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CURRENT AFFAIRS

WEEKLY 16th Feb. - 22nd Feb. (2026)

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POLITY

Separate Census Enumeration for Denotified & Nomadic Tribes

Syllabus Mapping:
✓GS Paper II – Polity & Governance (Vulnerable Sections, Welfare Schemes, Census & Representation)
✓GS Paper I – Indian Society (Social Justice, Marginalised Communities)
✓GS Paper II – Social Justice (Affirmative Action, Institutional Mechanisms)

Introduction

The Office of the Registrar General of India has decided to enumerate **Denotified, Nomadic and Semi-Nomadic Tribes (DNTs)** in the upcoming **Census 2027**, following demands for a **distinct identification column** in census schedules.

This move carries significance for **data-driven policymaking, targeted welfare delivery, and social justice**, given the historical marginalisation of these communities.

Who are Denotified, Nomadic and Semi-Nomadic Tribes (DNTs)?

Historical Background

- During British rule, several communities were labelled as "criminal tribes" under the **Criminal Tribes Act**.
- The Act enabled:
  - Surveillance
  - Movement restrictions
  - Collective punishment
- It institutionalised stigma and discrimination.

Post-Independence Developments

- The Act was repealed in **1952**.
- These groups were subsequently "denotified".
- However, stigma persisted socially and administratively.

Census History

- Enumerated in **1911 and 1931 Census**.
- **1931 Census** was the last to comprehensively document such communities.
- Post-independence censuses did not distinctly capture DNT data.

The absence of updated data has hindered **policy targeting and representation**.

Current Status and Classification Issues

Idate Commission (2014–17)

- Identified nearly **1,200 DNT communities**.
  - Many absorbed into existing **SC, ST, and OBC categories**.
  - **268 communities** remained unclassified.

Role of Anthropological Survey of India (AnSI)

- Conducted a comprehensive categorisation of the 268 unclassified DNTs.
- Recommended inclusion within SC/ST/OBC lists.

Despite partial classification, many DNT groups continue to face:

- Social exclusion
- Educational deprivation
- Economic vulnerability
- Political underrepresentation

Institutional Mechanisms for DNT Welfare

1. Renke Commission (2008)

- First National Commission to identify DNT communities.
- Highlighted extreme marginalisation.

2. Idate Commission (2014–17)

- Prepared state-wise lists.
- Suggested welfare measures and proper categorisation.

3. National Commission for DNTs (2014)

- Mandated to prepare lists and recommend safeguards.

4. Development and Welfare Board for DNTs (DWBDNC)

- Registered society to:
  - Design welfare programmes
  - Implement development schemes
  - Monitor progress

Government Welfare Schemes

Under the Ministry of Social Justice & Empowerment:

1. SEED (Scheme for Economic Empowerment of DNTs)

- Educational support
- Health insurance coverage
- Livelihood assistance
- Housing support

2. Dr. Ambedkar Pre-Matric & Post-Matric Scholarship (2014–15)

- Promotes educational access.

3. Nanaji Deshmukh Hostel Scheme (2014–15)

- Residential facilities for DNT boys and girls.

Why a Separate Census Column Matters

1. Data Deficit and Policy Blindness

- Without accurate enumeration:
  - No precise population estimates.
  - Inadequate resource allocation.
  - Limited policy visibility.

2. Targeted Welfare Delivery

- Enables evidence-based:
  - Scholarship allocation
  - Livelihood schemes
  - Health coverage

3. Social Recognition

- Symbolic acknowledgment of historical injustice.
- Corrective step toward restorative justice.

4. Constitutional Perspective

Articles:

- **Article 14** – Equality before law

- **Article 15(4)** – Special provisions for socially and educationally backward classes
- **Article 46** – Promotion of educational and economic interests of weaker sections

Enumeration strengthens implementation of constitutional mandates.

Challenges in Enumeration

- Nomadic lifestyle complicates identification.
- Overlap with SC/ST/OBC categories.
- Risk of politicisation.
- Need for clear definitional criteria.

Broader Social Justice Context

Sociologist **Andre Béteille** emphasised that affirmative action must be supported by reliable data for legitimacy and effectiveness.

Accurate enumeration of DNTs aligns with the principle that **recognition precedes redistribution**.

Way Forward

- Develop clear definitional framework for DNT identification.
- Ensure community participation in enumeration.
- Integrate Census data with welfare databases.
- Consider long-term policy clarity regarding classification.
- Strengthen institutional mechanisms for monitoring.

Conclusion

The decision to enumerate Denotified, Nomadic, and Semi-Nomadic Tribes in Census 2027 represents a significant step toward **data-driven inclusion and social justice**. Given their history of colonial criminalisation and post-independence neglect, systematic enumeration can serve as the foundation for equitable representation and targeted welfare interventions.

However, effective implementation will require administrative clarity, political consensus, and sustained institutional commitment.

Mains Practice Question

"Discuss the historical marginalisation of Denotified, Nomadic and Semi-Nomadic Tribes (DNTs) in India. How can separate census enumeration contribute to their socio-economic empowerment?"

INTERNATIONAL RELATIONS

Reforming the Global Trading System: Revitalising the WTO

Syllabus Mapping:
✓GS Paper II – International Relations (Multilateral Institutions, Global Governance)
✓GS Paper III – Indian Economy (Global Trade, WTO, Agricultural Subsidies)
✓GS Paper III – Environment (Climate Change & Trade Linkages)

Introduction

The head of the **World Trade Organization (WTO)** has emphasized the urgent need to reform the global trading architecture in response to rising geopolitical tensions and rapid technological disruptions. While reform is necessary, the call also underlined the importance of **preserving multilateral cooperation** to prevent fragmentation and systemic instability in global trade.

The statement reflects the growing strain on the post-1995 multilateral trading order.

Genesis and Structure of WTO

- Established in **1995** following the **Marrakesh Agreement**.
- Successor to the **General Agreement on Tariffs and Trade (GATT)**.
- Outcome of the **Uruguay Round (1986–1994)** negotiations.
- Membership: **166 countries**, including India.

- Headquarters: **Geneva, Switzerland**.
- Decision-making based on **consensus principle**.
- Core functions:
  - Trade negotiations
  - Dispute settlement
  - Trade policy review
  - Capacity building

Key Challenges Facing the Global Trading System

1. Crisis in Dispute Resolution Mechanism

- WTO's **Appellate Body**, central to its two-tier dispute settlement system, has been non-functional since **December 2019**.
- The blockage has:
  - Weakened enforcement capacity.
  - Encouraged unilateral trade actions.
  - Undermined rule-based dispute settlement.

Without a binding appellate process, the system risks reverting to **power-based bargaining** rather than rule-based governance.

2. Stalled Negotiations & Unresolved Issues

Several core concerns remain unresolved:

- **Agricultural subsidies**
- Market access for agricultural goods
- Application of **Special and Differential (S&D) Treatment** to emerging economies
- Deadlock of the **Doha Development Agenda (DDA)**

The DDA aimed to make global trade more development-oriented but remains largely incomplete.

For India, issues like **public stockholding for food security** remain contentious.

3. Geopolitical Shifts & Protectionism

- Rise of **reciprocal tariffs**.
- Escalating trade wars.
- Growing reliance on **bilateral and regional trade agreements**.
- Strategic decoupling in sensitive sectors like semiconductors and rare earths.

This marks a shift from globalization toward **"strategic trade nationalism."**

4. Emerging 21st-Century Trade Issues

The existing WTO framework struggles to accommodate new realities:

- **Cross-border data flows**
- Digital taxation
- Data privacy regulations
- Climate-linked trade measures (e.g., carbon border taxes)
- Supply chain resilience

These issues require updated rule-making to reflect the **Anthropocene era**, where trade intersects with environmental sustainability and digital transformation.

Consequences of a Weak Multilateral Trading System

Dimension	Impact
Global Economy	Increased uncertainty, supply chain disruptions
Developing Countries	Reduced bargaining power
Climate Action	Fragmented green trade policies
Digital Economy	Regulatory divergence

As economist **Jagadish Bhagwati** argued, multilateralism prevents discriminatory trade blocs and promotes global welfare maximization.

Ways to Strengthen the Global Trading System

1. Reaffirm Multilateralism

- Recognize WTO as the cornerstone of global trade governance.

- Preserve principles of:
  - Non-discrimination (MFN)
  - National treatment
  - Transparency

2. Restore Dispute Settlement Mechanism

- Reactivate a fully functional **Appellate Body**.
- Ensure timely and binding rulings.
- Enhance institutional credibility.

3. Responsible Use of Plurilateral Agreements

- Where full consensus is unattainable, allow issue-based coalitions.
- Ensure plurilateral agreements remain compatible with multilateral norms.

4. Address Developmental Concerns

- Clarify application of **S&D provisions**.
- Resolve agricultural subsidy disputes.
- Provide flexibility for food security programs.

5. Integrate Climate & Digital Governance

- Align trade policies with **climate commitments**.
- Promote interoperability in digital standards.
- Encourage sustainable supply chains.

India's Perspective

India advocates:

- Protection of food security programs.
- Equitable application of S&D treatment.
- Restoration of dispute settlement.
- Balanced approach between climate commitments and development needs.

India views WTO reform as essential but insists on **development-centric multilateralism**.

Conclusion

The global trading system stands at a critical juncture. The paralysis of dispute settlement, rising protectionism, and the emergence of digital and climate-linked trade challenges have exposed structural limitations within the WTO framework. Reform is imperative—but fragmentation would deepen instability.

A strengthened, inclusive, and development-oriented multilateral trading order remains essential to ensure **predictability, equity, and sustainability in global commerce**.

Mains Practice Question

"The World Trade Organization faces a legitimacy and functional crisis in the contemporary geopolitical context. Examine the key challenges confronting the global trading system and suggest reforms to strengthen multilateral trade governance."

India–France Special Global Strategic Partnership

Syllabus Mapping:
✓GS Paper II – International Relations (Bilateral Relations, Strategic Partnerships)
✓GS Paper III – Defence & Security (Defence Manufacturing, Strategic Autonomy)
✓GS Paper III – Energy & Economy (Critical Minerals, Nuclear Cooperation)

Introduction

India and France have elevated their bilateral engagement to a **Special Global Strategic Partnership** following the French President's visit to India. The visit culminated in **21 key outcomes** spanning defence, advanced technology, energy security, trade, and innovation.

This upgrade reflects deepening convergence in the **Indo-Pacific, defence industrial cooperation, and strategic autonomy**.

Evolution of India–France Relations

- **Strategic Partnership established in 1998** – India's first with a Western nation.
- **Horizon 2047 Roadmap (2023)** – Long-term framework for cooperation over 25 years.
- Bilateral trade crossed **€12.67 billion (2024–25)**.
- Regular joint military exercises:
  - **SHAKTI (Army)**
  - **GARUDA (Air Force)**
  - **VARUNA (Navy)**

France has been a consistent partner in supporting India's **strategic autonomy**, including during critical geopolitical phases.

Key Outcomes of the Visit

1. Defence and Security Cooperation

a) H125 Helicopter Assembly Line

- Inauguration of Final Assembly Line at **Vemagal, Karnataka**.
- H125 is a light utility helicopter manufactured by Airbus.
- Known as the only helicopter to have landed on the **Mt. Everest summit**.
- Promotes:
  - Defence indigenisation
  - Make in India

b) HAMMER Missile Production

- Joint venture between **Bharat Electronics Limited (BEL)** and **Safran**.
- Production of **Highly Agile Modular Munition Extended Range (HAMMER)**.
- A smart precision-guided air-to-ground weapon.
- Compatible with:
  - Rafale
  - LCA Tejas

Enhances indigenous defence manufacturing capacity.

2. Technology & Innovation Cooperation

- Launch of **India–France Year of Innovation 2026**.
- Establishment of:
  - Joint Advanced Technology Development Group
  - Indo-French Centre for Digital Sciences & Technology
  - Indo-French Centre for AI in Health at AIIMS, New Delhi

These initiatives strengthen collaboration in:

- AI
- Health-tech
- Deep technology

3. Critical Minerals & Energy Security

- Joint Declaration on cooperation in **critical minerals**.
  - Ensures diversified and resilient supply chains.
  - Reduces dependency on concentrated sources.
- Enhanced cooperation in:
  - Large nuclear power projects (including **Jaitapur Nuclear Power Project**)
  - Small Modular Reactors (SMRs)
  - Advanced Modular Reactors (AMRs)

This strengthens India's **energy transition and clean energy ambitions**.

4. Trade & Economic Cooperation

- Amendment of the **Double Tax Avoidance Agreement (DTAA)**.
- Expanding collaboration in:
  - Startups
  - Renewable energy
  - Student mobility

- Skill development

France is among India's major European investors.

Strategic Significance

1. Indo-Pacific Convergence

- France is a resident Indo-Pacific power (Reunion Island, New Caledonia).
- Shared interest in:
  - Maritime security
  - Freedom of navigation
  - Rules-based order

2. Defence Industrial Partnership

- Shift from buyer-seller to **co-development and co-production** model.
- Supports India's Atmanirbhar Bharat in defence.

3. Energy & Climate Alignment

- Nuclear energy cooperation aligns with:
  - India's net-zero targets
  - Clean energy transition

4. Supply Chain Resilience

- Critical minerals cooperation reduces exposure to geopolitical concentration risks.

Challenges

- Implementation delays in nuclear projects.
- Technology transfer complexities.
- Geopolitical pressures in Indo-Pacific.
- EU regulatory frameworks affecting trade.

Broader Perspective

International Relations scholar **Hedley Bull's concept of "balance of power"** is relevant: India and France enhance mutual strategic leverage without formal alliance commitments.

France's consistent support for India in:

- UNSC reform
- NSG membership

reinforces trust-based strategic alignment.

Way Forward

- Fast-track defence technology transfers.
- Accelerate Jaitapur project implementation.
- Institutionalise innovation partnerships.
- Expand Indo-Pacific maritime cooperation.
- Enhance people-to-people exchanges.

Conclusion

The elevation to a Special Global Strategic Partnership signifies the maturity of India–France relations. Rooted in strategic autonomy, defence collaboration, energy security, and technological innovation, the partnership reflects shared geopolitical interests and developmental priorities.

If effectively implemented, it can serve as a pillar of India's Indo-Pacific strategy and a model for balanced, multi-dimensional bilateral engagement.

Mains Practice Question

"India–France relations have evolved into a Special Global Strategic Partnership. Analyse the strategic, defence, energy, and technological dimensions of this partnership in the context of India's Indo-Pacific policy."

India Joins Pax Silica: Deepening Tech & Supply Chain Alignment

Syllabus Mapping:
✓GS Paper II – International Relations (India–U.S. Relations, Strategic Partnerships, Economic Security)
✓GS Paper III – Science & Technology (AI, Semiconductor & Critical Tech Supply Chains)
✓GS Paper III – Indian Economy (Manufacturing, Critical Minerals, Supply Chain Resilience)

Introduction

India has joined the **Pax Silica Initiative (2025)** by signing the Pax Silica Declaration along with a bilateral Joint Statement under the **India–U.S. AI Opportunity Partnership**. The move advances deeper technological cooperation within the broader **Transforming the Relationship Utilizing Strategic Technology (TRUST)** framework in India–U.S. relations.

The initiative reflects a shift toward **AI-led economic security partnerships** in an era of supply chain realignments and digital geopolitics.

What is the Pax Silica Initiative (2025)?

Meaning of "Pax Silica"

- "Pax" historically denotes peace and stability.
- "Silica" symbolises semiconductor and digital technology ecosystems.
- Together, the term reflects a **technology-driven stable economic order**.

Nature

- A **U.S.-led initiative**.
- Focused on:
  - AI cooperation
  - Supply chain security
  - Trusted digital infrastructure

Core Objectives

1. **Reduce Coercive Dependencies**
   - Diversify supply chains.
   - Prevent strategic vulnerabilities.
2. **Secure Global Tech Supply Chains**
   - Address AI supply chain risks.
   - Promote joint investments.
3. **Protect Sensitive Technologies**
   - Build trusted digital infrastructure.
   - Safeguard advanced technology ecosystems.

Long-Term Framework

- Unite advanced technology nations.
- Build a durable economic order.
- Harness AI for shared prosperity.

Signatory Countries

Australia, Greece, Israel, Japan, Qatar, Republic of Korea, Singapore, UAE, United Kingdom — and now India.

Strategic Importance for India

1. Securing Critical Supply Chains

- Australia is a major exporter of **Lithium**.
- Holds significant **Rare Earth Elements (REEs)** reserves.
- Essential for:
  - Batteries
  - Semiconductors
  - AI hardware

India's participation ensures access to diversified critical mineral sources.

2. Reducing Dependence on China

- China dominates global REE supply chains.
- Possesses strong leverage in processing capacity.
- Pax Silica provides alternative sourcing channels.

This aligns with India's strategic autonomy objectives.

3. Boost to Domestic Manufacturing

- Encourages AI and semiconductor investments.
- Supports Make in India and PLI schemes.
- Integrates India into trusted tech value chains.

4. Advancing India–U.S. Strategic Technology Ties

- Deepens cooperation under TRUST initiative.
- Strengthens collaboration in:
  - AI research
  - Semiconductor manufacturing
  - Secure digital infrastructure

Broader Geopolitical Context

The initiative reflects a transition from **globalisation to "friend-shoring"**, where supply chains are realigned among trusted partners.

Political economist **Robert Keohane's theory of complex interdependence** suggests that economic networks shape power relations. Pax Silica institutionalises strategic interdependence among AI-capable nations.

Economic Implications

Dimension	Impact
AI Ecosystem	Enhanced compute and hardware security
Critical Minerals	Diversified sourcing
Manufacturing	Investment inflows
Strategic Autonomy	Reduced vulnerability

Potential Challenges

- Managing geopolitical sensitivities.
- Ensuring balanced trade benefits.
- Avoiding over-alignment risks.
- Addressing domestic infrastructure gaps.

Way Forward

- Strengthen domestic semiconductor ecosystem.
- Expand critical mineral exploration.
- Develop trusted AI governance frameworks.
- Promote joint R&D and innovation hubs.
- Maintain strategic autonomy while deepening partnerships.

Conclusion

India's entry into the Pax Silica Initiative signals a strategic pivot toward securing AI and technology supply chains through trusted partnerships. By aligning with advanced economies, India enhances its economic security, reduces dependency vulnerabilities, and strengthens its position in the evolving global AI order.

The long-term success of this engagement will depend on sustained investment, domestic capacity-building, and calibrated geopolitical balancing.

Mains Practice Question

"India's participation in the Pax Silica Initiative reflects the growing convergence between technology and economic security. Examine its strategic and economic implications for India in the context of evolving global supply chains."

ECONOMY

CBDC-Based Digital Food Coupons: Reforming PDS Delivery

Syllabus Mapping:
✓GS Paper III – Indian Economy (Inclusive Growth, Digital Economy, Monetary Policy)
✓GS Paper II – Governance (Welfare Schemes, PDS Reforms, DBT Mechanism)
✓GS Paper III – Science & Technology (FinTech, Digital Payments Infrastructure)

Introduction

The Union Government has initiated a **Central Bank Digital Currency (CBDC)-linked Digital Food Coupons Pilot** to strengthen the **Public Distribution System (PDS)**. By integrating the **Digital Rupee (e₹)** into food subsidy delivery, the reform seeks to enhance **transparency, accountability, efficiency, and beneficiary empowerment** in India's food security architecture.

This initiative marks a convergence of **monetary innovation and welfare governance**, reflecting India's evolving digital state capacity.

About the Pilot Project

Core Design

- A **programmable Digital Rupee (e₹)** is credited directly into beneficiaries' **digital wallets**.
- Funds can be used **only for purchasing entitled foodgrains** at **Fair Price Shops (FPS)**.
- Transactions are executed using **QR codes or digital coupons**.

Operational Features

- **Real-time and traceable transactions**
- Elimination of **repeated biometric authentication**
- Reduction in **leakages and diversion**
- Strengthening of **last-mile delivery**

This shifts PDS from a physical grain-transfer model toward a **digitally verified, condition-based transfer mechanism**.

Understanding Central Bank Digital Currency (CBDC)

Definition

CBDC is the **digital version of sovereign fiat currency**, issued and regulated by the **Reserve Bank of India (RBI)**.

Legal Status

- Recognized as **legal tender**.
- A **direct liability of the RBI**.
- Issued under **Section 26 of the RBI Act, 1934**.
- Denominated in Indian Rupees (₹).
- Appears on the central bank's balance sheet.

India's CBDC Rollout

- Pilot launched in **December 2022**.
  - **e₹-W (Wholesale)** – Interbank settlements.
  - **e₹-R (Retail)** – For general public transactions.

How CBDC Integration Transforms PDS

1. Transparency & Accountability

- Every transaction recorded on a **digital ledger**.
- Enables **real-time audit trails**.
- Minimizes ghost beneficiaries and duplication.

2. Reduction in Leakages

- Prevents diversion of subsidized grains.
- Conditional usage ensures funds cannot be misused.

3. Beneficiary Empowerment

- Direct credit to digital wallet.
- Reduces dependency on intermediaries.
- Simplifies authentication processes.

4. Administrative Efficiency

- Reduces paperwork.
- Speeds up reconciliation between central and state agencies.

Significance of CBDC in Welfare Architecture

1. Financial Inclusion

- Expands access to digital payments for the **unbanked and underbanked**.
- Complements **Jan Dhan–Aadhaar–Mobile (JAM)** architecture.
- Promotes digital literacy and fintech penetration in rural India.

2. Leak-Proof Governance

- Real-time traceability reduces:
  - Corruption
  - Tax evasion
  - Subsidy diversion

3. Programmable Payments

- Enables **conditional transfers**.
- Funds can be earmarked for:
  - Food subsidies
  - Fertilizer subsidies
  - Health benefits

This improves **Direct Benefit Transfer (DBT)** efficiency and strengthens policy targeting.

4. Monetary Policy Implications

- CBDC provides central banks with enhanced transaction visibility.
- May improve **policy transmission mechanisms** in the long term.

Broader Governance Context

Dimension	Relevance
Food Security	Supports NFSA implementation
Digital Governance	Builds on India Stack infrastructure
Fiscal Discipline	Reduces subsidy wastage
Social Justice	Ensures equitable access to entitlements

Potential Challenges

- Digital divide in remote regions.
- Cybersecurity risks.
- Data privacy concerns.
- Dependence on digital infrastructure stability.
- Need for awareness among beneficiaries.

Way Forward

- Strengthen digital literacy campaigns.
- Integrate robust **cybersecurity safeguards**.
- Develop clear data protection protocols aligned with Digital Personal Data Protection Act.
- Conduct phased expansion with continuous impact assessment.
- Ensure state-level capacity building.

Conclusion

The CBDC-based Digital Food Coupon pilot represents a significant evolution in India's welfare delivery model. By combining **programmable monetary innovation with food security governance**, it holds the potential to reduce leakages, empower beneficiaries, and build a transparent and accountable subsidy ecosystem.

If implemented inclusively and securely, it can become a template for integrating **digital currency into welfare state mechanisms**, reinforcing India's commitment to **inclusive growth and digital governance reform**.

Mains Practice Question

"Examine the potential of Central Bank Digital Currency (CBDC) in transforming welfare delivery mechanisms in India, with special reference to the Public Distribution System."

AI-Led Transformation of Indian Agriculture

Syllabus Mapping:
✓GS Paper III – Indian Economy (Agriculture, Inclusive Growth, Technology in Farming)
✓GS Paper III – Science & Technology (Artificial Intelligence, Emerging Technologies)
✓GS Paper III – Environment & Disaster Management (Climate-Resilient Agriculture)

Introduction

Agriculture remains the **foundation of India's socio-economic structure**, supporting nearly **50% of the population** and contributing approximately **18% to GDP**. However, structural challenges—such as **fragmented landholdings, climate variability, price volatility, and low productivity**—limit its potential.

The integration of **Artificial Intelligence (AI)** into agriculture is emerging as a transformative solution, aligning with India's push toward **technology-driven inclusive growth**.

Why AI in Agriculture? – Structural Context

Indian agriculture faces:

- **Climate uncertainty** (erratic monsoons, heatwaves)
- **Declining soil fertility**
- **Labour shortages**
- **Market inefficiencies**
- **Post-harvest losses**

AI offers predictive, data-driven, and real-time decision-making capabilities to address these constraints.

Key Applications of AI in Agriculture

1. Soil Health Diagnostics

- AI-driven deep learning models analyse:
  - Satellite imagery
  - Drone-based observations
  - Soil sensor data
- Enables:
  - Nutrient deficiency detection
  - Soil moisture assessment
  - Optimised fertiliser recommendations

This supports **scientific input management** and reduces overuse of fertilisers.

2. Climate-Responsive Crop Monitoring

- AI models process:
  - Weather forecasts
  - Rainfall patterns
  - Temperature variations
- Provides:
  - Early warning advisories
  - Crop selection guidance
  - Irrigation scheduling

This strengthens **climate-resilient agriculture**, crucial in the era of global warming.

3. Enhancing Farm Mechanisation

- AI-enabled surveillance systems:
  - Monitor high-value crops 24×7
  - Detect pest attacks early
  - Optimise irrigation and pesticide use
- Reduces labour dependency.
- Improves operational efficiency.

4. Improving Price Realisation

- Predictive analytics utilise large datasets from:
  - e-NAM
  - AGMARKNET
- Forecast price trends.
- Help farmers decide:
  - When to sell
  - Where to sell

This addresses **information asymmetry**, a key structural issue highlighted by agricultural economist **T.W. Schultz**regarding productivity and market access.

5. Precision Farming

- Integrates data from:
  - GPS
  - IoT sensors
  - Satellites
  - Drones
- Provides **localised advisories** at farm level.
- Minimises input wastage.
- Maximises yield per hectare.

Government Initiatives Promoting AI-Driven Agriculture

1. Advisory & Decision Support

- **Kisan e-Mitra**: AI-powered voice chatbot assisting farmers.
- National Pest Surveillance System:
  - Early detection of pest outbreaks.
  - Prevents large-scale crop losses.

2. Data-Driven Governance

- **Digital Agriculture Mission (2024)**:
  - Promotes farmer-centric digital solutions.
- **AgriStack**:
  - Unique digital ID linked to land records.
  - Enables targeted service delivery.
- **Krishi Decision Support System (KDSS)**:
  - Integrates weather, soil, and crop data for advisories.

3. Union Budget 2026–27: Bharat-VISTAAR

- **Bharat-VISTAAR (Virtually Integrated System to Access Agricultural Resources)**:
  - Integrates AgriStack with AI systems.
  - Creates an interoperable agricultural data ecosystem.

4. Soil Mapping Initiative

- Nationwide Soil Resource Mapping Project.
- Implemented by the **Soil and Land Use Survey of India (SLUSI)**.
- Supports region-specific agricultural planning.

5. Crop Insurance & AI Integration

- **Pradhan Mantri Fasal Bima Yojana (PMFBY)**.
- YES-TECH:
  - Technology-based yield estimation.

- CROPIC:
  - Real-time crop observation system.
- WINDS:
  - Weather data network for risk assessment.

These initiatives enhance **transparency and accuracy** in crop loss assessment.

Benefits of AI Integration

Dimension	Impact
Productivity	Higher yield with optimised input use
Sustainability	Reduced chemical overuse
Risk Mitigation	Better climate prediction
Market Access	Informed selling decisions
Governance	Data-driven subsidy targeting

Challenges and Concerns

- Digital divide in rural India.
- High initial investment costs.
- Data privacy and ownership issues.
- Dependence on reliable internet connectivity.
- Need for capacity building among farmers.

Amartya Sen's capability approach suggests that **technology must enhance real freedoms**, not deepen inequality—highlighting the importance of inclusive AI deployment.

Way Forward

- Promote AI literacy among farmers.
- Ensure interoperability between platforms.
- Strengthen rural broadband under BharatNet.
- Develop strong data protection mechanisms.
- Encourage public-private partnerships in agri-tech innovation.

Conclusion

Artificial Intelligence is reshaping Indian agriculture from a **monsoon-dependent, labour-intensive system** into a **data-driven, precision-oriented ecosystem**. If implemented inclusively, AI can enhance productivity, improve farmer incomes, strengthen climate resilience, and support India's vision of **Viksit Bharat**.

However, equitable access, institutional capacity, and robust governance frameworks will determine whether AI becomes a tool of transformation or exclusion.

Mains Practice Question

"Discuss the role of Artificial Intelligence in transforming Indian agriculture. Analyse its potential benefits and the challenges associated with its large-scale adoption."

A Decade of UPI: Transforming India's Digital Payments Ecosystem

Syllabus Mapping:
✓GS Paper III – Indian Economy (Digital Economy, Financial Inclusion, Payment Systems)
✓GS Paper II – Governance (DBT, Public Service Delivery, Financial Sector Reforms)
✓GS Paper III – Science & Technology (FinTech, Cybersecurity, AI Applications)

Introduction

Ten years after the launch of the Unified Payments Interface (UPI), the Department of Financial Services, Ministry of Finance, has released a report titled *"Socio-Economic Impact Analysis of Incentive Scheme for Promotion of RuPay Debit Card and Low-Value BHIM-UPI Transactions (P2M)"*.

The findings highlight how UPI has reshaped India's payment landscape—driving **financial inclusion, economic efficiency, and global digital leadership**.

Understanding UPI and Its Institutional Framework

UPI was developed by the **National Payments Corporation of India (NPCI)** under the regulatory oversight of the **Reserve Bank of India (RBI)**. It enables **real-time, interoperable bank-to-bank transactions** using mobile platforms.

Key features include:

- Instant payments
- Interoperability across banks
- QR-based merchant payments
- Low transaction cost
- 24×7 availability

Key Findings of the Report

1. Dominance in Domestic Transactions

- UPI is the **most preferred payment mode (57%)**, surpassing **cash usage (38%)**.
- Reflects behavioural shift toward digital payments.

2. India's Global Leadership

- India accounts for nearly **49% of global instant payment transactions**.
- Establishes India as a global leader in digital public infrastructure.

3. Merchant Adoption

- **94% merchant integration** achieved.
- Benefits include:
  - Faster settlement cycles
  - Better transaction records
  - Reduced cash-handling risks

Particularly transformative for **MSMEs and street vendors**.

4. Economic Contribution

- UPI added an estimated **$16.2 billion to India's GDP (2022)**.
- Gains attributed to:
  - Reduced transaction costs
  - Improved efficiency
  - Formalisation of economy

This aligns with the concept of **transaction cost economics (Ronald Coase)**—lower transaction costs enhance market efficiency.

5. International Expansion

UPI and RuPay are operational in eight countries:

- UAE
- Singapore
- Bhutan
- Nepal
- Sri Lanka
- France
- Qatar
- Mauritius

This supports India's ambition to internationalise its **digital payment architecture**.

Socio-Economic Impact

Dimension	Impact
Financial Inclusion	Access for unbanked populations
Formalisation	Improved tax compliance
Women Empowerment	Easier access to digital finance
Ease of Doing Business	Seamless merchant payments
Governance	Supports DBT transparency

UPI strengthens the **JAM Trinity (Jan Dhan–Aadhaar–Mobile)** ecosystem.

Recommendations of the Report

1. Expand Merchant Acceptance

- Promote QR code and soundbox deployment in Tier 3–6 cities.
- Subsidise POS terminals.

2. Improve Offline Capability

- Scale **UPI Lite**.
- Expand **123Pay** for feature-phone users.
- Address low-bandwidth and rural connectivity constraints.

3. Deepen Financial Inclusion

- Integrate UPI with **Direct Benefit Transfer (DBT)**.
- Promote usage among rural women entrepreneurs.
- Conduct digital literacy programs.

4. Strengthen Security Architecture

- Deploy **AI-based anomaly detection systems**.
- Real-time fraud alerts.
- Enable scheduled and recurring payments (education, healthcare).

Challenges

1. Infrastructure Constraints

- Poor network coverage in rural and remote areas.
- Limited internet penetration.

2. Cybersecurity Risks

- Online frauds and phishing attacks.
- Data privacy concerns.

3. Digital Literacy Gap

- Limited adoption of advanced features:
  - UPI Lite
  - 123Pay
  - AutoPay

Bridging the **capability gap** is essential to prevent digital exclusion.

Broader Economic Perspective

Economist **Joseph Schumpeter's theory of innovation** suggests technological disruption drives economic transformation. UPI exemplifies this by disrupting traditional banking and cash-based systems.

At the same time, inclusive innovation—ensuring access for vulnerable groups—is essential for sustainable development.

Way Forward

- Invest in rural broadband infrastructure.
- Strengthen cybersecurity frameworks under RBI oversight.
- Enhance digital literacy through community-based outreach.
- Promote cross-border UPI interoperability agreements.
- Encourage fintech innovation while safeguarding data.

Conclusion

A decade after its launch, UPI has evolved from a payment interface into a cornerstone of India's **Digital Public Infrastructure (DPI)**. It has enhanced financial inclusion, reduced transaction costs, and positioned India as a global leader in instant payments.

However, addressing cybersecurity risks, digital literacy gaps, and infrastructure challenges remains crucial to ensure equitable and sustainable growth of India's digital payments ecosystem.

Mains Practice Question

"Evaluate the socio-economic impact of UPI in India over the past decade. What challenges must be addressed to ensure inclusive and secure growth of digital payments?"

Future of Employability in the Age of Artificial Intelligence

Syllabus Mapping:
✓GS Paper III – Indian Economy (Employment, Human Capital, Inclusive Growth)
✓GS Paper III – Science & Technology (Artificial Intelligence, Emerging Technologies)
✓GS Paper II – Governance (Education Policy, Skill Development, Digital Inclusion)

Introduction

Artificial Intelligence (AI) has evolved from a niche technological innovation to a **general-purpose economic technology**, comparable to electricity or the internet in its transformative potential. Its growing integration across sectors—manufacturing, finance, healthcare, governance, and services—is fundamentally reshaping the **nature of employability**.

The high-level discussion on the future of employability highlighted the urgent need to align **AI-driven growth with human capital development**, ensuring that technological progress enhances rather than displaces workforce participation.

How AI is Redefining Employability

1. Job Displacement in Routine Sectors

AI systems are increasingly automating:

- Assembly line operations
- Customer service through chatbots
- Routine accounting processes
- Administrative and clerical tasks

These jobs involve **predictable, rule-based functions**, which are highly susceptible to automation.

This aligns with economist **David Autor's "routine-biased technological change"** theory—technology substitutes routine tasks while complementing non-routine skills.

2. Emergence of New Occupations

Simultaneously, AI is generating demand for:

- Data scientists
- Machine learning engineers
- AI ethics specialists
- Niche AI solution providers
- Cybersecurity experts

These roles require advanced technical competencies and interdisciplinary skills.

3. Shift Toward Skills-Based Hiring

Employability is moving away from degree-centric recruitment to:

- Skill-based assessment
- Project portfolios
- Micro-certifications

According to World Bank estimates, AI-focused roles command approximately **28% higher wages**, reflecting a growing **wage premium for digital skills**.

4. Labour Productivity and Employment Dynamics

- Full-scale adoption of Generative AI could increase labour productivity by **around 15%**.
- However, productivity gains may temporarily translate into:
  - Job displacement
  - Transitional unemployment

This reflects **Schumpeter's "creative destruction"**—innovation creates and destroys jobs simultaneously.

Socio-Economic Implications

Dimension	Impact
Income Distribution	Risk of widening wage inequality
Gender Gap	Potential for both inclusion and exclusion
SMEs	Need for technological adaptation
Informal Sector	Vulnerable to automation shocks
Urban-Rural Divide	Digital access disparities

Without inclusive policies, AI adoption could deepen **structural inequality**.

Strategies for Adaptation

1. Skill Diffusion

- Promote short-term, modular training programmes.
- Encourage continuous reskilling.
- Focus on:
  - Digital literacy
  - Data handling
  - Critical thinking

2. Educational Overhaul

- Transition from static knowledge models to:
  - Lifelong learning frameworks
  - Problem-solving orientation
  - Adaptive curricula

The **National Education Policy 2020** emphasises flexibility and multidisciplinary learning, aligning education with emerging technologies.

3. Collaborative National Approach

- Government, industry, and academia must coordinate.
- Align AI deployment with citizen welfare.
- Develop national AI employment frameworks.

4. Democratization of AI Benefits

- Support **Small and Medium Enterprises (SMEs)** in adopting AI.
- Provide affordable certification pathways.
- Prevent digital monopolies and skill concentration.

5. Ethical and Regulatory Safeguards

- Ensure transparency in AI-driven hiring tools.
- Prevent algorithmic bias.
- Protect worker data privacy.
- Promote fair labour standards.

Ethical AI governance is essential to maintain trust.

Key Initiatives Supporting AI Adoption

1. Digital Infrastructure Expansion

- Development of data centres.
- Broadband connectivity expansion.
- AI deployment platforms.

2. National AI Framework

India's national AI programme aims to foster:

- Innovation ecosystem
- Industry partnerships
- Responsible AI adoption

3. Skilling Initiatives

- SOAR (Skilling for AI Readiness)
- YUVAi (Youth for Unnati with AI)
- FutureSkills Prime
- NEP 2020 reforms

4. BHASHINI Initiative

- AI-enabled multilingual platform.
- Supports over 36 Indian languages.
- Enhances workforce participation in non-English speaking regions.
- Promotes digital inclusion.

Balancing Productivity and Employment

The policy challenge lies in:

- Harnessing AI for **productivity gains**.
- Preventing structural unemployment.
- Ensuring inclusive digital transformation.

Economist **Amartya Sen's capability approach** suggests that technological advancement must expand human freedoms, not restrict them.

Way Forward

- Integrate AI literacy into school curricula.
- Expand public-private partnerships in skill development.
- Strengthen labour market data systems.
- Promote social safety nets for displaced workers.
- Encourage ethical AI regulatory frameworks.

Conclusion

AI is not merely a technological shift—it is a structural transformation of labour markets. While it enhances productivity and creates high-value employment opportunities, it also disrupts traditional job structures.

The future of employability depends on India's ability to combine **skill development, inclusive governance, ethical regulation, and institutional coordination**, ensuring that AI becomes an enabler of broad-based prosperity rather than a driver of inequality.

Mains Practice Question

"Artificial Intelligence is reshaping labour markets through both job displacement and job creation. Discuss the implications of AI for employability in India and suggest policy measures to ensure inclusive adaptation."

Revised External Commercial Borrowings (ECBs) Framework 2026

Syllabus Mapping:
✓GS Paper III – Indian Economy (External Sector, Capital Flows, Forex Management)
✓GS Paper III – Banking & Finance (Regulatory Framework, FEMA)
✓GS Paper II – Governance (Regulatory Institutions – RBI)

Introduction

The **Reserve Bank of India (RBI)** has updated the framework governing **External Commercial Borrowings (ECBs)**through amendments to the **Foreign Exchange Management (Borrowing and Lending) Regulations, 2018**, under powers conferred by the **Foreign Exchange Management Act (FEMA)**.

The revised guidelines aim to enhance access to foreign capital while maintaining macroeconomic and financial stability.

What are External Commercial Borrowings (ECBs)?

ECBs refer to loans raised by eligible Indian entities from **foreign lenders** in the form of:

- Foreign currency loans
- **Foreign Currency Convertible Bonds (FCCBs)**
- Other recognised financial instruments

Borrowings can be denominated in:

- **Foreign Currency (FCY)**
- **Indian Rupees (INR)**

ECBs serve as an important source of **non-resident capital inflows**.

Why are ECBs Important?

1. Lower Cost of Capital

- Interest rates in global markets are often lower than domestic borrowing costs.
- Reduces overall financing cost for corporates.

2. Diversification of Funding Sources

- Reduces dependence on domestic banking system.
- Enhances financial resilience.

3. Infrastructure and Industrial Financing

- Supports long-term capital-intensive projects.

However, ECBs also expose borrowers to:

- **Exchange rate risk**
- Global financial volatility

Key Features of the Revised ECB Framework (2026)

1. Expanded Eligibility

- Any **non-individual resident entity** incorporated under Central or State law can now raise ECBs.
- Subject to statutory approvals and sectoral caps.

This broadens access to overseas capital.

2. Enhanced Borrowing Limits

- Eligible companies may raise up to:
  - **USD 1 billion**, or
  - **300% of their net worth**

Higher caps aim to facilitate large-scale investments, particularly in infrastructure and manufacturing.

3. Maturity Norms

- **General minimum average maturity period:** 3 years.
- Manufacturing sector allowed shorter maturity (1–3 years) under specified conditions.

This provides sector-specific flexibility while limiting short-term speculative inflows.

4. Conversion into Non-Debt Instruments

- ECB (including matured but unpaid borrowings) may be converted into equity or other non-debt instruments.
- Must comply with:
  - Foreign Exchange Management (Non-Debt Instruments) Rules, 2019.

This reduces repayment pressure and strengthens corporate balance sheets.

5. Arm's Length Principle

ECB transactions between related parties must follow the **arm's length principle**:

- Transactions must occur as if parties are unrelated.
- Prevents:
  - Transfer pricing abuse
  - Conflict of interest
  - Round-tripping

This ensures transparency and financial integrity.

6. End-Use Restrictions

ECB proceeds cannot be utilised for:

- Chit funds
- Nidhi companies
- Investment in stock markets
- Speculative activities

This aligns with macroprudential safeguards.

Macro-Economic Implications

Dimension	Impact
Capital Inflows	Strengthens forex reserves
Corporate Financing	Expands investment capacity
Exchange Rate Risk	Potential vulnerability to currency depreciation
External Debt Profile	Influences debt sustainability

ECBs form part of India's broader **capital account management strategy**.

Balancing Opportunity and Risk

Economist **Hyman Minsky's Financial Instability Hypothesis** warns that excessive external borrowing can increase systemic vulnerability during global shocks.

Therefore, regulatory safeguards such as:

- Maturity conditions
- End-use restrictions
- Borrowing caps
  are crucial for macroeconomic stability.

Challenges

- Exposure to currency fluctuations.
- Global interest rate tightening.
- Corporate over-leverage.
- Potential impact on external debt sustainability.

Way Forward

- Encourage hedging of foreign currency risks.
- Monitor sectoral concentration of ECB exposure.
- Align ECB policy with external debt sustainability metrics.
- Strengthen corporate governance and disclosure norms.

Conclusion

The revised ECB framework reflects RBI's calibrated approach to balancing **capital accessibility and financial prudence**. By expanding eligibility and borrowing limits while retaining safeguards, the updated norms aim to facilitate growth-oriented investments without compromising macroeconomic stability.

Effective risk management and regulatory vigilance will determine whether ECB expansion contributes to sustainable economic growth or heightens external vulnerability.

Mains Practice Question

"External Commercial Borrowings (ECBs) provide Indian corporates access to global capital markets but carry macroeconomic risks. Examine the recent reforms in the ECB framework and analyse their implications for India's external sector stability."

Union Budget 2026–27: Expanding the Gender Budget Framework

Syllabus Mapping:
✓GS Paper II – Governance (Social Justice, Gender Equality, Welfare Schemes)

✓**GS Paper III – Indian Economy (Budgeting, Inclusive Growth, Public Finance)**
✓**GS Paper I – Indian Society (Women Empowerment, Structural Inequality)**

Introduction

The Union Budget 2026–27 marks a notable expansion in India's **Gender Budget (GB)** allocation, reaching **₹5.01 lakh crore**, reflecting an **11.55% increase** over the previous financial year.

The share of Gender Budget in the total Union Budget has risen to **9.37%**, with **53 Ministries/Departments and five Union Territories** reporting gender-responsive allocations. This indicates growing institutionalisation of gender-sensitive fiscal planning.

Understanding Gender Budgeting (GB)

Meaning

Gender Budgeting is a policy tool to assess whether government expenditure aligns with its commitments to **gender equality and women's empowerment**.

It does not create a separate budget for women but examines the **entire budget through a gender lens**.

Adoption in India

- Formally adopted in **2004–05**.
- Institutionalised at:
  - National level
  - State level

Gender Budget Cells have been established across ministries to mainstream gender perspectives.

Structure of Gender Budget in India

Part A

- Schemes with **100% allocation for women**.

Part B

- Schemes where at least **30% allocation benefits women**.

Part C

- Introduced in **Union Budget 2024–25**.
- Includes schemes where allocation for women is **below 30%**, enhancing transparency.

Significance of Increased Allocation

1. Institutional Deepening

- Participation of 53 ministries reflects cross-sectoral mainstreaming.
- Moves beyond women-specific schemes toward systemic integration.

2. Reducing Structural Inequalities

- Addresses:
  - Wage gaps
  - Workforce participation disparities
  - Access to education and health

India's Female Labour Force Participation Rate (FLFPR) remains lower than global averages, necessitating fiscal interventions.

3. Inclusive Development

Aligns with:

- Sustainable Development Goal 5 (Gender Equality).
- Constitutional mandates under:
  - Article 14 (Equality before law)
  - Article 15(3) (Special provisions for women)

- Article 39(a) & (d) (Equal livelihood & pay)

Key Initiatives Promoting Gender Budgeting

1. Gender Budgeting Scheme

- Implemented under **Mission Shakti** (Ministry of Women & Child Development).
- Falls within the **Samarthya sub-scheme**.
- Aims for **100% coverage of GB** across:
  - Central ministries
  - State departments
  - Urban and rural local bodies

2. Gender Budgeting Knowledge Portal (2025)

- Developed by the Ministry of Women & Child Development.
- Serves as:
  - Digital repository
  - Best-practice documentation platform
  - Monitoring and evaluation tool

3. State-Level Initiatives

- **Odisha**: Adopted Gender Responsive Budgeting (GRB) in 2004–05 through Women Component Plan.
- **Karnataka**: Developed a gender audit manual to strengthen monitoring mechanisms.

These sub-national efforts demonstrate decentralised adoption.

Broader Economic Perspective

Economist **Amartya Sen's capability approach** emphasises expanding real freedoms and opportunities. Gender budgeting operationalises this by directing public expenditure toward enhancing women's capabilities in:

- Health
- Education
- Livelihood

Gender-responsive budgeting also improves **human capital formation**, contributing to long-term GDP growth.

Challenges in Gender Budgeting

- Risk of over-reporting allocations without impact measurement.
- Limited gender-disaggregated data.
- Inadequate monitoring at implementation stage.
- Need for stronger outcome-based evaluation.

Way Forward

- Strengthen gender-disaggregated data systems.
- Introduce performance-based gender audits.
- Enhance capacity of Gender Budget Cells.
- Integrate intersectional analysis (caste, rural-urban, disability).
- Align fiscal allocation with measurable gender outcomes.

Conclusion

The significant increase in Gender Budget allocation in Union Budget 2026–27 reflects India's growing commitment to embedding gender equality within fiscal governance. While enhanced allocation is a positive step, the true measure of success lies in effective implementation, accountability, and measurable improvement in women's socio-economic outcomes.

Gender budgeting must evolve from a reporting exercise to a transformative instrument of **structural equality and inclusive development**.

Mains Practice Question

"Gender Budgeting in India has evolved as an important tool for inclusive governance. Examine the significance of the increased allocation in Union Budget 2026–27 and discuss the challenges in translating gender commitments into measurable outcomes."

Export Promotion Mission (EPM): Strengthening MSME Export Competitiveness

Syllabus Mapping:
✓GS Paper III – Indian Economy (External Sector, MSMEs, Export Promotion)
✓GS Paper II – Governance (Trade Policy, Institutional Mechanisms)
✓GS Paper III – Infrastructure & Logistics (Supply Chain, Trade Facilitation)

Introduction

The Ministry of Commerce and Industry has launched **seven additional interventions** under the **Export Promotion Mission (EPM)** to strengthen the export ecosystem, particularly for Micro, Small and Medium Enterprises (MSMEs).

EPM is a flagship initiative designed to enhance India's export competitiveness through a combination of **financial and non-financial support mechanisms**, aligned with the broader goal of expanding India's footprint in global markets.

About Export Promotion Mission (EPM)

- **Vision:** A comprehensive, flexible, digitally-driven export promotion framework.
- **Financial Outlay:** ₹25,060 crore.
- **Timeline:** FY 2025–26 to FY 2030–31 (Six years).
- **Implementing Agency: Directorate General of Foreign Trade (DGFT)**.

Two Sub-Schemes

Sub-Scheme	Nature	Objective
Niryat Protsahan	Financial Support	Improve access to trade finance
Niryat Disha	Non-Financial Support	Enhance market readiness & competitiveness

New Interventions Under Niryat Protsahan

1. Export Factoring Support

- Promotes export factoring as a working capital solution.
- Enables MSMEs to:
  - Convert receivables into immediate liquidity.
  - Reduce payment cycle risks.
- Introduces digital claim mechanisms for transparency.

2. Credit Assistance for E-Commerce Exporters

- **Direct E-Commerce Credit Facility:**
  - Support up to ₹50 lakh.
  - 90% guarantee coverage.
- **Overseas Inventory Credit Facility:**
  - Support up to ₹5 crore.
  - 75% guarantee coverage.

Encourages digital export platforms and global e-commerce integration.

3. Support for Emerging Export Opportunities

- Focus on high-risk or untapped markets.
- Encourages diversification beyond traditional destinations.

New Interventions Under Niryat Disha

1. TRACE (Trade Regulations, Accreditation & Compliance Enablement)

- Assists exporters in meeting:
  - Testing
  - Inspection
  - Certification (TIC) standards
- Reduces non-tariff barriers.

2. FLOW (Facilitating Logistics, Overseas Warehousing & Fulfilment)

- Supports overseas warehousing.
- Develops e-commerce export hubs.
- Reduces delivery timelines and shipping costs.

3. LIFT (Logistics Interventions for Freight & Transport)

- Addresses geographical disadvantages.
- Supports exporters in low export-intensity districts.

4. INSIGHT (Integrated Support for Trade Intelligence & Facilitation)

- Builds exporter capacity.
- Supports the **Districts as Export Hubs** initiative.
- Develops trade intelligence systems.

Strategic Significance

1. MSME Empowerment

- MSMEs contribute significantly to:
  - Employment generation
  - Export diversification
- Improved trade finance enhances resilience.

2. Export Diversification

- Encourages penetration into new markets.
- Reduces dependence on limited geographies.

3. Logistics Competitiveness

- Addresses structural bottlenecks.
- Aligns with National Logistics Policy.

4. Digital Trade Expansion

- Boosts e-commerce exports.
- Integrates MSMEs into global digital value chains.

Economic Perspective

Economist **Paul Krugman's theory of competitiveness** emphasises productivity and scale efficiency. By improving logistics, credit access, and compliance capacity, EPM strengthens India's structural competitiveness in global trade.

Challenges

- Global protectionism.
- Non-tariff barriers.
- Currency volatility.
- MSME awareness gaps.
- Infrastructure constraints in smaller districts.

Way Forward

- Strengthen digital trade platforms.
- Enhance export insurance mechanisms.
- Promote trade agreements for market access.
- Build district-level export clusters.
- Integrate AI-driven trade analytics.

Conclusion

The additional interventions under the Export Promotion Mission reflect a multi-dimensional strategy to strengthen MSME participation in global trade. By combining financial facilitation, compliance support, logistics enhancement, and trade intelligence, EPM seeks to build a resilient and competitive export ecosystem.

Sustained implementation and market diversification will be critical for achieving long-term export growth and economic resilience.

Mains Practice Question

"Discuss the role of the Export Promotion Mission in enhancing MSME competitiveness and export diversification in India. Evaluate the significance of the newly introduced interventions."

Revitalising India's Apprenticeship Ecosystem: NITI Aayog's Reform Blueprint

Syllabus Mapping:
✓GS Paper III – Indian Economy (Employment, Skill Development, Human Capital)
✓GS Paper II – Governance (Policy Reforms, Institutional Mechanisms)
✓GS Paper I – Social Issues (Youth Employment, Gender Participation)

Introduction

The **NITI Aayog** has released a policy report on *Revitalising the Apprenticeship Ecosystem*, outlining actionable reforms to strengthen apprenticeships as a core pillar of India's skilling and employment strategy.

Apprenticeships—structured vocational training programs combining classroom instruction with hands-on industry experience—are increasingly seen as critical for bridging India's **skill-employment mismatch**.

Understanding Apprenticeships

Apprenticeships are:

- Formal vocational education and training systems.
- Integrate institutional learning with work-based training.
- Promote the principle of **"earning while learning."**

They align education outcomes with industry requirements.

Current Status of Apprenticeships in India

Under National Apprenticeship Promotion Scheme (NAPS)

- **51,133 active establishments (FY 2024–25)**.
- Engagement under National Apprenticeship Program (NAP) increased **27-fold since 2018–19**.
- Active apprentices reached **9.85 lakh in FY 2024–25**.

However:

- Completion rate declined to **25.47%**.
- Dropout rate remains high at **35.46%**.

This reflects quantitative growth but qualitative concerns.

Key Challenges Identified

1. Policy & Structural Gaps

- Multiple overlapping schemes.
- Low stipend levels.
- Lack of standardized certification.
- Administrative complexity.

2. Regional & Industry Disparities

- Underutilisation in:
  - BIMARU states.
  - North Eastern region.
- Low MSME participation due to:
  - Compliance burdens.
  - Perceived low return on investment.

3. Aspirant-Level Barriers

- Female participation around **20%**.
- Weak career counselling systems.
- Social bias favouring academic degrees over vocational pathways.

These issues reduce apprenticeship attractiveness.

Recommendations of the Report

1. Policy & Systemic Reforms

- Establish a **National Apprenticeship Mission**.
- Consolidate apprenticeship portals for seamless access.
- Enable mobility between formal education and skill pathways.

2. Structural & Governance Improvements

- Introduce an **Apprenticeship Engagement Index** to benchmark performance.
- Upgrade ITIs aligned with Industry 4.0 technologies.
- Improve monitoring and evaluation systems.

3. Industry-Facing Reforms

- Encourage MSMEs via:
  - Cluster-based apprenticeship consortia.
- Launch **Startup Apprenticeship Programme (SAP)**.
- Simplify compliance norms.

4. Apprentice-Level Support

- Increase stipend adequacy.
- Expand insurance and social security coverage.
- Facilitate international mobility of apprentices.

Existing Policy Framework

Apprentices Act

- Provides statutory backing.
- Defines employer obligations.

National Apprenticeship Promotion Scheme (NAPS)

National Apprenticeship Training Scheme (NATS)

- Incentivise employers.
- Strengthen industry-academia linkages.

National Education Policy (NEP 2020)

- Promotes vocational-academic convergence.
- Encourages flexible learning pathways.

Significance for India's Economy

Dimension	Impact
Youth Employment	Reduces skill mismatch
MSME Growth	Skilled workforce availability
Gender Inclusion	Enhances female workforce participation
Industrial Competitiveness	Industry 4.0 readiness

Apprenticeships can support India's demographic dividend by converting youth potential into productive capital.

Broader Economic Perspective

Economist **Gary Becker's Human Capital Theory** suggests investment in skill formation enhances productivity and long-term economic growth.

Apprenticeships operationalise this by linking education directly with employability outcomes.

Way Forward

- Institutionalise National Apprenticeship Mission.
- Strengthen public-private partnerships.
- Integrate digital skilling platforms.
- Improve gender-sensitive outreach.
- Develop outcome-based evaluation metrics.

Conclusion

The NITI Aayog report underscores that while India has expanded apprenticeship numbers significantly, structural reforms are essential to improve completion rates, regional equity, and industry participation.

A revitalised apprenticeship ecosystem can become a cornerstone of India's employment strategy, ensuring that skill development translates into sustainable livelihood opportunities and economic competitiveness.

Mains Practice Question

"Apprenticeships are critical for bridging India's skill-employment gap. Analyse the challenges in India's apprenticeship ecosystem and evaluate the reforms suggested by NITI Aayog.

AGRICULTURE

Soil Health Degradation in India: Implications for Food and Nutrition Security

Syllabus Mapping:
✓GS Paper III – Agriculture (Soil Health, Cropping Patterns, Sustainable Farming)
✓GS Paper III – Environment (Land Degradation, Resource Conservation)
✓GS Paper II – Social Justice (Nutrition, Public Health)

Introduction

The report titled *"Healing Soils in India: For Better Crop Health and Human Nutrition"* released by the **Indian Council for Research on International Economic Relations (ICRIER)** highlights the alarming deterioration of soil quality in India.

Given that agriculture supports nearly half of India's population, soil degradation poses a serious threat to **food security, farmer incomes, and public health outcomes**.

Primary Causes of Soil Degradation

1. Distorted Fertilizer Policy

- Urea (Nitrogen source) receives **over 80% subsidy**.
- Phosphorus (P) and Potassium (K) subsidies are comparatively lower.
- Leads to **imbalanced NPK application**.
- Excess nitrogen causes:
  - Soil nutrient imbalance
  - Groundwater contamination
  - Decline in soil organic matter

This distortion incentivises overuse of nitrogenous fertilisers.

2. Faulty Farming Practices

- Intensive tillage.
- Prolonged water stagnation in paddy cultivation.
- Monocropping (e.g., cereal–cereal rotations).
- Crop residue burning.

These practices accelerate:

- Loss of native soil carbon.
- Structural degradation.
- Decline in microbial diversity.

3. Massive Soil Erosion

- India loses approximately **5.3 billion tonnes of topsoil annually**.
- Results in loss of **5.4–8.4 million tonnes of primary nutrients each year**.
- Caused by:
  - Water erosion
  - Wind erosion
  - Deforestation

Topsoil loss severely reduces long-term agricultural productivity.

Impact on Crop and Human Health

1. Declining Crop Efficiency

- Nutrient-deficient soils reduce nutrient uptake efficiency.
- Lower yield response per unit input.

2. Nutritional Quality Decline

- Crops become deficient in essential micronutrients:
  - Zinc
  - Iron
- Affects dietary diversity.

3. Rise of "Hidden Hunger"

- Micronutrient-deficient crops contribute to:
  - Stunting
  - Wasting
  - Child malnutrition

Links soil degradation directly with **public health challenges**.

4. Water Contamination

- Excess fertiliser leaches into groundwater.
- Increases nitrate concentration.
- Affects drinking water safety.

Policy and Structural Dimensions

Dimension	Implication
Agricultural Productivity	Long-term yield stagnation
Farmer Income	Rising input costs with declining returns
Nutrition Security	Micronutrient deficiency
Environmental Sustainability	Land degradation & water pollution

The issue intersects with SDG 2 (Zero Hunger) and SDG 15 (Life on Land).

Way Forward

1. Fertilizer Policy Reform

- Bring urea under the **Nutrient-Based Subsidy (NBS)** regime.
- Replace subsidy distortion with **direct income support**.
- Encourage balanced nutrient application.

2. Promote Innovative Fertilizer Products

- Customized fertilizers.
- Water-soluble formulations.
- Bio-fertilizers.

3. Digital & AI Integration

- Use AI and machine learning.
- Integrate:
  - Land records
  - Satellite imagery

    - Fertilizer sales data
- Identify tenant farmers and target support efficiently.

4. Adopt the 4R Nutrient Stewardship Framework

- Right Source
- Right Rate
- Right Time
- Right Place

Enhances input efficiency and reduces environmental damage.

5. Integrated Nutrient Management (INM)

- Combine chemical fertilisers with:
    - Farmyard manure
    - Biochar
    - Compost

Restores soil organic carbon and microbial balance.

6. Sustainable Agricultural Practices

- Cover cropping.
- Crop diversification (including legumes).
- Conservation agriculture.

These practices rebuild soil structure and improve resilience.

Government Initiatives

- **Soil Health Card Scheme**
- **PM-PRANAM Scheme**
- **Paramparagat Krishi Vikas Yojana**
- Neem-Coated Urea to reduce nitrogen loss.

Broader Theoretical Insight

Ecological economist **Herman Daly** emphasised that sustainable development requires maintaining natural capital. Soil is a foundational form of **natural capital**, and its degradation undermines long-term economic sustainability.

Conclusion

The ICRIER report underscores that soil degradation is not merely an agronomic issue—it is a systemic challenge affecting food security, public health, environmental sustainability, and economic stability.

Addressing fertilizer distortions, promoting sustainable farming practices, and integrating digital tools are essential to restoring soil health. Long-term agricultural resilience and nutritional security depend on rebuilding India's soil ecosystem.

Mains Practice Question

"Soil health degradation in India has far-reaching implications beyond agriculture. Discuss the causes, consequences, and policy measures required to restore soil sustainability."

ENVIRONMENT & ECOLOGY

Great Nicobar Project: Development–Ecology Dilemma

Syllabus Mapping:
✓GS Paper III – Environment (EIA, Coastal Regulation, Biodiversity Conservation)
✓GS Paper III – Infrastructure & Internal Security (Strategic Infrastructure, Maritime Security)
✓GS Paper II – Governance (Tribal Rights, FRA, Environmental Institutions)

Introduction

The **National Green Tribunal (NGT)** has upheld the environmental clearance granted to the **Great Nicobar Mega-Infrastructure Project**, citing its **strategic importance** and compliance with **ICRZ (Island Coastal Regulation Zone)**and **CRZ (Coastal Regulation Zone)** norms.

The decision has reignited debates over balancing **national security imperatives and ecological sustainability** in fragile island ecosystems.

Geographical Context: Great Nicobar Island

- Southernmost island of the Andaman and Nicobar archipelago.
- Includes ecologically sensitive areas such as:
  - **Galathea Bay**
  - **Campbell Bay National Park**
  - **Galathea National Park**
  - Great Nicobar Biosphere Reserve
  - **Indira Point**

The island lies close to the **Strait of Malacca**, a key global maritime chokepoint.

About the Great Nicobar Project

Location: Great Nicobar Island, covering parts of Galathea Bay and Campbell Bay.

Vision

Transform the island into:

- A **major transshipment hub**
- A **defence logistics centre**
- An integrated township
- A **450 MVA gas and solar-based power plant**
- A **dual-use (civil-military) international airport**
- An international container transshipment terminal

Implementing Agency

- Andaman and Nicobar Islands Integrated Development Corporation
- In collaboration with **NITI Aayog**

Strategic and Economic Significance

1. Strategic Importance

- Overlooks the **Strait of Malacca**.
- Nearly **40% of global trade** and a majority of China's energy imports pass through this corridor.
- Enhances India's maritime presence in the Indo-Pacific.

Supports India's vision of:

- **SAGAR (Security and Growth for All in the Region)**
- Act East Policy

2. Logistics & Trade Efficiency

- Around **75% of India's transshipment cargo** is currently routed through foreign ports.
- Domestic transshipment hub would:
  - Reduce logistics costs
  - Enhance trade competitiveness
  - Improve port-led development

3. Regional Development

- Improved connectivity.
- Tourism potential.
- Infrastructure expansion in remote region.

Major Concerns Associated with the Project

1. Regulatory and Procedural Concerns

- Environmental Impact Assessment (EIA) reportedly based on **single-season data**, not multi-season analysis.
- Questions raised regarding robustness of impact assessment.

2. Forest Diversion and Biodiversity Threat

- Diversion of approximately **130 sq. km of tropical rainforest**.
- Felling of nearly **one million trees**.

Affected species include:

- Nicobar megapode
- Nicobar tree shrew
- Giant leatherback turtles
- Coral ecosystems

Tropical rainforests represent **irreversible ecological capital**, not easily compensable.

3. Compensatory Afforestation Issue

- Proposed afforestation in Haryana.
- Critics argue ecological mismatch:
    - Tropical rainforest cannot be replaced by plantation elsewhere.

This raises concerns under the principle of **ecological equivalence**.

4. Forest Rights Act (FRA) Concerns

- Allegations that project proceeded despite withdrawal of consent by tribal council.
- Potential violation of **Forest Rights Act, 2006** provisions.
- Impacts Particularly Vulnerable Tribal Group (PVTG):
    - **Shompen**
    - Nicobarese community

5. Natural Disaster Vulnerability

- Located in the **highest seismic-risk zone (Zone VI)**.
- 2004 Tsunami significantly affected the island.
- Raises concerns about disaster resilience of mega infrastructure.

Environmental Governance Perspective

The decision reflects tension between:

Development Imperative	Ecological Safeguard
Maritime security	Biodiversity conservation
Trade competitiveness	Tribal rights
Strategic autonomy	Disaster vulnerability

The doctrine of **Sustainable Development**, recognised in Indian environmental jurisprudence (e.g., Vellore Citizens Welfare Forum case), requires balancing these dimensions.

Arguments in Favour

- Strengthens India's Indo-Pacific strategy.
- Reduces foreign port dependency.
- Enhances maritime logistics efficiency.
- Boosts economic development in remote territory.

Arguments Against

- Potential irreversible biodiversity loss.
- Risk to indigenous communities.
- Questionable adequacy of environmental assessment.
- High seismic vulnerability.

Way Forward

- Conduct independent multi-season EIA review.
- Ensure strict compliance with Forest Rights Act.
- Adopt nature-sensitive infrastructure design.
- Develop disaster-resilient construction standards.
- Continuous ecological monitoring with public transparency.

Conclusion

The Great Nicobar Project represents a strategic leap for India's maritime ambitions but also poses serious ecological and social questions. The NGT's clearance underscores the perceived national security imperative; however, long-term sustainability will depend on how effectively environmental safeguards and tribal rights are upheld.

Balancing **strategic necessity with ecological prudence** will determine whether the project becomes a model of sustainable island development or a case of environmental overreach.

Mains Practice Question

"The Great Nicobar Mega-Infrastructure Project reflects the tension between strategic development and environmental sustainability. Critically examine the ecological, social, and strategic dimensions of the project."

ISA's Global AI-for-Energy Mission: Digitalising the Clean Energy Transition

Syllabus Mapping:
✓GS Paper III – Environment & Energy (Renewable Energy, Climate Change Mitigation)
✓GS Paper III – Science & Technology (Artificial Intelligence, Clean Tech Innovation)
✓GS Paper II – International Relations (Climate Diplomacy, Multilateral Institutions)

Introduction

At the India AI Impact Summit 2026, the **International Solar Alliance (ISA)** launched a **Global AI-for-Energy Mission**aimed at accelerating the adoption of Artificial Intelligence in clean energy systems across its 120+ member countries.

The initiative places **digital infrastructure and citizen-centric energy platforms** at the core of the global energy transition, signalling a convergence of AI and climate action.

About the International Solar Alliance (ISA)

- **Established:** 2015 at COP21, Paris
- Founding members: India and France
- **Headquarters:** Gurugram, India
- Treaty-based intergovernmental organisation

Aim

To mobilise **USD 1000 billion by 2030** for large-scale solar deployment in member countries.

Key Initiatives

- **One Sun One World One Grid (OSOWOG)** – Global solar grid connectivity vision
- Global Solar Facility (GSF) – De-risking solar investments
- Solar Technology Application Resource Centre (STAR-C) – Capacity building

The AI-for-Energy Mission complements these initiatives by integrating intelligent digital systems into renewable infrastructure.

Role of AI in Energy Systems

1. Energy Savings

- AI applications globally could save over **13 exajoules (EJ)** of energy by 2035.
- Optimises:
  - Demand forecasting
  - Load balancing

- Consumption efficiency

2. Cost Reduction & Affordability

- AI platform by Tata Consultancy Services (TCS) reduced operational costs by **15–20%** in an off-grid pilot project in Uttar Pradesh.
- Improves viability of decentralised renewable systems.

3. Grid Optimisation

- AI-native decision-support systems (e.g., by Pravah startup) enable:
  - Grid digitisation
  - Demand forecasting
  - Power flow simulation
- Reduces transmission and distribution losses.

4. Predictive Maintenance

- AI-enabled Energy Management Systems (EMS) like those by Kazam:
  - Use predictive analytics
  - Optimise EV charging
  - Enable demand flexibility

Reduces downtime and enhances grid reliability.

5. Mineral Exploration

- AI processes geophysical datasets.
- Enhances anomaly detection and orebody prediction.
- Critical for securing minerals needed for renewable technologies.

Strategic Significance of the AI-for-Energy Mission

1. Accelerating Net-Zero Goals

- Enhances renewable efficiency.
- Reduces energy wastage.
- Supports climate commitments under the Paris Agreement.

2. Strengthening Global South Leadership

- ISA's 120+ member countries include many developing nations.
- AI-driven optimisation can bridge technology gaps.

3. Digital Public Infrastructure Integration

- Combines energy systems with digital platforms.
- Promotes citizen-centric service delivery.

Challenges in AI Adoption in Energy Sector

1. Rising Electricity Demand

- AI-driven data centres may consume nearly **3% of global electricity by 2030**.
- Risk of offsetting renewable gains.

2. Grid Infrastructure Strain

- Rapid AI integration challenges:
  - Transmission capacity
  - Policy frameworks
  - Long-term planning mechanisms

3. Equity and Digital Divide

- Developing nations may lack:
  - Data infrastructure
  - Skilled workforce
  - Regulatory frameworks

Broader Perspective

The mission reflects the concept of **"Energy Informatics"**—the integration of data science and energy systems.

Economist **Nicholas Stern** argues that technological innovation is essential for achieving sustainable growth pathways. AI integration in renewable energy aligns with this green growth framework.

Way Forward

- Promote green data centres powered by renewable energy.
- Strengthen international AI-energy standards.
- Encourage South-South knowledge sharing.
- Develop AI-skilling programmes in member countries.
- Integrate AI solutions with energy storage systems.

Conclusion

The ISA's Global AI-for-Energy Mission represents a transformative step in aligning artificial intelligence with climate action. By embedding digital intelligence into renewable infrastructure, the initiative seeks to enhance efficiency, affordability, and sustainability across member countries.

However, careful management of energy consumption, infrastructure resilience, and equitable access will be critical to ensuring that AI becomes an enabler—not a burden—of the global clean energy transition.

Mains Practice Question

"Artificial Intelligence can significantly accelerate the global clean energy transition. Examine the role of the International Solar Alliance's AI-for-Energy Mission in promoting sustainable and equitable energy systems."

Supreme Court Directions on Solid Waste Management Rules, 2026

Syllabus Mapping:
✓GS Paper III – Environment (Waste Management, Environmental Governance)
✓GS Paper II – Polity & Governance (Judicial Activism, Local Governance)
✓GS Paper III – Disaster & Urban Infrastructure (Urban Planning & Civic Administration)

Introduction

The **Supreme Court of India** has issued comprehensive directions to ensure strict enforcement of the upcoming **Solid Waste Management (SWM) Rules, 2026**, effective from April 1, 2026.

Reaffirming that the **right to a clean and healthy environment forms part of Article 21**, the Court emphasised that poor waste management undermines public health, environmental sustainability, and even tourism potential, despite India's rich heritage.

Constitutional and Legal Basis

- **Article 21** – Right to life includes right to clean environment.
- Environmental Protection Act, 1986.
- Principle of **Sustainable Development**.
- Polluter Pays Principle (recognized in Indian environmental jurisprudence).

The Court has elevated waste management compliance from administrative discretion to **constitutional obligation**.

Key Directions of the Supreme Court

1. Four-Stream Waste Segregation

Pollution Control Boards must expedite infrastructure for:

- Wet waste
- Dry waste
- Sanitary waste
- Special care waste

Immediate communication of compliance norms to **Bulk Waste Generators (BWGs)** is mandatory.

2. Role of Elected Representatives

- Councillors, Mayors, Corporators, Ward Members designated as **lead facilitators**.
- Statutory duty to:
  - Promote source segregation.
  - Ensure citizen enrolment in SWM implementation.

This strengthens local accountability and decentralised governance.

3. Three-Tier Enforcement Mechanism

Tier 1: Immediate Fines

- Monetary penalties for initial non-compliance.

Tier 2: Criminal Prosecution

- For continued violation under environmental laws.

Tier 3: Accountability of Officials

- Prosecution extends to:
  - Negligent public officials.
  - Oversight failures.

Non-compliance is no longer treated as a routine lapse.

4. Legacy Waste Management

- Separate time-bound action plan for:
  - Remediation of dumpsites.
  - Scientific processing.
  - Environmental restoration.

India has thousands of legacy dump sites contributing to methane emissions and groundwater contamination.

5. Directions to MoEFCC

The **Ministry of Environment, Forest and Climate Change (MoEFCC)** must:

- Issue directions under the Environmental Protection Act (1986).
- Conduct infrastructure audits via District Collectors.
- Mandate each local body to declare a deadline for **100% compliance**.

Significance of the Directions

Dimension	Impact
Public Health	Reduced disease burden
Urban Governance	Strengthened accountability
Climate Action	Reduced methane emissions
Tourism	Improved civic cleanliness
Judicial Oversight	Enhanced environmental enforcement

The Court's intervention reinforces environmental federalism and cooperative governance.

Broader Governance Perspective

Environmental jurisprudence in India has evolved through judicial activism.

The doctrine of **Public Trust**, articulated in cases like M.C. Mehta, holds the state accountable as trustee of natural resources.

The Court's directive operationalises this principle in urban waste management.

Challenges in Implementation

- Infrastructure gaps in smaller municipalities.
- Behavioural resistance to segregation.
- Funding constraints.
- Capacity deficits in urban local bodies.
- Monitoring and enforcement bottlenecks.

Way Forward

- Promote decentralised waste processing.
- Strengthen municipal capacity.
- Encourage citizen awareness campaigns.
- Integrate waste-to-energy technologies.
- Digitise compliance monitoring systems.

Conclusion

The Supreme Court's directions on SWM Rules 2026 mark a decisive step toward strengthening environmental governance in India. By linking waste management compliance with constitutional rights and imposing a stringent enforcement framework, the Court has elevated civic cleanliness from a policy objective to a legal mandate.

Sustained implementation, public participation, and institutional coordination will determine whether India can transition toward a cleaner, sustainable urban future.

Mains Practice Question

"Discuss the significance of the Supreme Court's directions on the Solid Waste Management Rules, 2026. How can stricter enforcement transform urban environmental governance in India?"

SCIENCE & TECHNOLOGY

Quantum-Safe Security: C-DOT's Strategic Leap

Syllabus Mapping:
✓GS Paper III – Science & Technology (Emerging Technologies, Quantum Technology, Cyber Security)
✓GS Paper III – Internal Security (Cyber Threats, Critical Infrastructure Protection)
✓GS Paper II – Government Policies & Interventions (Digital Infrastructure, Strategic Sectors)

Introduction

With the rapid evolution of **quantum computing**, traditional encryption systems face unprecedented risks. Recognizing this emerging threat, the **Centre for Development of Telematics (C-DOT)** has collaborated with **Synergy Quantum** to develop an **automated quantum-vulnerability detection tool**. This initiative aims to prepare India's digital ecosystem for the transition toward **Post-Quantum Cryptography (PQC)**.

Background: Why Quantum-Safe Security is Urgent

1. The Quantum Threat

- Quantum computers, leveraging principles like **superposition** and **entanglement**, can potentially break widely used cryptographic systems such as RSA and ECC.
- Algorithms like **Shor's Algorithm** can factor large prime numbers exponentially faster than classical computers.
- Critical sectors such as:
  - **Defense networks**
  - **Telecommunications**
  - **Banking & financial systems**
  - **IoT devices**
  - **Government data repositories**

  are especially vulnerable.

2. "Harvest Now, Decrypt Later" Risk

Adversaries may collect encrypted data today and decrypt it in the future once quantum computing becomes sufficiently powerful.

The Automated Quantum Vulnerability Detection Tool

Core Objective

To identify and catalogue **cryptographic weaknesses** in digital networks and devices, enabling institutions to shift to **quantum-resistant systems** in a planned and informed manner.

Key Features

- Generates a **comprehensive diagnostic report**.
- Identifies:
  - **Quantum-vulnerable algorithms**
  - Their **functional role**
  - Their **exact deployment location within devices or applications**
- Facilitates **systematic migration planning** to PQC standards.

Three Core Modules

1. **Web Application Module**
   - Monitors network traffic.
   - Conducts vulnerability assessments.
   - Detects potential quantum-related risks.
2. **Security Scanner Agent**
   - Deployed across devices.
   - Identifies cryptographic implementations in use.
3. **Control Software**
   - Integrates findings.
   - Coordinates mitigation strategies.

Understanding Post-Quantum Cryptography (PQC)

Definition: Post-Quantum Cryptography refers to cryptographic algorithms specifically designed to resist attacks from quantum computers.

Purpose

- Ensures **data confidentiality** even in a quantum-computing era.
- Protects sensitive digital infrastructure against future decryption capabilities.

Global Developments

The **National Institute of Standards and Technology (NIST)** in the United States has finalized its first set of **post-quantum cryptographic standards**, signaling global transition momentum.

What is Quantum Cryptography?

Quantum Cryptography differs from PQC in its approach.

Definition: It utilizes principles of **quantum mechanics** to secure communication.

Key Tools

- Quantum sensors capable of detecting **individual photons**.
- Exploits quantum properties to detect interception attempts.

Types of Quantum Cryptographic Methods

1. Quantum Key Distribution (QKD)

- Enables secure exchange of encryption keys.
- If an adversary intercepts photons, the quantum state changes—revealing intrusion.
- Example: BB84 protocol.

2. Quantum Coin-Flipping

- A cryptographic primitive.
- Allows two distrustful parties to agree on parameters in a secure manner.
- Useful in distributed computing and blockchain systems.

Difference: PQC vs Quantum Cryptography

Aspect	Post-Quantum Cryptography	Quantum Cryptography
Basis	Classical mathematical algorithms	Laws of quantum mechanics
Infrastructure	Works on existing hardware	Requires quantum devices
Cost	Relatively lower transition cost	High infrastructure cost
Scalability	More practical for mass adoption	Limited by hardware deployment

Strategic Importance for India

1. National Security

- Secures military communication and strategic assets.
- Supports India's ambitions under the **National Quantum Mission (2023)**.

2. Digital Economy Protection

- Protects UPI, digital banking, Aadhaar-linked systems.
- Ensures long-term integrity of financial infrastructure.

3. Cyber Sovereignty

- Reduces dependency on foreign encryption standards.
- Strengthens indigenous R&D ecosystem.

Challenges Ahead

- High migration cost.
- Compatibility issues with legacy systems.
- Skilled manpower shortage in quantum cybersecurity.
- Need for regulatory framework for PQC adoption.

Way Forward

- Develop a **national roadmap for PQC migration**.
- Integrate quantum-safe audits into cybersecurity norms.
- Promote academia-industry-government collaboration.
- Align with global standards while preserving strategic autonomy.

Conclusion

The collaboration between C-DOT and Synergy Quantum marks a **proactive strategic shift** toward **quantum-resilient cybersecurity**. As quantum computing transitions from theoretical possibility to practical reality, early detection of vulnerabilities and migration to PQC is essential to safeguard **national security, digital infrastructure, and economic stability**.

India's preparedness today will determine its resilience in tomorrow's quantum era.

Mains Practice Question

"The advent of quantum computing poses a structural threat to existing encryption systems. Examine India's preparedness for quantum-safe cybersecurity in light of recent institutional initiatives."

India AI Impact Summit 2026: Global South's AI Moment

Syllabus Mapping:
✓GS Paper III – Science & Technology (Artificial Intelligence, Emerging Technologies)
✓GS Paper II – International Relations (Multilateralism, Global Governance, Global South Leadership)
✓GS Paper III – Indian Economy (Innovation, Startups, Digital Public Infrastructure)

Introduction

The **India AI Impact Summit 2026**, inaugurated in New Delhi, marks a significant milestone as the **first multilateral AI summit hosted in the Global South**. The event reflects India's growing ambition to shape global Artificial Intelligence governance while aligning technological advancement with developmental priorities.

The summit positions India as both a **technology innovator and normative voice** in global AI discourse.

Theme and Vision

Theme

"Sarvajana Hitaya, Sarvajana Sukhaya"
(Welfare for all, happiness for all)

This philosophical grounding signals India's commitment to **human-centric, inclusive, and ethical AI**—drawing from civilizational values while engaging with modern technological transformation.

Core Objectives

- Translate global AI debates into **practical developmental outcomes** under:
  - IndiaAI Mission
  - Digital India Initiative
- Promote **responsible and ethical AI frameworks**.
- Strengthen international AI collaboration.
- Position India as a **global AI innovation hub**.

The summit seeks to move beyond abstract discussions toward **implementation-oriented cooperation**.

Conceptual Architecture: 3 Sutras & 7 Chakras

3 Sutras (Guiding Principles)

These define how AI can serve collective good:

- Inclusivity
- Sustainability
- Ethical accountability

7 Chakras (Areas of Multilateral Cooperation)

Represent priority areas such as:

- Governance frameworks
- Digital infrastructure
- Innovation ecosystems
- Capacity building
- Skill development
- AI safety
- Development applications

The framework symbolically integrates **Indian philosophical motifs with policy design**.

Flagship Events and Initiatives

1. Global Impact Challenges

- Identify scalable AI solutions for development.
- Focus on real-world impact rather than theoretical prototypes.

2. AI for ALL

- Partnership with Startup India.
- Focus on large-scale, socially relevant AI innovations.

3. AI by HER

- In collaboration with **NITI Aayog's Women Entrepreneurship Platform**.
- Promotes women-led AI enterprises.
- Encourages gender inclusion in deep-tech sectors.

4. YUVAi

- Partnership with MyBharat and National Institute of Electronics & IT.
- Encourages innovation among youth aged 13–21.
- Nurtures early-stage AI problem-solvers.

India's Position in Global AI Governance

India's hosting of this summit reinforces its emerging role in global AI diplomacy.

Other Major Multilateral AI Forums

1. Global Partnership on Artificial Intelligence (GPAI)

- Human-centric and trustworthy AI initiative.
- Hosted by OECD.
- India is a founding member.
- 29 member countries.

2. UK AI Safety Summit

- Focused on risks from Frontier AI.
- Produced the Bletchley Declaration.
- Established common safety principles.

3. G7 Hiroshima AI Process

- Promotes global guardrails.
- Develops code of conduct for advanced AI systems.

Strategic Significance for India

1. Leadership of the Global South

- Ensures AI governance reflects developmental concerns.
- Counters dominance of Global North in AI norm-setting.

2. Economic Competitiveness

- Strengthens startup ecosystem.
- Enhances AI innovation ecosystem.
- Attracts global investment.

3. Ethical and Responsible AI

- Promotes transparency and fairness.
- Aligns AI development with constitutional values.

Challenges Ahead

- Balancing innovation with regulation.
- Bridging digital divide.
- Preventing algorithmic bias.
- Ensuring data protection.
- Avoiding concentration of AI power in large corporations.

Broader Perspective

AI governance debates mirror earlier global discussions on nuclear energy and biotechnology—where technological progress required global norms.

Political theorist **Joseph Nye's concept of "soft power"** becomes relevant here: by shaping AI norms, India strengthens its influence beyond traditional military or economic metrics.

Way Forward

- Strengthen IndiaAI Mission with measurable targets.
- Promote open-source AI ecosystems.
- Encourage multilingual AI solutions (linked to BHASHINI).
- Deepen South-South AI cooperation.
- Institutionalise ethical AI audit mechanisms.

Conclusion

The India AI Impact Summit 2026 represents more than a technology conference—it is a strategic assertion of India's intent to shape the future of AI governance from a development-oriented perspective. By integrating ethical values, inclusive growth, and multilateral engagement, India aims to ensure that AI becomes a tool for **collective welfare rather than concentrated power**.

If sustained through concrete implementation, this initiative can establish India as a bridge between innovation and equity in the global AI order.

Mains Practice Question

"Discuss the significance of the India AI Impact Summit 2026 in shaping global AI governance from a Global South perspective. How can India balance innovation, ethics, and inclusivity in its AI strategy?"

SAHI & BODH: Building India's Responsible Health-AI Ecosystem

Syllabus Mapping:
✓GS Paper III – Science & Technology (Artificial Intelligence, Health-Tech, Digital Public Infrastructure)
✓GS Paper II – Governance (Health Policy, Ayushman Bharat, Ethical Regulation)
✓GS Paper III – Indian Economy (Innovation, Digital Public Goods, Startup Ecosystem)

Introduction

At the India AI Impact Summit 2026, two significant initiatives—**SAHI (Strategy for Artificial Intelligence in Healthcare for India)** and **BODH (Benchmarking Open Data Platform for Health AI)**—were launched. These initiatives aim to institutionalise a **responsible, ethical, and globally competitive AI-driven healthcare ecosystem** in India.

They represent a shift from isolated AI experimentation to **systematic national-level health-AI governance**.

SAHI: Strategy for Artificial Intelligence in Healthcare for India

Nature and Objective: SAHI is a **national policy framework** designed to guide the structured integration of AI into India's healthcare system.

Vision

To enable **safe, ethical, evidence-based, and inclusive** AI adoption across:

- Public health systems
- Clinical services
- Diagnostics
- Preventive care

Key Features

- Establishes shared principles for stakeholders.
- Provides strategic direction for:
  - AI developers
  - Hospitals
  - Regulators
  - Policymakers
- Leverages **Digital Public Infrastructure (DPI)** for scalability.
- Aligns AI adoption with:
  - Equity
  - Accessibility
  - Affordability

Strategic Importance

- Enhances diagnostic accuracy.
- Improves patient outcomes.
- Expands healthcare access in rural and underserved areas.
- Positions India as a leader in **responsible AI for public health**.

SAHI reflects the principle that technological deployment must be **human-centric**, not merely efficiency-driven.

BODH: Benchmarking Open Data Platform for Health AI

Developed By

- **Indian Institute of Technology Kanpur (IIT Kanpur)**
- In collaboration with the **National Health Authority (NHA)**

Purpose

- A **privacy-preserving benchmarking platform**.
- Enables rigorous testing and validation of AI models.
- Uses diverse real-world datasets **without exposing raw patient data**.

This reduces risks of:

- Data breaches
- Privacy violations
- Model bias

Institutional Positioning

- Recognised as a **Digital Public Good**.
- Integrated under the **Ayushman Bharat Digital Mission (ABDM)** framework.

BODH strengthens transparency and accountability in health-AI model deployment.

Other AI in Healthcare Initiatives

1. Centres of Excellence

- **AIIMS Delhi**
- **PGIMER Chandigarh**
- **AIIMS Rishikesh**

These institutions lead development of indigenous AI solutions.

2. Ethical Governance

- AI deployment follows **ICMR Ethical Guidelines (2023)**.
- Emphasises:
  - Transparency
  - Accountability
  - Informed consent
  - Bias mitigation

3. IndiaAI Application Development Initiative

- Under IndiaAI Mission.
- Promotes development and scaling of impactful AI solutions addressing national challenges.

Significance of SAHI & BODH

Dimension	Impact
Health Access	Expanded reach in rural areas
Innovation Ecosystem	Encourages AI startups
Global Leadership	Positions India as responsible AI hub
Data Governance	Privacy-preserving evaluation
Public Trust	Ethical deployment safeguards

Key Challenges

- Interoperability between health databases.
- Risk of algorithmic bias.
- Digital divide in healthcare infrastructure.
- Need for skilled workforce in AI-health interface.
- Regulatory clarity on liability issues.

Broader Governance Perspective

Bioethicist **Onora O'Neill** argues that trust in public institutions depends on accountability and transparency.

SAHI and BODH operationalise this principle by embedding **ethical safeguards and benchmarking standards** into AI healthcare systems.

Way Forward

- Strengthen data standardisation protocols.
- Expand digital health infrastructure.
- Promote AI literacy among healthcare professionals.

- Establish independent AI audit bodies.
- Encourage global collaboration in medical AI research.

Conclusion

The launch of SAHI and BODH marks a decisive step in institutionalising **responsible, scalable, and ethically governed AI integration into healthcare**. By combining strategic vision with technical safeguards, India seeks to ensure that AI enhances healthcare equity and efficiency while protecting patient rights.

If effectively implemented, these initiatives can transform India into a **global leader in public-health-oriented AI innovation**.

Mains Practice Question

"Examine the significance of the SAHI and BODH initiatives in advancing responsible Artificial Intelligence in India's healthcare sector. What challenges must be addressed to ensure ethical and equitable AI integration?"

Sovereign AI Push: India Unveils Three Foundational Models

Syllabus Mapping:
✓GS Paper III – Science & Technology (Artificial Intelligence, Supercomputing, Emerging Technologies)
✓GS Paper III – Indian Economy (Innovation, Startup Ecosystem, Digital Infrastructure)
✓GS Paper II – Governance (Digital Sovereignty, Strategic Autonomy)

Introduction

At the AI Impact Summit 2026, India unveiled **three Sovereign AI models**, signalling a decisive move toward **India-first Artificial Intelligence development**. The announcement, made under the broader **IndiaAI Mission**, was accompanied by the addition of **20,000 new GPUs**, taking the total available under the mission to **58,000 GPUs**—far exceeding the original target.

This marks a significant step in strengthening **digital sovereignty, compute independence, and indigenous AI innovation**.

Understanding Sovereign AI

Meaning

Sovereign AI refers to a nation's capacity to:

- Develop AI technologies on **domestic infrastructure**
- Use **local datasets**
- Leverage **national talent pools**
- Maintain control over:
  - Data collection
  - Model training
  - Deployment
  - Governance

It reduces dependence on foreign platforms and global technology monopolies.

Why Sovereign AI Matters

- Protects **data sovereignty**
- Ensures compliance with national regulations
- Strengthens strategic autonomy
- Reduces vulnerability to geopolitical disruptions
- Promotes local language and context-sensitive AI systems

In an era of digital geopolitics, AI capability is increasingly viewed as a pillar of national power.

IndiaAI Mission: Institutional Backbone

The sovereign AI push operates under the **IndiaAI Mission**, launched in 2024.

Budget & Timeline

- ₹10,371.92 crore allocation
- Five-year implementation period
- Ministry: **Ministry of Electronics and Information Technology (MeitY)**

Compute Infrastructure Expansion

- Initial target: 10,000 GPUs
- Achieved: 38,000 GPUs
- Additional announcement: 20,000 GPUs
- Total capacity: 58,000 GPUs

This significantly enhances India's AI training and inference capabilities.

Key Pillars of IndiaAI Mission

1. IndiaAI Compute Capacity
2. IndiaAI Application Development Initiative
3. IndiaAI Datasets Platform (AIKosh)
4. IndiaAI FutureSkills
5. IndiaAI Startup Financing
6. Safe & Trusted AI

The Three Sovereign AI Models Launched

1. Two Large Language Models (LLMs) – By Sarvam AI

- Advanced generative AI systems capable of producing human-like text.
- Reportedly outperform models like:
  - DeepSeek R1
  - Gemini Flash
    on certain benchmarks.
- Tailored to Indian linguistic and contextual requirements.

LLMs are trained on vast datasets using deep learning architectures to perform tasks such as:

- Content generation
- Question answering
- Code writing

2. Vachana – Text-to-Speech Model

- Developed by **Gnani.ai**.
- Capable of cloning human voices.
- Supports **12 Indian languages**.
- Enhances:
  - Accessibility
  - Voice-based digital services
  - Inclusion in non-English regions

3. Param2 17B – Multilingual Foundational Model

- Developed under **BharatGen**.
- Uses **Mixture-of-Experts (MoE)** architecture.
- Focuses on multilingual capability.
- Designed specifically for Indian languages and societal contexts.

BharatGen represents India's first government-supported national initiative for sovereign foundational models.

Strategic Significance

1. Digital Sovereignty

- Reduces dependence on foreign AI ecosystems.
- Enables indigenous governance frameworks.

2. Linguistic Inclusivity

- Supports multilingual AI solutions.
- Promotes digital participation across diverse populations.

3. Innovation Ecosystem

- Boosts startup ecosystem.

- Encourages domestic AI R&D.
- Creates high-skill employment opportunities.

4. National Security

- Ensures AI infrastructure remains under sovereign control.
- Protects sensitive data.

Challenges

- High capital and energy requirements.
- Competition with global AI giants.
- Need for ethical oversight.
- Risk of algorithmic bias.
- Sustaining compute infrastructure growth.

Global Context

Countries such as the USA, China, and EU are investing heavily in national AI capabilities. Sovereign AI has become part of strategic competition in the digital age.

Political scientist **Joseph Nye's "power transition" framework** suggests that technological capability increasingly shapes geopolitical influence.

Way Forward

- Strengthen AI hardware ecosystem (semiconductors).
- Encourage open-source collaboration.
- Build AI safety and audit frameworks.
- Expand AI education and skilling.
- Promote international partnerships without compromising sovereignty.

Conclusion

The unveiling of three sovereign AI models under the IndiaAI Mission represents a decisive move toward technological self-reliance and digital sovereignty. By expanding compute capacity and developing indigenous foundational models, India is positioning itself as a serious player in the global AI ecosystem.

However, long-term success will depend on sustained investment, ethical governance, talent development, and integration of AI into developmental priorities.

Mains Practice Question

"Discuss the concept of Sovereign AI in the context of India's IndiaAI Mission. How do indigenous AI models strengthen digital sovereignty and strategic autonomy?"

M.A.N.A.V. Roadmap: India's Human-Centric AI Vision

Syllabus Mapping:
✓GS Paper III – Science & Technology (Artificial Intelligence, Emerging Technologies, Cyber Ethics)
✓GS Paper II – Governance (Regulatory Frameworks, Digital Governance, Accountability)
✓GS Paper III – Indian Economy (Innovation, Digital Public Infrastructure, Skill Development)

Introduction

At the India AI Impact Summit 2026, the Prime Minister articulated a human-centric AI vision through the **M.A.N.A.V. Framework**. The roadmap emphasises embedding ethical safeguards, national interest, inclusivity, and institutional accountability into AI development.

The framework seeks to translate guiding principles into **sector-specific outcomes**, particularly in education, healthcare, governance, and economic transformation.

Understanding the M.A.N.A.V. Framework

M – Moral and Ethical Systems

- Ensures:
  - Fairness
  - Transparency
  - Human oversight
- Prevents bias and discrimination.
- Encourages ethical-by-design AI systems.

Example: The **National Education Policy (NEP 2020)** promotes digital and AI literacy, fostering early exposure to ethical AI practices.

A – Accountable Governance

- Transparent regulatory frameworks.
- Clear institutional responsibility.
- Monitoring and compliance mechanisms.

Example: The **IndiaAI Mission** institutionalises responsible AI standards and monitoring mechanisms.

N – National Sovereignty

- Protect critical datasets.
- Expand domestic compute infrastructure.
- Promote indigenous AI models.

Example: The **India Semiconductor Mission** reduces dependence on imports and strengthens AI hardware ecosystem.

A – Accessible and Inclusive AI

- AI must benefit all sections of society.
- Avoid concentration of AI power.
- Promote equitable digital access.

Example: India's Digital Public Infrastructure such as **MeghRaj (GI Cloud)** democratises computing resources and supports scalable AI deployment.

V – Valid and Legitimate Systems

- Emphasises:
  - Trust
  - Safety
  - Legal compliance
- Addresses risks like deepfakes and misinformation.

Example: The **Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Amendment Rules** defines synthetically generated content to enhance accountability.

New Delhi Frontier AI Impact Commitments

Announced by the Minister for Electronics & IT at the Summit.

Nature

- Voluntary framework.
- Collaboration between frontier AI companies and domestic innovators.
- Focus on inclusive and equitable AI deployment, especially for the Global South.

Two Key Commitments

1. Advancing Understanding of Real-World AI Usage

- Data-driven analysis of:
  - AI's impact on jobs
  - Skills transformation
  - Productivity changes
- Helps governments design evidence-based AI policies.

2. Strengthening Multilingual & Contextual Evaluations

- Ensures AI effectiveness across:
  - Diverse languages
  - Cultural contexts
- Develop datasets and benchmarks for under-represented languages.

- Supports equitable AI for multilingual societies like India.

Strategic Significance

Dimension	Impact
Governance	Establishes normative AI framework
Digital Sovereignty	Strengthens domestic AI ecosystem
Inclusion	Promotes multilingual, accessible AI
Trust	Builds legal safeguards
Economic Transition	Prepares workforce for AI disruption

Broader Theoretical Perspective

Political philosopher **Onora O'Neill** emphasises that public trust arises from transparency and accountability. The M.A.N.A.V. framework integrates this principle into AI governance.

Similarly, **Amartya Sen's capability approach** underlines that technology must expand human freedoms—aligning with the "Accessible and Inclusive" pillar.

Challenges in Implementation

- Balancing innovation and regulation.
- Ensuring cross-sector coordination.
- Addressing algorithmic bias.
- Building domestic compute capacity.
- Preventing misuse of generative AI.

Way Forward

- Establish independent AI audit authorities.
- Strengthen public-private partnerships.
- Expand AI literacy programmes.
- Promote open-source AI collaboration.
- Align AI governance with global norms while safeguarding sovereignty.

Conclusion

The M.A.N.A.V. Roadmap provides a structured, value-driven framework for AI governance in India. By integrating ethics, accountability, sovereignty, inclusivity, and legitimacy, it positions AI as a tool for societal welfare rather than unchecked technological disruption.

Effective operationalisation across sectors will determine whether India can build a **human-centric AI ecosystem that balances innovation with responsibility**.

Mains Practice Question

"Discuss the significance of the M.A.N.A.V. Framework in shaping a human-centric AI governance model in India. How can these principles be operationalised to balance innovation with ethical responsibility?"

Gaganyaan Drogue Parachute Test: Strengthening India's Human Spaceflight Safety

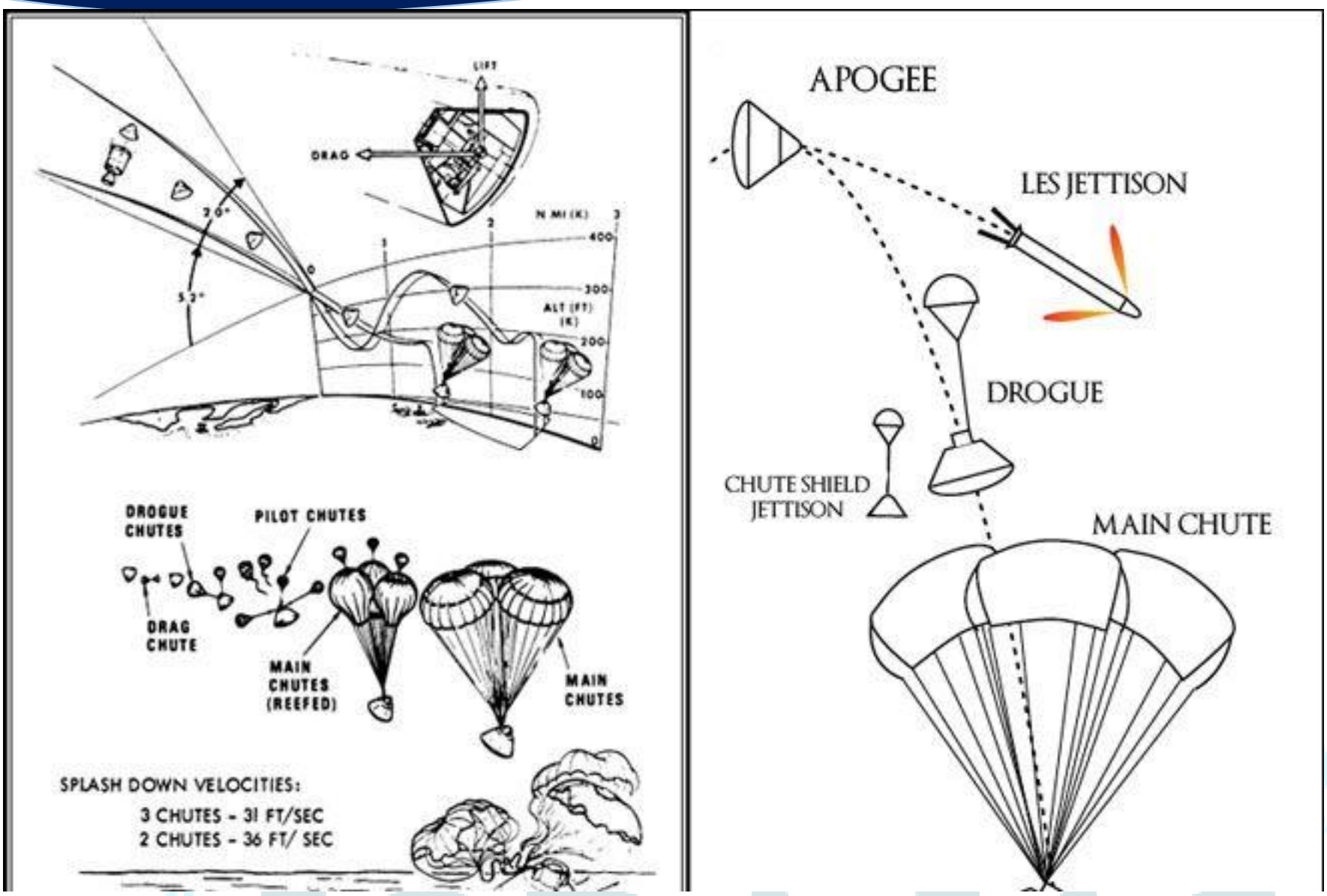
Syllabus Mapping:
✓GS Paper III – Science & Technology (Space Technology, Indigenous Innovation)
✓GS Paper III – Security & Disaster Management (Crew Safety Systems)
✓GS Paper II – International Relations (Space Diplomacy)

Introduction

India achieved a critical milestone in its human spaceflight programme with the successful qualification test of the **Gaganyaan drogue parachute**. The test was conducted by the **Defence Research and Development Organisation(DRDO)** in collaboration with the **Indian Space Research Organisation (ISRO)** and the **Aerial Delivery Research and Development Establishment (ADRDE)**.

The successful test validates India's capability in designing and manufacturing **high-strength ribbon parachutes**, a crucial element of crew safety during re-entry and landing.

What is a Drogue Parachute?



A **drogue parachute** is a small stabilising parachute deployed during the early phase of descent.

Functions:

- Stabilises the crew module.
- Reduces speed before main parachute deployment.
- Ensures controlled descent trajectory.

It forms part of the broader **Crew Escape System (CES)**—a safety mechanism designed to protect astronauts during launch emergencies.

Crew Escape System (CES)

The CES ensures that if a malfunction occurs during launch:

- The crew module separates from the rocket.
- Astronauts are moved to a safe distance.
- Parachutes deploy to enable safe splashdown.

This system is fundamental to **human-rated launch vehicle safety standards**.

About the Gaganyaan Mission

Objective

To demonstrate India's human spaceflight capability by:

- Sending a crew of **three astronauts**.
- Into **Low Earth Orbit (LEO) at 400 km altitude**.
- For a **three-day mission**.
- Ensuring safe return and splashdown in Indian waters.

Components of Gaganyaan Mission

1. Human Rated Launch Vehicle (HLVM-3)

(Formerly GSLV Mk-III)

Three-stage rocket:

- **First Stage:** Two solid-fuel boosters.
- **Second Stage:** Liquid-fuelled Vikas-2 engines.
- **Third Stage:** Indigenous **CE-20 cryogenic engine** using:
  - Liquid hydrogen (fuel)
  - Liquid oxygen (oxidiser)

2. Orbital Module

Crew Module

- Pressurised cabin.
- Environmental Control & Life Support System (ECLSS).
- Parachute systems for safe landing.

Service Module

- Unpressurised.
- Carries propulsion system.
- Houses power systems, radiators, oxygen and water tanks.

Significance of Successful Drogue Parachute Test

1. Enhanced Crew Safety

- Validates reliability of descent and landing systems.
- Critical for human-rating certification.

2. Indigenous Technological Capability

- Demonstrates domestic expertise in:
  - High-strength aerospace textiles
  - Precision manufacturing
  - Aerodynamic testing

Strengthens Atmanirbhar Bharat in space technology.

3. Strategic and Diplomatic Significance

- India will become the **fourth country** after:
  - United States
  - Russia
  - China
    to independently launch humans into space.

Enhances India's **space diplomacy leverage** and collaboration potential.

4. Societal & Economic Benefits

Technologies developed will have spillover effects in:

- Telecommunications
- Remote sensing
- Weather forecasting
- Disaster management
- Healthcare

5. Future Missions

- Paves the way for:
  - **Bharatiya Antariksh Station**
  - Deep space exploration missions

Challenges Ahead

- Stringent human-rating certification.
- Zero-failure tolerance requirement.
- High mission cost.
- Ensuring astronaut training readiness.

Broader Perspective

Space exploration historically drives technological innovation—often referred to as **"spin-off effect" theory** in science policy studies.

Investment in space missions enhances:

- National prestige
- Technological depth
- Industrial ecosystem growth

Way Forward

- Continue integrated testing of safety subsystems.
- Strengthen public-private collaboration in aerospace manufacturing.
- Enhance astronaut training infrastructure.
- Expand international cooperation for future deep-space missions.

Conclusion

The successful qualification test of the Gaganyaan drogue parachute represents a crucial step toward ensuring astronaut safety in India's first human spaceflight mission. By validating a key descent safety component, India moves closer to achieving independent human spaceflight capability—marking a transformative milestone in its space journey.

Mains Practice Question

"Discuss the technological and strategic significance of the Gaganyaan Mission for India. How does the successful testing of safety systems like the drogue parachute enhance India's human spaceflight preparedness?"