

Success Story : Rajapur, Bihar

100% ZT wheat adoption increased yields (3·5–4 to 5·5 tonnes/ha) and reduced costs, inspiring nearby farmers.

Benefits and Beyond

- Cost reduction (₹ 2,000–5,760/ha)
- Yield gains (10–17%)
- Fuel savings (up to 67%)
- Water savings (25–35%)
- Climate benefits via carbon sequestration
- Reduced air and water pollution

Challenges and Way Forward

Barriers include high machinery costs, limited awareness and fragmented landholdings. Suggested solutions : mechanisation hubs, participatory research and scalable business models. CA should be prioritised for sustainable, climate-resilient agriculture.

GENE EDITING TECHNOLOGY : TRANSFORMING AGRICULTURE

- Gene/genome editing is a transformative technology with huge potential in agriculture.
- CRISPR/Cas9, derived from a bacterial immune system, allows precise DNA modifications.
- Discovered by Jennifer Doudna & Emmanuelle Charpentier (2012), who won Nobel Prize in Chemistry 2020.
- Offers opportunities for higher productivity, stress resilience, pest/disease resistance and nutritional improvements.
- Now applied to over 40 crops in over 25 countries, with 6 crops approved commercially in the US and Japan.

Gene-Edited Crops : Sustaining Food and Nutritional Security

- Staple crops (rice, wheat, maize, soybean) = backbone of global food security.
- Gene editing enhances yield, nutrition and consumer traits.
- Examples :
  - **Rice :** OsAPL (yield), OsSXK1 (photosynthesis), OsBADH2 (aroma), OsNAS (iron & zinc biofortification).
  - **Golden Rice/Maize :** Enriched with pro-vitamin A.
  - **Wheat :** Reduced gliadin (celiac-safe), reduced acrylamide (cancer risk), improved nutritional profile.
  - **Maize :** Higher lysine content.
  - **Potato :** Smoother starch, reduced acrylamide.
  - **Soybean :** Improved protein, oil quality, reduced phytic acid.
  - **Fruits (Apple, Tomato) :** Enhanced ripen-ing, shelf-life.
- **Commercial Products :** Browning-resistant mushrooms, high-GABA tomato (Japan), omega-3 camelina.
- **Even Gene-edited Fish (Japan) :** Larger, faster growing.

Technology to Manage Biotic and Abiotic Stresses

- **Drought Tolerance :** Maize (ZmHDT103 gene), Wheat (TaRPK1 gene – deeper roots).
- **Disease Resistance :** Rice blast – knockout OsERF922 gene. Rice bacterial blight – targeted gene editing. Citrus canker – LOB gene promoter editing. Banana wilt – DMR gene editing.
- **Insect Pest Control :** Knockout of vitellogenin → failed reproduction in pests like diamondback moth. Abdominal gene editing → defects in fall armyworm & others.

World's First Two Genome-edited Rice Varieties (India)

1. **DRR Dhan 100 (Kamla) :** high yield (more than 19%), early maturity, moderate drought tolerance.
2. **Pusa DST Rice 1 :** Drought & salt tolerant, needs less water, higher tillering & grain yield.

Gene Editing Technology in Climate Change Mitigation

- CRISPR can help create methane-free cows, drought/heat tolerant crops.
- Example : Banana streak virus resistance in plantains (Kenya).
- Edited plants can improve carbon sequestration efficiency.

Application of Gene Editing Technology in Agriculture (India's Achievements)

- India is the first country to release genome-edited rice (May 2025).
- Other breakthroughs : Mustard with reduced glucosinolates (Delhi University). First gene-edited sheep with higher muscle mass (SKUAST-K, Kashmir).
- Institutions : ICAR, CSIR labs (Lucknow), universities working on 24 field crops & 15 horticultural crops.
- Budget 2023-24 : ₹ 500 crore allocated for genome editing.

Simplified Regulatory Framework

- CRISPR edits without foreign DNA → not GM crops.
- India's 2022 guidelines exempt SDN-1 & SDN-2 edits from strict GM regulations.
- Oversight by Institutional Biosafety Committees (IBSCs) and approvals from MoA&FW & FSSAI.
- Accepted as equivalent to conventional breeding in ~30 countries.

Potential for Commercial Gains

- **Global agri-genomics market :** USD 4·32B (2024) expected to reach USD 10·32B (2035).
- **India's genomics market :** USD 2·2B (2024).
- **Indian seed industry :** USD 3·61B (2024) → USD 5·01B (2030).
- **954 agri-biotech startups globally :** India hosts 209 startups.
- **Companies :** Syngenta, Mahyco, Bayer (Vitamin D3 tomatoes).
- **Concerns :** Off-target effects, biodiversity impact, ethical issues.
- Still, CRISPR seen as the future of plant genetics; aligned with Borlaug's vision of meeting food demand through genetics.

Conclusion : Gene editing (esp. CRISPR/Cas9) is a revolution in plant genetics. With India pioneering genome-edited rice and livestock, the technology promises food & nutritional security, climate resilience, and commercial gains – provided ethical, environmental, and safety concerns are carefully managed.

CARBON FARMING FOR CLIMATE-SMART AGRICULTURE

With the 2022 amendment to the Energy Conservation Act, India's carbon market allows farmers to earn credits through eco-friendly practices such as zero tillage and agroforestry. Carbon farming enhances soil carbon sequestration, improves productivity, reduces emissions, and creates new income opportunities for farmers. Despite its potential, it remains underutilised in India, where most farmers are smallholders.

Carbon Farming

Carbon farming involves agricultural practices that increase carbon sequestration in soil and vegetation. It transforms agriculture from a carbon emitter into a carbon sink by using photosynthesis and soil organic matter. In India, it could unlock $ 63 billion potential from 170 million hectares of arable land, with soils capable of storing 3–8 billion tonnes of CO_2 annually. Farmers can trade credits for revenue while improving soil fertility and resilience.

Core Carbon Farming Practices

- **Forest Management :** Sustainable forestry and agroforestry enhance carbon sequestration while diversifying farmer incomes.

- **Grasslands Conservation :** Protects native grasses, aiding carbon absorption.
- **Reduced Fertiliser Application :** Precision farming, controlled-release fertilisers, and fertigation cut emissions and improve soil health.
- **Biochar Application :** Long-term carbon sink, improves fertility and water retention.
- **Reduced Tillage :** Prevents soil carbon loss, boosts resilience, and reduces costs.
- **Cover Cropping :** Improves nitrogen fixation, reduces erosion, suppresses weeds, and maintains soil moisture.
- **Crop Rotation & Companion Cropping :** Increases biodiversity, improves yields and reduces pests.
- **4Rs Nutrient Management** : Right time, rate, source and place of fertiliser use.
- **Eliminating Bare Fallows :** Replacing idle land with cover crops enhances carbon capture.
- **Rotational Grazing and Silvopasture :** Combine livestock, trees and pastures for sequestration and productivity.
- **Improved Residue & Water Management :** Mulching, residue retention, and efficient irrigation reduce carbon losses.
- **Data-driven Decision Systems :** Precision tools enhance input efficiency and sustainability.

Carbon Market and its Role in Promoting Carbon Farming

Carbon markets enable trading of carbon credits (1 credit equivalent to 1 tonne CO_2 reduced). India, with its CDM projects under the Kyoto Protocol, plays a key role globally. The 2022 amendment created the foundation for the Indian Carbon Market, offering new income streams for farmers adopting climate-smart practices like zero tillage, agroforestry and cover cropping. This incentivises sustainability, reduces stubble burning and aligns agriculture with emission reduction goals.

Way Forward

- **Policy Support** : Establish a National Carbon Farming Mission, integrate the Soil Health Card Scheme & NMSA and develop carbon measurement protocols.
- **Research & Innovation :** Invest in low-cost carbon measuring tools, crop-specific sequestration and demonstration farms.
- **Capacity Building** : Use Krishi Vigyan Kendras for farmer training on carbon farming benefits.
- **Market Systems :** Develop transparent trading platforms, farmer-producer models, and credible MRV systems.
- **Monitoring and Accountability :** District-level carbon targets aligned with Net Zero 2070 goals.

Conclusion : Carbon farming can revolutionise Indian agriculture by boosting productivity, resilience and sustainability while generating income through carbon credits. With robust markets, supportive policies, and farmer-centric initiatives, India can transform agriculture into a climate mitigation tool and contribute significantly to global carbon reduction efforts.

PLOUGHS TO PRECISION : DIGITAL REVOLUTION IN AGRICULTURE

Agriculture and Allied Sector – Contribution

- Agriculture remains the backbone of the Indian economy, contributing 18% to GVA (2023-24) and providing livelihood to 46% population.
- GVA grew from ₹ 15·02 lakh crore (2011-12) to ₹ 48·78 lakh crore (2023-24).
- Despite growth, the relative share declined due to the faster rise of industry and services. Hence, there is need for digitisation and moder-nisation.

Transition from Tradition to Technology

- **Earlier :** Manual labour, wooden ploughs, weather-dependent.
- **Now :** AI, drones, IoT, GPS, satellite imagery, precision farming.
- Enables real-time data-driven decisions, climate resilience, and improved productivity.

Precision Farming and IoT

- IoT sensors monitor soil, crop, weather → guides irrigation, fertiliser, pesticide use.
- Minimises waste, maximises efficiency, promotes sustainability.

Artificial Intelligence

- AI analyses weather, soil and satellite data which improves soil health, pest detection, irrigation, yield forecasting.

- Example : Microsoft's Farm Vibes (Maharashtra) led to 40% yield rise, 25% fertiliser cut, 50% water saving.

Satellite and Remote Sensing

- Monitors crop growth, soil moisture, pest outbreaks, yield estimation.
- Programmes : FASAL (ISRO), agri-tech firms like Cropin, Syngenta.

Digital Marketplaces and e-Governance

- e-NAM connects 18 million farmers with buyers.
- Platforms like ONDC, e-Choupal, SmartGaon, DeHaat, AgriBazaar, AgroStar improve market access.
- Apps like Kisan Suvidha and m-Kisan deliver advisories in local languages.

Blockchain Technology

- Ensures traceability, food safety and fair pricing.
- Boosts consumer trust and helps farmers reach premium markets.

Hardware Automation

- Drones, automated irrigation, mobile-controlled pumps, remote-operated machinery.
- Reduces labour strain, increases efficiency, benefits small farmers.

Government Initiatives in Digital Agriculture

Digital Agriculture Mission : Launched in 2024, outlay ₹ 2,817 crore. Uses AI, blockchain, drones, IoT, to facilitate unified digital ecosystem.

AgriStack Project : Digital farmer database (11 crore farmers). Components : Farmers' Registry, Geo-mapped village lands, Crop Sown Registry.

Government Digital Platforms and Apps :

- **e-NAM :** 1,522 mandis integrated, ₹ 4·01 lakh crore trade.
- **Kisan Suvidha App :** Weather, prices, advisories.
- **m-Kisan :** SMS-based advisories in local languages.

Common Service Centres (CSCs) : 5·6 lakh CSCs (77·9% in rural areas). Services : soil testing, insurance, weather info, schemes.

Sub-Mission on Agricultural Mechanization (SMAM) : Subsidies for machinery, drones, CHCs and Farm Machinery Banks.

Women-Led Agri-Tech Adoption : Namo Drone Didi Scheme (2023) → 15,000 drones for SHGs, ₹ 1,261 crore outlay. Promotes women empowerment and precision farming.

Soil Health and Fertility Scheme : Soil Health Card Scheme (2015) → 24·74 crore cards issued. 2023 upgrade with GIS mapping, mobile app, QR codes.

Benefits to the Farmers : Higher yields with real-time data. Cost savings on inputs (water, fertiliser, pesticides). Sustainability through resource conservation. Direct market access → better income.

Challenges Ahead : Poor internet access, low digital literacy, lack of regional content. High cost of devices, weak rural infrastructure. Issues of data privacy and trust.

Way Forward : Improve rural digital infrastructure. Train farmers in local languages. Strengthen PPPs with start-ups, FPOs and research institutions. Build affordable, farmer-centric digital tools.

Conclusion

Indian agriculture is shifting to data-driven, AI-powered, sustainable farming. Initiatives like Digital Agriculture Mission, AgriStack, e-NAM, Namo Drone Didi are transforming farming. With investment in infrastructure, training, and inclusive policies → India can achieve precision, profitability, and sustainability in agriculture.

AGRI STARTUPS

The Agritech Boom in India

- Agriculture employs nearly half of India's workforce and contributes 17% to GDP.
- **Challenges :** Low productivity, fragmented supply chains, poor market access, climate risks.
- Over 4,000 agritech startups in India (2025) leveraging AI, IoT and data analytics.
- Sector attracted $ 2·4 billion investments since 2014; Startup India and Digital India provided major policy push.

Key Areas of Impact

Precision Farming : AI, IoT, drones and satellite data enable efficient resource use. Can increase yields by 30% while reducing costs and environmental impact.

Supply Chain Optimisation : Startups like Ninjacart reduce 20–30% post-harvest losses by connecting farmers directly to buyers.

Access to Inputs and Finance : Digital marketplaces provide affordable inputs. Agri-fintechs like Arya.ag, Jai Kisan bridge credit gap for smallholder farmers.

Digital Advisory Services : Platforms like BharatAgri and KrishiHub deliver real-time crop and weather advisories via mobile/SMS.

Sustainable Practices : Startups like Ecozen promote solar-powered cold storage, eco-friendly irrigation and carbon reduction.

Success Stories : Pioneers of Change

DeHaat

- Founded in 2012, offers end-to-end services (inputs, advisory, markets).
- Serves 2·65 lakh farmers, aims for 5 million by 2027.
- Farmers' incomes rose by 20% via direct market linkages.

Farmtheory

- Founded in 2019, tackles agri-waste by supplying surplus produce to food processors.
- Works with 3,000 farmers and 1,500 kitchens.
- Farmers earn extra income, reduce food waste and cut methane emissions.

The Future of Agritech Startups in India

- **AI & IoT Integration :** Real-time crop monitoring, pest detection, yield prediction.
- **Climate-Resilient Farming :** Vertical farming, hydroponics, drought-resistant crops.
- **Global Collaboration :** Partnerships with international firms and research institutions.
- **Agri-Fintech Growth :** Blockchain-based loans; sector may attract $100M by 2027.
- **Policy Support :** Govt. missions and funds to expand startups; expected 5,000 by 2030.

Challenges to Overcome

- Low digital literacy (only 23% rural access to smartphones).
- High cost of advanced tech (drones, IoT).
- Fragmented landholdings require region-specific solutions.
- Regulatory inconsistencies across states.
- Solutions : farmer training, partnerships with KVKs, subsidies, pay-per-use models, micro-entrepreneur engagement.

Conclusion

- Agritech startups are transforming Indian agriculture into a tech-driven, profitable sector.
- With investment, policy support, and innovations, they can ensure sustainability, food security, and global leadership.
- Addressing digital literacy and scalability challenges remains key for inclusive growth.

COOPERATIVE PATH TO THE SDGs

India, with 8·2% GDP growth in FY 2023–24 and rising per capita income, aims to become a $5 trillion economy and a developed nation by 2047. Achieving this requires inclusive growth, human development, and sustainability. Co-operatives, rooted in community participation, are key to aligning India's economic aspirations with the SDGs.

Cooperatives and the SDGs : Natural Partners in Sustainable Development

The SDGs envision an inclusive and sustainable world. Cooperatives, based on principles of democracy, equity, and solidarity, mirror these values. Unlike profit-driven models, they prioritize member welfare, community development, and sustainability, making them natural partners in realizing the SDGs.

The Cooperative Advantage

- India has 8·5 lakh cooperatives with 30 crore members across agriculture, dairy, banking, fisheries, textiles and housing. Historic movements like the Green Revolution, White Revolution (AMUL), and Blue Revolution highlight their role in food security and rural empowerment. Globally too, cooperatives provide jobs to 280 million people and strengthen inclusive economies.
- The Ministry of Cooperation (est. 2021) is driving reforms through digitalisation, PACS modernisation, multi-state societies, and databases. This reflects the vision of *Sahkar Se Samriddhi* (Prosperity through Cooperation).
- Traditional and Emerging Types of Cooperatives: Expanding Horizons for Sustainable Development.
- While Indian cooperatives are concentrated in agriculture, dairy, and credit, new opportunities lie in renewable energy, IT platforms, education, health, care economy, and sustainable tourism. Global models like renewable energy cooperatives (Germany, Denmark) and platform cooperatives (US, Europe) show the way. India must diversify beyond legacy sectors to address urbanisation, climate challenges and youth unemployment.

Challenges to Address in the Cooperative Sector

- **Governance Deficits :** Weak leadership, political interference, poor accountability.
- **Technology Gaps :** Limited digitalisation and IT access.
- **Youth Engagement :** Low participation and awareness among youth.
- **Regulatory Complexity :** Multiple overlapping laws.
- **Financial Constraints :** Inadequate capital and limited bank credit.
- **Market & Value Addition Issues :** Limited processing, branding and competition from corporates.

Conclusion

Cooperatives are central to India's socio-economic fabric, combining democratic governance with community participation. With reforms and modernisation, they can drive inclusive growth, align with the SDGs, and help India achieve its vision of becoming a developed nation by 2047. The cooperative movement thus embodies *Sabka Saath, Sabka Vikas, Sabka Vishwas, Sabka Prayas*, ensuring no one is left behind.

August 2025

GIST OF DOWN TO EARTH

Topic :
- How India Moves (16-31 July)
- Race to Efficiency (1-15 August)

HOW INDIA MOVES : TRAFFIC, POLLUTION AND MOBILITY TRENDS

1. Congestion & Its Impacts

- Travel times in Indian cities double during peak hours, harming productivity, mental health and family time.
- Congestion worsens air pollution in Delhi, vehicles contribute ~40% of particulate matter and 81% of NOx emissions; winter share can exceed 50%.
- Despite flyovers, road widening, and metro expansion, congestion has not eased.

2. Travel Patterns Across Cities

Non-Motorised Transport (NMT) :

- Walking & cycling still crucial ~50% of commuters in cities like Mumbai, Kolkata, Varanasi, Singrauli and Visakhapatnam use them.
- NMT share rose 5% in mega cities, 1·5% in million-plus cities, 3·21% in smaller cities.
- Most cities lack safe NMT infrastructure, except few like Mysuru, Kochi.

Private Vehicles :

- **Mega/Metro :** Two-wheelers rose 4·13%, cars rose 0·51% in 2 decades. Delhi added 187k cars in 2024–25 (~513/day).
- **Million-plus :** Two-wheeler share often >30%; cars 5–28%.
- **Sub-million :** Two-wheeler use rose 4%, cars rose 5% (esp. in hilly towns like Gangtok – 54% trips by car).

Public Transport Decline :

- **Mega cities :** Bus use rose 5·69%, metro rose marginally (0·81%). Kolkata highest PT share (36·8%), Delhi 23·5%, Bengaluru 32%.
- **Million-plus :** Modest growth; Srinagar notable at 64% due to vehicle restraint policies.
- **Smaller cities :** Rose 4·03% bus use but uneven; many towns near-zero coverage.

Informal Public Transport (IPT)

- Shared autos, e-rickshaws, minibuses fill gaps—growth : +5·98% in million-plus, +3·4% in smaller cities.
- In Patna, Ranchi and Varanasi, IPT often exceeds formal PT usage.

Urban Sprawl & Trip Length

- **Mega cities :** Trips/day rose 11·5%, avg. trip length rose 9·4% (Delhi from 6 km to ~11 km).
- **Million-plus :** Trips rose 5·3%, lengths rose 13%.
- **Smaller cities :** Trips steady, but lengths rose 11%.

Congestion Data (Aug 2024, TomTom NV)

- **Worst congestion :** Mega/metro cities (39·05%), followed by million-plus (34·63%) and smaller cities (28·47%).
- Peak-hour speeds drop drastically :
  - **Bengaluru :** 17·5 km/h (decreased from 32.4) despite only 7% car share.
  - **Chennai :** 40·26% congestion, 7% car share—suburban sprawl main cause.
  - **Kolkata :** 38·97% congestion with just 5·3% car trips—limited road space & PT issues.
  - Hill towns like Shillong and Rishikesh also face severe seasonal/tourism congestion.

Bottom line : Indian cities face a **mobility crisis**—rising private vehicle use, declining bus reliance, weak NMT infrastructure, and sprawling cities all reinforce congestion and pollution. Informal transport keeps many cities moving but adds to chaos. Without strong, integrated public transport and better urban planning, both air quality and quality of life will worsen.

DELHI FOREVER STUCK

Delhi has taken bold steps toward cleaner transport—CNG buses, expanding metro, electric vehicles—but remains the world's most polluted capital (IQAir, 2024). Strong plans exist, but weak execution and fragmented oversight undermine results.

Public Buses

- Vital for affordable mobility, yet poorly aligned with travel needs.
- 60% of trips are under 4 km, but routes favour long-distance travel.
- One-third of neighbourhoods lack bus stops within 500 m, violating walkability norms.

Pedestrianisation

- Ajmal Khan Road (2019) and Chandni Chowk initially reduced congestion and pollution.
- Gains reversed by 2025 due to poor maintenance, weak enforcement and overlapping agency control.

- Lack of shaded walkways and infrastructure discouraged long-term use.

Circular Rail System

- Built in 1982 for the Asian Games, now dilapidated with rare trains and poor connectivity to metro/buses.
- Remains an untapped asset for easing congestion and pollution.

Way Forward : Delhi's 2025 pollution control plan emphasizes integrated transport—last-mile links, revived rail, and pedestrian zones. Success, however, depends on effective collaboration across agencies and consistent upkeep.

CHANDIGARH : OUTSIDE PRESSURE

Once admired for its wide roads and orderly grid, Chandigarh is now choking under rising congestion, collapsing public transport, and deteriorating air quality. With 1.32 million vehicles for 1·25 million people, it has the highest per capita vehicle density in India.

Congestion and Safety

- Commutes now take 3–4 times longer than a decade ago.
- Fuel costs for residents have risen sharply.
- Footpaths and cycle tracks are encroached by parked vehicles.
- Pedestrian fatalities rose from 35% (2019) to 42% (2023).

Planning Erosion

- Le Corbusier's original master plan envisioned a 25 km buffer zone, but unchecked growth of Mohali and Panchkula has eroded it.
- Expansion of satellite towns has worsened traffic.

Public Transport Decline

- Bus ridership fell from 5·69 lakh (2016-17) to 1·31 lakh (2022-23) despite fleet expansion.
- Poor route design makes short trips inconvenient; cars remain faster and more reliable.

Air Quality and EV Push

- PM2·5 levels have more than doubled since 2020, with vehicles as the main source.
- EVs now form 15% of the fleet, but experts warn they cannot solve congestion.

Way Forward

The 2031 Comprehensive Mobility Plan (including metro rail) remains largely unimplemented. Without integrated, efficient and sustainable mobility solutions, Chandigarh's model city image will continue to fade.

LUCKNOW : SPACE CRUNCH

Key Issues

- Commutes take double/triple the time due to traffic mismanagement, construction and excess e-rickshaws.
- Metro exists but has limited coverage, missing key areas like Old Lucknow and Telibagh.
- Bus system failing – long waits (avg. 12 minutes), poor stop infrastructure, few direct routes.
- Working poor hit hardest – high commuting costs and long walks.
- Vehicle explosion – over 3·1 million registered vehicles, growing 10–12% yearly, but only 4,000 legal parking spaces.
- Flyovers and Shaheed Path worsen bottlenecks instead of easing them.
- Cycling infrastructure collapsing (taken over by shops/parking).
- EV push exists but is ineffective without reliable public transport.

Bottom Line : Lucknow's unchecked vehicle growth and weak public transport are creating an urban mobility crisis.

JAIPUR : BUS BLUES

Key Issues

- Buses unreliable late, low frequency and breakdowns. Mobile app is ineffective.
- Shrinking fleet from 400 JNNURM buses, only 190 run daily, soon to fall to 110, serving a city of 4 million.
- Public bus demand unmet : needs 50 buses per 100,000 people, has less than half.
- Metro focus misplaced : ₹ 200 crore spent on a 1·35 km metro extension, while the network is just 12 km. Experts say the same cost could fund 500 buses.

- Rising private vehicles : 2·6 million two-wheelers and 750,000 cars, adding to congestion.
- App-based transport booming : 1·2 million residents rely on autos, taxis, e-rickshaws.

Surveys show 70% would switch back to buses if services improved.

Bottom Line : Jaipur prioritises prestige projects (metro) over practical solutions (bus expansion), worsening reliance on private and app-based vehicles.

INDORE : WIDE GAP

- A 40-hour traffic jam on the Indore-Dewas NH exposed weak transport planning.
- Vehicle numbers doubled in a decade (2·4 million in 2020), but only 19% use public transport; buses remain scarce.
- The Bus Rapid Transit System (BRTS), once serving 60,000 daily commuters, was dismantled after court intervention, forcing people back to costly and time-consuming travel.
- City focus is on flyovers and widening roads, benefitting car users, not the majority.
- The Metro project started in June 2025, but ridership plummeted quickly, showing affordability and accessibility gaps.
- Activists argue for a comprehensive, affordable public transport network, not elite-centric metro expansion.

BHOPAL : BROKEN COMMUTE

- Rapid expansion (population grew from 0·1 m in 1951 to 2·3 m in 2011) has outpaced mobility planning.
- A mason's daily cycle commute reflects poor alternatives—buses require multiple changes, are slow, and limited (only 22 routes are active).
- The BRTS was scrapped due to poor implementation, making Bhopal the first city to dismantle such a system.
- Private vehicles dominate : over 1 million two-wheelers out of 1·5 m vehicles.
- Despite AMRUT buses and ongoing metro construction, gaps remain; metro will cover limited areas.
- Road safety is poor : 8 accidents daily in 2024, with fatalities in half the cases.
- Experts warn against over-reliance on metro; stress need for integrated, people-friendly transport (pedestrians, cyclists, buses).

Overall Message : Both Indore and Bhopal suffer from car-centric planning, dismantling of affordable systems (BRTS), inadequate buses, and misplaced faith in metros. Without inclusive, multimodal transport, the cities risk worsening congestion, pollution and inequality.

SINGRAULI : TRUCK GRIDLOCK

- Known as India's *energy capital* with 8 power plants & 11 coal mines.
- Roads are flooded with 36-wheeler coal trucks, causing massive jams and accidents.
- 1 road fatality every 48 hours – deaths rose from 163 (2017) to 285 (2024).
- 35,000 families were displaced for projects, but only 4,000 got jobs.
- The city has just one 7 km arterial road for 3·5 lakh people.
- Bikes are common but often driven by hired drivers since many cannot ride.
- Public transport is almost absent – only 4 buses, 2 non-functional.
- Severe air pollution (95% from power plants/mines) with no proper emission control.
- Singrauli powers the nation but leaves its own citizens stranded in traffic, displacement, and toxic air.

LUDHIANA : TRANSIT VOID

- India's *small-scale industrial hub* but no formal bus system.
- Workers rely on autos, e-rickshaws, cycles and walking which is unsafe, costly, chaotic.
- Nearly 1 million workers face long, unsafe commutes; cyclists are especially vulnerable.
- Private vehicle registrations doubled (2021–24), worsening congestion.
- Footpaths blocked by cars & stalls leads to pedestrians forced onto roads.
- Pollution up : PM2·5 rose from 51 (2018) to 61·1 (2024).

- The 014 mobility plan (60% public transport, cycle/pedestrian push) remains unimplemented.
- Recently, 100 electric buses approved, but rollout will take time.
- Ludhiana's economy runs on workers, but their mobility depends on unsafe and unregulated transport.

SRINAGAR AND SHIMLA : MOBILITY IN THE MOUNTAINS

Srinagar – Forced Private Vehicle Boom

- Until Nov 2023, the city had no proper bus service; residents relied on overcrowded minibuses & shared taxis.
- Many took loans to buy cars/two-wheelers just to commute; in 2023 alone, ₹ 1,600 crore in auto loans were issued for 22,000 new vehicles.
- Vehicle registrations in J&K doubled from 1·36 million (2016) to 2·72 million (2024), while roads stagnated.
- Relief came with 100 new e-buses (Nov 2023) under the Smart City project :
  - Now 60,000 daily riders, 6·1 million passengers (Jan–Nov 2024).
  - Reduced traffic stress, emissions, and commute times.
  - Experts say the city needs at least 500 e-buses for a real transition.

Key Lesson : Without reliable public transport, cities force even poor/middle-class families into unsustainable private vehicle ownership.

SHIMLA : TOURISM PRESSURE AND WEAK PUBLIC TRANSPORT

- Congestion worsened due to narrow roads, daily influx of 5,000–8,000 outside vehicles and high tourist traffic.
- Public transport share just 35%, private vehicles 41%, walking 23%.
- Fleet inadequate : 182 govt. buses + 106 private buses for ~0·4M population (resident + floating).
- Accident deaths rose : 98 (2015) to 137 (2024).
- Mobility plans stuck :
  - 2012 Comprehensive Mobility Plan (₹ 4,700 cr, trams + ropeways + rapid transit) never approved.
  - Shimla Smart City Project (₹ 3,000 cr for mobility) made little progress.

Key Lesson : Mountain cities need **multi-modal solutions** (trams, ropeways, electric buses, cycle tracks, lifts). Weak planning pushes people to private vehicles, worsening accidents & pollution.

DEHRADUN : CREEP MODE

- Once a quiet Himalayan town, Dehradun is now gridlocked with traffic.
- Residents like Megha Pant shifted from shared autos (*Vikrams*) to scooters due to congestion, pollution and discomfort.
- Vehicle surge : 1·05 million registered vehicles by April 2025 (increased 1300% in 20 years), 94% private.
- Public transport makes up just 2·26% of traffic, with only 17 public vehicles per 1,000 residents.
- Electric buses exist but are too infrequent/long-routed; Metro Neo light rail remains stuck in planning.
- Impact : Road accidents doubled (201 deaths in 2023), high pollution from vehicular emissions.
- Policies stalled: Uttarakhand Clean Mobility Policy 2024 not implemented fully; only a few diesel autos upgraded, no city buses switched to clean fuel.
- Mobility indicators : Trip rate fell (1·18 to 1·08 per day), trip length shortened (11·2 to 8 km).
- City remains choked, with residents forced into private modes.

VARANASI : TIME TRAVEL

- Ancient city with narrow lanes, sacred ghats and huge tourist inflows (floating population ~0·5M daily; spikes to millions during festivals).
- No formal public transport—streets dominated by motorcycles, e-rickshaws and private vehicles.
- Vehicle registrations : 1·6 million and rising.

- Traditional mobility (tongas, cycle rickshaws) has disappeared, replaced by autos and motorbikes.
- Chronic congestion at intersections like Godowlia & Maidagin, worsened by overlapping functions (markets, temples, hospitals, universities).
- Authorities rely on stopgap measures—temporary parking, vehicle-free temple zones, tourist bus restrictions.
- **Major innovation :** India's first urban ropeway (linking railway station to Kashi Vishwanath temple) under trial; expected to cut core-area traffic.
- Residents demand mini-buses & sustainable transit to reduce dependence on private vehicles.
- Past mobility relied heavily on walking & cycling, but tourism growth outpaced public transport planning.

BADDI : INDUSTRIAL TRAP

- **Commuter Struggles :** Workers like Manoj Kumar face long, unsafe commutes due to crumbling roads and lack of buses.
- **Industrial Growth *Vs.* Mobility :** Since 2003, Baddi-Barotiwala-Nalagarh corridor has boomed with 2,150+ industries and 100,000+ workers, but transport hasn't kept up.
- **Transit Gaps :** Only 144 bus routes with ~750 daily trips for 450,000+ people. Many stretches face traffic far beyond road capacity.
- **Accidents :** Road accidents more than doubled in a decade (58 in 2014 → 143 in 2024).
- **Infrastructure Stalled :**
  - Four-lane Pinjore–Nalagarh highway only 37% complete after 3 years.
  - Chandigarh–Nalagarh rail line, approved in 2007, still unfinished.
- **Expert View :** Needs integrated mobility plan (public transport, walkability, rail links, real-time traffic).

RISHIKESH : TOURISM FLIPSIDE

- **Tourism Pressure :** Gateway to Char Dham, yoga hub, rafting centre. Attracted 1 million visitors in 2024.
- **No Bus System :** City lacks formal public bus service; people rely on e-rickshaws, Vikrams and private vehicles.
- **Vehicle Load :** 8,246 public transport vehicles (mainly e-rickshaws, maxi cabs, taxis, few buses) + 168,000 + private vehicles.
- **Congestion Impact :** Residents avoid weekends outdoors; 5 km trips can take 3·5 hours.
- **Constraints :** Narrow roads and geography cited as reasons buses can't run.
- **Air Quality Risk :** Listed among 131 non-attainment cities under NCAP. Diesel vehicles still dominate.
- **Proposed Fixes :** Replace old Vikrams with clean vehicles; proposal for four electric city buses under NCAP; improve intercity buses (esp. Rishikesh–Dehradun evenings).

MUMBAI : CAR-FOCUSED POLICIES, STRAINED PUBLIC TRANSIT

- **Speed pattern :**
  - Off-peak : 35·6 km/h
  - Peak : 19 km/h
  - Congestion Index : 42·23%
- **Travel patterns (2017)** :
  - Suburban rail : Growth of 46·9% of trips
  - Bus share : 8·7% (declined from 26% in 2005 to 20% in 2017 to projected 9% by 2040)
  - Metro : 0·6% (minimal, partly operational)
  - Cars & two-wheelers rising sharply.
- **Challenges** :
  - Decline of BEST buses (2,603 buses, shrinking fleet).
  - Overdependence on suburban rail (~7·56M daily, often delayed).
  - Rise in private vehicles : from 1·37M (2001) to 6·7M (2018).
  - Govt. projects (flyovers, coastal road, sea link) are mostly car-centric.
  - Road accidents are rising, esp. two- and three-wheeler fatalities.
- **Key insight :** Experts say Mumbai needs high-capacity public transit, but policies continue to promote cars instead.

PUNE : POLICY INERTIA & VEHICLE EXPLOSION

- **Speed pattern :**
  - Off-peak : 34·8 km/h
  - Peak : 19 km/h
  - Congestion Index : 39·56%
- **Travel patterns (2018) :**
  - Two-wheelers: **35%** (steady high)
  - Cars : 13%
  - Bus : 27%
  - IPT (autos etc.) : 8%
  - NMT : 12%
- **Challenges**:
  - Pune is India's 3rd slowest city (avg 33 min for 10 km).
  - Vehicle registrations doubled in 5 years; hybrid/flexible work fueling private use.
  - Bus system failing : required 6,500 buses, only 1,880 operational (473 electric).
  - Breakdowns are frequent (561 in April 2025).
  - BRT (2006) was undermined by poor management, encroachment.
  - The Metro under construction worsens congestion.
  - Road accidents rising : 1,404 in 2024 vs 1,230 in 2023.
- **Key insight :** Without investment in last-mile connectivity, better buses, and pedestrian-friendly design, congestion will worsen.

AHMEDABAD : PRIVATE PURSUIT

- **Traffic and Congestion :** Avg. speeds fall from 36·7 km/h (off-peak) to 20·7 km/h (peak), congestion index 38·4%.
- **Trip Patterns :** 46% use non-motorised transport (walk-ing/cycling). Two-wheelers dominate (36%), cars at 12%, buses and IPT much lower.
- **Mobility Trends :** Trip rate : ~1·4 trips/person/day, trip length ~6·5 km. High vehicle ownership : ~4·4M vehicles for 7·4M people (≈1 for every 2 residents). AMTS buses (~800) + BRTS Janmarg (since 2009), but fares deter poor users. Nearly half the population depends on auto-rickshaws (200k+ operate, mostly shared).
- **Fuel Shift :** CNG vehicles rising fast; petrol declining; EV adoption growing but inconsistent.
- **Core Issue :** Lack of last-mile connectivity → heavy reliance on autorickshaws & private vehicles.
- **Expert View :** City needs 2,000+ buses, metro expansion, better footpaths and parking solutions.

PANAJI (GOA) : VEHICLE-HEAVY

- **Traffic and Congestion :** Speeds drop from 34 km/h (off-peak) to 21·2 km/h (peak), congestion index 34·7%.
- **Trip Patterns :** Two-wheelers 59·6%, cars 22%, buses 11·8%, IPT 6·6%, NMT just 1%.
- **Mobility Trends :** Vehicle ownership extremely high : 1·35 M vehicles for 1.5M people (≈ 8 per 10 Goans). Boosted by 2019 road tax cuts and tourism-linked demand (bike taxis, cabs).
- **Public Transport Weak** : buses run 7am–7pm, low frequency, poor integration between private & state-run services.
- **CMP 2020 :** 73% of roads lack footpaths, 90% lack basic infrastructure (bus shelters).
- **Core Issue :** Poor first- & last-mile connectivity and limited public transport leading to car & two-wheeler dependency.
- **Expert Warning :** While congestion is not yet extreme, Goa is heading toward metro-level traffic pressure.
- **Government Focus :** Improve bus fleet & add 300 new routes.

SURAT

- **Rapid growth** : Booming textile & diamond hub, but transport lags.
- **Congestion** : Speeds drop from 33·8 km/hr (off-peak) to 20·1 km/hr (peak); congestion index 34·58%.
- **Trip patterns :** 85% trips = private vehicles (2016 survey). Two-wheelers dominate (36% share, rising). Public transport (city buses + BRTS) = only 1·75% of motorised trips. NMT (cycling/walking) declined from 54% (2004) to 43% (2016).

- **Reasons :** Limited bus/BRTS coverage in outer areas; poor last-mile connectivity; affordability issues.
- **Result :** 3 million vehicles (2025), rising pollution & congestion.

CHENNAI

- **Growth and sprawl :** CMA population 14·5 m (2023); vehicles grew from 0·5 m (1992) to 5·7 m (2018).
- **Mode share :** Public transport 28·2%; personal vehicles 36·7%.
- **Rail systems (MRTS, metro, suburban) :** Low uptake (rail = only 5%).
- **Problems :** Fewer bus stops, longer walking distances. Poor integration between bus, metro, train & IPT. First- & last-mile gaps push people to private vehicles.
- **Consequences :** Severe congestion, air pollution (NCAP non-attainment city).
- **Recent steps** : Plans for more buses, cleaner fuels, electric buses, strengthening shared auto services.

BENGALURU : 'PERPETUAL JAM'

- **Congestion :** Avg. speed just 18 km/hr; 30 min to cover 10 km (2nd slowest in India after Kolkata).
- **Vehicle explosion :** 12 million vehicles (2025) on weak road density (1 km per 1,000 residents *vs.* national avg 5 km).
- **Trip patterns (2020) :** Two-wheelers 31·7%. Car 27·1%, Bus 7%, Metro 0·2%, NMT 27·3%.
- Trip rate dropped (1·3 to 1·24/day), but trip length shrank sharply (19·6 km to 7·34 km).
- **Issues** : Metro is overcrowded, limited routes, real estate-driven. Bus fleet stagnant (50 per 100,000 residents for 20 years). Flyovers/tunnels seen as worsening congestion.
- **Result :** Long commutes, dependence on private vehicles, worsening pollution.

HYDERABAD : 'COSTLY CRAWL'

- **Congestion** : Peak speed 17 km/hr; congestion index 40·6%.
- **Mode share (2011) :** Private vehicles 29%. Car 4%. Bus 14%, NMT 41%, IPT 6%.
- **Trip rate :** 1·45 to 1·5/day (2008–2011).
- **Trip length :** 7·9 to 7·5 km.
- **Key issues :** Public transport costly, inconvenient *Vs.* private vehicles. Bus fleet declined (3,811 in 2014 to 3,042 in 2024). Despite free bus travel for women (2023, Mahalakshmi scheme), supply lags. Need for better integration of metro, MMTS & buses.
- **Concerns :** Slow traffic leads to higher fuel cost, pollution, health risks.
- **Way forward** : Experts recommend Bus Rapid Transit (BRTS), dedicated bus lanes and multimodal integration.

MYSURU : SLOW PEDALLING

- **Trin Trin**, India's first public bicycle-sharing system (launched 2017), has 48 docking hubs and 500 bicycles.
- **Usage :** ~33,462 monthly rides (15,640 km). Registered users : ~17,000.
- **Main users** : Students & tourists. Office-goers prefer private vehicles.
- **Challenges** : Poor cycle infrastructure; cycling track damaged.
- **Context :** Mysuru's population grew to 1·3 million in 2023 (2·2% rise). Public bus fleet may fall short despite adding e-buses.
- **Need :** Better cycle lanes, delinking car ownership from social status, stronger push for non-motorised transport (NMT).

VISAKHAPATNAM : BUS BOTTLENECK

- The population rose from 1·9 mn (2015) to 2·4 mn (2025).
- **Mode share :** 46% personal vehicles, 25% public transport.
- **Decline in buses :** APSRTC reduced fleet from 608 (2015-16) to 541 (2024-25), worsening congestion.
- **Problems** : Overcrowded buses (150 people at peak). Peak jams (7:30–9 am) due to

colleges & autos stopping anywhere. Stalled BRTS corridor, now misused by cars.

- **Geography worsens pollution :** City sits in a basin, trapping industrial emissions. Listed as a non-attainment city under NCAP.
- Electric buses planned, but experts say they will cut pollution, not congestion.

KOCHI : ELECTRIC FOCUS

- **Multimodal Integration :** Kochi Metro integrates with e-autorickshaws, feeder e-buses and even an electric water metro.
- **Climate resilience :** Investment in low-emission, electrified transport helps reduce vulnerability to flooding and pollution.
- **Impact :** Analysis shows daily avoided emissions of up to 16·7 million kg CO_2, 14,000+ kg NOx, and ~2,000 kg PM.
- **Accessibility :** 25–50% of metro users walk to stations due to strong pedestrian infrastructure.
- **Challenges :** Feeder buses not available at all stations; water metro more tourist-oriented than practical for residents; automation of communication needed.
- **Modal shift trends (2008 to 2024) :** Two-wheelers (25%); Cars (3%); Bus use (–28%); Metro share now 3%; NMT(–6%).

THIRUVANANTHAPURAM : STRONG LEGACY

- **Historic network :** Roots in Travancore transport (1930s), evolved into KSRTC (1965). Still state-run buses dominate, with 413 buses (115 electric) operating across the city.
- **Pollution control :** PM2·5 annual avg 28·4 $\mu g/m^3$ (below CPCB limit 40), making it among India's least polluted cities.
- **Goal :** Carbon-neutral by 2035.
- **Concerns :** IT hubs (Kazhakoottam, Akkulam) show rising private vehicle use, congestion and accidents.
- **Infrastructure push** : 12 'smart roads' with cycle tracks, walking paths, stormwater drains, modern lighting (opened May 2025).
- **Shifting mobility culture :** Growing cyclists, adoption of **electric two-wheelers**; some residents now walking instead of driving.
- **Modal shift trends (2011 → 2023)** : Two-wheelers (+22·8%); Cars (+10·5%); Buses (–14·7%); NMT (–20·6%).

TIRUCHIRAPPALLI (TRICHY) : TRAFFIC REROUTE

- **Bus Shortage :** Needs 732 buses (50 per lakh pop norm) but has only 587, shortage of 145 buses.
- **Modal Share :** Two-wheelers 41%, public transport 22%, cars 15%, walking 11%.
- **Congestion :** Peak-hour speeds drop to 11–20 kmph on ~50% of roads; bus halts cause 12% of delays.
- **Decongestion Strategy :** Relocating wholesale Gandhi Market, new integrated Panjapur bus terminus (2025).
- **Challenge :** UMTA not yet set up; residents like Subhashree face longer commutes due to relocation.

KOLKATA : SMOKE HAZARD

- **Pollution :** Annual PM10 = 94 $\mu g/m^3$ (limit 60). PM2·5 above safe levels 75% of winter days.
- **Health Impact :** ~185,000 premature deaths (2011–19) due to PM2·5.
- **Congestion** : Most congested Indian city (TomTom, 2024).
- **Vehicles :** Cars ↑ 5x (2016–24), two-wheelers ↑ 2x; buses stagnant, trams being phased out.
- **Policy Paradox :** Talk of reviving banned, polluting old commercial vehicles.
- **Public Transit :** Metro expanding, but insufficient; tram phaseout seen as a mistake.

PATNA : INFORMAL GROWTH

- **Public Transport Gap** : Needs 1,000 buses; has only 465. No CMP yet.
- **Rise of Informal Modes :** Autorickshaws, e-rickshaws and bike taxis dominate.
- **Vehicle Growth (2020–24)** : 2-wheelers 40%; Cars 72%; 3-wheelers 82%; E-rickshaws 405%
- **Rail :** MEMU trains carry 30% of suburban commuters.
- **Infrastructure** : Metro Blue Line (6·5 km) to start Aug 2025; double-decker flyover opened (June 2025).
- **Congestion Index :** 39·9% (speed drop from 31·8 km/h off-peak → 17·3 km/h peak).

BHUBANESWAR : NEAT NETWORK

- **Urban Growth :** Planned city (1948), but rapid unbalanced expansion post-2011 (30% pop growth).
- **Shift to Buses :** Pre-2018 : Buses 8%, autos 17%, 2-wheelers 55%, cars 7%. Post-2018 Mo Bus (Ama Bus) : Ridership increased 200%, 57% shift from private to public modes.
- **Fleet :** 560 buses (180 electric). Frequent and affordable.
- **Recognition :** 'Best Public Transport System' award 6 times.
- **Challenge :** Growth concentrated along certain corridors (malls, real estate hotspots) → localized congestion.

RAIPUR (CHHATTISGARH) : SHARED COMMUTE

- **Dependence on IPT :** ~600,000 people (1 in 3 residents) rely on autorickshaws & e-rickshaws.
- **Fleet size :** 15,000+ vehicles; 10,188 e-rickshaws (2021–25), 6,484 autos (since 2016).
- **Buses :** Just 40 city buses for the public (out of 140+), very poor frequency/coverage.
- **BRTS :** Only 30 AC buses run between Raipur & New Raipur; the railway link is underutilized.
- **Mobility stats :** Trip length 6·12 km (2017); trip rate 0·87 per person/day.
- **Speeds :** Off-peak 32·3 km/h, peak 19·6 km/h; congestion index 33·4%.
- **Mode share (2023) :** Two-wheeler 25%, car 2·5%, bus 3·1%, IPT 2·8%, NMT 63·8%.
- **Problem :** Public transport failed post-pandemic, informal IPT dominates.

AGARTALA (TRIPURA) : FAST MEETS SLOW

- **Urban growth :** Rapid, but public transport collapsed.
- **Buses :** 70% of JNNURM buses out of service.
- **Traffic :** Mix of cars + slow cycle rickshaws → dangerous congestion.
- **Fleet :** 15,000 motor rickshaws, 16,000 autos, 10,000 cars; 90,000 vehicles move daily in/out.
- **Speeds :** Peak hour speed down to 4 km/h (from 7 km/h in 2014).
- **Mobility stats :** Trip rate 1·05/day (2023); trip length 5·93 km.
- **Mode share (2023) :** Two-wheeler 35%, car 10%, bus 30%, IPT 15%, NMT 8%.
- **Problem :** Congestion + unsafe for walking/cycling; pollution rising.

GANGTOK (SIKKIM) : WALKER'S HEAVEN

- **Clean and controlled mobility :** PM2·5 at 13·8 (2024).
- **Odd-even scheme :** Implemented in Nov 2024 to ease traffic.
- **No Horn Zones :** Key institutions declared silent areas.
- **Mode share (2010) :** Cars 53·8%, NMT (walking) 42·6%, two-wheelers 2·4%, buses <1%.
- **Mobility stats :** Trip rate 0·96/day; trip length 19 km (2010).
- **Speeds :** Off-peak 30·6 km/h; peak 20·9 km/h; congestion index 30·5%.
- **Strength :** Pedestrian-friendly, strong regulation.
- **Gap :** Bus transport negligible.

SILCHAR (ASSAM) : ON THREE WHEELS

- **IPT dominance :** No permits needed → 10,000+ autos & e-rickshaws serve ~100,000 commuters daily.
- **Congestion :** 6 km commute can take 1 hour.
- **Registrations(2024–25) :** 19,823 two-wheelers, 4,890 three-wheelers, 2,312 LMVs (district-wide).
- **Road network :** Only two arterial roads; bottlenecks near Capital Point.
- **Mobility stats (Assam-wide 2022) :** Trip rate 1·24/day; trip length 3·8 km.
- **Mode share (2022) :** IPT 38%, two-wheeler 28%, car 19%, bus 0%, NMT 5%.
- **Speeds :** Off-peak 25·6 km/h; peak 17·7 km/h; congestion index 28·7%.
- **Problem :** Chaotic three-wheeler growth, weak regulation, highest vehicular emissions from two-wheelers.

AIZAWL (MIZORAM)

- Hilly terrain, narrow roads and unplanned expansion cause severe jams despite traffic discipline.
- Vehicle growth is alarming: 51,569 new registrations (2020–23) in Aizawl alone.
- Public transport is inaccessible/unviable (*e.g.*, Mizoram University has no bus link).
- Measures like odd-even rule and parking subsidies failed; many residents rely on two-wheelers.

SHILLONG (MEGHALAYA)

- Traditional wooden buses (Bos Dieng) replaced by 2,000+ local taxis, making taxis the dominant mode.
- Public buses (red buses) are too few (90), poorly integrated and slow due to traffic.
- Congestion high : commuters spend ~70 mins/day in jams.
- 2024 Urban Mobility Plan aims to boost bus & Non-Motorised Transport (NMT) and reduce private cars.

RANCHI (JHARKHAND)

- Despite being a Smart City Mission (2016) city, bus system is almost absent (~25–41 buses *vs.* need for 580).
- Parking shortages worsen congestion; e-rickshaws and private vehicles choke roads.
- Vehicle boom : 1·56 million two-wheelers, 0·25 million cars added (2021–25).
- Cycling exists but lacks tracks or secure parking.

KOHIMA (NAGALAND)

- Built on hilly terrain with narrow roads → little scope for widening.
- High car ownership : ~2,000 new cars registered annually; 2,000+ taxis & 74 buses operate.
- Pollution rising: PM2·5 seven times WHO limits.
- Multi-level parking projects underway, but experts warn it may induce more car use.

ITANAGAR (ARUNACHAL PRADESH) : NOVEL APPROACHES

- **Rising private vehicles** : ~1,200 new registrations/month; population grew from 59,490 (2011) to ~85,000.
- **Weak public transport :** Only 40 buses; people shifted to cars & small autos.
- **Trip patterns (2021 vs 2019) :** Two-wheelers ↓ (34%, –6%); Cars ↓ (7·3%, –7·7%); IPT ↑ (23·5%, +3·5%); NMT ↑ (31·8%, +19·8%).
- **Congestion index :** 25·4% (35 km/h off-peak 25 km/h peak).
- **Govt. plans :** Ropeway (Naharlagun–city points) & river transport (Chandannagar–Banderdewa).
- **Challenges :** People's preference for private vehicles, lack of reliable AC buses with women's facilities.

IMPHAL (MANIPUR) : IN A BIND

- **Geography** : Valley city, radial roads converge at Kangla Gate; expansion limited by hills & rivers.
- **No functional public transport :** Only a few irregular buses; dependence on private diesel autos, minibuses.
- **Trip patterns (2023 *Vs.* 2011) :** Two-wheelers (36·8% to 1·8%); Cars (6·1% to 1·1%); Buses (4·3%, to – 1·7%); IPT (30·2% to + 2·2%); NMT (20·8% to – 4·2%).
- **Congestion index :** 24·6% (33·3 km/h off-peak → 24 km/h peak).
- **Pollution :** PM2·5 from diesel, road dust, stone crushers, phased-out vehicles from metros.
- **Govt. measures :** 51 km Ring Road (to ease central gridlock); EV policy (2022) targets 20% adoption by 2026. However progress is poor (diesel 12,556 *Vs.* EV 1,548 registered, 2020–25).

Down to Earth 1–15 August

DRAFT UN RESOLUTION ON TRANS-FASTS : CONCERNS AND IMPLICATIONS

Background

- UN to adopt Political Declaration on Prevention & Control of NCDs (heart disease, diabetes, obesity, cancer).
- Draft (May 2025) calls for elimination of trans-fats in food & beverages.
- Issue : Draft fails to distinguish between industrially produced trans-fats and naturally occurring trans-fats in milk, meat, and dairy products.

Why Distinction Matters ?

- Industrial trans-fats (from hydrogenated oils, vanaspati, processed foods, repeated frying) harmful and linked to heart disease, obesity, diabetes, cancers.
- Natural trans-fats (in dairy & meat) → present in small amounts (2–5% fat), provide essential nutrients (protein, iron, zinc, calcium, vitamin B12, A, D, etc.), not linked with adverse health effects.
- WHO (2018) targeted only industrial trans-fats under REPLACE framework; now (2025) claiming both types equally harmful → creates confusion.

Expert Concerns

- 117 scientists signed open letter (July 10, 2025) urging UN to clarify.
- **Risk :** Policy may discourage animal-sourced foods, worsening malnutrition in low- and middle-income countries (LMICs).

Risks of Ambiguity

- **Children & vulnerable groups :** Depend on animal foods for growth, immunity, brain development.
- **Global South :** Per capita meat/milk intake is extremely low (*e.g.*, 68 g meat/person/year in sub-Saharan Africa *Vs.* 138 kg in US).
- **Plant-based push :** Could benefit plant protein industry, but plant alternatives may lack nutrients (*e.g.*, B12) and are expensive in poor countries.

Global Best Practices

- Successful examples show targeting only industrial trans-fats works : Denmark (2003) capped at 2g/100g fat in foods. New York City (2007) banned industrial trans-fats in restaurants. US FDA eliminated industrial transfats from processed foods via labeling.

Key Takeaways

- Industrial trans-fats is harmful and must be eliminated.
- Natural trans-fats in animal products is nutritionally valuable and should not be targeted.
- A balanced diet (diverse plant foods + modest animal-source foods) is essential for preventing both malnutrition and NCDs.
- UN resolution must clarify scope to avoid undermining nutrition security in vulnerable nations.

In short : The UN's draft resolution risks being misinterpreted as a ban on all trans-fats, which could harm nutrition in poorer nations. Experts urge a clear distinction—eliminate harmful industrial trans-fats, but protect nutrient-rich natural ones.

RISKY OVERLAP : OFFSHORE SAND MINING IN KOLLAM, KERALA

- Union government announced offshore mining auctions (Nov 2024) in Gujarat, Andaman & Nicobar and Kerala.
- Kollam, Kerala, earmarked for offshore sand mining. Auction scheduled for August 22, 2025.
- Objective : To reduce dependence on land-based sand sources by tapping 'sustainable' offshore reserves.

Importance of Kollam

- Kollam is major fishing hub, contributing 20% of Kerala's fish production by value.
- 27 fishing villages, 27,470 active fishers, 17,831 allied workers.
- Offshore mining zone (27–33 km from shore) overlaps with traditional fishing grounds.

Ecological and Livelihood Concerns

1. Marine biodiversity : Kollam sandbanks: feeding & breeding ground for fish, shrimp, corals. Dredging disturbs habitats, increases turbidity and may cause local extinctions. Corals (protected under Wildlife Protection Act, 1972) at risk.

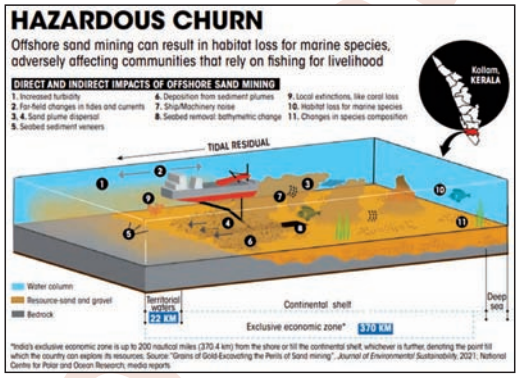
2. Fish catch reduction : Sediment plumes, noise and silt disposal from dredging may displace fish stocks. Fisher communities fear livelihood collapse.

3. Coastal erosion : Kollam already erosion-prone; mining may alter sand drift patterns, weakening groynes & seawalls. Residents report worsening wave impact and house damage.

4. Silt and pollution : Ashtamudi Lake discharges silt into sea → operators may wash sand, disposing extra silt offshore, harming nearshore fishers.

5. Social impacts :

Examples from Indonesia : reduced fish catch, poor water quality, tourism decline, social conflicts between pro-environment groups and miners.



Government Justification

- Offshore mining practiced in UK, Sweden, Indonesia, Namibia, South Africa.
- India amended Offshore Areas Mineral (Development & Regulation) Act, 2002 in 2023 to allow transparent auctions.
- Offshore Areas Mineral Trust to fund research, administration & mitigation.

Challenges

- Enforcement & monitoring of mining impacts in dynamic offshore ecosystems.
- India's track record in regulating land-based mining raises doubts about effective governance in offshore operations.

Summary Insight

Offshore sand mining in Kollam represents a development–livelihood–ecology conflict. While the government pushes it as a sustainable resource solution, fishers fear loss of livelihood, worsening erosion, and ecological damage in one of Kerala's richest fishing zones. Monitoring and governance will be critical, but past mining experiences in India cast doubts on effective safeguards.

BLIND SPOTS IN CLIMATE MODELS FOR POLAR REGIONS

Challenges in Polar Climate Modelling

- Polar regions are remote, harsh, and data-scarce, making accurate climate simulations difficult.
- Sea ice dynamics and ocean-atmosphere interactions are highly complex, adding uncertainty.

Southern Ocean – The 'Engine Room' of Climate

- Strongest winds and waves on Earth playing major role in heat and CO_2 exchange.
- Contains the Antarctic Circumpolar Current (ACC) and Southern Meridional Overturning Circulation (SMOC), crucial for global heat, oxygen and nutrient transport.

Discrepancy in Antarctic Sea Ice Trends

- Earlier models predicted Antarctic sea ice expansion due to stratification from freshwater input.
- Observations : Between 1979–2014 sea ice expan-ded. Since 2015–16 consistent decline, lowest extents recorded.

New Findings (PNAS Study, June 2025)

- Unexpected increase in salinity and warmth in Southern Ocean.
- Altered freshwater flux brings heat to sea ice edge, enhancing melting and creating polynyas (ice-free zones).
- **Potential impacts :** More iceberg calving. Antarctic ecosystem disruptions. Changes in ACC and SMOC causes global ripple effects. Possible CO_2 release from deep waters.

Technological Advances

- Barcelona Expert Center improved salinity data via European SMOS satellite with new polar-tuned processor.
- Enabled better explanation of Antarctic sea ice loss and methodologies for tracking water mass transformation.

Arctic Warming Challenges

- Arctic is warming ~4 times faster than global average.
- Traditional models emphasized ice-albedo feedback.
- New study (Kyushu University, May 2025) : Problem lies in misrepresentation of Arctic mixed-phase clouds. Models overestimate ice content in clouds and underestimate warming effect. 21 out of 30 models flawed in cloud feedbacks.

Way Forward

- Climate models must integrate high-quality data, improve small-scale process representation and enhance international collaboration.
- Current models lag behind rapid, complex polar changes, risking underestimation of global climate impacts.

MISTAKEN IDENTITY IN MUSK DEER CONSERVATION

Key Issue

- **Species Confusion :** Alpine musk deer (*Moschus chrysogaster*) and Himalayan musk deer (*Moschus leucogaster*) have been confused due to their sympatric distribution.
- **Consequence :** Indian zoos likely bred Himalayan musk deer instead of Alpine musk deer under conservation programmes.

CZA Report (2024) Findings

- No recognized zoo currently holds Alpine musk deer.
- Past efforts in Uttarakhand (Chopta) and Darjeeling (Padmaja Naidu Zoo) were misidentified.
- Alpine musk deer population status is unclear; last estimate ~1,000 in the 1980s.
- IUCN (2014) lists it as Critically Endangered with declining numbers.

Expert Concerns

- Captive breeding of musk deer in India has completely failed due to wrong identification.
- Lack of founder stock undermines scientific breeding efforts.
- Reflects systemic confusion in animal conservation programmes.

Institutional Context

- **Central Zoo Authority (CZA) :** statutory body (est. 1992) under MoEFCC to oversee captive breeding.
- **Wildlife (Protection) Act, 1972 Amended in 2022 :** expanded definition of zoos to include conservation breeding centres under regulatory framework.

Funding and Breeding Efforts

- RTI (2022) showed no specific expenditure details available on musk deer.
- Total allocation for zoo breeding programmes (2006–2021) : ₹ 28·94 crore.
- CZA identified 35 species (1992) which expanded to 74 species (2011) but narrowed to 26 species for focused funding.
- Target : 250 pedigreed individuals per species, with at least 100 in Indian zoos.

Broader Challenges

- Delayed and mismanaged conservation breeding in India since 1960s.
- IUCN Red List outdated, reflects global trends not India-specific conditions.
- Report recommends no new species should be added until existing programmes are fixed.
- Urgent need for India's own updated species conservation list.

GAME CHANGERS IN ENERGY EFFICIENCY

Importance of Efficiency

- Improving energy efficiency of everyday appliances is one of the fastest and cheapest ways to ensure energy security and cut CO_2 emissions.
- By 2030, ACs and water pumps alone could account for one-third of India's energy consumption.

India's Challenge

- India is the largest extractor of groundwater globally; ~32 million irrigation pumps are in use.
- ACs are no longer luxury items—1 in 10 households owns an AC, projected to exceed 1 billion units by 2050.
- This rapid growth in cooling demand risks massive electricity use and urban heat island effects.

Global and National Commitments

- **COP28 (Dubai, 2023) :** Countries pledged to double energy efficiency improvements by 2030.
- India committed to 4% annual energy efficiency improvement (*Vs.* current 2%).
- **Government target (2025) :** Cut energy consumption by 1,035 TWh by 2030, with 17% achievable from ACs and water pumps.

Standards and Progress

- BEE's Standards & Labelling (S&L) Programme (2006) : Star ratings (1–5) for appliances. Covers 41 appliances, but only 16 mandatory (including ACs). Water pumps still voluntary—mandatory by 2026.
- Between 2018–2023 : Saved 81·64 billion units of energy and avoided 58·24 MT CO_2 emissions (2022-23 alone).

ACs : From Guzzlers to Efficient Cooling

- Inverter ACs now dominate (77% market share in 2023 *Vs.* 1% in 2015), ~50% more efficient.
- However, India's standards lag behind global benchmarks (34–45% lower).
- Star-rating revisions delayed → less savings achieved.
- Market skewed toward mid-tier 3-star ACs (67% share in 2023-24).
- Payback on 5-star ACs : Extra ₹ 7,000 cost, recovered in ~4·5 years (faster in hotter states).

Cooling and Climate Risks

- ACs reduce indoor heat risk but release waste heat, worsening urban heat islands.
- India Cooling Action Plan (ICAP, 2019): Target to reduce cooling demand by 20–25% by 2037-38.
- Government exploring default higher temperature settings (24–28°C)—each +1°C saves ~6% electricity.
- Thermal comfort through passive design and better building codes can cut indoor temps by 7°C, reducing cooling demand.

Domestic Manufacturing & Policy Push

- **PLI Scheme (2021) :** ₹ 6,238 crore support for white goods (ACs, components).
- Yet, India remains import-dependent (65–70% AC components from China).
- Risk of India becoming a dumping ground for inefficient models if standards aren't raised.

Key Takeaways

- ACs and pumps are biggest energy guzzlers which must be made efficient.
- India's efficiency standards lag global norms, revisions too slow.
- Inverter ACs are a positive shift, but 5-star adoption remains low.
- Thermal comfort and passive cooling (traditional design, building codes) are essential complements.
- Stronger standards, incentives, and domestic manufacturing are crucial to align with net-zero targets.

OWNERSHIP RIGHTS AND COMMUNITY FOREST MANAGEMENT

Context

- Chhattisgarh recorded 19,000+ forest fires in January–April 2025, the highest in four years.
- Yet, some villages like Karlajhar (Udanti-Sitanadi Tiger Reserve) have successfully contained fires and restored forests through CFRR under the Forest Rights Act (FRA), 2006.

What is CFRR ?

- **FRA, 2006 recognizes 3 rights :** 1. Individual Forest Rights (IFR); 2. Community Forest Rights (CFR); 3. Community Forest Resource Rights (CFRR) – most powerful, under Section 5.

- **Key feature :** Gives gram sabhas legal authority & responsibility to *use, manage, and protect* forests.

Impact on the Ground

- **Karlajhar Village (1,623 hectare, CFRR granted 2023) :**
  - **Fire management :** Community patrols, WhatsApp alerts, fire lines.
  - **Traditional systems revived :** *Thengapalli* (forest patrol teams).
  - **Illegal felling & poaching stopped :** Offenders punished.
  - **Eco-restoration :** Seed balls, nurseries, check dams, gully plugs.
  - **Social innovations :** Renting canopies/bamboo for functions to avoid tree felling.
  - **Cross-border pact :** Agreement with Odisha's Achala village to share forest sustainably.
- **Other villages :**
  - **Amad (1,517 hectare) :** No fires after CFRR; mahua, sal, teak groves thriving.
  - **Kamepur (3,304 hectare) :** Shifted from grazing rights to full forest management; now earns 60–70% income from forest produce.

Scale in Chhattisgarh

- **As of Oct 2023 :** 4,307 villages with CFRR, covering 1·94 million hectare (highest in India).
- **District leaders :** Bijapur (195,162 hectare), Korba (161,182 hectare), Kondagaon (149,800 hectare).

Struggles and Gains

- CFRR often takes a decade of protests, petitions and rallies to secure, as seen in Karlajhar.
- Forest Department reluctant to cede control, treating forests as property.
- But once secured, CFRR leads to better fire control, biodiversity revival and sustainable livelihoods.

National Opportunity

- 40 Million ha of forestland in India eligible for CFRR (Rights & Resources Initiative, 2015).
- Could benefit 150 million people (incl. 90 million tribals).
- CFRR seen as a tool for : Restoring degraded ecosystems; Strengthening rural livelihoods; Advancing inclusive, sustain-able development.

Key Idea

State forestry views forests as timber; communities view forests as life. CFRR bridges this gap by empowering gram sabhas with both rights and responsibilities, ensuring sustainability, conservation and livelihoods.

SILENT SPREAD

Issue

- Unauthorised herbicide-tolerant (HT) cotton seeds are being circulated and cultivated in Dhar district, Madhya Pradesh, and other cotton belts of Maharashtra and Gujarat.
- These seeds are illegal, as India has not approved HT cotton for commercial cultivation.

Key Concerns

1. Health and Environment Risks : Glyphosate, used with HT cotton, is classified by WHO's IARC as 'probably carcinogenic'. Risks of soil microbial imbalance and emergence of herbicide-resistant weeds.

2. Illegal GM Seeds : Packets branded as *"Yugam 5G, Bahubali 4G, Glypho Guard 4G, Killer, Honey 4G, Rudra Plus"* etc. sold without authorization. Farmers aware these are 'illegal' but still purchase due to pest and weed resistance benefits. Seeds cost ₹ 1,500–2,100 per packet, compared to ₹ 900–1,000 for BG II (approved Bt cotton).

3. Farmer Motivation : BG II seeds losing effectiveness against pink bollworm & secondary pests (whitefly, aphids, thrips). Heavy pesticide use (up to 15 sprays/season) still causing yield loss. Labour shortage makes glyphosate-tolerant varieties attractive (reduced weeding costs).

4. Regulatory and Institutional Gaps : Only BG I & BG II Bt cotton officially approved in India. Monsanto's BG II RRF (herbicide-tolerant cotton) approval withdrawn in 2016; re-submitted by Bayer in 2021, still pending. Weak regulation, poor monitoring, retreat of public agri-R&D and absence of credible extension services enabling illegal seed networks.

5. Mixed Farmer Outcomes : Some farmers shifting back to BG II or other crops (soyabean, maize, banana) due to lower yield weight despite fibre quality. Cotton dealers facing losses from reduced demand for legal seeds.

Policy Context

- **Supreme Court (July 2024)** in GM Mustard case : directed Centre to draft a National Policy on GM Crops within 4 months (still pending).
- Highlights urgent need for clear national GM policy, stronger regulatory oversight and farmer support.

Conclusion

The spread of illegal herbicide-tolerant cotton reflects regulatory failure, market gaps, and farmer distress. Without urgent reforms, such shadow seed systems will silently reshape Indian agriculture, with significant implications for health, environment, and farmer–state relations.

BOUND BY DISASTER

1. Climate Disasters and Child Marriage

- **2004 Tsunami in Tamil Nadu :** Families married off adolescent daughters to protect them from uncertainty.
- **2025 Drought in Marathwada :** Families arranged quick 'gate-cane' weddings ahead of sugarcane harvest, linking marriage with survival and labour needs.
- **Pattern :** Disasters are sudden (tsunami) or slow (drought), pushing families toward early marriage.

2. South Asia's Vulnerability

- South Asia is highly climate-vulnerable and has the world's highest child marriage rates.
- Over 750 million people in South Asia affected by climate-related disasters in two decades.
- Families use child marriage as risk management during poverty, displacement and food insecurity.

3. Country Examples

- **Bangladesh :** Two-thirds of girls marry before 18; 39% rise in child marriages in climate-hit regions (2022 report).
- **Pakistan floods 2022 :** 33 million displaced; spike in child marriages (45 in one Sindh village within months).
- **Similar trends** after 2004 tsunami (Indonesia, Sri Lanka) and during Ebola crisis (West Africa).

4. Complex Drivers

- Climate change does not directly cause child marriage but magnifies vulnerabilities.
- **Effects vary :** In dowry-dependent areas economic stress can delay marriage, while in others it accelerates weddings.
- **Root factors :** Poverty, gender inequality, displacement, hunger, weak institutions.

5. Long-term Consequences

- Early marriage leads to school dropouts, early pregnancies, domestic violence, entrenched poverty.
- Disasters deepen gender divides—women eat last, take on care burdens, lose agency.

6. Policy Gaps

- National climate adaptation plans focus on infrastructure (embankments, energy) rather than social resilience.
- **Data gaps :** Many child marriages remain unrecorded in displaced/informal settings.

7. Interventions and Hope

- Efforts include cash incentives for schooling, mobile education, legal aid, community protection systems.
- Example : Karauli, Rajasthan – Dalit Adivasi Pichhada Varg Kishori Shiksha Abhiyan mobilised 1,200 girls to resist child marriage.
- Grassroots initiatives show promise but remain underfunded and neglected.

8. Way Forward

- Treat child marriage not just as a moral issue, but as a signal of systemic risk.
- Adaptation must address education continuity, livelihoods and safety for girls.
- Community-led, girl-centred approaches should be central to resilience planning.

Conclusion : Climate change intensifies vulnerabilities that drive child marriage in South Asia. Without integrating gender and child protection into climate adaptation strategies, resilience plans will remain incomplete and ineffective.

EUROPE'S RIVER-BARRIERS DEMOLITION : KEY POINTS

1. Record Barrier Removals (2024)

- 23 European countries demolished 542 barriers in 2024 – the highest since the campaign began in 2020.
- **Goal :** Make 25,000 km of rivers barrier-free by 2030 (EU Nature Restoration Law, 2023).

2. Scale of the Problem

- Europe has one dam per km of river; ~1·2 million in-stream barriers exist.

- Globally, ~62,000 large dams and millions of smaller barriers alter rivers.

3. Ecological and Social Concerns

- **UNEP's *Frontiers 2025*** : *The Weight of Time* report warns : By 2030, 89% of global river volume may face moderate to severe fragmentation (up from 43% in 2010). Barriers disrupt ecosystems, alter water flow & temperature, block fish migration, reduce sediment transport, and damage inland fisheries vital for local food security. Indigenous and fishing communities often face livelihood loss.

4. Global Perspective

- **Europe and North America :** Removing obsolete, unsafe, or uneconomic dams to restore ecosystems.
- **Africa, Asia, South America :** Still building hydropower dams as 'green energy' option, though UNEP urges careful design to reduce ecological damage.

5. Policy Context

- EU's Water Framework Directive (2000) first flagged barriers as major anthropogenic pressures.
- The Nature Restoration Law (2023) legally mandates restoration by reconnecting rivers.

6. Way Forward

- Demolition offers learning opportunities: ecosystems can take decades (up to 50 years) to restore naturally.
- Communities and governments increasingly recognize ecological & socio-economic benefits of free-flowing rivers.

August 2025

GIST OF SCIENCE REPORTER

Topic : Axiom Space Mission

MILESTONES IN INDIAN SCIENCE : A BIOBANK FOR THE FUTURE AND HEENG BLOOMS AT HOME

Key Milestones

1. Phenome India 'National Biobank' : Established under CSIR (Council of Scientific and Industrial Research). Aims to create a comprehensive genetic and health database of Indians. Will aid in precision medicine, disease prediction, and public health planning. Supports collaborative research between hospitals, researchers and policymakers.

2. Domestication of Heeng (Asafoetida) India, despite being the largest consumer of Heeng, never cultivated it traditionally (relied on imports). CSIR-IHBT (Institute of Himalayan Bioresource Technology, Palampur, HP) introduced its cultivation. First flowering of Heeng on Indian soil marks a major breakthrough. Expected benefits : self-reliance in spice production, boost to farmers in cold desert regions (Lahaul–Spiti, HP) and agri-innovation.

Significance

- Biobank strengthens India's public health infrastructure and advances personalized healthcare.
- Heeng domestication enhances agricultural diversification, import substitution and farmer income.
- Together, they reflect India's scientific innovation in both healthcare and agriculture.

AXIOM SPACE'S MISSION 4 : THE INDIAN PERSPECTIVE

Mission Overview

- Axiom Space's 4th private mission (Ax-4) to the International Space Station (ISS).
- Marked the historic return of India, Poland, and Hungary to space after 40+ years.
- First time all three nations jointly participated in an ISS mission.

Indian Milestone

- Shubhanshu Shukla (ISRO pilot) became the first Indian to step on the ISS; Second Indian in space after Rakesh Sharma (1984, Soyuz T-11).
- **Crew :** Peggy Whitson (Commander, ex-NASA). Shubhanshu Shukla (Pilot, ISRO). Sławosz Uznański-Wiśniewski (Poland, ESA). Tibor Kapu (Hungary).

Science and Experiments

- 60 experiments across 31 countries → most science-focused Axiom mission so far.
- Research covered microgravity, human adaptation, agriculture, biology, technology tests.
- **India's contribution :** 7 experiments led by Capt. Shubhanshu Shukla. Designed by ISRO and Indian research institutions. Focus on microgravity's impact on agriculture, biology, human physiology. These experiments will aid design of efficient space modules for future human spaceflight missions.

Significance for India

- Strengthens India's role in global space collaborations.
- Advances ISRO's human spaceflight programme (Gaganyaan & beyond).
- Boosts India's scientific diplomacy by contributing to international microgravity research.

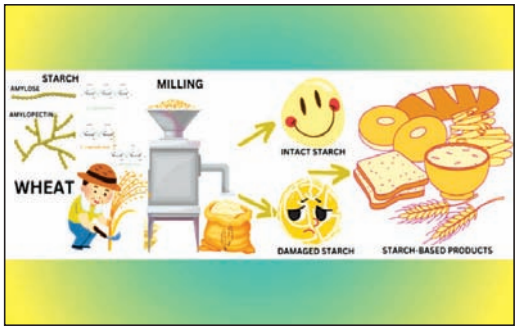
WHEAT STARCH UNDER STRESS : WHY DAMAGED STARCH MATTERS IN FOODS

Wheat's Global Role

- 785 million tonnes produced annually (FAO, 2023).
- Provides 20% of global caloric intake; upto 40% in South Asia & North Africa.
- Core component: starch, shaping texture & structure in foods (bread, pasta, etc.).

What is Damaged Starch ?

- Produced when starch granules are fractured during milling / processing.



- Structural exposure → higher water absorption & stronger enzyme interaction.
- Not a waste, but a functional ingredient in food science.

Functional Importance

- **Dough hydration & fermentation** : Damaged starch regulates water uptake & yeast activity.
- **Nutritional profile** : Higher digestibility due to greater enzymatic access.
- **Industrial use** : Key in baked goods, noodles, pasta and even brewing.

Significance

- Damaged starch is a critical variable in food processing, not just a byproduct.
- Balancing starch damage helps optimize quality, texture, and nutrition in wheat-based foods.
- Links food science with nutrition security and global wheat dependency.

HOT WATER SPRINGS : SPRINGS OF HOPE AND NATURE'S SAUNA

What are Hot Springs ?

- Formed when groundwater gets heated by shallow magma or geothermal heat and emerges at the surface.
- Also called geothermal springs or hydrothermal springs.
- Water temperatures range from warm to boiling.

Global Example

- Shanay-Timpishka River (Peru, South America) : World's only boiling river. 6·4 km long. Water temperature: 45°C–100°C.

Indian Context

- Hot springs often diverted into 'kunds' (ponds).
- Traditionally used for bathing and testing heat (*e.g.*, cooking eggs / rice in the water).
- Associated with spiritual, medicinal, and cultural practices.

Source of Geothermal Heat

- Radioactive decay in Earth's mantle → accounts for 45–90% of escaping heat.
- Additional heat in volcanically active regions.

Significance

- Natural saunas with recreational, cultural, and therapeutic importance.
- Hold potential for geothermal energy exploration.
- Represent a link between Earth sciences, health traditions, and renewable energy.

THE MOUSE THAT MADE HISTORY : THE STORY OF REWIRING NEUROSCIENCE

Background

- In 1979, Nobel laureate Francis Crick wrote that mapping the exact wiring of brain tissue and tracking neuron firing was 'impossible'.
- Decades later, neurotechnology advances have proved him wrong.

The Breakthrough Experiment

- A lab mouse (born 19 Dec., 2017, 65 days old) was shown clips from *The Matrix*.
- Researchers used it to build the largest-ever functional brain map.
- The map covered 84,000 neurons, showing connections & real-time firing patterns.

Scientific Significance

- First time such a detailed wiring diagram of mammalian brain tissue has been created.
- **Provides insights into :** Neural connectivity (who talks to whom in the brain); Brain function in real time; Potential applications in AI, mental health, neurodegenerative disease research.

Why It Matters ?

- A giant leap for neuroscience – bridging the gap between science fiction and reality.
- **Opens pathways for :** Precision brain therapies. Better models of consciousness & cognition. AI inspired by neural wiring.

THE HANSA -3 (NG) : ADVANCING INDIA'S AVIATION FUTURE

Overview

- HANSA-3 (NG) is the next-generation, two-seater trainer aircraft.
- Developed by CSIR-NAL (National Aerospace Laboratories), Bengaluru.

- Project led by Dr. Abhay A. Pashilkar (Director, CSIR-NAL).

Features and Advantages

- Indigenous design which boosts Atmanirbhar Bharat in aviation.
- Cost-effective & reliable platform for flight training schools.
- Modern avionics, safety systems and improved efficiency.
- Designed to meet growing demand for skilled pilots.

Significance

- Strengthens India's aviation training infrastructure.
- Reduces dependency on imported trainer aircraft.
- Positions India as a potential global aviation hub.
- Contributes to self-reliance & technological innovation in aerospace.

In short : HANSA-3 (NG) is a symbol of India's self-reliance in aviation, ensuring affordable, high-quality pilot training while fueling India's rise in the global aviation ecosystem.

REASON'S LIGHT : NAVIGATING MISSION VIKSIT BHARAT WITH SCIENCE AND CRITICAL THINKING

Science as the Foundation of Progress

- Modern life (electricity, transport, gadgets, buildings, plastics, etc.) is a result of the Scientific Revolution which took place 500 years ago.
- Science is not a collection of facts, but a method to uncover truth through observation, experiment and error-correction.
- Its role is to reduce uncertainty by focusing on objective reality, not beliefs or opinions.

Distinction Between Science and Values

- Science is based on facts & objective truth.
- Ethics/morality examines how society uses science (*e.g.*, nuclear fission for energy *Vs.* weapons).
- Example : Climate change is scientifically proven, irrespective of personal belief.

Science, Technology AND Mission Viksit Bharat

- Technology is applied science that solves daily problems.
- For *Mission Viksit Bharat (Developed India @2047)*, science & critical thinking must drive : Innovation; Evidence-based policy-making; Sustainable growth.

Key Message

To achieve Viksit Bharat, India must embrace : Scientific temper (as enshrined in Article 51A(h) of the Constitution). Critical thinking to fight misinformation, superstition and pseudoscience. Responsible use of technology for societal good.

In short : Science is reason's light—not just knowledge, but a method for truth-seeking. For India's journey to *Viksit Bharat 2047*, nurturing scientific temper and critical thinking is as vital as economic and technological progress.

DOGS AND HUMANS : MEMORY, BRAINS AND A SHARED STORY

Ancient Companionship

- Dogs have been with humans for 11,000+ years, from early farmers to modern cities.
- They share not just our lives but also memory and cognition traits.

Memory in Dogs

- Dogs remember faces, places, and smells far longer than assumed.
- **Toy experiment :** 5 dogs learned 12 toy names → recalled them even after 2 years.
- **Imitation experiment :** Dogs trained to copy actions → remembered & repeated after 1 hour, without cues shows episodic/event memory, once thought uniquely human.
- **Everyday signs :** Dogs remember walks, owners, commands and emotional cues.

Significance

- Challenges the idea that complex memory is only human.
- Dogs have a shared cognitive evolution with humans.
- Strengthens the human–animal bond through science.
- Opens pathways for research in memory, learning, and emotional intelligence in animals.

OUR CELLS ARE INTELLIGENT

Concept of Cellular Intelligence

- Term **'Cell Intelligence'** first proposed by Nels Quevli (1916) in his book *Cell Intelligence*. He described cells as conscious, intelligent beings responsible for growth, heredity, and instinctive actions.

Examples of Cellular Intelligence

- **Adaptation :** Cells sense environmental changes (*e.g.*, stress, nutrient availability) and adjust functions.
- **Learning and memory-like behaviour :** Immune cells 'remember' pathogens (basis of immunity).
- **Problem-solving :** Cells repair DNA, regulate energy use and communicate via signaling.
- **Collective intelligence :** Billions of cells coordinate to form tissues and organs, just like humans collaborate in society.

Significance

- Reframes life : cells are not passive units, but dynamic, decision-making systems.
- Crucial for understanding health, disease, immunity, aging and regeneration.
- Offers insights into biotechnology, medicine, and synthetic biology.

In short : Our bodies are built on intelligent cells that sense, adapt and act much like thinking beings—making life itself a story of microscopic intelligence at work.

HARNESSING NATURE : THE EMERGENCE OF WOOD-BASED AEROGELS

- **Aerogels Overview :** Materials with low density, high porosity, and large surface area. Offer excellent mechanical strength and thermal insulation. Potential applications: oil–water separation, CO_2 capture, electronics, aerospace.
- **Traditional Aerogels :** Silica-based aerogels were the first commercialized. Other biopolymer-based aerogels studied : cellulose, gelatin, agar, albumin.
- **Manufacturing Process (Sol–Gel Method) :** Starts with a colloidal solution of reactants in solvent. Crosslinking facilitates gel formation through polymerization. Solvent removal via ambient drying, supercritical drying, freeze drying, etc.
- **Key Finding :** Almost any material can be converted into aerogels via sol–gel and drying. The uniqueness of the raw material determines aerogel properties and applications.
- **Example :** Silica aerogels (≈99% empty space) are widely used in space exploration due to their extreme lightness and insulation.

A STEP FORWARD IN SYNTHETIC BIOLOGY : XENO-GENETICS, AN ADVANCED MOLECULAR DEVICE TO CREATE DESIRED AND TARGETED DNA MOLECULES

- **Genetic inheritance** : DNA inherited from parents determines the traits and functioning of offspring. This inheritance can be advantageous or disadvantageous depending on encoded information.
- **Molecular intervention :** New molecular devices have been developed to modify DNA structures, aiming to achieve desired traits or eliminate disorders.
- **Genetic technologies** :
  - **Conventional methods** : Androgenesis, gynogenesis, diploidy, triploidy, induced mutations, recombinants, transgenesis.
  - **Advanced methods :** Modern gene editing techniques for precise DNA modification.
- **Applications :** Used across agriculture, animal husbandry, fisheries, and increasingly in human medicine.
- **Human focus :** With the Human Genome Project completed, gene modulation and gene therapy are emerging as tools to treat severe and incurable disorders, including cancer.
- **Xeno-genetics :** Represents a new step in synthetic biology, offering advanced tools for creating targeted DNA molecules to enable precision interventions in biological systems.

CRYONICS : A SURE BET OR WISHFUL THINKING ?

- **Concept of Cryonics** : Involves freezing human bodies at cryogenic temperatures after legal death, hoping future medicine can revive and cure them.
- **Scientific Basis :** Rooted in cryobiology—study of how organisms respond to extreme cold.
- **Process** : Immediately after death, body cooled with ice : Heart-lung resuscitator maintains minimal circulation. Blood replaced with cryoprotectant solution to prevent damaging ice crystal formation.
- **Philosophical Questions** : Raises debates on life, death and humanity's relationship with time.
- **Uncertainty :** Though scientifically inspired, it remains speculative—between hope and wishful thinking.