



## Secure Synopsis compilation for June-2025

### General Studies-3

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## **Indian Economy and issues relating to planning, mobilization, of resources, growth, development and employment.**

**Q. How is generative AI impacting India's white-collar employment? What are the economic implications of automation-led job displacement? Suggest a strategy for skilling and labour market adaptation. (15 M)**

### **Introduction**

India's white-collar workforce is facing structural disruption as **generative AI replaces routine cognitive tasks**, threatening entry-level roles and raising concerns over employment-led growth and future workforce preparedness.

### **Body**

#### **Impact of generative AI on white-collar employment**

- Displacement of routine cognitive roles:** Gen AI is automating documentation, customer support, HR onboarding, and coding.
  - Eg: **Infosys** launched over **200 AI agents** (April 2025) automating HR, compliance, and workflow tasks across sectors (**Topaz suite**, Google Vertex AI)
- Erosion of entry-level job pipeline:** AI systems perform tasks traditionally assigned to freshers, limiting job creation at the bottom of the pyramid.
  - Eg: **LinkedIn Workforce Confidence Index (2025)** reported that **two-thirds of employers** believe AI will overtake many entry-level tasks.
- Sectoral shifts in hiring patterns:** Industries like IT, media, and banking are replacing junior staff with AI tools.
  - Eg: **TeamLease Report (April–Sep 2025)** showed **job growth slowed to 2.8% from 7.1%**, citing AI-enabled operations and cost optimization
- Growing skill redundancy:** Skills like basic data entry, scheduling, and content creation are being rendered obsolete.

- Eg: **Goldman Sachs (2023)** projected that **300 million full-time jobs globally** could be impacted by Gen AI, with white-collar jobs most at risk
- 5. **Rise of human-AI collaboration models**: Instead of full job loss, roles are evolving to include AI tools as co-workers.
  - Eg: **Deloitte AI Trends Report (2025)** found **70% of Indian companies** are integrating Gen AI to augment tasks rather than replace all roles

### **Economic implications of automation-led job displacement**

1. **Decline in private consumption demand**: Reduced employment in entry-level jobs affects household incomes and GDP growth.
  - Eg: **Private Final Consumption** contributes **56.5% to India's GDP**; automation-linked displacement threatens this engine.
2. **Jobless growth phenomenon**: Output rises due to AI efficiency, but employment does not follow suit.
  - Eg: **IMF Report (2024)** estimated **40% of jobs globally** to be affected by AI, risking economic decoupling between growth and jobs
3. **Widening socio-economic inequality**: AI benefits firms and skilled elites while leaving low-skilled youth behind.
  - Eg: **World Economic Forum (2024)** highlighted that **85% of AI investment** flows to developed economies, with limited access for low-income segments
4. **Underutilisation of demographic dividend**: India's large youth population remains unemployable without AI-aligned skills.
  - Eg: **CMIE (2024)** noted **youth unemployment at 17%**, worsened by tech-led hiring saturation in services
5. **Mismatch between education and industry**: Current curricula fail to address AI integration, worsening structural unemployment.
  - Eg: **AICTE-SAMARTH audit (2023)** found that **over 65% of technical institutes** had no AI curriculum or lab exposure

### **Strategy for skilling and labour market adaptation**

1. **Curriculum overhaul for AI-readiness**: Incorporate AI, data literacy, and algorithmic thinking in higher education and vocational training.
  - Eg: **NEP 2020 + NCeF guidelines (2023)** encourage integration of **21st-century skills**, but rollout remains uneven across states
2. **AI-focused reskilling initiatives**: National programs for retraining mid-career and entry-level employees in AI and automation tools.
  - Eg: **Skill India Digital Platform (2024)** launched **AI Upskilling Modules** targeting 1 crore learners by 2026 .
3. **Promotion of public-private skilling partnerships**: Industry-led training with government incentives to align supply and demand.
  - Eg: **Tata STRIVE + NSDC collaboration** offers **AI/ML bootcamps** with placement-linked outcomes
4. **Regional skilling hubs for displaced sectors**: Setup of localized centres for industries undergoing automation.

- Eg: **Tamil Nadu AI Mission (2023)** piloted **district-level AI skilling hubs** to upskill those affected by automation in MSMEs
- 5. **Inclusive skilling for vulnerable groups**: Focus on women, rural youth, and tier-2/3 college graduates in AI-based roles.
  - Eg: **FutureSkills PRIME** portal by **MeitY + NASSCOM** offers **free AI foundational courses** with a focus on women and underrepresented groups

### Conclusion

India stands at a critical junction where **AI can either widen the employment crisis or catalyse a productivity revolution**. Only a proactive, inclusive, and scalable skilling ecosystem can ensure India's demographic dividend is future-proofed in the age of AI.

**Q. What are the key macroeconomic challenges India faces in sustaining growth in 2025–26? Examine the risks arising from global policy unpredictability, fiscal tapering, and slowing domestic demand. (15 M)**

### Introduction:

India's 6.5% GDP growth in FY 2024–25 has been impressive amid global volatility, but sustaining this pace demands navigating complex macroeconomic pressures rooted in both domestic shifts and international uncertainty.

### Body

#### **Key macroeconomic challenges in 2025–26**

1. **Weak private investment momentum**: Corporate capex remains cautious due to global demand concerns.
  - Eg: RBI's May 2025 OBICUS report shows capacity utilisation fell to **72%**, limiting new investments.
2. **Urban consumption plateauing**: Pandemic-era drivers like excess savings and wage hikes have faded.
  - Eg: Fitch Ratings 2025 noted a dip in **urban 4-wheeler sales** and premium FMCG growth.
3. **Public capex saturation**: Fiscal constraints are limiting further expansion of government capital expenditure.
  - Eg: Union Budget 2025–26 projected only a **5.7% rise in capex**, much lower than the previous year's **33%**.
4. **Labour market dualism**: The informal sector recovery remains slow despite headline growth.
  - Eg: CMIE April 2025 reported **female LFPR** still stagnant around **20%**, limiting inclusive growth.
5. **Energy price volatility**: Despite recent moderation, imported energy shocks remain a risk.
  - Eg: IEA 2025 warns of Brent crude returning to **\$90/barrel** if Middle East tensions escalate.

#### **Risks from global policy unpredictability, fiscal tapering, and domestic demand slowdown**

##### **A. Global policy unpredictability**

1. **US tariff uncertainty**: Unclear US trade posture under legal flux is dampening investor confidence.

- **Eg:** US Supreme Court ruling (April 2025) questioned broad tariff powers under **IEEPA**, raising unpredictability.
- 2. **Global FDI hesitation:** Trade policy fragmentation is deferring investment decisions globally.
  - **Eg:** UNCTAD's World Investment Report 2025 noted a **12% drop in FDI flows to emerging Asia** due to trade uncertainty.
- 3. **Supply chain dislocation risks:** Re-routing from China faces logistic and geopolitical hurdles.
  - **Eg:** GVC Index 2025 shows India's integration remains below **Vietnam and Mexico**, despite 'China+1' potential.

## **B. Fiscal tapering constraints**

1. **Limited headroom for counter-cyclicality:** FRBM targets tighten space for fiscal stimulus.
  - **Eg:** Finance Commission 2025 Review Committee urged fiscal deficit to be kept below **4.5% by FY26**.
2. **Subsidy compression affecting demand:** Rationalisation of food and fertiliser subsidies impacts rural liquidity.
  - **Eg:** Budget 2025–26 cut fertiliser subsidy by **13%**, affecting farmer spending power.

## **C. Slowing domestic demand**

1. **Rural distress and job quality:** MGNREGA demand remains high despite agriculture rebound.
  - **Eg:** Rural Development Ministry (May 2025) data showed **16 crore person-days** demanded in April alone.
2. **Housing and real estate slowdown:** Rising unsold inventory signals demand moderation.
  - **Eg:** Knight Frank Q1 2025 reports unsold inventory up by **9.5%** in top 8 Indian cities.
3. **Widening consumption inequality:** Growth is concentrated in upper-income brackets, reducing mass demand.
  - **Eg:** India Inequality Report 2025 (Oxfam) flagged top **10% households account for 77% of total wealth**.

## **Way forward**

1. **Accelerate trade diversification:** Fast-track FTAs with the **US, EU, and EFTA** to hedge against tariff shocks.
  - **Eg:** India–UK FTA 2025 is projected to add **\$10 bn** to exports over 5 years (Commerce Ministry).
2. **Boost rural and MSME demand:** Frontload schemes like PMAY-Gramin and ECLGS 4.0 with enhanced credit access.
  - **Eg:** RBI's Financial Stability Report 2025 notes MSMEs still face **NPAs at 8.6%**, needing structured relief.
3. **Enhance monetary policy transmission:** Ensure rate cuts benefit end-users via NBFCs and cooperative banks.
  - **Eg:** RBI April 2025 Monetary Policy Minutes stressed need for **faster MCLR pass-through**.
4. **Implement labour and land reforms:** Enact **4 labour codes** and reduce regulatory burden on industry.

- **Eg:** Economic Survey 2024–25 estimated **15% rise in job formalisation** post implementation of labour codes.

### **Conclusion:**

India's growth story in 2025–26 hinges on managing transition from public-led to private-led drivers, amid external turbulence. Balancing domestic reform with global positioning is not just a necessity—it is an economic imperative.

**Q. “India’s long-term growth narrative is strong, but its structural vulnerabilities remain unresolved”. Assess the nature of these vulnerabilities. Examine their implications for sustaining high growth. Suggest policy responses to address them. (15 M)**

### **Introduction**

India's status as the **world's fastest-growing major economy** is contrasted by persistent structural weaknesses in investment, employment, and consumption. Bridging this gap is vital for realising inclusive and sustainable growth.

### **Body**

#### **Nature of structural vulnerabilities**

1. **Stagnant private capital expenditure:** Private sector investment has not responded proportionally to tax cuts and reforms.
  - **Eg:** **Gross fixed capital formation** remains at **~25% of GDP**, the same as in **2014** despite corporate tax cuts in **2019**.
2. **Weak consumption and demand uncertainty:** Urban and rural demand remain inconsistent, limiting investment incentives.
  - **Eg:** Despite income tax relief in Budget 2025, **urban consumption** and **rural demand** recovery remain patchy (RBI Bulletin, May 2025).
3. **Jobless growth and labour underutilisation:** Growth has not translated into proportional employment gains.
  - **Eg:** Over **8 million jobs/year** needed till 2030, yet capacity utilisation in industry stuck at **75%** since 2014 (CMIE, 2025).
4. **Household financial stress:** Debt burdens and reduced wage growth are straining consumption.
  - **Eg:** **Compensation growth** has lagged behind **profit growth** in key sectors like IT and manufacturing (Centre for Monitoring Indian Economy, 2025).
5. **Policy inertia and reform fatigue:** With reform appetite diminishing, long-pending structural reforms remain stalled.
  - **Eg:** **Labour Codes** passed in 2020 remain unimplemented due to political resistance and federal friction (Standing Committee on Labour, 2024).

#### **Implications for sustaining high growth**

1. **Reduced investment multiplier effect:** Low private capex limits productivity gains and dampens job creation.

- **Eg:** Despite Centre's capex push, crowding-in of private investment has been negligible (World Bank, 2025).
- 2. **Insufficient employment elasticity:** Growth concentrated in capital-intensive sectors leads to skewed benefits.
  - **Eg:** Services growth has been strong, but **employment-intensive manufacturing** has underperformed (NITI Aayog Job Diagnostics Report, 2023).
- 3. **External vulnerability amidst global shocks:** Protectionism and supply chain risks may worsen trade dependence.
  - **Eg:** **US tariff uncertainties** and **EU carbon border taxes** could hurt India's exports (WTO & EXIM Bank, 2025).
- 4. **Skewed wealth distribution and inequality:** Persistent income and wealth gaps reduce inclusive growth potential.
  - **Eg:** **Top 10% of Indians hold 77% of national wealth** (Oxfam India Inequality Report, 2024).
- 5. **Fiscal constraints on counter-cyclical response:** Limited tax buoyancy and rising subsidies constrain state spending.
  - **Eg:** **Centre's capital expenditure (BE 2025-26)** at ₹11.1 lakh crore is not being matched by state-level spending due to fiscal stress (Union Budget, 2025).

### **Policy responses to address vulnerabilities**

1. **Boost private capex through demand-side incentives:** Shift from supply-side tax cuts to targeted consumption stimulus.
  - **Eg:** Incentivise investments in **sunrise sectors** via PLI 2.0 with demand-linked subsidies (MoF 2025 discussion paper).
2. **Labour market reform with state-centre coordination:** Devolve flexibility for implementation of Labour Codes.
  - **Eg:** Use **Inter-State Council** to evolve consensus on phased rollout of labour reforms.
3. **Strengthen social safety nets and skilling:** Scale up public employment, urban livelihood missions, and job-linked skilling.
  - **Eg:** Expand **PM Vishwakarma Yojana** and link with **Skill India 2.0** to boost informal sector productivity.
4. **Address credit flow asymmetry:** Tackle slowing credit to MSMEs and rural borrowers via differentiated interest subvention.
  - **Eg:** Extend **RBI's Priority Sector Lending guidelines** to include gig and platform workers.
5. **Initiate governance reforms in states:** Push fiscal devolution-linked performance metrics and state-level infrastructure reforms.
  - **Eg:** Tie **Finance Commission devolution** to ease-of-doing business and capex efficiency (15th Finance Commission Recommendations).

### **Conclusion**

India's growth story needs a **second generation of structural reforms**, focused not only on macroeconomic stability but on **jobs, equity, and demand revival**. Institutional innovation, state-centre cooperation, and people-centric policies must drive this transformation.

**Q. What are the main drivers of over-indebtedness in India's microfinance sector? How does this affect borrower behaviour and credit institutions? Suggest structural solutions to address this challenge. (15 M)**

### **Introduction**

The recent surge in microfinance defaults and coercive recoveries reflects a **systemic build-up of over-indebtedness**, weakening both borrower welfare and institutional stability. This crisis demands urgent structural introspection.

### **Body**

#### **Main drivers of over-indebtedness**

1. **Multiple lending without consolidated borrower profiling**: Borrowers access parallel loans due to lack of a unified credit check.
  - **Eg:** As per **CRIF High Mark (2025)**, states like **Bihar and Odisha** saw **27%+ duplication** across MFIs and banks.
2. **Weak income-based credit appraisal**: Lenders often ignore actual repayment capacity in favour of group-based metrics.
  - **Eg:** **RBI Deputy Governor Rao (2025)** highlighted that many institutions use “proxy indicators” instead of verifiable income checks.
3. **Agent-centric disbursement models**: Field agents are incentivised for volume, not quality, compromising due diligence.
  - **Eg:** **Telangana 2023 audit** found **agent-led disbursement bypassed income checks in 40% of rural loans**.
4. **Short-term loan recycling under distress**: Borrowers use new loans to repay existing ones due to irregular earnings.
  - **Eg:** **SEBI Household Finance Report (2022)** showed **43% of borrowers** relied on fresh loans to cover old dues.
5. **Aggressive cross-selling by institutions**: Lenders push multiple loans or top-ups without borrower demand or capacity.
  - **Eg:** **NBFC-MFI top-up loans** grew **22% year-on-year** in FY24 (MFIN Micrometer, 2024).

#### **Effects on borrower behaviour and credit institutions**

1. **Repayment stress and mental health fallout**: Persistent loan pressure creates psychological distress and fatal outcomes.
  - **Eg:** In **Kandhamal (Odisha, 2024)**, three borrower suicides were directly linked to coercive recovery calls.
2. **Withdrawal from formal finance ecosystem**: Defaulting borrowers avoid future engagement with formal institutions.
  - **Eg:** **MFIN 2023 report** revealed **20% first-time defaulters** permanently exited formal credit access.
3. **Institutional asset quality deterioration**: Rising borrower insolvency leads to mounting NPAs and liquidity risks.

- **Eg: PAR >30 days rose 163% in FY25**, reaching **₹43,075 crore** (CRIF High Mark, 2025).
- 4. **Credit tightening and financial exclusion**: Lenders become risk-averse, limiting outreach to needy segments.
  - **Eg: Gross Loan Portfolio dropped by 13.9% in FY25**, from **₹4.42 lakh crore to ₹3.81 lakh crore** (MFIN, 2025).
- 5. **Loss of sectoral credibility and reputational damage**: Media and regulatory scrutiny create trust deficits and investor caution.
  - **Eg: After the Andhra Pradesh 2010 microfinance crisis**, RBI introduced stricter recovery norms via **Malegam Committee recommendations**.

### **Structural solutions to address over-indebtedness**

1. **Establish a unified real-time borrower registry**: Mandate borrower-level data sharing across MFIs, NBFCs, SFBs, and banks.
  - **Eg: The upcoming Public Credit Registry (RBI)** aims to streamline borrower tracking and exposure capping.
2. **Introduce loan caps and repayment-to-income thresholds**: Limit loan volumes based on verifiable income and household liabilities.
  - **Eg: The Malegam Committee (2011)** capped total borrower exposure at **₹50,000**, guiding subsequent RBI norms.
3. **Reform field-agent incentives**: Link rewards to long-term loan quality and ethical behaviour, not disbursement volume.
  - **Eg: SIDBI's 2023 pilot** in Uttar Pradesh tied agent incentives to **90-day repayment consistency**, reducing defaults by 18%.
4. **Expand borrower financial literacy and rights awareness**: Educate borrowers on credit risks, grievance tools, and negotiation rights.
  - **Eg: RBI's Financial Literacy Week 2024** focused on "Rights in Credit Contracts" across 100+ districts.
5. **Create a sector-wide borrower protection code**: Institutionalise norms for non-coercive recovery and grievance redress.
  - **Eg: Sa-Dhan's Voluntary Code of Conduct (2022)** includes borrower dignity clauses adopted by major MFIs.

### **Conclusion**

Over-indebtedness is not merely a financial metric—it is a **social risk with economic consequences**. The future of microfinance lies in transitioning from **loan proliferation to responsible credit ecosystems** grounded in empathy, ethics, and institutional accountability.

**Q. Explain the need for embedding entrepreneurship education across academic disciplines in India. Analyse how such integration can transform job seekers into job creators. (10 M)**

### **Introduction**

India's demographic dividend offers a unique opportunity but risks being wasted if youth lack entrepreneurial skills; mainstreaming entrepreneurship can convert this challenge into a growth engine.

## Body

### Need for embedding entrepreneurship education across disciplines

1. **Skill gap in existing higher education**: Current education focuses on job-oriented knowledge, ignoring entrepreneurial competencies.
  - Eg: **NASSCOM 2025** estimates that only **20% graduates are employable in emerging tech sectors** despite 90 lakh projected job creation.
2. **Demographic dividend utilization**: To harness the large youth population into productive contributors.
  - Eg: **UNFPA 2023** notes that over **50% of India's population is under 25 years**.
3. **Addressing regional and grassroots challenges**: Students from rural/semi-urban areas can develop localized solutions.
  - Eg: **Atal Innovation Mission's Atal Tinkering Labs (2024)** encourage rural youth for grassroots innovations.
4. **Interdisciplinary problem solving**: Innovation today lies at the intersection of disciplines like AI, health, climate, and design.
  - Eg: **Stanford University's cross-disciplinary startup model** integrating AI, sustainability and design.
5. **Support to national missions**: Aligns with government schemes promoting self-employment and startups.
  - Eg: **Startup India (2016), Stand-Up India (2016), and PMEGP (2023 revised guidelines)**.

### How integration transforms job seekers into job creators

1. **Mindset shift towards risk-taking**: Students learn resilience, adaptability and risk management early.
  - Eg: **BITS Pilani's New Venture Creation minor (2024)** focuses on live venture creation modules.
2. **Enhancing real-world problem-solving**: Exposure to live challenges nurtures entrepreneurial instincts.
  - Eg: **Smart India Hackathon 2024** solving real-world government and private sector problems.
3. **Access to funding and incubation**: Educational institutes provide direct pathways to seed funding and mentorship.
  - Eg: **NSRCEL, IIM Bangalore** has incubated over **700 startups since 2017**.
4. **Leveraging technology for rapid prototyping**: Digital tools enable faster venture development cycles.
  - Eg: Use of **ChatGPT, Canva AI, Microsoft Copilot** by students for business simulations and prototypes.
5. **Inclusive opportunities for underrepresented groups**: Entrepreneurship reduces dependence on traditional jobs, opening doors for women, rural youth and minorities.
  - Eg: **MUDRA Yojana (2025 data)** has sanctioned over **₹23 lakh crore loans**, with significant share to women entrepreneurs.

## Conclusion

Mainstreaming entrepreneurship education will not only democratize wealth creation but also build a resilient, innovative and self-reliant India ready for global leadership.

**Q. Explain the major causes behind the higher female unemployment rate compared to males. Analyse its consequences for labour market efficiency and economic resilience. Outline comprehensive measures required to address the gender gap in employment. (15 M)**

## Introduction

The **PLFS May 2025 data** shows female unemployment at **5.8%** against **5.6%** for males, exposing persistent gender gaps driven by structural, social, and policy challenges.

## Body

### Major causes behind higher female unemployment rate

1. **Patriarchal norms and mobility restrictions**: Societal expectations limit women's workforce entry and sectoral choice.
  - Eg: **CMIE 2024**: Nearly **60% of women** cite family restrictions as key barrier to employment.
2. **Unpaid care work burden**: Domestic responsibilities hinder active job seeking and retention.
  - Eg: **ILO 2023**: Indian women spend **7 times more** time than men on unpaid care work.
3. **Safety and infrastructure deficits**: Inadequate public transport, security and workplace facilities deter participation.
  - Eg: **NITI Aayog 2024**: **40% urban women** avoid late shifts due to safety concerns.
4. **Skill-job mismatch**: Educational qualifications often do not align with market requirements.
  - Eg: **PLFS 2023**: Unemployment among educated women at **12.2%**, nearly double that of uneducated.
5. **Informality and sectoral vulnerability**: High dependence on agriculture and informal sector leads to volatility.
  - Eg: **Economic Survey 2023-24**: **Over 70% women** engaged in informal or vulnerable employment.

### Consequences for labour market efficiency and economic resilience

1. **Underutilisation of human capital**: Wasted potential hampers demographic dividend realisation.
  - Eg: **World Bank 2024**: Gender parity could add **\$700 billion** to India's GDP.
2. **Labour market distortions**: Reduced female participation limits sectoral labour availability and flexibility.
  - Eg: **ILO 2023**: Female labour force addition could boost participation rate by **27%**.
3. **Income inequality and consumption slowdown**: Joblessness widens income disparities and dampens household demand.
  - Eg: **NSSO 2023**: Dual-income households record **40% higher consumption** levels.
4. **Intergenerational poverty trap**: Economic exclusion of women perpetuates family-level poverty cycles.
  - Eg: **UNDP HDR 2024**: Gender Inequality Index for India stagnates at **0.49**.

5. **Fragile economic recovery**: Exclusion of women weakens resilience against global or domestic economic shocks.
  - Eg: **Asian Development Bank 2023**: Inclusive growth models show faster post-pandemic recovery.

### **Comprehensive measures required to address gender gap in employment**

1. **Strengthening care infrastructure**: Public investment in childcare, elderly care to reduce unpaid care load.
  - Eg: **Economic Survey 2023-24**: Advocated **community-level crèche networks**.
2. **Targeted skill development**: Industry-aligned training programmes for emerging sectors.
  - Eg: **PMKVY 4.0 (2024)**: Introduced dedicated **women-centric skilling modules**.
3. **Enhancing safety frameworks**: Stronger enforcement of workplace safety and harassment laws.
  - Eg: **POSH Act 2013** and **Vishaka Guidelines 1997** provide legal foundation for safer workplaces.
4. **Formalisation of female employment**: Incentivising employers to provide formal contracts and social security.
  - Eg: **ESIC 2023**: Noted rising formal sector coverage of women under maternity benefit schemes.
5. **Flexible work arrangements**: Encouraging hybrid, part-time, and gig work models suitable for women.
  - Eg: **Labour Codes 2020**: Enabled greater flexibility through gig and platform economy recognition.

### **Conclusion**

Unlocking India's **female workforce potential** is central to achieving **balanced, resilient, and inclusive economic growth** in the coming decade.

**Q. The challenge of employment in India lies at the intersection of formalisation, skilling, and labour market flexibility. Comment. Also examine how formal staffing agencies can contribute to achieving these goals. (15 M)**

### **Introduction**

India's demographic dividend offers immense growth potential, but fragmented skilling, persistent informality, and rigid labour markets threaten to turn this advantage into a liability.

### **Body**

#### **Employment challenges at the intersection of formalisation, skilling, and flexibility**

1. **High informality in workforce**: Over 85% of India's workforce is in the informal sector, lacking security and benefits.
  - Eg: **Periodic Labour Force Survey (PLFS) 2023-24** shows informal sector employment still dominates rural and urban non-agricultural sectors.
2. **Skilling-employability mismatch**: Inadequate alignment between skilling programs and market needs limits productive employment.

- Eg: **MSDE 2024 data** shows only **4.69% workforce received formal vocational training**, despite annual workforce addition of 12 million.
- 3. **Labour market rigidity**: Strict hire-and-fire rules and compliance burdens discourage formal sector job creation.
  - Eg: **OECD Employment Outlook 2023** highlights India's **stringent labour codes on job security** as a bottleneck for formal job creation.
- 4. **Low productivity sectors dominating absorption**: Sectors like construction and low-end services absorb surplus labour but limit productivity gains.
  - Eg: **Economic Survey 2023-24** shows construction sector's high share of new jobs but stagnant productivity levels.
- 5. **Limited social security coverage**: Absence of universal social protection discourages formal transition.
  - Eg: **NSSO 2023** shows only **24% workers covered under any form of social security**.
- 6. **Fragmented implementation of labour reforms**: Uneven adoption of the 4 Labour Codes across states hampers uniform formalisation.
  - Eg: **Labour Ministry 2025** reports full implementation still pending in **major industrial states like Maharashtra and Tamil Nadu**.
- 7. **Populist employment schemes favouring quantity over quality**: Short-term schemes often prioritise job numbers without ensuring productivity or protection.
  - Eg: **CAG report 2024** flagged concerns about limited formal job creation under some **urban wage employment pilot schemes**.

### **Role of formal staffing agencies in addressing employment challenges**

1. **Facilitating formalisation of workforce**: Staffing agencies directly employ and formalise contractual workers while ensuring compliance.
  - Eg: **Indian Staffing Federation (ISF) 2025 report** notes **4.2 million formal workers placed through organised staffing agencies**.
2. **Bridging skilling gaps with demand-driven training**: They provide targeted upskilling aligned to employer requirements, reducing employability gaps.
  - Eg: Collaboration between **ISF and NSDC (2024)** designed industry-specific skilling modules for logistics and IT sectors.
3. **Enhancing labour market flexibility**: Offer flexibility to employers while ensuring security and benefits to workers.
  - Eg: **ILO Global Staffing Industry Statistics 2023** lists India's staffing sector as among the fastest-growing globally in providing flexible formal employment.
4. **Integration with social security schemes**: Staffing firms ensure coverage under EPFO, ESIC, gratuity, maternity benefits etc.
  - Eg: Under **Code on Social Security 2020**, staffing agencies brought gig and platform workers under formal coverage.
5. **Reducing compliance burden for MSMEs**: Staffing agencies handle HR, legal and payroll functions, enabling small enterprises to hire formal workers without complexity.
  - Eg: **SIDBI 2024 survey** highlights staffing as a preferred hiring route for MSMEs adopting formalisation.
6. **Enabling sectoral formalisation in emerging sectors**: Staffing supports formal employment in gig economy, IT-ITeS, logistics, fintech, and healthcare.

- Eg: **IT-ITeS sector (NASSCOM 2025)** employs over **5 lakh contract staff through formal staffing agencies**.
7. **Supporting tripartite partnerships**: Facilitate collaboration between government, educational institutions and industry for skill development.
- Eg: **Skill India and ISF MoU (2024)** on integrated apprenticeship and staffing solutions.

## Conclusion

A robust formal staffing ecosystem can strategically unlock India's employment potential by synchronising formalisation, skilling and flexibility, thereby securing both economic growth and social inclusion in the coming decades.

## Q. How does the performance of India's private sector reflect both global demand trends and domestic structural reforms? Suggest a roadmap for enhancing future resilience. (15 M)

### Introduction

The recent surge in India's **private sector output** mirrors both global demand revival and the cumulative effects of domestic **structural reforms** in trade, manufacturing, and services.

### Body

#### Reflection of global demand trends

1. **Robust export performance in manufacturing**: Rising international sales, particularly in engineering goods and electronics.
  - Eg: **HSBC Flash PMI June 2025** showed manufacturing-led export growth driven by robust **global demand**.
2. **Rising service exports in IT and business services**: India's IT and consulting sectors cater to global digitalisation needs.
  - Eg: **NASSCOM Report 2025** highlighted **13% YoY growth** in service exports despite global uncertainties.
3. **Impact of global supply chain shifts**: Benefitting from diversification away from China and "China plus one" strategies.
  - Eg: **PLI-linked mobile exports** to US and EU surged by **15% in Q1 2025** (Commerce Ministry data).
4. **Influence of global commodity and input price trends**: Affecting margins and inflation trends in private sector.
  - Eg: **April–June 2025 RBI Bulletin** flagged softening **input cost pressures** across sectors.
5. **Employment trends driven by global project inflows**: Higher hiring in manufacturing to meet overseas orders.
  - Eg: **HSBC Flash PMI June 2025** noted **record employment growth** in manufacturing on rising **global orders**.

#### Reflection of domestic structural reforms

1. **Production Linked Incentive (PLI) schemes**: Boosting scale, competitiveness and export capabilities.

- **Eg: PLI in electronics** led to **USD 11 billion worth of production** in FY 2024–25 (DPIIT data).
- 2. **Improved ease of doing business**: Enhanced compliance processes post **Insolvency and Bankruptcy Code (IBC)** and **faceless tax regime**.
  - **Eg: World Bank Doing Business subnational index** shows steady improvement in Indian states.
- 3. **Digital infrastructure and e-governance**: Increased adoption of **UPI, ONDC**, enabling new business models.
  - **Eg: UPI transactions crossed 13 billion/month** as of **June 2025** (NPCI data).
- 4. **Taxation and trade reforms under GST**: Reducing cascading effects, improving interstate trade efficiency.
  - **Eg: GST revenue touched all-time high in May 2025** at **Rs 1.87 lakh crore** (Finance Ministry).
- 5. **Labour market flexibility and skilling initiatives**: Improved training and employment through **Skill India** and new labour codes.
  - **Eg: MSDE 2025 report** cites **6 million skilled workers trained** in FY 2024–25.

### **Roadmap for enhancing future resilience**

- 1. **Diversify export markets**: Reduce over-dependence on US-EU and tap newer markets like Africa and Latin America.
  - **Eg: India-UAE CEPA 2025 review** highlighted 20% rise in trade post-deal.
- 2. **Boost MSME competitiveness**: Encourage formalisation, credit access, and tech adoption in MSMEs.
  - **Eg: SIDBI–World Bank 2025 report** stressed critical need for digital upgradation in MSMEs.
- 3. **Strengthen logistics and supply chain efficiency**: Invest in multimodal logistics and National Logistics Policy execution.
  - **Eg: NLP 2025 dashboard** shows **10% reduction in logistics costs** in pilot states.
- 4. **Enhance R&D and innovation capacity**: Promote public-private partnerships in frontier technologies.
  - **Eg: National Research Foundation (NRF)** rollout in Budget 2025–26 to fund R&D ecosystem.
- 5. **Strengthen financial sector depth**: Broaden access to credit and capital markets for private firms.
  - **Eg: RBI June 2025 report** recommended boosting **corporate bond market participation**.

### **Conclusion**

A balanced synergy of **external demand integration** and robust **domestic reforms** can future-proof India's private sector and steer it toward **sustainable high-growth pathways**.

**Q. What are the current trends in States' non-tax revenue mobilisation. Analyse the reasons for its decline. Suggest measures to improve the composition and growth of non-tax revenues. (15 M)**

**Introduction:**

In recent years, States' non-tax revenue — critical for fiscal autonomy — has steadily declined due to inefficiencies, centralisation, and weak policy focus, deepening dependence on Central transfers.

**Body**

**Current trends in States' non-tax revenue mobilisation**

1. **Declining share in total revenue:** The share of non-tax revenue is projected to fall below **24% of States' revenue in FY25**, lowest in over two decades, showing systemic weakening.
  - Eg: **Tamil Nadu's non-tax revenue fell from 27% in FY17 to 21% in FY24**, despite steady growth in State expenditure (TN Budget 2024-25).
2. **Rising dependence on Central grants:** **65-70% of non-tax revenue** is now composed of Central grants, up from **55-60%** in 2000s, reducing States' financial flexibility.
  - Eg: In **West Bengal's FY25 Budget**, more than **68% of non-tax revenue** was sourced from grants linked to flagship Central schemes (State Finance Dept 2025).
3. **Low PSU profitability:** Dividends and profits from State PSUs continue below **1% of total non-tax revenue**, signalling deep inefficiencies and poor asset utilisation.
  - Eg: **Karnataka ESCOMs and Kerala Financial Corporation** contributed less than **₹100 crore dividends** in FY24 despite combined operational budgets exceeding ₹50,000 crore.
4. **Stagnant earnings from economic services:** Revenues from transport, energy, irrigation, and other services remain under **30% of non-tax income** in most States.
  - Eg: **Delhi Transport Corporation's operating loss of ₹1,650 crore in FY24** wiped out service revenues despite fare increases (Delhi Budget 2025).
5. **Falling interest income:** Interest receipts on loans and advances now form under **5% of non-tax revenue**, reflecting reduced lending to State PSUs and agencies.
  - Eg: **Madhya Pradesh's interest receipts declined to ₹1,024 crore in FY25 BE**, down from ₹1,870 crore in FY15, showing lower recoveries.

**Reasons for decline in non-tax revenue**

1. **Inefficient PSU governance:** Many State PSUs suffer from outdated technology, poor management, and politicised boards, eroding profitability.
  - Eg: **Bihar State Road Transport Corporation** continues to incur over ₹500 crore annual losses despite two major restructuring plans since 2018 (Bihar Transport Dept).
2. **Politically distorted user charges:** Tariffs for public services are kept artificially low for populist reasons, undermining cost recovery.
  - Eg: **Punjab's free electricity subsidy** for farmers causes an annual revenue shortfall of nearly ₹10,000 crore in the power sector (Punjab Power Dept 2025).
3. **Delayed and weak asset monetisation:** Poorly structured PPPs, land disputes, and lack of inventory lead to underutilisation of government assets.

- Eg: **Maharashtra's FY24 asset monetisation yield was only ₹3,100 crore**, less than 40% of its ₹8,000 crore target (Maharashtra Finance Dept 2025).
- 4. **Litigation on royalties and outdated rates**: Legal delays and political hesitation prevent timely revision of royalty rates on minerals, water, and forest produce.
  - Eg: **Odisha's iron ore royalty revision**, pending since 2019 due to ongoing court cases, led to foregone revenue of ₹1,500 crore per annum (Odisha Mines Dept).
- 5. **Fiscal erosion post-GST**: Centralisation of indirect taxation under GST limits States' ability to levy compensatory sectoral fees and cesses.
  - Eg: **Kerala's 2023 attempt to introduce an eco-environment fee** was blocked by GST Council, impacting local environmental funding (Kerala Budget 2024).

### **Measures to improve composition and growth of non-tax revenues**

1. **Reforming PSU governance**: Strategic disinvestment, professional management, and transparent reporting to improve returns and accountability.
  - Eg: **Tamil Nadu's 2024 TANGEDCO restructuring**, supported by ADB, targets ₹9,000 crore loss reduction over five years (TN Power Sector Reform Plan 2024).
2. **Rationalising user charges**: Regular indexation of fees for services like water supply, transport, and health to inflation and service quality.
  - Eg: **Karnataka's 2023 Urban Water Pricing Framework** mandates biennial revision of tariffs based on CPI and service cost (Karnataka Water Supply Act 2023).
3. **Accelerating asset monetisation**: Creation of GIS-based asset inventories and state-level PPP cells to fast-track monetisation pipelines.
  - Eg: **Maharashtra's 2025 Urban Asset Monetisation Policy** targets ₹10,000 crore over five years from metro land parcels and surplus urban land (Maha Budget 2025).
4. **Establishing independent royalty boards**: De-politicised boards to review and update royalties regularly and resolve disputes faster.
  - Eg: **Chhattisgarh's 2024 Mineral Royalty Board** updated rates within six months, adding ₹1,200 crore to FY25 revenues (Chhattisgarh Mines Dept).
5. **Institutionalising revenue policy**: Creation of Revenue Enhancement Commissions or Revenue Policy Cells for continuous policy innovation.
  - Eg: **Kerala Finance Commission 2023** proposed a permanent **Revenue Policy Cell** under Finance Dept to design dynamic non-tax revenue strategies (Kerala FC Report 2023).

### **Conclusion:**

For a resilient and fiscally autonomous federal structure, States must aggressively reform and innovate in non-tax revenue policy — enabling a sustainable, diversified revenue base in line with their developmental aspirations.

**Q. “The global economy today faces an unprecedented mix of geopolitical tensions, tariff wars, and technological disruptions”. Examine these trends. How should India adapt its trade and economic strategies? (15 M)**

### **Introduction**

The **World Economic Forum (2025)** has described today's global landscape as the “**most complex**

**geopolitical and geo-economic backdrop in decades”,** with intensifying uncertainties reshaping trade and growth patterns.

## **Body**

### **Examining the trends**

1. **Geopolitical conflicts straining global trade:** Ongoing conflicts like **Iran-Israel tensions** and the **Russia-Ukraine war** are impacting energy markets and disrupting trade flows.
  - **Eg: Brent crude prices** crossed **\$90/barrel in June 2025** due to heightened West Asia tensions (**Indian Express, June 2025**).
2. **Emergence of tariff wars and protectionism:** The **US-China tariff war** and rising protectionist trends are undermining rules-based trade.
  - **Eg: US tariffs on \$18 billion worth of Chinese goods** imposed in **May 2025 (Reuters)**.
3. **Weaponisation of supply chains:** Export restrictions on **semiconductors, rare earths, and critical minerals** are fragmenting global value chains.
  - **Eg: China’s export restrictions on gallium and germanium in 2024** disrupted tech supply chains (**Financial Times**).
4. **Technological disruptions altering growth patterns:** **AI, automation, and digital trade** are redefining production, employment and competitiveness.
  - **Eg: China targets 30% AI contribution to GDP by 2035 (WEF Tianjin, 2025)**.
5. **Shift from traditional globalisation models:** Movement towards **bilateral FTAs** and regional blocs is replacing multilateral WTO-led trade.
  - **Eg: RCEP expansion** and India’s negotiations with **EU, UK, EFTA (MEA Annual Report 2024-25)**.

### **How should India adapt its trade and economic strategies**

1. **Diversifying export markets:** Reduce over-reliance on traditional partners and expand trade with **Africa, ASEAN, Latin America**.
  - **Eg: India-ASEAN trade** reached **\$135 billion in FY 2024-25 (Commerce Ministry)**.
2. **Building resilient domestic value chains:** Scale up **PLI schemes** for electronics, renewable energy, defence and pharmaceuticals.
  - **Eg: PLI for Advanced Chemistry Cell Batteries** launched in **2024**, targeting **50 GWh by 2029 (PIB)**.
3. **Investing in AI and frontier technologies:** Develop **national AI infrastructure** and drive productivity-led growth.
  - **Eg: IndiaAI Mission (2024)** with **₹10,000 crore** allocation (**Union Budget 2024-25**).
4. **Strengthening trade infrastructure:** Upgrade **ports, logistics** and strategic corridors such as the **India-Middle East-Europe Corridor (IMEC)**.
  - **Eg: Sagarmala projects** worth **₹6.5 lakh crore** are under implementation (**MoPSW Annual Report 2025**).
5. **Promoting digital trade and services:** Finalise **digital trade agreements** and enable robust cross-border data flows.
  - **Eg: India-EU Digital Partnership 2025 Roadmap** signed in **May 2025**.

6. **Reorienting FTAs towards tech access**: Align future FTAs with objectives of **technology transfer, market access and value chain integration**.
  - **Eg: India-EU FTA negotiations** actively addressing **IPR and data governance** (MEA Brief, June 2025).
7. **Advancing trade diplomacy in multilateral forums**: Lead **WTO reform efforts** and enhance Global South cooperation for inclusive trade norms.
  - **Eg: India chaired G20 Trade Ministers' meeting** on WTO reforms (**G20 Delhi 2023**).

## Conclusion

To thrive amid a fragmented global order, India must craft a **future-ready trade strategy** anchored in **technology, resilience, and diversified partnerships**, ensuring sustainable growth in the coming decade.

**Q. Why has economic growth failed to eliminate poverty in India? How has the pattern of growth deepened exclusion, and what shifts are needed to align development with social equity? (15 M)**

## Introduction

Despite consistent GDP expansion, India's growth trajectory has failed to translate into inclusive human development, as it neither created sufficient jobs nor ensured distributive justice.

## Body

### Why growth has failed to eliminate poverty

1. **Jobless growth and informalisation**: GDP rise has not led to proportional employment generation, especially in formal sectors.
  - **Eg: As per CMIE**, youth unemployment stayed around **22%** over the past decade despite robust growth.
2. **Disproportionate wealth accumulation**: Economic benefits have accrued mainly to the elite rather than the poor.
  - **Eg: Oxfam 2023 Report**: top **1% own over 40%** of wealth, while the bottom 50% hold only 3%.
3. **Neglect of the agrarian economy**: Growth has been led by services and capital-intensive sectors, bypassing agriculture.
  - **Eg: NABARD All-India Rural Survey 2022** showed real rural wages remained stagnant despite flagship rural schemes.
4. **Poverty redefined beyond income**: A narrow focus on monetary poverty has ignored multidimensional deprivation.
  - **Eg: UNDP 2024 MPI** counted **234 million** Indians as multidimensionally poor, despite fall in income-poverty rates.
5. **Exclusion of marginalised groups**: Growth has not sufficiently uplifted Scheduled Castes, Tribes, or minorities.
  - **Eg: NFHS-5 (2019–21)** found **stunting** among ST children at over **40%**, above the national average.

### Growth pattern has deepened exclusion

1. **Urban-centric infrastructure investment**: Public spending has been skewed toward urban corridors and megacities.
  - **Eg: NITI SDG Index 2023** reported worst scores in tribal districts like **Malkangiri (Odisha)** and **Dahod (Gujarat)**.
2. **Digital and financial divide**: Technological growth has outpaced grassroots readiness.
  - **Eg: RBI Financial Inclusion Index 2023** revealed poor access to digital banking in **rural eastern India**.
3. **Gender disparities in workforce participation**: Women remain excluded from fast-growing sectors.
  - **Eg: PLFS 2025** shows **female LFPR** at just **25.7%**, limiting their stake in growth.
4. **Skewed access to skilling and education**: Quality education remains limited to privileged sections.
  - **Eg: ASER 2023** reported only **43%** of rural Class 5 students can read a Class 2-level text.
5. **Regressive fiscal priorities**: Policy has favoured corporate incentives over social sector investment.
  - **Eg: Economic Survey 2022–23** showed declining **corporate tax–GDP ratio** alongside rising subsidies for industry.

### **What shifts are needed to align development with social equity**

1. **Prioritising employment-led growth**: Shift from capital-intensive to labour-intensive sectors like MSMEs, textiles, and agro-processing.
  - **Eg: Arvind Panagariya Committee (2020)** advised scaling labour-intensive exports to boost inclusive job growth.
2. **Integrated and lifecycle-based welfare**: Consolidate fragmented schemes into universal, targeted social protection.
  - **Eg: NITI Aayog’s Draft Social Protection Framework 2021** recommends a **Universal Social Registry** for efficient delivery.
3. **Progressive fiscal reforms**: Strengthen redistribution through direct taxation and rationalised subsidies.
  - **Eg: Rangarajan Committee** proposed higher investments in **nutrition, schooling, and health infrastructure**.
4. **Decentralised, regionalised planning**: Adopt bottom-up approaches under the Aspirational Districts model.
  - **Eg: Nandurbar (Maharashtra)** improved maternal health via **real-time monitoring and convergence planning**.
5. **Empowered grassroots governance**: Strengthen **Panchayats** and **Urban Local Bodies** under **Article 243G** for equitable service delivery.
  - **Eg: Kerala’s People’s Plan Campaign** enabled participatory planning and better welfare outreach.

### **Conclusion**

India’s challenge is not just to grow, but to grow **justly and inclusively**. A shift towards **capability-centred, employment-intensive, and regionally balanced development** is vital for meaningful poverty eradication.

## Inclusive growth and issues arising from it.

**Q. Discuss how gold-backed lending reflects financial inclusion trends in India. Examine the regulatory risks posed by its rapid expansion. (10 M)**

### Introduction

Gold-backed loans have emerged as a key credit tool for low-income households, bridging the gap between informal wealth and formal finance. However, their surge also exposes critical regulatory blind spots.

### Body

#### Gold-backed lending and financial inclusion trends

1. **Accessibility for asset-poor but gold-owning households**: Gold serves as easily collateralised wealth, enabling credit access without formal income proof.
  - **Eg: NBFCs like Muthoot and Manappuram** have expanded credit to **rural and semi-urban borrowers** without formal banking history.
2. **Fills credit gap in low-banking penetration areas**: Enables liquidity in regions underserved by traditional credit institutions.
  - **Eg: In Tamil Nadu and Kerala**, over **60% of rural gold loans** are from NBFCs due to weak commercial bank outreach (Economic Survey, 2022–23).
3. **Emergency financial support during shocks**: Used to meet sudden expenses like healthcare or education in absence of insurance or savings.
  - **Eg: During COVID-19**, gold loan disbursements rose **by 77% in FY21** among the bottom two income quintiles (NABARD All India Financial Inclusion Survey, 2021).
4. **Minimal documentation enables informal sector inclusion**: Low compliance burden helps include gig workers, farmers, and women.
  - **Eg: Over 30% of gold loan accounts in 2024** belonged to **first-time formal borrowers**.
5. **Acts as a bridge between informal savings and formal credit**: Converts idle gold holdings into working capital or consumption loans.
  - **Eg: Estimated 25,000 tonnes of household gold** remains underutilised, yet is now being monetised through **regulated lending** (World Gold Council, 2023).

#### Regulatory risks of rapid gold loan expansion

1. **Rising NPAs and auction stress**: Defaults trigger auctions, creating both credit losses and borrower distress.
  - **Eg: As of Dec 2024**, gold loan NPAs of commercial banks **crossed ₹2,040 crore**, up from ₹1,404 crore in 2023.
2. **LTV manipulation and over-leveraging**: High Loan-to-Value ratios can inflate credit risk during gold price volatility.
  - **Eg: RBI capped LTV at 75% in April 2025** to contain overexposure amid record gold prices of **₹95,760 per 10 gm**.
3. **Lack of standardised valuation mechanisms**: Assaying and price benchmarking inconsistencies lead to disputes and fraud.
  - **Eg: RBI's 2025 draft guidelines** mandate valuation based on **22-carat standard prices and certified assayers**.

4. **Unregulated re-pledging and dual-loan risks:** Multiple loans on same gold assets increase systemic vulnerability.
  - **Eg:** New norms ban loans against **re-pledged collateral** unless full repayment of prior loan is done .
5. **Possibility of financial exclusion under rigid norms:** Over-regulation may limit access for those lacking documentation.
  - **Eg: Tamil Nadu CM's letter** urged exemption for loans **below ₹2 lakh**, citing hardship for small borrowers.

### Conclusion

Gold-backed credit must remain a lever of financial inclusion, not a liability trap. A balance of **prudent regulation** and **socially aware implementation** is essential to ensure credit justice in India's evolving financial architecture.

**Q. While educational attainment for Indian women nears parity, labour force participation remains stagnant. Examine the reasons behind this paradox. Discuss its implications for inclusive growth. (10 M)**

### Introduction

The **WEF Global Gender Gap Report 2025** shows India achieving **97.1% parity in educational attainment** but only **40.7% in economic participation**, exposing a stark education-employment disconnect.

### Body

#### Reasons behind the paradox

1. **Patriarchal social norms and unpaid care burden:** Women continue to shoulder disproportionate domestic responsibilities limiting formal workforce entry.
  - **Eg: ILO 2024 report** states Indian women spend **312 minutes/day** on unpaid care work vs. **29 minutes/day** for men.
2. **Safety and mobility concerns:** Inadequate public transport, workplace harassment, and safety risks deter women's workforce participation.
  - **Eg: NCRB 2023 data** reports over **4 lakh cases of crimes against women**, creating an unsafe work environment.
3. **Structural bias in labour markets:** Gender stereotypes restrict women to informal, low-paid sectors with limited formal job opportunities.
  - **Eg: Periodic Labour Force Survey (PLFS) 2023-24** shows over **70% female workforce engaged in informal sector**.
4. **Skills-employment mismatch:** Education does not always equip women with industry-relevant or employable skills.
  - **Eg: India Skills Report 2024** finds only **47% women graduates employable** vis-à-vis industry needs.
5. **Marriage and motherhood penalties:** Career interruptions post-marriage or childbirth lead to permanent workforce exits.
  - **Eg: CMIE 2024** highlights significant female workforce drop after marriage and childbirth.

## Implications for inclusive growth

1. **Reduced demographic dividend utilisation:** Skilled female workforce remains underutilised, reducing productivity potential.
  - **Eg: World Bank 2024** estimates India could add **\$700 billion to GDP** by 2030 by closing gender employment gaps.
2. **Widening income inequality:** Persistent gender wage gaps exacerbate wealth concentration and limit poverty reduction.
  - **Eg: Oxfam India Inequality Report 2024** states women earn **63% of men's income** for similar work.
3. **Low female financial inclusion:** Lack of employment restricts women's access to credit, savings, and entrepreneurship.
  - **Eg: Global Findex 2023** reports only **54% Indian women have active bank accounts vs. 77% men.**
4. **Negative impact on innovation and competitiveness:** Gender-diverse workplaces foster innovation and better problem-solving, absence of which weakens global competitiveness.
  - **Eg: McKinsey 2023 report** highlights companies with greater gender diversity are **25% more likely** to outperform financially.
5. **Social consequences and intergenerational effects:** Women's disempowerment impacts children's health, education, and future economic outcomes.
  - **Eg: UNICEF 2024** links maternal employment with better child nutrition and school enrolment.

## Conclusion

Unlocking women's economic potential is not just a gender issue but a national economic imperative.

**Targeted skilling, safety reforms, and care economy investment** hold the key to achieving true inclusive growth.

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### **Implications for inclusive growth**

2. **Reduced demographic dividend utilisation**: Skilled female workforce remains underutilised, reducing productivity potential.
  - **Eg: World Bank 2024** estimates India could add **\$700 billion to GDP** by 2030 by closing gender employment gaps.
3. **Widening income inequality**: Persistent gender wage gaps exacerbate wealth concentration and limit poverty reduction.
  - **Eg: Oxfam India Inequality Report 2024** states women earn **63% of men's income** for similar work.
4. **Low female financial inclusion**: Lack of employment restricts women's access to credit, savings, and entrepreneurship.
  - **Eg: Global Findex 2023** reports only **54% Indian women have active bank accounts vs. 77% men**.
5. **Negative impact on innovation and competitiveness**: Gender-diverse workplaces foster innovation and better problem-solving, absence of which weakens global competitiveness.
  - **Eg: McKinsey 2023 report** highlights companies with greater gender diversity are **25% more likely** to outperform financially.
6. **Social consequences and intergenerational effects**: Women's disempowerment impacts children's health, education, and future economic outcomes.
  - **Eg: UNICEF 2024** links maternal employment with better child nutrition and school enrolment.

### **Conclusion**

Unlocking women's economic potential is not just a gender issue but a national economic imperative.

**Targeted skilling, safety reforms, and care economy investment** hold the key to achieving true inclusive growth.

## Q. Why has economic formalisation in India remained uneven despite major digital and regulatory interventions? What measures are needed to make formalisation more inclusive and sustainable? (10 M)

### Introduction

Despite major policy and digital reforms, India's informal sector continues to dominate due to structural dependence, weak incentives, and institutional mistrust.

### Body

#### Reasons for uneven formalisation

1. **Structural dependence on informality:** A vast majority of India's workforce is engaged in informal, low-productivity activities.
  - Eg: PLFS 2022-23 data shows over **90% of workers** remain in the informal economy, lacking job security or social benefits (MoSPI).
2. **High cost of compliance:** Complex tax procedures and documentation disincentivise small businesses from formal entry.
  - Eg: As per MSME Ministry (June 2024), only **3.5 crore MSMEs** are registered out of an estimated **6.3 crore**.
3. **Lack of tangible benefits post-registration:** Formalisation doesn't guarantee access to credit, insurance, or procurement.
  - Eg: RBI's 2024 MSME Credit Report revealed only **14% of newly registered MSMEs** accessed institutional credit within a year.
4. **Digital divide and literacy barriers:** Poor digital literacy and access hinder uptake of digital platforms for formalisation.
  - Eg: NCAER's 2023 Digital Inclusion Index shows **rural female internet use below 20%**, especially in northern states.
5. **Fear of punitive enforcement:** Formal entities fear exposure to tax scrutiny and harassment by enforcement agencies.
  - Eg: Informal trader protests in 2023 opposed mandatory GST e-invoicing due to **perceived risk of surveillance**.

#### Measures for inclusive and sustainable formalisation

1. **Link formalisation to concrete benefits:** Tie registration to targeted credit, insurance, skill-building, and welfare schemes.
  - Eg: The PM SVANidhi scheme offers **collateral-free loans** to registered street vendors via the **UDAAN platform** (MoHUA, 2024).
2. **Simplify compliance architecture:** Create single-window systems, allow self-certification, and ease return filing norms.
  - Eg: The E-Shram portal enables **one-time Aadhaar-linked registration**, reducing duplication and entry barriers for unorganised workers.
3. **Invest in digital and financial literacy:** Focused training for digitally excluded groups like rural women and migrant workers.

- Eg: PMGDISHA trained over **6 crore rural citizens** as of 2024 to enable access to formal schemes and services (MeitY).
4. **Empower grassroots intermediaries**: Use SHGs, Panchayats, and cooperatives as on-ground formalisation agents.
    - Eg: The Kudumbashree model in Kerala formalised over **2.5 lakh microenterprises** by linking SHGs to banks and markets.
  5. **Operationalise labour code reforms**: Ensure uniform, state-level rollout of labour and social security codes for informal workers.
    - Eg: The Code on Social Security, 2020 aims for **universal worker coverage**, but implementation remains uneven across states (Labour Ministry, 2025).

### Conclusion

Inclusive formalisation demands a shift from coercive enforcement to trust-based incentives. Empowering citizens and simplifying systems is key to unlocking India's full economic potential.

## Government Budgeting.

**Major crops-cropping patterns in various parts of the country, - different types of irrigation and irrigation systems storage, transport and marketing of agricultural produce and issues and related constraints; e-technology in the aid of farmers.**

**Q. Pollination is both a biological service and an economic input. Explain how pollinator decline challenges sustainable agriculture. Analyse the potential and risks of scaling up managed pollination services. Suggest ways to incentivise farmers to adopt pollinator-supportive practices. (15 M)**

### Introduction

Pollinators bridge ecology and economy—without them, agriculture becomes costlier, climate-vulnerable, and nutritionally inadequate.

### Body

#### **Pollinator decline and its impact on sustainable agriculture**

1. **Decline in crop yield and quality**: Pollination failure reduces fertilisation rates, directly impacting fruit set and grain quality.
  - **Eg: In Himachal Pradesh**, apple growers now rent over **4 lakh bee boxes** annually due to wild pollinator scarcity.
2. **Escalation in production costs**: Farmers turn to artificial or hired pollination, increasing input costs.
  - **Eg: In Kashmir**, saffron growers resort to **manual pollination**, raising labour costs (SKUAST, 2024).
3. **Agro-biodiversity erosion**: Pollinator absence discourages diverse crop cultivation, fostering monocultures.
  - **Eg: A 2023 UoKolkata study** found that pollinator decline led to **crop homogenisation** across Punjab farms.

4. **Disruption of ecosystem services**: Pollinators support natural pest control, seed dispersal, and soil resilience.
  - **Eg: FAO (2021)** linked pollinator loss with **increased pest loads** in pesticide-intensive areas.
5. **Threat to nutritional security**: Decline in fruits, nuts, and vegetables affects essential micronutrient access.
  - **Eg: Pollinator-dependent crops provide over 30% of global human nutrition** (FAO, 2021).

### **Potential and risks of scaling up managed pollination services**

1. **Boost to crop productivity**: Targeted hive placement increases pollination efficiency in high-value crops.
  - **Eg: NBHM (2023)** reported **up to 24% yield gains** in mustard, apple, and sunflower via managed pollination.
2. **Rural livelihood generation**: Beekeeping creates employment and entrepreneurial pathways.
  - **Eg: KVK Solan’s training** enabled over **300 rural youth** to operate pollination logistics businesses (2024).
3. **Disease transmission to native bees**: Commercial bees may spread pathogens, harming native pollinator diversity.
  - **Eg: ICAR-NBAIR (2023)** detected **Nosema ceranae infections** in wild bees near commercial hives in Tamil Nadu.
4. **Monoculture stress and hive collapse**: Focused deployment in monocultures heightens ecological and bee stress.
  - **Eg: US almond farms** reported **50% hive failure** in 2022 due to large-scale monoculture-induced stress.
5. **Exclusion of marginal farmers**: Hive rental costs make access unequal and unsustainable for smallholders.
  - **Eg: Bee box prices in Janjehli** rose by **40%** from 2020 to 2024, hurting poor farmers .

### **Ways to incentivise pollinator-supportive practices**

1. **Agroecological subsidy reforms**: Support for intercropping, flowering strips, and habitat buffers to attract pollinators.
  - **Eg: Sikkim’s organic farming policy (2023)** provides subsidies for **bee-friendly crop diversification**.
2. **Pollinator-based certification and premiums**: “Bee-safe” labelling can attract better markets and prices.
  - **Eg: The European Bee-Friendly Label** model can be localised via **APEDA certification** in India.
3. **Payments for ecosystem services (PES)**: Compensate farmers for conserving native pollinator habitats.
  - **Eg: Madhya Pradesh’s Deori model** pays tribal farmers for **preserving wild bee zones** .
4. **Community apiary support programmes**: Subsidised hives managed by panchayats and SHGs promote shared benefits.
  - **Eg: Kerala’s Kudumbashree Mission** launched **200+ women-run apiaries** between 2022–2024.
5. **Pollination-linked crop insurance**: Include pollinator failure parameters in schemes like PMFBY.

- **Eg: NITI Aayog (2024)** proposed ecosystem-service indicators in **climate-resilient agricultural insurance**.

### Conclusion

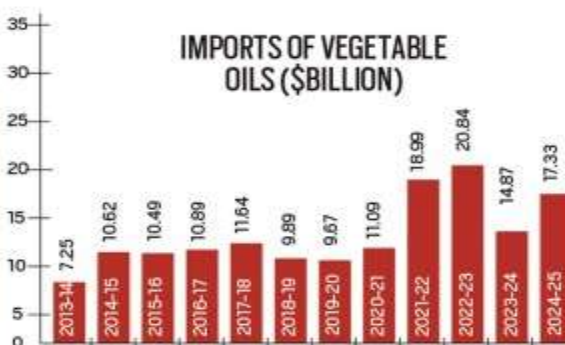
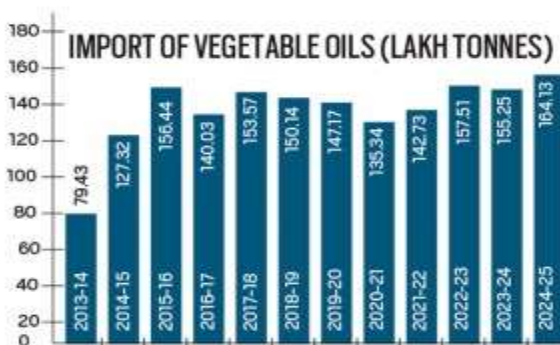
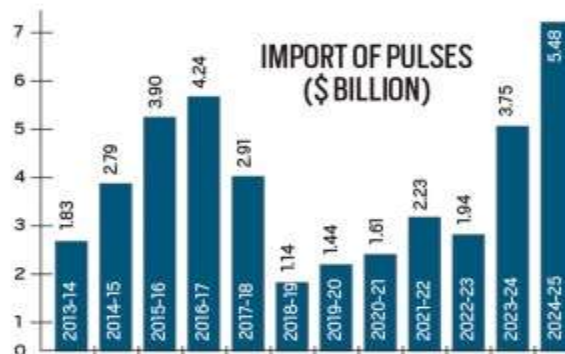
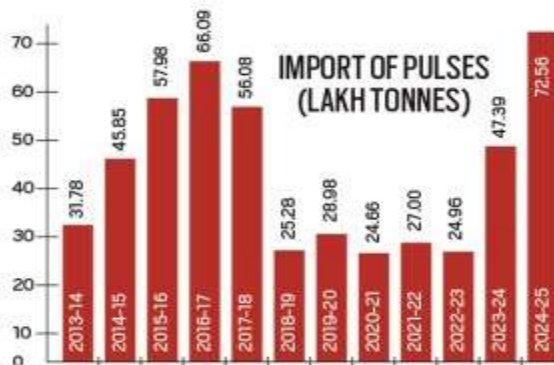
India’s pollination crisis is both an ecological warning and a policy opportunity. By **investing in pollinator health**, we can secure agricultural resilience, rural incomes, and food system sustainability for the future.

**Q. “India’s rising import bill in pulses and edible oils reflects a deeper crisis in crop diversification and farm income sustainability”. Evaluate the underlying structural factors contributing to this crisis. Discuss the major policy deficiencies that have aggravated the situation. Suggest sustainable solutions. (15 M)**

### Introduction

India’s surging import bill in pulses and edible oils exposes deep-rooted challenges in farm diversification, input-output price asymmetry, and long-term income security for millions of non-cereal farmers.

### Body



### Underlying structural factors contributing to the crisis

1. **Green Revolution crop bias**: Historical focus on rice-wheat due to irrigation suitability and procurement assurance marginalized pulses and oilseeds.
  - **Eg: Punjab and Haryana produce over 60% of public procured wheat and rice** while pulses remain largely outside MSP procurement
2. **Rainfed cultivation dependence**: Pulses and oilseeds are primarily grown in semi-arid, rainfed areas with low yield stability.
  - **Eg: Over 70% of India's pulses area lies in rainfed regions of Madhya Pradesh, Maharashtra, and Rajasthan**
3. **Price volatility and weak market support**: Absence of assured procurement exposes farmers to severe price fluctuations.
  - **Eg: Moong prices in MP's Narsinghpur mandi fell to Rs 6000 per quintal against MSP of Rs 8682 in 2025.**
4. **Limited technological breakthrough**: Slower seed research and limited productivity growth compared to cereals.
  - **Eg: Average pulses yield stagnates around 800-900 kg/ha vs rice-wheat yields of 2500-3000 kg/ha IIPR 2024).**
5. **Import dependency driven by global competitiveness**: Cheaper imports undercut domestic production due to lower global prices and higher domestic costs.
  - **Eg: India imported 7.3 MT pulses and 16.4 MT edible oils in 2024-25** (Ministry of Commerce, 2025).

#### Major policy deficiencies aggravating the situation

1. **Skewed MSP procurement architecture**: MSP benefits concentrated on rice and wheat with negligible procurement of pulses and oilseeds.
  - **Eg: Wheat and rice procurement crosses 80 MT annually while pulses procurement barely crosses 1-2 MT** (CACP, 2025).
2. **Ineffective price deficiency payment schemes**: Poor implementation of schemes like PM-AASHA failed to compensate farmers adequately.
  - **Eg: PM-AASHA covered only 0.2% of oilseed area in 2022-23**(NITI Aayog, 2023 review).
3. **Delayed investment in R&D and seed technology**: Insufficient breeder seed development, poor seed replacement rate, and weak extension services.
  - **Eg: Seed replacement rate for pulses remains under 33% against desired 50%** (ICAR-IIPR, 2024).
4. **Import duty fluctuations**: Ad-hoc tariff changes distort domestic price signals and farmer planting decisions.
  - **Eg: 2025 duty cuts reduced crude edible oil import duty from 20% to 10%, hitting oilseed farmers** (USDA Report, June 2025).
5. **Weak institutional support**: Absence of dedicated institutional mechanism to stabilize non-cereal crop production and marketing.
  - **Eg: Soyabean Processors Association of India warned of reduced oilseed planting due to duty cuts.**

#### Sustainable solutions

1. **Expanding assured procurement beyond cereals:** Institutionalize decentralized procurement for pulses and oilseeds via FPOs and state agencies.
  - **Eg: Rajasthan's pilot procurement model for mustard by state cooperatives improved farmer returns** (NABARD Report, 2024).
2. **Long-term MSP stabilization:** Announce multi-year MSPs for pulses and oilseeds to reduce policy unpredictability.
  - **Eg: MS Swaminathan Commission recommended MSP at 50% above C2 costs to ensure remunerative pricing** (National Commission on Farmers Report, 2006).
3. **Boosting R&D and seed innovation:** Strengthen varietal development, drought tolerance breeding, and public-private partnerships in research.
  - **Eg: Pusa Manav variety in chana and PDM 139 in moong improved yields in central India** (ICAR-IARI, 2024).
4. **Promoting oil palm and integrated oilseed missions:** Expand targeted oil palm cultivation and integrated oilseed clusters with irrigation support.
  - **Eg: National Edible Oil Mission–Oil Palm (NEOM-OP) targets 1 million ha expansion by 2025-26** (Agriculture Ministry, 2024).
5. **Trade policy stabilization: Frame predictable,** long-term import duty structure protecting domestic producers during global price swings.
  - **Eg: Indonesia's palm oil export levy model balances farmer income and trade competitiveness** (FAO 2023).

## Conclusion

Unless India rebalances its policy focus towards pulses and oilseeds with stable pricing, strong institutions, and resilient technologies, the import bill will continue to rise, undermining both farmer welfare and food sovereignty.

## Q5. Analyse how India's ethanol blending programme is altering cropping patterns. Examine the consequences for small and marginal farmers. (10 M)

### Introduction

India's ambitious **Ethanol Blending Programme (EBP)**, targeting **20% blending by 2025-26 (MoPNG, 2023)**, is reshaping cropping patterns, with significant implications for small and marginal farmers.

### Body

#### How ethanol blending programme is altering cropping patterns

1. **Shift towards ethanol-friendly crops:** Farmers are shifting from food grains to ethanol-feed crops like maize, sugarcane, and broken rice.
  - **Eg: Maize area increased in Uttar Pradesh, Madhya Pradesh, and Karnataka post-2022** (Ministry of Agriculture, 2024).
2. **Reduction in food crop diversity:** Mono-cropping tendencies are rising due to price incentives for ethanol crops.
  - **Eg: National Bio-Energy Mission (2023) incentivized maize over pulses and oilseeds.**

3. **Regional imbalance in crop choices:** States with better ethanol distillery infrastructure are witnessing concentrated crop shifts.
  - Eg: **Maharashtra and Uttar Pradesh account for over 50% of maize-based ethanol production.**
4. **Water stress aggravation:** Crops like sugarcane and maize demand high water, straining groundwater resources.
  - Eg: **CGWB report (2023) highlights declining water tables in Western Uttar Pradesh.**
5. **Market-driven cropping decisions:** Private distilleries provide forward contracts, influencing farmers' sowing choices.
  - Eg: **Distillery-linked maize contracts expanded in Bihar and Madhya Pradesh post 2023 (NITI Aayog, 2024).**

### Consequences for small and marginal farmers

1. **Income volatility:** Price fluctuations in ethanol feedstock markets expose small farmers to income risks.
  - Eg: **Maize mandi prices fluctuated by 30-40% during 2023-24 (Agmarknet data).**
2. **Increased input costs:** High fertilizer, water, and pesticide use for ethanol crops raise production costs.
  - Eg: **FAO (2024) reports rising nitrogen fertilizer prices impacting small maize farmers in India.**
3. **Credit dependency:** Contract farming models often push small farmers into credit linkages with private distilleries.
  - Eg: **SEWA report highlights debt traps among small maize growers in Bihar.**
4. **Land use conflicts:** Limited land forces smallholders to abandon subsistence or food crops for commercial ethanol crops.
  - Eg: **Pulse and oilseed acreage declined in Maharashtra's ethanol cluster zones post 2022 (ICAR).**
5. **Vulnerability to climatic shocks:** Monoculture maize is highly sensitive to rainfall variability and pest attacks.
  - Eg: **FAO (2024) warned about maize crop failures in Karnataka due to erratic monsoon.**

### Conclusion

The ethanol-driven crop transition offers opportunities but threatens the livelihood security of small farmers if unregulated. A **balanced feedstock strategy with regional crop planning and price stabilization** is vital for inclusive energy and agricultural sustainability.

**Q. Analyse how India's ethanol blending programme is altering cropping patterns. Examine the consequences for small and marginal farmers. (10 M)**

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## **Conclusion**

The ethanol-driven crop transition offers opportunities but threatens the livelihood security of small farmers if unregulated. A **balanced feedstock strategy with regional crop planning and price stabilization** is vital for inclusive energy and agricultural sustainability.

**Q. Examine the role of adaptive farming measures in mitigating the impact of climate change on staple crop yields. What are the limitations of such approaches, and how can India's agricultural policy evolve? (15 M)**

### **Introduction**

Global warming is projected to reduce **per capita calorie availability by 4% by 2100** (Nature, 2025). Adaptive farming is crucial but not sufficient to protect India's food security under escalating climate stress.

### **Body**

#### **Role of adaptive farming in mitigating climate change impacts**

1. **Deployment of heat-resistant crop varieties**: Development and promotion of varieties tolerant to temperature and drought stress stabilises yields.
  - **Eg: ICAR's wheat varieties HD-3226 and HD-2733** perform better under late rabi heat stress (ICAR, 2023).
2. **Modification of sowing calendars**: Shifting sowing dates helps crops escape critical growth stages coinciding with extreme weather.
  - **Eg: Punjab Agricultural University** advises preponing wheat sowing to October to mitigate terminal heat (PAU Advisory 2024).
3. **Water-efficient irrigation technologies**: Adoption of drip, sprinkler, and micro-irrigation optimises water use in variable rainfall scenarios.
  - **Eg: PM Krishi Sinchai Yojana** expanded micro-irrigation to **18 lakh hectares** (Ministry of Agriculture, 2024).
4. **Agroforestry and crop diversification**: Integrating trees and diverse crops enhances microclimates and soil resilience.
  - **Eg: National Agroforestry Policy** has enabled agroforestry on **2.3 million hectares** (MoEFCC, 2024).
5. **Use of ICT-based weather advisories**: Real-time advisories help farmers adjust operations to weather forecasts.
  - **Eg: IMD's Meghdoot app** delivers actionable advisories to **3 crore farmers** (IMD, 2024).

#### **Limitations of adaptive farming approaches**

1. **Persistent residual yield losses**: Even optimal adaptation cannot fully offset climate-induced yield decline.
  - **Eg: Nature (2025) study** estimates **23% global yield loss** by 2050 despite adaptation, with **30%-40% wheat losses** in North India.
2. **Socio-economic barriers for smallholders**: Limited access to credit and technology constrains adoption among small farmers.
  - **Eg: Dalwai Committee (2018)** flagged that smallholders access only **10% of institutional credit** for climate-resilient equipment.
3. **Policy and extension gaps**: Weak delivery of adaptive knowledge reduces adoption at farm level.
  - **Eg: CAG Report (2022)** noted only **36% of PMFBY small farmers** received full advisory support.

4. **Slow varietal replacement rates**: Poor dissemination delays uptake of climate-resilient crop varieties.
  - **Eg: ICAR (2023)** reports varietal replacement rate below **15%** in major wheat and paddy belts.
5. **Insufficient adaptive R&D investment**: Budgetary allocations for stress-tolerant breeding remain inadequate.
  - **Eg: DARE (2024)** noted only **4.8%** of agri-R&D budget directed to abiotic stress research.

### **How India's agricultural policy should evolve**

1. **Integrate resilience in national missions**: Embed climate adaptation across NMSA and allied missions.
  - **Eg: Draft 2025 NMSA update** targets **climate-proofing 50%** of cropped area by 2030.
2. **Increase R&D investment**: Prioritise breeding of climate-resilient varieties and agronomic innovation.
  - **Eg: NITI Aayog (2023)** recommends increasing agri-R&D to **1% of Agri GDP**.
3. **Strengthen extension systems**: Equip KVKs with digital platforms and capacity for climate-smart agriculture.
  - **Eg: Krishi Megh platform** connects **731 KVKs** with AI-based tools (ICAR 2024).
4. **Promote large-scale agroecological practices**: Expand support for natural farming and regenerative agriculture.
  - **Eg: Andhra Pradesh's ZBNF** covers over **1 million farmers** (FAO 2023).
5. **Enhance risk financing**: Broaden insurance, credit, and green finance tools for climate adaptation.
  - **Eg: RBI's 2024 Green Finance Framework** enables concessional credit for resilient agriculture.

### **Conclusion**

India must move towards **system-wide resilience** by combining adaptive farming with innovation, equity, and institutional reforms to secure food production in a changing climate.

Issues related to direct and indirect farm subsidies and minimum support prices; Public Distribution System-objectives, functioning, limitations, revamping; issues of buffer stocks and food security; Technology missions; economics of animal-rearing.

Food processing and related industries in India- scope' and significance, location, upstream and downstream requirements, supply chain management.

Land reforms in India.

Effects of liberalization on the economy, changes in industrial policy and their effects on industrial growth.

Q. How does India's new EV manufacturing scheme attempt to balance foreign investment with domestic industrialisation? Analyse the key localisation challenges in India's EV ecosystem. Suggest a comprehensive strategy to strengthen India's self-reliance in electric mobility. (15 M)

### Introduction

India's EV strategy is at a critical inflection point—aiming to attract global capital while building local capability in a rapidly transforming mobility sector.

### Body

#### Balancing foreign investment with domestic industrialisation

1. **Duty rationalisation for strategic entry**: The 2025 EV scheme reduces import duty to 15% for specified models to attract global players.
  - **Eg**: Under the scheme, EVs priced up to **\$35,000 (₹29.75 lakh)** can be imported at **15% duty** if the firm invests **₹4,150 crore** in India within 3 years (Ministry of Heavy Industries, 2025).
2. **Conditional incentives linked to DVA**: Firms must achieve **25% domestic value addition (DVA)** within 3 years and **50% within 5 years**.
  - **Eg**: The scheme caps total duty foregone at **₹6,484 crore**, ensuring incentives are tied to localisation goals (MHI Guidelines, 2025).
3. **Fixed import ceilings to avoid market flooding**: Annual cap of **8,000 units** ensures imports complement but don't dominate domestic supply.
  - **Eg**: Tesla's entry debate highlighted concern that large imports may undermine Indian EV makers.

#### Localisation challenges in India's EV ecosystem

1. **Low indigenisation in core components**: Batteries, semiconductors, and controllers are heavily import dependent.

- **Eg:** As per **S&P Global Mobility (2025)**, India still imports **70% of EV components**, limiting value capture.
- 2. **Weak R&D and technology access:** No binding clause mandates foreign firms to share IP or R&D with Indian entities.
  - **Eg:** Experts like **Prof. Shouvik Chakraborty (UMass, 2025)** warn India risks becoming a **mere assembly hub** without tech transfer.
- 3. **Skilling and innovation deficit:** Labour and engineers trained in ICE systems need EV-specific reskilling.
  - **Eg:** **Dinesh Abrol (JNU)** highlights lack of public sector investment in **skilling and innovation infrastructure**, unlike **China or South Korea**.
- 4. **Policy inconsistency and domestic pushback:** Sudden duty relaxations may affect investor confidence of local players.
  - **Eg:** **Tata Motors (2023)** opposed Tesla's import duty cut, citing disruption to **stable policy expectations**.
- 5. **Neglect of mass EV segments:** Policy tilt towards four-wheelers ignores two- and three-wheelers driving real EV adoption.
  - **Eg:** **FADA data (2025)** shows **57% of EV sales** came from **three-wheelers**, yet policy focus remains on premium cars.

### **Strategy to strengthen self-reliance in electric mobility**

1. **Mandate phased tech transfer models:** Integrate clauses for **joint ventures, R&D co-development**, and open innovation platforms.
  - **Eg:** China's early EV policies required **foreign firms to partner with local entities** for IP sharing (IEA Report, 2024).
2. **Develop battery and critical mineral ecosystem:** Expand schemes like **PLI-ACC**, promote local cell production, and ensure **supply chain security**.
  - **Eg:** Under **PLI-ACC (2023)**, **₹18,100 crore** was allocated to support domestic battery manufacturing (NITI Aayog).
3. **Strengthen MSME integration and value chains:** Offer capital, testing, and market access support for EV-focused MSMEs.
  - **Eg:** Tamil Nadu's **EV Policy (2023)** provides **subsidies and land** to MSMEs in **EV supply chain clusters**.
4. **Invest in skill and research infrastructure:** Launch **EV Centres of Excellence** and **curriculum revamps** in ITIs and engineering colleges.
  - **Eg:** **Delhi Skill University** partnered with **Hero Electric (2023)** to offer **EV technician training modules**.
5. **Focus on mass mobility and inclusive innovation:** Prioritise electric buses, shared mobility, and affordable e-two/three-wheelers.
  - **Eg:** India was the **world's largest e-three wheeler market in 2024** with 20% YoY growth (IEA Global EV Outlook, 2025).

### **Conclusion**

India's EV roadmap must not just import technology but embed capacity. A strategic blend of localisation mandates, skilling, and inclusive innovation will anchor India's leadership in electric mobility for the future.

## Q. Analyse the economic and labour market implications of clean energy adoption in rural households. (10 M)

### Introduction

Clean energy adoption in rural areas redefines household economics by saving time, improving health, and expanding women's labour force participation, contributing to inclusive development.

### Body

#### Economic implications of clean energy adoption

1. **Reduction in healthcare expenditure:** Lower indoor air pollution reduces out-of-pocket health expenses.
  - Eg: WHO (2023) estimated **3.2 million global deaths** due to indoor air pollution; in India, around **5 lakh deaths annually (WHO 2020)**.
2. **Savings on fuel collection costs:** Eliminates costs associated with firewood collection or purchase.
  - Eg: NITI Aayog (2023) observed that **PMUY households saved up to ₹1200 annually** on biomass fuel purchase.
3. **Boost to rural entrepreneurship:** Creation of local LPG distributorships and maintenance services generates rural non-farm employment.
  - Eg: Over **12,000 new LPG distributorships created under PMUY Phase II (Ministry of Petroleum & Natural Gas, 2025)**.
4. **Increased disposable income:** Time and cost savings allow higher allocation towards education, nutrition, and assets.
  - Eg: Oxfam India (2019) found women spent **1 hour more on paid work** after adopting LPG.
5. **Macroeconomic contribution:** Supports national energy security by reducing dependency on biomass, with secondary benefits for climate commitments.
  - Eg: India's **Energy Transition Roadmap (IEA, 2022)** links clean cooking with achieving **net-zero by 2070**.

#### Labour market implications of clean energy adoption

1. **Expansion of female workforce participation:** Reduced unpaid work enables women to engage in income-generating activities.
  - Eg: **Time Use Survey 2024 (MoSPI)** reported unpaid domestic work reduced from **315 mins (2019) to 305 mins (2024)**.
2. **Improvement in worker productivity:** Better health due to reduced smoke exposure enhances physical capacity for work.
  - Eg: **Indonesia study (2023, J-PAL)** found **11.22 L/min increase in women's lung capacity** after switching to LPG.
3. **Support for care economy reforms:** Frees women for formal sector jobs while enabling better caregiving balance.
  - Eg: **ILO (2023)** recommends integrating energy policies with **care economy expansion** for gender-balanced growth.

4. **Creation of energy sector jobs**: LPG logistics, distribution, and maintenance create rural semi-skilled employment.
  - Eg: **Skill India Mission (2024)** integrated **LPG mechanics training** into rural skilling programs.
5. **Indirect employment through supply chains**: Manufacturing of cylinders, stoves, and accessories boosts industrial employment.
  - Eg: **PMUY Phase II (2025)** linked to **growth in domestic LPG cylinder manufacturing units**.

### Conclusion

Clean energy adoption not only improves rural living standards but also unlocks latent economic potential, particularly for women, driving India towards inclusive growth and sustainable development.

**Q. India's integration with global value chains remains weak in mid-tech manufacturing. Examine structural causes. Assess the opportunities emerging from supply chain shifts post-pandemic. Recommend a comprehensive trade strategy. (15 M)**

### Introduction

India's mid-tech sectors hold significant potential amid a global pivot to diversified sourcing. However, internal bottlenecks continue to constrain deeper value chain integration.

### Body

#### **Structural causes of weak GVC integration in mid-tech manufacturing**

1. **High import tariffs and inverted duty structures**: Discourage efficient assembly and scaling.
  - Eg: **Smartphone assembly firms face up to 15% duties on inputs** despite domestic PLI incentives (Economic Survey 2024-25).
2. **Fragmented labour markets and rigid laws**: Complex state regulations increase compliance costs.
  - Eg: **Apparel MSMEs in Rajasthan face hiring constraints** limiting output flexibility vs Bangladesh (NITI Aayog report 2024).
3. **Inefficient logistics and supply chain infrastructure**: Raises operational costs and delivery times.
  - Eg: **Average turnaround time at Indian ports** is 2x compared to Singapore (World Bank Logistics Performance Index 2025).
4. **Low R&D and technology adoption**: Limits quality and competitiveness in mid-tech products.
  - Eg: **India's R&D spending at 0.7% of GDP** vs 2.1% in South Korea (DST, 2025).
5. **Limited trade agreements coverage**: Constrains market access and cost competitiveness.
  - Eg: **Vietnam's \$20 bn increase in textile exports** post-EU FTA (WTO data 2024).

#### **Opportunities emerging from supply chain shifts post-pandemic**

1. **Geopolitical realignments and China + 1 strategy**: Multinationals diversifying sourcing.
  - Eg: **Foxconn's \$1.5 bn new investment in India** for electronics.
2. **Shifts in US trade policy**: Potential tariff escalations under second Trump term.
  - Eg: **100% tariff on Chinese EVs** by US in 2024 sets precedent for wider tariff moves (USTR 2024).
3. **Resilience and transparency in global supply chains**: ESG-driven sourcing preferences.

- Eg: **H&M sourcing more from India** post-2024 EU Supply Chain Due Diligence Law (EU Commission 2025).
- 4. **Rising labour costs in China and SE Asia**: Enhances India's wage-cost advantage.
  - Eg: **India's median manufacturing wage** is 30% below Vietnam's (ILO 2025).
- 5. **Growth of regional trade hubs**: Indo-Pacific supply hubs opening opportunities.
  - Eg: **Quad Supply Chain Resilience initiative** targets electronics and critical materials (MEITY 2025).

### **Comprehensive trade strategy to boost GVC integration**

1. **Tariff rationalisation and duty inversion correction**: Align with export promotion needs.
  - Eg: **2025 PLI 2.0 reforms for IT hardware** address input tariff distortions (Ministry of Commerce 2025).
2. **Bilateral and multilateral trade agreements**: Secure market access for mid-tech exports.
  - Eg: **India-UK FTA near finalisation** with benefits for auto components and textiles (Commerce Ministry June 2025).
3. **Logistics infrastructure enhancement**: Implement integrated multimodal hubs.
  - Eg: **PM Gati Shakti framework** integrates 600+ infra projects across sectors (DPIIT 2025).
4. **Labour market reforms**: Ensure consistent and flexible labour frameworks.
  - Eg: **Tamil Nadu Industrial Policy 2025** incentivises flexible hiring in garment clusters (State Govt 2025).
5. **Cluster-based MSME upgradation**: Foster modern, competitive supplier networks.
  - Eg: **Mega Integrated Textile Region and Apparel Parks (MITRA)** approved in 7 states (Ministry of Textiles 2024).

### **Conclusion**

To capitalise on emerging global shifts, India must execute coordinated reforms unlocking the full potential of its mid-tech sectors. A competitive and deeply integrated manufacturing ecosystem can transform India into a global supply chain hub.

## **Infrastructure: Energy, Ports, Roads, Airports, Railways etc.**

**Q. Connectivity is no longer a privilege but a prerequisite for economic justice in Northeast India. Examine how recent infrastructure initiatives are addressing regional isolation. Evaluate why improved connectivity alone may not guarantee inclusive development. (10 M)**

### **Introduction**

Connectivity is redefining the developmental paradigm in the Northeast by linking historically excluded regions to national supply chains, governance platforms, and strategic corridors. However, without institutional safeguards, such growth may remain unequal.

### **Body**

#### **How recent infrastructure initiatives are addressing regional isolation**

1. **Railway modernisation for mobility and commerce**: Revamp of key stations connects underserved regions to national markets.

- **Eg:** Under **Amrit Bharat Station Scheme**, **103 railway stations** in the Northeast are being redeveloped (PMO, May 2025).
- 2. **Tunnels and highways for all-weather access:** Enables year-round movement across difficult terrain and border areas.
  - **Eg: Sela Tunnel** (Arunachal Pradesh), operationalised in **2024**, connects Tawang with Tezpur via NH13.
- 3. **Digital backbone for remote connectivity:** Expands e-governance, banking, education, and healthcare access.
  - **Eg: BharatNet Phase II** covers over **3,000 villages** in the Northeast with optical fibre (MeitY, 2024).
- 4. **Air connectivity for mobility and perishables:** Reduces travel time and aids export of regional produce.
  - **Eg: Hollongi Airport** (2022) improved access to Arunachal; supports cargo handling of **organic pineapples and spices**.
- 5. **Inland waterways for regional integration:** Revives traditional trade routes and reduces logistics cost.
  - **Eg: National Waterway 2 on Brahmaputra River** supports trade with **Bangladesh and Assam hinterland** (Ministry of Ports, 2023).

### **Why improved connectivity alone may not guarantee inclusive development**

1. **Digital exclusion in tribal areas:** Connectivity doesn't ensure access due to device, skill, and language barriers.
  - **Eg: NITI Aayog SDG Index 2023** ranks **Nagaland and Meghalaya** lowest on digital inclusion metrics.
2. **Displacement without consent:** Projects can trigger alienation when imposed without local consultation.
  - **Eg: Manipur tribal protests (2022)** over highway expansion cited violation of **FPIC norms under UNDRIP**.
3. **Ecological degradation from unplanned development:** Infrastructure in biodiversity hotspots worsens environmental fragility.
  - **Eg: Kaziranga flyover project** faced stay from **Guwahati High Court (2023)** due to elephant corridor concerns.
4. **Urban-rural development skew:** Benefits of connectivity often accrue to urban centres, leaving remote areas underserved.
  - **Eg: Guwahati and Shillong** absorb most tourism and trade gains, while tribal belts lack last-mile access (MoDoNER data 2024).
5. **Weak local institutional capacity:** Panchayats and ADCs lack capacity to leverage or regulate rapid development.
  - **Eg: Sixth Schedule councils** often excluded from infrastructure planning, leading to overlaps and friction (MHA Report 2023).

### **Conclusion**

Connectivity is a necessary catalyst, but without **community participation, ecological foresight, and governance reform**, it cannot translate into inclusive development. Northeast India's rise must be rooted in justice, not just infrastructure.

**Q. Discuss the key reasons behind the global underinvestment in electricity grids despite rapid growth in renewable generation. How can this mismatch be corrected in the Indian context? (10 M)**

**Introduction:**

The global clean energy push is being undermined by outdated grid infrastructure, creating a paradox where generation capacity grows faster than the ability to deliver power.

**Body**

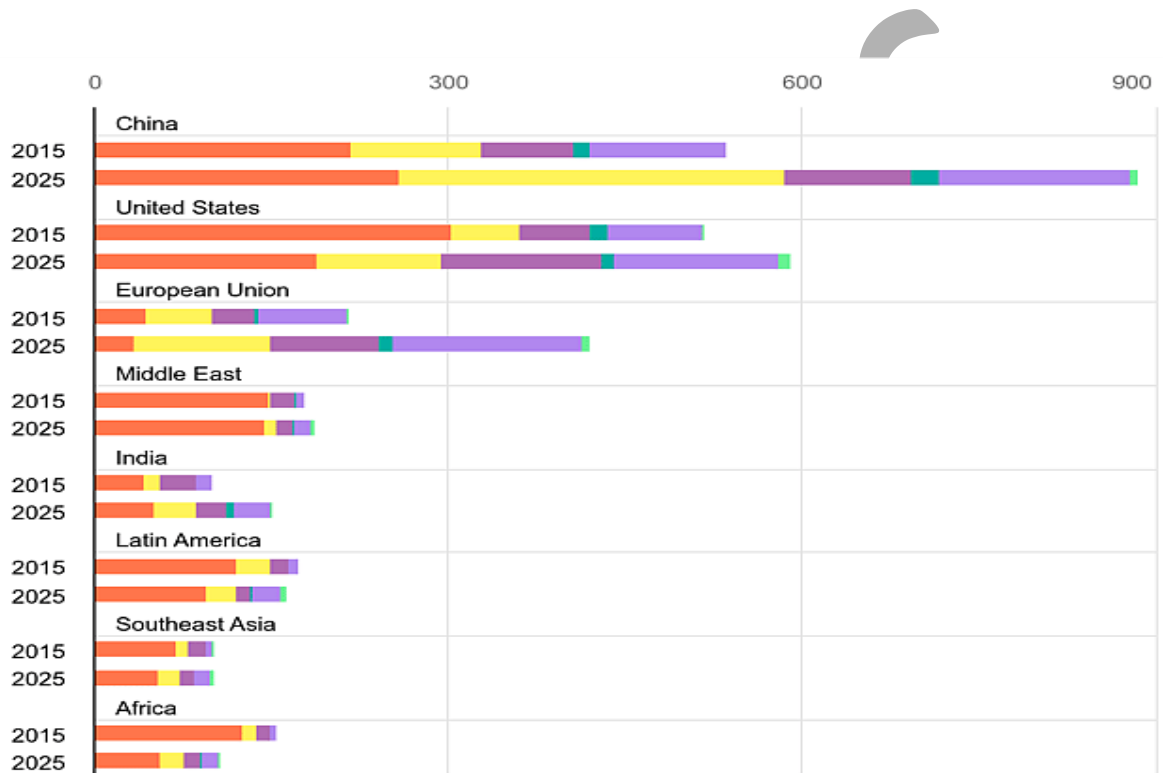


Fig: Energy investment across regions and sectors in 2015 and 2025

**Reasons for global underinvestment in electricity grids**

- High capital intensity and delayed returns:** Grid projects are costly and offer slow, regulated returns, deterring private investment.
  - Eg:** According to **IEA 2025**, grid investment lags behind generation by **~\$600 billion annually** due to poor commercial viability.
- Lengthy permitting and land acquisition delays:** Transmission projects face procedural bottlenecks and social resistance.
  - Eg:** **World Bank 2023** flagged that grid expansion timelines in developing countries often exceed **5–7 years**.
- Weak financial health of utilities:** Distribution companies are unable to recover costs, deterring upstream investment.
  - Eg:** **NITI Aayog 2022** reported that Indian DISCOMs carry **debts over ₹6 lakh crore**, limiting grid upgrades.
- Focus skewed towards generation:** Policy and financial incentives are largely directed at solar, wind, or nuclear generation.

- **Eg:** While global renewable generation investment will reach **\$1 trillion in 2025**, grid investment remains capped at **\$400 billion** (IEA).
- 5. **Material and supply chain constraints:** Global shortage of cables and transformers has raised project costs.
  - **Eg:** IEA 2025 noted prices for **transformers and cables doubled** in five years, stalling projects.

### **Corrective strategies for India's grid investment mismatch**

1. **Incentivised private participation:** De-risking and viability gap funding for grid investments to attract capital.
  - **Eg:** The **Revamped Distribution Sector Scheme (RDSS)** aims to modernise India's power sector with **₹3 lakh crore** (MoP, 2023).
2. **Time-bound regulatory clearances:** Single-window digital systems to expedite approvals.
  - **Eg:** **Green Energy Open Access Rules 2022** reduced grid clearance timelines for RE projects.
3. **Strengthening DISCOM finances:** Tariff reforms and DBT for subsidies to improve financial viability.
  - **Eg:** **Power Finance Corporation's UDAY 2.0** framework aims to improve **billing efficiency and AT&C loss recovery**.
4. **Grid digitisation and smart metering:** Deploying smart technologies to reduce T&D losses and manage loads.
  - **Eg:** India targets **250 million smart meters by 2025** under the **Smart Meter National Programme**.
5. **Integrated grid planning and storage focus:** Align transmission planning with renewable zones and energy storage.
  - **Eg:** **Central Electricity Authority's 2023 plan** recommends **500 GW renewable grid integration** with battery and pump storage support.

### **Conclusion:**

India's energy transition hinges not just on generation but transmission. A resilient, modernised grid is essential to energise the promise of a low-carbon future.

**Q. "India's rapid economic growth is increasingly energy-intensive". Assess its implications for India's emission targets. Discuss recent trends in green energy productivity. Outline structural reforms to enhance overall energy efficiency. (15 M)**

### **Introduction**

India's **energy consumption** rose **40 percent (2013–2023)** as the country pursued high growth, with fossil fuels still dominating the energy mix — posing new challenges for **NDC and net-zero 2070 goals**.

### **Body**

#### **Implications for India's emission targets**

1. **Higher CO2 emissions trajectory:** Continued energy-intensive growth increases CO2 output, threatening compliance with India's **updated NDC (2022)**.

- Eg: **5.3 percent CO2 emissions rise in 2024**, triple global rate (IEA, 2025).
- 2. **Delayed GDP-emission decoupling**: Rising energy demand risks delaying the structural decoupling essential for net-zero transition.
  - Eg: Fossil fuel share still **~80 percent** of India's electricity (MoP, 2025).
- 3. **Pressures on clean energy targets**: Growing demand may overrun renewable capacity expansion timelines.
  - Eg: India targets **500 GW non-fossil capacity by 2030** under NDC (MNRE).
- 4. **Increased fuel import dependency**: Greater energy intensity may force higher **coal and gas imports**, impacting energy security.
  - Eg: **Coal imports rose 9 percent in 2024** to meet power demand (Ministry of Coal).

### **Recent trends in green energy productivity**

1. **Stagnation in green electricity productivity**: Gains from renewables are flattening due to grid and technology gaps.
  - Eg: Green electricity productivity shows **declining gains post-2020** (IIT Kanpur study, 2025).
2. **Sectoral imbalance in efficiency gains**: While industry shows strong gains, transport and agriculture lag behind.
  - Eg: **PAT scheme** improved **steel, cement** efficiency, but transport energy use grew faster than GDP (BEE PAT report).
3. **Grid integration bottlenecks**: Inadequate grid readiness reduces renewable utilisation efficiency.
  - Eg: **Curtailed wind/solar in Tamil Nadu, Maharashtra** due to grid mismatch (CEA, 2024).
4. **Rising energy demand from digital economy**: New sectors like **data centres** intensify energy demand with lower productivity.
  - Eg: **Data centre electricity demand** to rise **40 percent by 2028** (CEEW).

### **Structural reforms to enhance overall energy efficiency**

1. **Adopt energy productivity as core metric**: Shift policy focus to **GDP per unit energy used**, not just capacity targets.
  - Eg: **NITI Aayog 2023** recommended national energy productivity framework (NITI Aayog).
2. **Extend PAT to non-industrial sectors**: Target transport, agriculture with new market-based efficiency schemes.
  - Eg: **BEE 2024** proposed PAT-like model for freight and buses (BEE).
3. **Modernise grid for variable renewables**: Invest in **smart grids**, flexible generation, storage to improve renewable productivity.
  - Eg: **Smart Grid Mission Phase-II** to cover **500 cities** by 2027 (MoP).
4. **Develop integrated energy-economic databases**: Create harmonised sector-wise data for precision policy and monitoring.
  - Eg: **IIT Kanpur–MOSPI study** flagged gaps in current energy-economic datasets (MOSPI).
5. **Promote aggressive demand-side management**: Boost adoption of high-efficiency appliances, standards and behaviour change.
  - Eg: **UJALA LED programme** cut demand by **47 billion kWh/year** (EESL).

6. **Accelerate innovation in green technologies:** Incentivise R&D and scale-up of emerging clean technologies.
  - Eg: India's first **offshore wind tender (2024)** launched for Gujarat coast (MNRE).

### Conclusion

To align **high growth with climate goals**, India must urgently shift to an **energy productivity-driven model**, integrating **smart grids, market reforms, and innovation** — making every unit of energy count toward **sustainable development**.

### Investment models.

## Science and Technology- developments and their applications and effects in everyday life.

### Achievements of Indians in science & technology; indigenization of technology and developing new technology.

**Q. Evaluate the role of new technologies like molten salt reactors (MSR) and subcritical systems with proton accelerators in India's future nuclear roadmap. Discuss their feasibility and potential contributions. (15 M)**

### Introduction

India's ambition for net zero by 2070 demands disruptive nuclear technologies to overcome fuel, safety, and scalability constraints. Molten salt reactors (MSRs) and subcritical systems with proton accelerators represent next-generation options with significant promise.

### Body

#### Role of MSR and subcritical technologies in India's nuclear roadmap

1. **High fuel efficiency and closed fuel cycle:** MSRs allow recycling of spent fuel, reducing waste and maximizing resource use.
  - Eg: **Bhabha Atomic Research Centre (BARC)** is studying thorium-based MSR designs (BARC Annual Report 2024).
2. **Utilisation of thorium reserves:** MSRs can directly use India's abundant thorium, enabling Stage-III of the nuclear programme.
  - Eg: India holds **25% of global thorium reserves (IAEA 2023)**.
3. **Enhanced safety features:** MSRs operate at atmospheric pressure with passive safety, reducing risk of catastrophic failures.
  - Eg: **Oak Ridge National Laboratory (US) MSR prototypes** demonstrate inherent safety (ORNL, 2023).
4. **Decentralised grid integration:** Modular MSRs allow flexible deployment even in remote and power-deficit regions.
  - Eg: **China's 2 MW MSR prototype operational since 2021** shows off-grid applications (World Nuclear News, 2023).

5. **Reduced proliferation risks:** Subcritical systems minimize fissile material build-up and can safely transmute nuclear waste.
  - Eg: **MYRRHA project (Belgium)** demonstrates accelerator-driven subcritical systems (IAEA 2024).

### **Feasibility of MSR and subcritical systems in India**

1. **Technological readiness gaps:** India lacks full-scale operational experience in MSRs and ADS systems.
  - Eg: No indigenous **MSR prototypes yet commissioned by BARC (BARC Annual Report 2024).**
2. **High capital costs:** Advanced R&D, specialized materials, and new supply chains raise financial barriers.
  - Eg: **INR 8000 crore investment estimated for ADS pilot (NITI Aayog 2024).**
3. **Complex regulatory frameworks:** New licensing, safety, and fuel cycle regulations are required for MSR deployment.
  - Eg: **Atomic Energy Regulatory Board (AERB)** yet to draft MSR-specific norms (AERB Bulletin, 2025).
4. **Skilled manpower shortages:** Advanced reactor designs need highly specialised engineering and operational expertise.
  - Eg: **Department of Atomic Energy's 2025 Human Resource Report** highlights shortage of MSR-trained personnel.
5. **International technology access constraints:** Export control regimes restrict technology transfers for critical components.
  - Eg: India faces barriers under **Nuclear Suppliers Group (NSG)** restrictions despite 2008 waiver.

### **Potential contributions of MSR and subcritical systems**

1. **Long-term energy security:** Reduces uranium dependence, maximises thorium use, and closes fuel cycles.
  - Eg: **BARC studies show thorium MSRs can extend fuel availability for centuries (BARC 2024).**
2. **Climate mitigation support:** Enables scalable, zero-emission base load power vital for 2070 net-zero target.
  - Eg: **International Energy Agency (IEA) Net Zero 2050 Report (2023)** recommends advanced nuclear deployment.
3. **Nuclear waste minimisation:** Subcritical systems can transmute long-lived actinides into short-lived waste forms.
  - Eg: **IAEA ADS Research (2024)** confirms over 90% reduction in high-level waste volume.
4. **Strategic technological leadership:** Early MSR adoption positions India as global leader in 4th generation reactors.
  - Eg: **India-France Joint Working Group on Advanced Nuclear (2025)** explores MSR collaborations.
5. **National energy autonomy:** Indigenous development aligns with Atmanirbhar Bharat and strategic autonomy goals.

- Eg: NITI Aayog's National Energy Roadmap 2030 recommends diversification of indigenous nuclear technologies.

## Conclusion

India's nuclear future hinges on unlocking indigenous innovation like MSRs and ADS systems. Timely investments, regulatory clarity, and international collaboration can transform these advanced technologies from prototypes into pillars of India's Viksit Bharat energy vision.

**Q. What is the significance of the Axiom-4 mission for India's human spaceflight ambitions. How can its outcomes contribute to the Gaganyaan programme. (10 M)**

## Introduction

India's involvement in the **Axiom-4 mission (June 2025)** marks a critical moment in transitioning from symbolic space achievements to institutionalised human spaceflight capability.

## Body

### Significance of Axiom-4 for India's human spaceflight ambitions

1. **Symbolic continuity after Rakesh Sharma**: It revives India's human spaceflight journey after 41 years, marking a generational leap.
  - Eg: Shubhanshu Shukla's voyage to ISS on Axiom-4 echoes the symbolic milestone set by Rakesh Sharma's 1984 spaceflight.
2. **Positioning India as an equal partner**: India participated not as a passive observer but as an **active partner in planning and execution**.
  - Eg: A large **ISRO delegation including Chairman V. Narayanan** was involved in last-mile troubleshooting with **Axiom Space and NASA**.
3. **Demonstration of readiness for routine human spaceflight**: Shows India's capability to collaborate in international crewed missions before its own crew launch.
  - Eg: Axiom-4 mission's success comes as **ISRO prepares for Gaganyaan's uncrewed test flights in 2025-26**.
4. **Strategic assertion in the global space order**: Projects India as a spacefaring democracy ready to enter the **Moon-Mars race**.
  - Eg: India has announced plans to **land humans on the Moon by 2040** and set up its own **space station by 2035** (ISRO Vision 2047).
5. **Inspiration and soft power**: Enhances national pride and attracts youth towards space science and innovation.
  - Eg: Shukla's **ISS message in Hindi** drew comparisons with the iconic "**Saare Jahan Se Achcha**" moment, capturing national imagination.

### Outcomes of Axiom-4 that can contribute to Gaganyaan

1. **Training and crew integration experience**: Offers insights into **international astronaut selection, training, and mission execution**.

- **Eg:** Shukla trained with astronauts from **NASA, Hungary, and Poland**, providing Gaganyaan insights on **multinational crew dynamics**.
- 2. **Technical exposure to LEO mission operations:** Aids in mastering **life support systems, docking, and in-orbit troubleshooting protocols**.
  - **Eg:** Axiom-4 delays due to technical issues allowed ISRO teams to **gain exposure to real-time problem-solving** in human missions.
- 3. **Refinement of ISRO's human-rated systems:** Allows benchmarking against **Crew Dragon and SpaceX systems** to adapt Gaganyaan designs.
  - **Eg:** ISRO teams studied **SpaceX's fault-tolerant capsule architecture** to refine India's **HLVM3-based crew module**.
- 4. **Strengthening global collaboration channels:** Builds long-term diplomatic and technological pathways for mission cooperation.
  - **Eg:** Axiom-4 deepens ties with **NASA and Axiom Space**, creating scope for **shared training and space medicine research** for Gaganyaan.
- 5. **Boost to psychological conditioning and mission planning:** Insights into astronaut well-being, food systems, and behavioural protocols.
  - **Eg:** Shukla's **mission log and biometric feedback** can help in customising **crew simulation and isolation protocols** for Gaganyaan.

## Conclusion

The Axiom-4 mission is a stepping stone, not a standalone success. To fully harness its value, India must convert experience into institutional memory and scale up capabilities through **Gaganyaan and beyond**.

**Awareness in the fields of IT, Space, Computers, robotics, Nano-technology, bio-technology and issues relating to intellectual property rights.**

**Q. How does nitrogen fertiliser production contribute to global carbon emissions? Explain how plasma-based green fertilisers offer emission reductions. (10 M)**

## Introduction

Nitrogen fertiliser production, primarily via the **Haber-Bosch process**, is highly energy intensive and fossil fuel dependent, making it a significant contributor to global greenhouse gas emissions.

## Body

### **Contribution of nitrogen fertiliser production to global carbon emissions**

1. **High energy consumption in Haber-Bosch process:** It requires high pressure and temperature, consuming large amounts of natural gas or coal.
  - Eg: IEA estimates that **fertiliser production accounts for 2.7% of global CO<sub>2</sub> emissions**.
2. **Indirect emissions from ammonia production:** Steam methane reforming generates CO<sub>2</sub> as a by-product while producing hydrogen.
  - Eg: UNEP reported that **ammonia production emits over 500 million tonnes of CO<sub>2</sub> annually**.
3. **Supply chain emissions:** Transportation and storage of fertilisers further add to total carbon footprint.

- Eg: FAO Report highlighted that **supply chain emissions contribute nearly 10% to total fertiliser lifecycle emissions.**
- 4. **Nitrous oxide release from fertiliser use:** Over-application leads to N<sub>2</sub>O release, a potent greenhouse gas.
  - Eg: IPCC AR6 noted that **agricultural N<sub>2</sub>O emissions account for nearly 6% of global GHG emissions.**
- 5. **Vulnerability to geopolitical energy shocks:** Dependence on fossil fuels links fertiliser production to volatile global energy markets.
  - Eg: Post-Ukraine War disruptions caused **fertiliser price surges by over 300% globally (World Bank, 2023).**

### **Emission reduction potential of plasma-based green fertilisers**

1. **Elimination of fossil fuel inputs:** Plasma technology uses air and renewable electricity, avoiding fossil fuel combustion.
  - Eg: NitroCapt (Sweden, 2025) demonstrates **nearly zero direct CO<sub>2</sub> emissions (Food Planet Prize, 2025).**
2. **Significant energy efficiency:** Plasma processes require lower energy input compared to Haber-Bosch.
  - Eg: NitroCapt (2025) **claims energy use reduction by 90%.**
3. **Decentralised production model:** Localised small-scale units cut transportation emissions and improve resilience.
  - Eg: **EU Green Deal (2024) supports local green fertiliser units for regional climate resilience.**
4. **Reduction of geopolitical dependence:** Countries gain self-sufficiency by producing fertilisers with domestic renewable energy.
  - Eg: **Sweden's Uppsala project aims at farmer cooperatives managing local fertiliser production.**
5. **Lower downstream nitrous oxide emissions:** Precision application may reduce field-level N<sub>2</sub>O emissions.
  - Eg: UN FAO Symposium (highlighted **benefits for soil health and emission reduction.**

### **Conclusion**

Disruptive innovations like **plasma-based fertilisers** offer a pathway to decouple fertiliser production from carbon emissions while enhancing food security resilience globally.

### **Q. Quantum communication can transform both military and civilian sectors. Elaborate. What are the major technical challenges in scaling such networks in India? (10 M)**

#### **Introduction**

Quantum communication, using principles like entanglement and quantum key distribution, offers **unprecedented levels of cybersecurity** and strategic advantages for military and civilian networks in an era of escalating cyber threats.

#### **Body**

## Transformative potential of quantum communication

1. **Securing military communications**: Enables unbreakable, real-time secure links between command centres, satellites, and mobile units.
  - **Eg: US Quantum Networking Strategy 2023** focuses on quantum-secure defence communication (**US DoD White Paper, 2023**)
2. **Protecting critical infrastructure**: Shields sensitive sectors like power grids, ports, and air traffic from quantum-enabled cyberattacks.
  - **Eg: China's 4,600 km quantum network (2021)** protects government and energy data.
3. **Enabling quantum internet**: Supports quantum computing and distributed secure networks for sectors like healthcare, finance, and telecom.
  - **Eg: EU Quantum Internet Alliance** targets pan-European quantum internet by **2030** (**EU Horizon Programme**)
4. **Strengthening financial systems**: Provides quantum key distribution for **secure financial transactions** and data storage.
  - **Eg: South Korea's Quantum Financial Network pilot, 2024** in banking sector (**Korea Quantum Initiative**)
5. **Boosting innovation ecosystems**: Drives collaboration across **academia, defence, and industry** to create indigenous quantum technology hubs.
  - **Eg: India's National Quantum Mission (Rs 6,000 crore, 2023-2031)** promotes such ecosystems (**DST India**)

## Major technical challenges in scaling networks in India

1. **Photon transmission losses**: Absorption, scattering, and decoherence over long distances reduce fidelity.
  - **Eg: In India's recent 380 km QKD fibre trial (2023)**, attenuation remains a limiting factor (**DST-DRDO Study**)
2. **Atmospheric interference**: **Weather, turbulence, pollution** affect free-space quantum channels.
  - **Eg: Demonstration of free-space QKD (2025)** faced **7% error rate** due to atmospheric conditions
3. **Limited indigenous quantum hardware**: Dependence on **imported photon sources, detectors, quantum memories**.
  - **Eg: India currently imports over 70% of core quantum components.**
4. **Lack of satellite-ground integration**: India is yet to deploy **quantum-enabled satellites** for global coverage.
  - **Eg: In contrast, China's Micius satellite (2016)** enabled **1,200 km quantum-secure link** (**Nature Photonics, 2017**)
5. **Insufficient skilled manpower**: Shortage of trained **quantum physicists, engineers, cybersecurity experts**.
  - **Eg: India needs over 25,000 quantum tech professionals by 2030** (**FICCI Quantum Technologies Report, 2024**)

## **Conclusion**

India must rapidly bridge its **quantum capability gaps** through targeted investments, global collaborations,

and capacity building — to secure both military advantage and economic competitiveness in the emerging quantum era.

## Conservation, environmental pollution and degradation, environmental impact assessment.

**Q. Discuss the rationale and need for establishing an independent biosafety institute in India. Evaluate how such an institute could complement existing bodies like the Genetic Engineering Appraisal Committee. (10 M)**

### Introduction

Gene-editing technologies like **CRISPR-Cas9** have outpaced India's regulatory architecture, making an **independent biosafety institute** essential for ensuring scientific, ethical and ecological safety in agri-biotech applications.

### Body

#### Rationale and need for an independent biosafety institute

1. **Conflict of interest in self-regulation**: Developer labs currently assess their own biosafety, undermining neutrality.
  - Eg: **ICAR's gene-edited rice (DRR Dhan 100)** was cleared based on **in-house Biosafety Committee** review without public domain scrutiny.
2. **Weak post-approval monitoring**: GEAC lacks capacity to conduct long-term environmental and health surveillance.
  - Eg: **Bt cotton resistance failure** by 2015 due to **pink bollworm resurgence** illustrates inadequate post-release biosafety checks.
3. **Absence of transparent scientific data**: Safety assessments and field trial results are rarely peer-reviewed or published.
  - Eg: No detailed data on **gene edits or field trials** for Pusa Rice DST1 has been released in **scientific journals**.
4. **Gap in regulatory independence**: Biosafety decisions are influenced by commercial, political or institutional interests.
  - Eg: 2022 **MoEFCC notification** exempting **SDN1 and SDN2 crops** from GEAC scrutiny was criticised for lack of scientific consultation (Environment Protection Act notification, March 2022).
5. **Lack of institutional continuity and expertise**: GEAC is an inter-ministerial committee, not a permanent scientific body.
  - Eg: **GEAC's meeting frequency and staffing** varies year to year, limiting consistent risk evaluation (Parliamentary Standing Committee on Science & Tech, 2023).
6. **Public trust deficit in biotechnology**: An autonomous body can improve credibility and democratic oversight.
  - Eg: **Bt brinjal moratorium (2010)** reflected public scepticism despite GEAC's approval (MoEFCC).

#### Complementarity with the Genetic Engineering Appraisal Committee (GEAC)

1. **Scientific validation and review arm:** The institute can provide independent, peer-reviewed safety data to guide GEAC decisions.
  - Eg: **Brazil's CTNBio** functions as a biosafety advisory body providing inputs to national regulators (OECD Report, 2021).
2. **Specialised infrastructure and human resources:** Permanent scientific staff can conduct field studies and lab tests.
  - Eg: **South Korea's National Institute of Agricultural Sciences** houses experts in crop biotechnology, toxicology and ecology (FAO Biotech Profiles, 2022).
3. **Long-term biosafety monitoring system:** Institute can maintain a central database of post-release crop performance and adverse impacts.
  - Eg: **EU's EFSA** monitors gene-edited crops' effects on biodiversity under a 10-year surveillance protocol (EU Commission Report, 2020).
4. **Training and certification role:** It can certify safety standards for universities, research institutes and private developers.
  - Eg: **Canada's CFIA** certifies GMO compliance standards through third-party testing (Health Canada Guidelines, 2021).

## Conclusion

India's biotech future hinges not just on innovation but on **institutions of trust and transparency**. A dedicated biosafety institute would ensure that **agri-tech growth remains farmer-centric, science-backed, and ecologically aligned**.

**Q. Explain the contribution of compressed biogas and feedstock diversification in India's bioenergy policy. How do they promote a circular energy economy? (10 M)**

## Introduction

India's bioenergy policy, anchored in **compressed biogas (CBG)** and **feedstock diversification**, reflects a shift towards **self-reliant, decentralised, and circular energy systems** that align clean energy goals with rural prosperity.

## Body

### Contribution of compressed biogas (CBG) in bioenergy policy

1. **Waste-to-energy conversion:** CBG transforms organic waste into clean fuel, reducing landfill burden and methane emissions.
  - **Eg: Indore CBG plant** by GAIL processes 400 tonnes/day organic waste and generates 17,000 kg/day of biogas (GAIL Annual Report, 2024).
2. **Import reduction and forex saving:** Domestic CBG cuts down LNG imports, saving foreign exchange.
  - **Eg: The 5% CBG blending mandate by 2028** could save over **₹10,000 crore** in oil imports (MoPNG, 2025).
3. **Rural livelihood generation:** Biomass sourcing and plant operations create jobs and income for farmers and SHGs.

- **Eg: IOC's CBG plant in Punjab** sources paddy straw from local farmers, offering viable income over stubble burning .
4. **Support to sustainable urbanisation**: CBG plants decentralise fuel access and aid in solid waste management.
    - **Eg: Pune's CBG buses** run on fuel from municipal biogas plants, reducing city emissions (Smart Cities Mission Report, 2023).

### **Role of feedstock diversification in bioenergy policy**

1. **Stability in ethanol production**: Multiple feedstocks ensure uninterrupted ethanol supply despite crop cycles or failures.
  - **Eg: Ethanol feedstocks** now include **molasses, maize, surplus grains and sugarcane juice** (MoPNG, 2025).
2. **State-specific crop utilisation**: Localised feedstock choices allow tailored policy implementation and agro-industry growth.
  - **Eg: Maize-based ethanol plants** in Bihar and MP leverage regional crop abundance .
3. **Boost to allied bio-economy**: Encourages investment in biotechnology and processing infrastructure.
  - **Eg: National Bio-Energy Mission (Draft)** incentivises multi-feedstock bio-refinery R&D (MNRE, 2024).
4. **Reduction of agri-waste and emissions**: Crop residues become valuable inputs, cutting open burning and emissions.
  - **Eg: Godavari Biorefineries** converts sugarcane press mud and spent wash into ethanol and biogas (NITI Aayog, 2023).

### **Promotion of circular energy economy**

1. **Resource reuse efficiency**: Biomass, agri-waste, and organic residues are re-entered into the energy value chain.
  - **Eg: Panipat refinery's hybrid hydrogen-CBG project** integrates **biomass gasification** into refinery operations.
2. **Emission reduction through waste valorisation**: Reduces GHGs by substituting fossil fuels with bio-derived gases.
  - **Eg: CBG from dairy waste in Gujarat** fuels public transport, cutting methane and diesel use.
3. **Income loop for farmers and local producers**: Waste generated by agriculture and food processing becomes a revenue stream.
  - **Eg: SATAT model contracts** pay farmers and waste aggregators for biomass, ensuring local economic circularity.
4. **Integration of decentralised energy systems**: Localised CBG and ethanol units reduce transmission losses and boost energy equity.
  - **Eg: CBG clusters in Maharashtra and Haryana** power village-level grids and local transport networks (MNRE Pilot Reports, 2023).

### **Conclusion**

India's bioenergy model reflects a **paradigm shift from fossil reliance to regenerative energy loops**. Ensuring price incentives, logistics support, and private sector participation will be key to scaling this circular momentum.

**Q. India's worsening environmental and health indicators reflect a deeper crisis of developmental planning. Analyse the interlinkages between climate shocks, public health gaps and the growing economic vulnerability of the population. Suggest an integrated policy roadmap. (15 M)**

### **Introduction**

The 2025 report by **Centre for Science and Environment (CSE)** highlights that India's multiple crises—environmental, health, and economic—are not isolated but deeply interconnected, revealing gaps in long-term development planning.

### **Body**

#### **Interlinkages between climate shocks and public health gaps**

1. **Extreme weather and disease outbreaks**: Climate events increase vector-borne and water-borne diseases, overwhelming weak health systems.
  - **Eg: In 2024, 88% of the days** saw extreme weather events, leading to flood-linked **leptospirosis and diarrhoea** spikes in **Assam and Bihar**.
2. **Displacement-induced health crises**: Climate-linked migration disrupts access to healthcare, nutrition, and sanitation.
  - **Eg: 5.4 million** people were internally displaced in **2024**, with **Assam** accounting for nearly half.
3. **Air pollution and NCD burden**: Climate-linked urban smog raises respiratory diseases amid limited public health capacity.
  - **Eg: 13 capitals** including **Delhi** had unsafe air **1 in 3 days** since 2021; **Delhi's life expectancy** reduced by **8 years**.
4. **Public health system inadequacy**: Climate shocks expose infrastructural gaps in rural and urban health provisioning.
  - **Eg: India faces 36% shortage of Community Health Centres** and **80% shortfall in specialists** (NITI Aayog, 2023).

#### **Interlinkages between climate shocks and economic vulnerability**

1. **Informal livelihoods disrupted**: Agriculture, construction, and informal services suffer from erratic climate, leading to income loss.
  - **Eg: Real incomes** of salaried and self-employed workers declined between **2017 and 2023**.
2. **Asset destruction from disasters**: Floods and heatwaves destroy homes, land, and tools, deepening poverty cycles.
  - **Eg: Floods accounted for two-thirds** of displacement in 2024 and caused over **₹30,000 crore** in damages.
3. **Out-of-pocket health expenses rise**: Poor access to public health forces spending, pushing families into debt.

- **Eg: 45% of total health expenditure** is out-of-pocket; in **Uttar Pradesh**, it exceeds **65%** (National Health Accounts, 2023).
- 4. **Job insecurity worsens vulnerability**: Informal workers lack social security or climate insurance.
  - **Eg: Over 73% of India's workforce** is informal; only **20% of women** are employed full-time (PLFS 2023-24).

### **Integrated policy roadmap for resilient development**

1. **Mainstream climate-health planning**: Adopt **Health in All Policies (HiAP)** approach integrating climate risks.
  - **Eg: Lancet Countdown 2024** recommends health-climate integration in local planning; Kerala initiated health risk mapping for heat zones.
2. **Strengthen rural and urban health systems**: Invest in **infrastructure, digital health**, and mobile outreach in vulnerable regions.
  - **Eg: 15th Finance Commission** suggested performance-linked health grants for primary care strengthening.
3. **Build climate-resilient livelihoods**: Promote **climate-smart agriculture**, green employment, and risk insurance for informal workers.
  - **Eg: Mahatma Gandhi NREGS Climate Resilience pilots** in Maharashtra and Odisha for floodproofing and dryland farming.
4. **Develop disaggregated climate vulnerability databases**: Prioritise **real-time data collection** on health, income and migration.
  - **Eg: CSE 2025** called for more granular data to target interventions; **NITI Aayog's SDG dashboard** should include climate-health indicators.
5. **Legal and institutional reform**: Revise **Environment Protection Act**, empower **State Disaster Management Authorities**, and ensure Centre–state coordination.
  - **Eg: T.S.R. Subramanian Committee (2014)** stressed on environmental governance reform and decentralisation.

### **Conclusion**

India's development blueprint must now align with climate, health, and equity imperatives. Investing in **climate-resilient public systems and data-driven governance** is not just adaptation—it is survival.

**Q. How can artificial intelligence serve as a catalyst for climate mitigation across diverse sectors? Analyse the ecological footprint of AI itself and propose strategies to ensure its deployment results in a net-positive climate impact. (15 M)**

### **Introduction**

AI stands at the confluence of digital innovation and environmental urgency, emerging as both a high-energy consumer and a tool for transformative climate solutions.

### **Body**

#### **AI as a catalyst for climate mitigation**

1. **Smart energy grid optimisation**: AI enables real-time load balancing, renewable energy integration, and fault prediction.
  - **Eg: Tapestry Project by Alphabet** accelerates clean energy approvals and grid automation in the US .
2. **Methane and short-lived pollutant detection**: AI enhances satellite and ground-based surveillance of climate super pollutants.
  - **Eg: GHGSat’s AI-driven satellites** detect methane leaks at facility level, reducing monitoring gaps (IEA, 2024).
3. **Precision irrigation and input use in agriculture**: AI supports climate-smart agriculture by reducing emissions and conserving resources.
  - **Eg: Baramati sugarcane farmers** reduced water usage by 30% and electricity consumption by 25% using AI scheduling tools
4. **AI in transport and logistics decarbonisation**: AI aids in route optimisation and fuel use efficiency in mobility sectors.
  - **Eg: Maersk’s AI route planning system** cut emissions by 5% in shipping operations (World Economic Forum, 2024).
5. **Industrial emissions reduction**: AI improves energy efficiency and operational precision in cement, steel, and textile sectors.
  - **Eg: JSW Cement** uses AI-optimised kiln controls to reduce fuel usage and CO<sub>2</sub> output by 7%.

### **Ecological footprint of AI**

1. **High computational energy demand**: Training large AI models consumes exponentially more energy than conventional computing.
  - **Eg: GPT-3 model training** consumed ~1,287 MWh—equivalent to a household’s annual electricity use (MIT Tech Review, 2023).
2. **Increasing power consumption in data centres**: AI workloads add to the global electricity burden through sustained compute operations.
  - **Eg: IEA 2024 report** estimates data centres consume 1.5% of global electricity, projected to double by 2030.
3. **Emissions from inference and cooling systems**: Operational energy use during inference and data processing raises GHG output.
  - **Eg: Google and Meta’s emissions** grew over 25% from 2020–2023 primarily due to AI workloads (Greenpeace, 2023).
4. **Rare-earth mining and hardware e-waste**: Rapid hardware upgrades for AI models increase raw material demand and waste.
  - **Eg: UNEP 2023** warned of AI-induced **e-waste and unsustainable material sourcing** for chips and servers.
5. **Opaque sustainability metrics**: Absence of AI-specific energy and emissions data hinders regulation and oversight.
  - **Eg: IEA 2024 survey** found only 17% of major tech firms disclose AI-related energy use.

### **Strategies for net-positive climate outcomes**

1. **Carbon-free data infrastructure**: Promote renewable-powered AI data centres and location shifting aligned with green grids.
  - **Eg: Microsoft’s Sweden data centre** operates fully on wind and hydro energy (IEA Casebook, 2023).
2. **Mandatory energy-use disclosures**: Legal frameworks must require firms to report energy and carbon footprint of AI systems.
  - **Eg: EU AI Act (to be enforced in 2026)** mandates firms to disclose AI-related energy consumption.
3. **Public funding for AI-for-climate R&D**: Create dedicated investment lines for sustainable AI development in public interest sectors.
  - **Eg: NITI Aayog’s AI Mission** proposes a focused vertical for AI solutions addressing climate and sustainability.
4. **Support for green AI startups**: Enable access to cloud computing, regulatory clarity, and patient capital.
  - **Eg: Google’s AI Startup Program** supports early-stage climate tech startups with compute credits and mentoring (2024).
5. **Global collaboration platforms**: Foster international missions to co-develop AI tools, datasets, and benchmarks for climate goals.
  - **Eg: Mission Innovation CleanTech Exchange** drives global AI-climate cooperation across 23 countries (UNEP, 2024).

## Conclusion

AI’s climate potential lies in strategic, ethical deployment—not blind scaling. With bold regulations, targeted innovation, and global cooperation, AI can become a cornerstone of sustainable transformation, not a burden on the climate ledger.

**Q. “Mass reforestation without biodiversity literacy may revive tree cover but not ecosystem function”. Explore the ecological pitfalls of non-specific afforestation strategies. Assess the role of biodiversity in ecological restoration. (10 M)**

## Introduction

Tree plantations without ecological understanding can green the land but often silence the forest—disrupting natural food chains, water cycles, and wildlife corridors.

## Body

### **Ecological pitfalls of non-specific afforestation strategies**

1. **Disruption of native species equilibrium**: Introducing exotic or non-site-specific species alters natural community structures.
  - **Eg: The spread of Eucalyptus and Acacia** in India’s afforestation schemes reduced **soil moisture** and displaced **native undergrowth** (MoEFCC Report, 2021).
2. **Loss of ecosystem services**: Uniform plantations lack functional diversity, reducing services like **pollination, soil health, and natural pest control**.

- **Eg:** In **Chhattisgarh**, monoculture teak plantations led to **decline in bird species** and native **fruit-bearing flora** (WII Study, 2020).
- 3. **Aggravation of human-wildlife conflict:** Fast-growing species may reduce food availability for wildlife or shrink habitats.
  - **Eg:** **Kerala's Vithoot Programme**, if not monitored, may worsen **conflict zones** by altering native vegetation
- 4. **Increased risk of invasive species:** Lack of monitoring may allow invasive plants to dominate.
  - **Eg:** **Lantana camara** has overtaken vast areas in the **Western Ghats**, affecting biodiversity and **livelihoods of tribal communities** (NCF Report, 2022).
- 5. **Failure of long-term survival and regeneration:** Trees planted without ecological fit often exhibit poor root establishment and die-off.
  - **Eg:** The **Green India Mission (2022 Review)** showed only **62% survival** in plantations lacking ecological alignment (MoEFCC data).

### **Role of biodiversity in ecological restoration**

1. **Enhances ecosystem resilience:** Biodiverse systems recover faster from droughts, diseases, or climate shifts.
  - **Eg:** **Miyawaki forests in Telangana** demonstrated rapid recovery after floods, unlike monoculture plantations (Forest Dept. Telangana, 2023).
2. **Supports trophic integrity and food webs:** Native diversity sustains pollinators, herbivores, and apex species.
  - **Eg:** **Aravalli Biodiversity Park (Gurugram)** restored with native flora revived **over 200 species of birds and insects** (UNEP India, 2022).
3. **Improves soil and water cycles:** Diverse root systems prevent erosion and enhance water retention.
  - **Eg:** **Watershed programmes in Jharkhand** using native mixed plantations improved **stream flow and groundwater recharge**
4. **Ensures long-term ecological stability:** Genetic diversity prevents diseases and maintains population viability.
  - **Eg:** **Kaziranga rewilding initiatives** used **local grass and shrub species** to support **rhino corridors** (WWF India, 2023).
5. **Enables cultural and livelihood restoration:** Indigenous communities depend on diverse forest products, not single-species timber.
  - **Eg:** **Odisha's Joint Forest Management Committees** restored **NTFP access** through **biodiversity-based plantation models** (Forest Rights Act Report, 2021).

### **Conclusion**

Restoration must grow forests, not just trees. A biodiversity-informed approach ensures that the future of afforestation nurtures not just green cover, but living ecosystems.

**Q. Why should agriculture be central to India's net-zero planning? Examine the policy shifts required for aligning agricultural practices with climate goals. (10 M)**

### **Introduction**

Agriculture contributes significantly to **GHG emissions** through energy use, enteric fermentation, and fertiliser application. Decarbonising agriculture is thus essential to achieve **India's net-zero target by 2070**.

## Body

### Why agriculture should be central to India's net-zero planning

1. **High emission contribution from agriculture**: Agriculture accounts for around **18% of India's total GHG emissions**, mainly from methane and nitrous oxide (Source: **MoEFCC, BUR Report 2021**).
  - **Eg: Enteric fermentation** from livestock and **rice cultivation** are top methane emitters.
2. **Energy-intensive irrigation**: Farm power relies on heavily subsidised electricity or diesel, adding to carbon intensity.
  - **Eg: Agriculture consumes 18% of electricity** in India (CEA 2021), mostly from **coal-based sources**.
3. **Unsustainable fertiliser use**: Overuse of nitrogen-based fertilisers leads to nitrous oxide emissions, a potent GHG.
  - **Eg: India is the second-largest consumer** of nitrogen fertilisers (FAO 2023).
4. **Impact on food security and climate resilience**: Climate change worsens agri-productivity and food insecurity, requiring urgent mitigation.
  - **Eg: IMF 2024 report** flagged India's climate-vulnerable districts overlapping with agri-dominant zones.
5. **Scope for co-benefits**: Decarbonising agriculture creates co-benefits like soil health, water conservation, and rural employment.
  - **Eg: Agri-PV systems** in Madhya Pradesh allow dual land use for energy and farming.

### Policy shifts required to align agriculture with climate goals

1. **Transition to renewable-powered irrigation**: Promote **solar-based feeder-level solutions** to replace fossil fuel use.
  - **Eg: PM-KUSUM Component C** aims to solarise 3.5 million grid-connected pumps by 2026.
2. **Shift from input subsidies to sustainability incentives**: Reforms in fertiliser and electricity subsidies to promote climate-smart inputs.
  - **Eg: Shanta Kumar Committee (2015)** recommended shifting to **Direct Benefit Transfer (DBT)** for fertilisers.
3. **Promote low-emission cropping systems**: Encourage diversified, less water-intensive cropping patterns.
  - **Eg: Millet Mission 2023** promotes climate-resilient cereals under **International Year of Millets**.
4. **Carbon budgeting and MRV systems**: Integrate agriculture into national carbon inventory with robust **Measurement, Reporting and Verification** mechanisms.
  - **Eg: India's Long-Term Low Emission Development Strategy (2022)** emphasises MRV in land use sectors.
5. **Agri-extension reforms and capacity building**: Train farmers on climate-friendly practices through local institutions.

- **Eg: National Mission on Sustainable Agriculture (NMSA)** includes skill training under **Krishi Vigyan Kendras**.

## Conclusion

Placing agriculture at the heart of climate policy is not just an ecological imperative but a development opportunity. A **climate-smart Green Revolution 2.0**, rooted in clean energy and resource efficiency, must be the next policy frontier.

**Q. Examine the structural weaknesses in the existing legal frameworks governing the high seas. How does the Biodiversity Beyond National Jurisdiction (BBNJ) treaty attempt to address them? (10 M)**

## Introduction

Over **two-thirds of the global oceans** lie beyond national jurisdiction, but existing legal regimes like **UNCLOS (1982)** lack enforceable mechanisms to conserve marine biodiversity. The **BBNJ treaty (2023)** addresses these long-standing gaps.

## Body

### Structural weaknesses in existing frameworks

1. **Fragmented sectoral governance**: Various agencies regulate independently with overlapping or conflicting mandates.
  - **Eg: IMO, International Seabed Authority, and RFMOs** regulate shipping, mining, and fisheries without coordination.
2. **Lack of binding conservation provisions**: UNCLOS contains general obligations but lacks binding biodiversity protection norms.
  - **Eg: UNCLOS Article 192** mandates general environmental protection but has no enforceable targets (UNCLOS text, 1982).
3. **No mechanism for benefit-sharing of marine genetic resources (MGRs)**: Existing frameworks allow unregulated bio-prospecting by developed nations.
  - **Eg: Over 10,000 MGR patents** are held globally, with 90% from 12 countries, mostly without equitable sharing.
4. **Weak environmental oversight**: There are no uniform EIA standards for projects like deep-sea mining in ABNJ.
  - **Eg: ISA guidelines (2023)** for seabed activities remain voluntary and non-binding (ISA Secretariat Report, 2023).
5. **Absence of enforcement and compliance mechanisms**: UNCLOS lacks a centralised authority to monitor or penalise violations in high seas.
  - **Eg: No global body monitors compliance for MPAs beyond national jurisdiction** (Ocean Protection Gap Report, 2025).

### Corrective measures under BBNJ treaty

1. **Legally binding conservation framework**: BBNJ establishes binding obligations to protect biodiversity in ABNJ.
  - **Eg**: Adopted in **June 2023**, signed by 134 countries; aims to cover **30% of oceans by 2030** (UNOC3, 2025).
2. **Equitable benefit-sharing of MGRs**: Introduces fair access rules and revenue-sharing for developing nations.
  - **Eg**: Article 10 mandates **capacity building and transfer of marine technology** to Global South (BBNJ 2023).
3. **Uniform EIAs and SEIAs**: Mandates Environmental Impact Assessments for high-seas projects based on transparent global criteria.
  - **Eg**: All activities affecting marine ecosystems must undergo EIA under Article 22 .
4. **Creation of Marine Protected Areas (MPAs)**: Enables designation of ecologically representative MPAs beyond national boundaries.
  - **Eg**: Less than **1.5% of high seas** currently protected; treaty aims to fill this gap (WDPA data, 2025).
5. **Establishment of Conference of Parties (COP)**: Institutionalises a global governance structure for monitoring and compliance.
  - **Eg**: First **PrepCom** held in **New York (April 2025)** to prepare COP rules (UN Meeting Record, 2025).

## Conclusion

The **BBNJ treaty offers a second-generation ocean governance regime**, but urgent ratification is key. Operationalising it can ensure the high seas are no longer a legal void but a shared ecological responsibility.

**Q. “India’s revised Green India Mission (GIM) reflects a strategic shift towards climate-resilient landscape restoration”. Analyse this view. What role can Green India Mission play in achieving India’s land degradation neutrality goals? (10 M)**

## Introduction

India’s revised **Green India Mission (2025)** adopts an **ecosystem-based, climate-resilient approach** to restore degraded landscapes and contribute to global **land degradation neutrality targets**.

## Body

### **Strategic shift towards climate-resilient landscape restoration**

1. **Region-specific restoration**: Focus on **Aravalli ranges, Western Ghats, Himalayas, mangroves** rather than uniform plantations.
  - **Eg**: **Aravalli Green Wall Project (2024)** creating a 5 km native buffer zone (Source: MoEFCC).
2. **Integration of hydrological aspects**: Emphasis on **groundwater recharge** and wetland ecosystem health.
  - **Eg**: **Western Ghats mining site eco-restoration** linked to aquifer recharge.
3. **Use of native species**: Plantation of **locally adapted native species** to sustain biodiversity and resilience.

- Eg: **Mangrove ecosystem revival** along eastern coastlines (Source: FSI, 2025).
- 4. **Enhancement of natural carbon sinks**: Targeting **wetlands, grasslands, open forests** for large-scale CO<sub>2</sub> sequestration.
  - Eg: **1.89 billion tonnes CO<sub>2</sub>** potential through impaired open forests (Source: FSI, 2025).
- 5. **Adaptive governance and scientific inputs**: Incorporation of **state-level feedback and expert studies** into the roadmap.
  - Eg: **Wildlife Institute of India** findings shaping Aravalli restoration (Source: WII, 2025).

### Role of GIM in achieving land degradation neutrality goals

1. **Progress towards UNCCD targets**: Supports India's pledge to restore **26 million hectares** of degraded land by **2030**.
  - Eg: **11.22 mha afforestation** achieved under GIM (2015-21) (Source: MoEFCC).
2. **Soil fertility enhancement**: Improves **soil organic carbon** and reduces erosion.
  - Eg: **Aravalli catchment regeneration** to combat desertification (Source: MoEFCC).
3. **Water security restoration**: Rejuvenation of **hydrological regimes** in degraded zones.
  - Eg: **Western Ghats interventions** for water table recovery (
4. **CO<sub>2</sub> sequestration and NDC goals**: Aims to meet **2.5–3 billion tonnes CO<sub>2</sub>** sink target under India's NDC.
  - Eg: **2.29 billion tonnes CO<sub>2</sub>** sink created (2005-21).
5. **Community-centric livelihoods**: Enhances **forest-based livelihood opportunities** through participatory restoration.
  - Eg: **Joint Forest Management Committees** integrated with GIM in Chhattisgarh (NAPCC review, 2024).

### **Conclusion**

GIM's evolution into a **climate-smart, landscape-level initiative** offers a robust pathway toward India's sustainable development and climate resilience, provided it ensures **grassroots-driven execution and institutional synergy**.

**Q. Modern warfare leaves invisible yet far-reaching environmental scars. Analyse this statement with reference to ongoing conflicts. Evaluate its impact on global climate goals. (10 M)**

### **Introduction**

Warfare today is not just a human tragedy but also a growing **ecological disaster**, with its footprint extending from the **stratosphere to the oceans** — undermining global climate ambitions.

### **Body**

#### Invisible yet far-reaching environmental scars

1. **Military emissions and unaccounted GHGs**: Large-scale **GHG emissions** from fuel use, vehicle fleets, and heavy machinery during war go unrecorded
  - Eg: **Global militaries emit ~5.5% of global GHGs**, more than **civil aviation and shipping combined**.

2. **Ozone depletion from missile warfare:** Missiles and interceptors release **black carbon, aluminium oxide** and reactive chemicals that damage the **ozone layer**
  - Eg: During the **2025 Israel-Iran conflict**, missile exchanges released pollutants causing potential **ozone thinning**.
3. **Risk of nuclear contamination:** Destruction of **nuclear facilities** can lead to **radiation leaks** into soil, air, and groundwater — with long-term bioaccumulation
  - Eg: **Natanz uranium facility (Iran)** damaged in June 2025; **IAEA** reported contamination risks though external radiation levels remained low (IAEA).
4. **Marine and coastal ecosystem damage:** Bombing near **refineries or ports** leads to **hydrocarbon leakage**, harming coastal biodiversity
  - Eg: **Bazan refinery fire (Israel, June 2025)** threatened **marine ecosystems** of the Gulf due to oil and chemical runoff .
5. **Soil and groundwater contamination from oil fires:** **Oil depot fires** release toxic **particulate matter, VOCs, dioxins** — contaminating local soils and aquifers
  - Eg: **Tehran Oil Refinery fire (2025)** polluted air, land and water, trapping **pollutants** in Tehran’s geographical basin (Conflict and Environment Observatory, 2025).

### **Impact on global climate goals**

1. **Exclusion of war emissions in climate accounting:** **Wartime emissions** are excluded from **UNFCCC inventories**, reducing transparency in global climate reporting
  - Eg: **Russia-Ukraine war (2022-25)** released **~230 million tCO<sub>2</sub>e**, yet is **unreported** in NDCs (GHG Accounting of War Initiative, 2025).
2. **Disruption of renewable energy transition:** Attacks on **clean energy infrastructure** force a return to **carbon-heavy fuels**
  - Eg: **South Pars gas field (Iran)** and **Ukrainian wind and solar farms** damaged during recent wars — delaying the **energy transition** (IEA reports, 2025).
3. **Military exemption loopholes in treaties:** **Kyoto Protocol (1997)** exempted military GHGs; **Paris Agreement (2015)** made military reporting voluntary — creating accountability gaps
  - Eg: Less than **10% of militaries** currently disclose **full GHG data** (UNFCCC records, 2025).
4. **Diversion of climate finance:** **Reconstruction after wars** drains funds from climate mitigation/adaptation commitments
  - Eg: The estimated **\$42 billion social cost** of Russia-Ukraine war emissions (2025) may divert **climate finance** from vulnerable nations (GHG Initiative).
5. **Increased regional climate vulnerability:** War zones suffer **compounded environmental degradation**, weakening climate resilience
  - Eg: **Gaza conflict (2024-25)** emitted **1.9 million tCO<sub>2</sub>e**, with additional ecosystem damage — amplifying local climate risks (War on Climate report, 2025).

### **Conclusion**

Without including the **invisible emissions of warfare**, global efforts toward **net-zero targets** risk failure. It is imperative to embed **war-related emissions** into international climate governance frameworks.

## Q. The growing momentum for seabed mining risks accelerating biodiversity loss in fragile marine ecosystems. Discuss key ecological threats. How can international regulatory frameworks be strengthened? (10 M)

### Introduction

Seabed mining is emerging as a major frontier in resource extraction, yet the **ecological dynamics of deep-sea ecosystems remain poorly understood** (Marine Pollution Bulletin, 2025). Unchecked exploitation could cause irreversible harm to marine biodiversity.

### Body

#### Key ecological threats

1. **Noise pollution and species displacement:** Chronic acoustic pollution disrupts communication and behaviour of cetaceans and soniferous fish.
  - Eg: **2025 study in Clarion Clipperton Zone (CCZ)** documented 70 dolphin groups and vulnerable sperm whales at risk (Frontiers in Marine Science).
2. **Habitat destruction:** Mining activities physically disrupt slow-growing, long-lived benthic communities on the ocean floor.
  - Eg: **ISA 2024 report** warns deep-sea sponges and corals may take centuries to recover post-mining.
3. **Sediment plumes:** Mining generates plumes that smother filter feeders and reduce oxygen availability.
  - Eg: **MIT-WHOI Joint Program (2023)** showed suspended sediments spreading over large distances in CCZ.
4. **Disruption of nutrient cycles:** Mining alters seabed geochemistry, affecting carbon sequestration and nutrient flows.
  - Eg: **2022 Nature Geoscience** paper highlighted risks to deep-sea carbon sinks from nodule mining.
5. **Loss of undiscovered species:** Vast knowledge gaps persist; 65% of taxonomic classes in CCZ unstudied for mining impacts.
  - Eg: **Marine Pollution Bulletin, 2025** review flagged high risk to undocumented biodiversity.

#### Strengthening international regulatory frameworks

1. **Comprehensive environmental impact assessments:** Mandate **baseline studies and long-term cumulative impact analyses** before approvals.
  - Eg: **IUCN (2023) recommendations** to ISA.
2. **Adopt precautionary moratorium:** Halt commercial mining until **robust scientific understanding** is in place.
  - Eg: Supported by **37 countries** at 2025 UN Ocean Conference.
3. **Legally binding mining code:** ISA to adopt enforceable **environmental protection standards**, not voluntary guidelines.
  - Eg: Current ISA draft code under negotiation (2025).
4. **Transparent and inclusive governance:** Broaden participation of **scientific bodies and civil society** in ISA decision-making.

- Eg: Model from **Antarctic Treaty System** cited by Earth Negotiations Bulletin, 2024.
- 5. **Global noise regulation**: Establish international norms to control **underwater noise pollution** from industrial activities.
  - Eg: Recommendation from **UN Decade of Ocean Science 2021-2030** initiatives.

## Conclusion

Sustainable ocean stewardship demands **science-driven, precautionary governance** before unleashing seabed mining. Strengthening global frameworks can ensure that economic gains do not come at the cost of fragile marine life.

**Q. Why is restoring grasslands as ecosystems as important as reforesting degraded woodlands? What are the barriers to grassland conservation in India? Propose measures to mainstream grassland ecology in forest planning. (15 M)**

## Introduction

India's grasslands are wrongly classified as wastelands despite being vital carbon sinks, biodiversity hotspots, and lifelines for pastoral economies, making their restoration as essential as that of forests.

## Body

### Restoring grasslands is as important as reforesting woodlands

1. **Critical for biodiversity conservation**: Grasslands support unique species not found in forests
  - Eg: The **Great Indian Bustard**, critically endangered, thrives only in **arid grassland ecosystems** (Source: MoEFCC, 2023)
2. **Carbon sequestration and climate resilience**: Grasslands store significant soil carbon and are more fire-resilient than forests
  - Eg: According to **TERI (2022)**, **Indian savannas store up to 33% of terrestrial carbon** in deep-rooted grasses
3. **Supports pastoralist livelihoods**: Grasslands sustain millions of livestock and nomadic communities
  - Eg: **Maldhari herders in Gujarat** and **Dhangar community in Maharashtra** depend on seasonal grassland grazing
4. **Natural habitat for large herbivores**: Many species such as blackbuck, nilgai, and wild buffalo require open plains
  - Eg: **Reintroduction of cheetahs in Kuno** necessitated identification of suitable **savanna-type grasslands**
5. **Flood buffering and soil health**: Grasslands reduce runoff, recharge groundwater, and maintain topsoil integrity
  - Eg: Studies by **ATREE (2023)** show **higher percolation rates** in native grasslands compared to afforested plots

### Barriers to grassland conservation in India

1. **Misclassification as wastelands**: Policy frameworks still label grasslands as degraded lands
  - Eg: **Wasteland Atlas of India (2021)** classifies **open scrub and grasslands** as 'non-productive' areas

2. **Afforestation bias in forest policy:** Green cover targets prioritise tree planting over ecological restoration
  - **Eg:** The **Compensatory Afforestation Fund Act (2016)** lacks any allocation for **non-forest ecosystem restoration**
3. **Lack of legal recognition and data:** Grasslands are not a distinct category in Forest Survey reports
  - **Eg:** The **India State of Forest Report 2023** does not separately map or report **grassland coverage**
4. **Encroachment and land use change:** Conversion for agriculture, mining, and infrastructure fragments grassland continuity
  - **Eg:** **Banni Grasslands in Gujarat** have lost **over 40% of area** to illegal plantations and fencing (Source: **GEER Foundation, 2022**)
5. **Inadequate institutional framework:** No dedicated body or program exists to monitor or manage grasslands
  - **Eg:** Unlike forests under **MoEFCC**, grasslands fall under **ambiguous jurisdiction between Revenue and Forest Departments**

### **Measures to mainstream grassland ecology in forest planning**

1. **Include grasslands in legal forest definitions:** Amend the Indian Forest Act to recognise open natural ecosystems
  - **Eg:** The **Supreme Court in Lafarge Case (2011)** highlighted the need to broaden ecological understanding beyond tree cover
2. **Create a national grassland mission:** Launch a time-bound program for grassland mapping, restoration, and management
  - **Eg:** Proposed under **MoEFCC consultations (2023)** but yet to be notified officially
3. **Integrate in working plans and CAMPA guidelines:** Make grassland restoration eligible under compensatory afforestation norms
  - **Eg:** **Ramnagar Forest Division in Uttarakhand (2025)** began replacing eucalyptus with **grasslands in elephant corridors**
4. **Community-based conservation models:** Engage pastoralists and local communities in participatory management
  - **Eg:** **Maldhari-led conservation of Velavadar Blackbuck Sanctuary** is a model of community stewardship
5. **Ecological zoning in landscape planning:** Avoid tree planting in native grassland zones; promote native herbaceous diversity
  - **Eg:** **Forest Research Institute (FRI) Dehradun's 2024 study** recommends **site-appropriate native planting protocols**

### **Conclusion**

India's ecological balance depends not only on its forests but also on the survival of its grasslands. A **paradigm shift in planning, funding, and ecological valuation** is key to giving grasslands their due space in conservation policy.

## Disaster and disaster management.

### Linkages between development and spread of extremism.

**Q. India's flood management is still dominated by structural measures, often neglecting catchment-wide solutions. Assess the need for integrated flood governance. (10 M)**

#### Introduction

Despite rising climate risks, India's flood control remains overly reliant on engineering structures, often ignoring the basin-wide ecological and governance complexities.

#### Body

##### India's flood management is still dominated by structural measures

1. **Colonial-era engineering legacy**: Embankments and dams remain the primary approach across flood-prone states.
  - **Eg**: India has constructed over **35,000 km of embankments** (CWC 2023), many in **Bihar and Assam** with recurrent breaches.
2. **Focus on flood exclusion**: Policies still aim at controlling floods rather than adapting to them through resilience and zoning.
  - **Eg**: **Brahmaputra flood management** mainly relies on levees, not floodplain zoning (CAG Report 2022).
3. **Fragmented institutional structures**: Multiple agencies with sectoral mandates manage flood control without integrated planning.
  - **Eg**: **MoWR and state WRDs** operate dams, while **urban bodies** handle drainage separately, leading to poor coordination (NIH Report 2023).
4. **Limited use of non-structural methods**: Minimal emphasis on land use planning, early warning and community-led management.
  - **Eg**: Only **9%** of total flood management budget (2023) allocated for non-structural components (MoEFCC data).

##### Neglecting catchment-wide solutions

1. **Neglect of basin-level hydrology**: Structural projects often ignore upstream deforestation and altered hydrology.
  - **Eg**: Increased **Assam floods (2022)** linked to upstream catchment degradation in **Arunachal Pradesh**.
2. **Poor interstate coordination**: Lack of integrated frameworks between upstream and downstream states on river management.
  - **Eg**: **Mahanadi Tribunal (2018)** exposed gaps between **Chhattisgarh and Odisha** during dam releases.
3. **Ignoring climate variability**: Structural designs not adapted for increasing frequency of extreme rainfall.
  - **Eg**: **Mumbai 2019 urban floods** exceeded design capacity of stormwater systems planned decades ago.

4. **Undervalued role of wetlands and floodplains**: Natural buffers like wetlands remain encroached and unprotected.
  - **Eg**: Loss of **East Kolkata Wetlands** worsened city flood risk (MoEFCC Wetland Atlas 2023).

### **Need for integrated flood governance**

1. **Basin-wide planning imperative**: Holistic planning across entire river basins to manage upstream-downstream linkages.
  - **Eg**: **Ganga River Basin Management Plan (GRBMP 2021)** advocates integrated flood management.
2. **Mainstreaming climate adaptation**: Aligning flood governance with **India's NDC (2022)** and **Sendai Framework** priorities.
  - **Eg**: **Assam's Climate Resilient Flood Management Project (2024)** by ADB focuses on adaptive governance.
3. **Strengthening interstate coordination**: Urgent reforms needed for cooperative frameworks in transboundary basins.
  - **Eg**: Proposed **National Inter-State River Basin Authority (NIRBA)** under consideration (MoWR, 2024).
4. **Empowering local institutions**: Panchayats and ULBs must be key actors in flood risk reduction.
  - **Eg**: **Odisha's CBDRR model** post-2019 scaled across vulnerable coastal panchayats.

### **Conclusion**

To manage India's rising flood risks, a paradigm shift is needed from fragmented, structural control towards **climate-resilient, integrated, catchment-wide flood governance**.

### **Role of external state and non-state actors in creating challenges to internal security.**

**Challenges to internal security through communication networks, role of media and social networking sites in internal security challenges, basics of cyber security; money-laundering and its prevention.**

**Q. How do cryptocurrencies and digital anonymity tools enable proliferation financing of Weapons of Mass Destruction (WMDs)? What reforms are needed in international financial regulations? (10 M)**

### **Introduction**

The emergence of **cryptocurrencies and anonymity tools** has created new digital avenues for **undetected financial flows**, severely complicating global efforts to combat proliferation financing (PF) of **Weapons of Mass Destruction (WMDs)**. Robust global reforms are urgently needed to counter this growing threat.

### **Body**

**How cryptocurrencies and anonymity tools enable proliferation financing of WMDs**

1. **Anonymity in transactions:** Cryptocurrencies facilitate anonymous, borderless financial flows, bypassing conventional oversight
  - Eg: DPRK's **Lazarus Group** used **privacy coins and crypto mixers** to conduct major **crypto-heists in 2025**, concealing both source and destination of funds (FATF Report, June 2025)
2. **Bypassing traditional banking controls:** Decentralised crypto markets allow PF actors to avoid regulated financial institutions and AML checks
  - Eg: FATF highlighted that **\$1.5 billion stolen from ByBit in February 2025** was routed through **DeFi platforms**, completely bypassing **KYC/AML frameworks**
3. **Use of decentralised finance (DeFi):** DeFi systems operate without centralised intermediaries, making it difficult to monitor or intercept PF activities
  - Eg: **DPRK cybercriminals** laundered stolen digital assets through **cross-chain bridges and DeFi lending protocols**, effectively erasing transaction trails (FATF, 2025)
4. **Exploitation of lax KYC in exchanges:** Crypto exchanges with weak compliance are exploited to convert crypto proceeds into fiat currencies
  - Eg: Investigations revealed that **crypto exchanges in unregulated jurisdictions** were used to launder large sums for **PF-linked networks** in 2025 (FATF 2025 report)
5. **Integration with cybercrime networks:** Cyberattacks generate crypto assets that are funnelled into WMD programs without touching the formal banking sector
  - Eg: The **UN Panel of Experts (2025)** reported that **DPRK state-sponsored cyberattacks** on multiple **crypto exchanges** directly financed **WMD development and missile programs**

#### **Reforms needed in international financial regulations**

1. **Global harmonisation of crypto regulations:** Widespread adoption of FATF standards to ensure no regulatory safe havens for PF actors
  - Eg: The **FATF's 2025 recommendations** call for universal implementation of **KYC/AML obligations** for all **Virtual Asset Service Providers (VASPs)** to close jurisdictional gaps
2. **Mandatory regulation of DeFi platforms:** Bringing decentralised platforms and services under effective regulatory oversight
  - Eg: **EU MiCA Regulation 2025** proposes mandatory regulation of **DeFi protocols and crypto mixers** to enhance accountability and transparency in digital finance
3. **Enhanced information sharing:** Improved intelligence exchange between nations to track PF networks operating across borders
  - Eg: The **Egmont Group of Financial Intelligence Units**, in coordination with **Interpol**, is working to strengthen data sharing on **crypto-enabled PF risks** (2025 FATF Report)
4. **Real-time blockchain analytics:** Deployment of advanced tools to monitor and analyse blockchain transactions for early PF detection
  - Eg: **US FinCEN (2025)** has adopted **AI-based blockchain analytics tools** to trace and disrupt illicit crypto flows linked to **WMD proliferation financing networks**
5. **Strengthening public-private partnerships:** Encouraging crypto industry collaboration with law enforcement and intelligence agencies
  - Eg: The **UK's Joint Money Laundering Intelligence Taskforce (JMLIT)** actively involves **crypto firms** to identify and report PF red flags, contributing to national CPF efforts (UK NCA 2025)

## **Conclusion**

Tackling PF through crypto demands **globally coordinated regulations**, real-time digital surveillance, and **innovative multi-stakeholder partnerships** to counter the ever-evolving threat to global peace and security.

**Security challenges and their management in border areas - linkages of organized crime with terrorism.**

**Various Security forces and agencies and their mandate.**

INSIGHTSIAS