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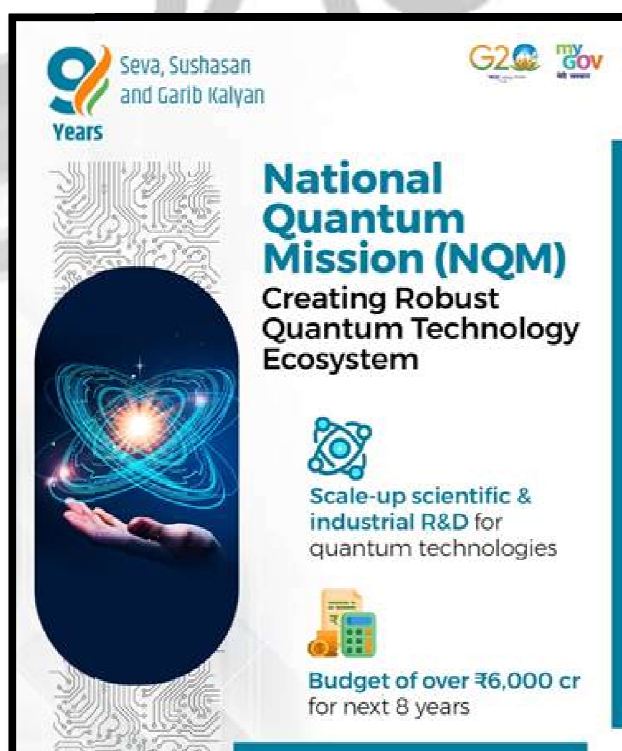
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NATIONAL QUANTUM MISSION: INDIA'S QUANTUM LEAP

WHY IN THE NEWS?

The National Quantum Mission (NQM) has been making headlines as a groundbreaking initiative by the Government of India to advance quantum technology research and development. Approved by the Union Cabinet on April 19, 2023, the mission is set to run from 2023–24 to 2030–31, with a substantial budget of ₹6,003.65 crore. This mission aims to position India as a global leader in quantum technologies, driving innovations in computing, communication, and cryptography. With the potential to revolutionize industries like healthcare, clean energy, cybersecurity, and climate research, the NQM is seen as a strategic step toward technological self-reliance and economic growth, making it a significant topic of discussion worldwide.



WHAT IS QUANTUM COMPUTING?

Quantum computing is an advanced field of computing that leverages the principles of quantum mechanics to perform calculations much faster than classical computers. Unlike traditional computers, which use bits (0s and 1s) to process data, quantum computers use qubits (quantum bits), which can exist in multiple states at once due to superposition.

Key Principles of Quantum Computing:

- 1. Superposition:** A qubit can be both 0 and 1 simultaneously, allowing quantum computers to process vast amounts of information in parallel.
- 2. Entanglement:** Qubits can be strongly correlated, meaning a change in one qubit instantly affects another, regardless of distance. This property enables faster and more secure computations.
- 3. Quantum Interference:** Quantum states can interfere with each other, helping optimize and refine computations.

OBJECTIVES OF THE NATIONAL QUANTUM MISSION

- 1. Quantum Computing Evolution:** Develop intermediate-scale quantum computers with 20-50 physical qubits (3 years), 50-100 physical qubits (5 years), and 50-1000 physical qubits (8 years) across platforms like superconducting and photonic technologies to advance computational capabilities.
- 2. Satellite-Based Quantum Communication:** Establish satellite-enabled quantum-secured communication between two ground stations over 2000 km within India and extend this technology for long-distance secure quantum communication with other countries.
- 3. Inter-City Quantum Key Distribution (QKD):** Implement quantum-secured communication spanning 2000 km using trusted nodes and wavelength division multiplexing (WDM) on existing optical fibre infrastructure, enhancing secure data transmission.
- 4. Multi-Node Quantum Networks:** Develop a multi-node quantum network incorporating quantum memories, entanglement swapping, and synchronized quantum repeaters at each node, enabling scalable and robust quantum communication (2-3 nodes).
- 5. Advanced Quantum Sensing & Clocks:** Design highly sensitive quantum devices, including magnetometers with 1 femto-Tesla/sqrt(Hz) sensitivity in atomic systems and better than 1 pico-Tesla/sqrt(Hz) in Nitrogen-Vacancy centres, gravity sensors with better than 100 nano-meter/second² sensitivity, and atomic clocks with 10⁻¹⁹ fractional instability for precision timing, navigation, and secure communication.
- 6. Quantum Materials & Devices:** Develop and synthesize next-generation quantum materials such as superconductors, novel semiconductor structures, and topological materials for the fabrication of qubits, single-photon sources/detectors, entangled photon sources, and quantum sensing/metrological devices for applications in computing and communication.

IMPLEMENTATION STRATEGY AND INITIATIVES

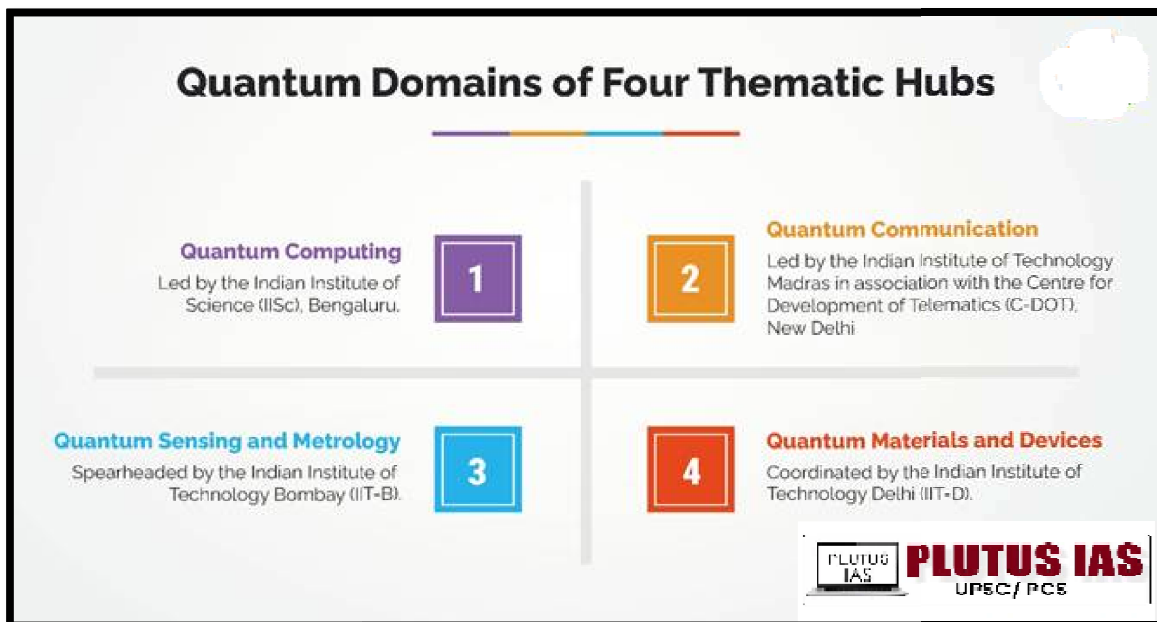
The National Quantum Mission is a nationwide initiative driving cutting-edge advancements in quantum technology. As part of this mission, four Thematic Hubs (T-Hubs) have been set up, bringing together 14 Technical Groups across 17 states and 2 Union Territories. These hubs focus on technology innovation, skill development, entrepreneurship, industry partnerships, and global collaborations, ensuring a truly national impact. Women scientists from every corner of the country are actively encouraged to participate and benefit from the mission's exciting programs.

The four T-Hubs have been established across leading institutions in India:

1. Indian Institute of Science (IISc) Bengaluru
2. Indian Institute of Technology (IIT), Madras, in association with the Centre for Development of Telematics, New Delhi
3. Indian Institute of Technology (IIT), Bombay

Indian Institute of Technology (IIT), Delhi.

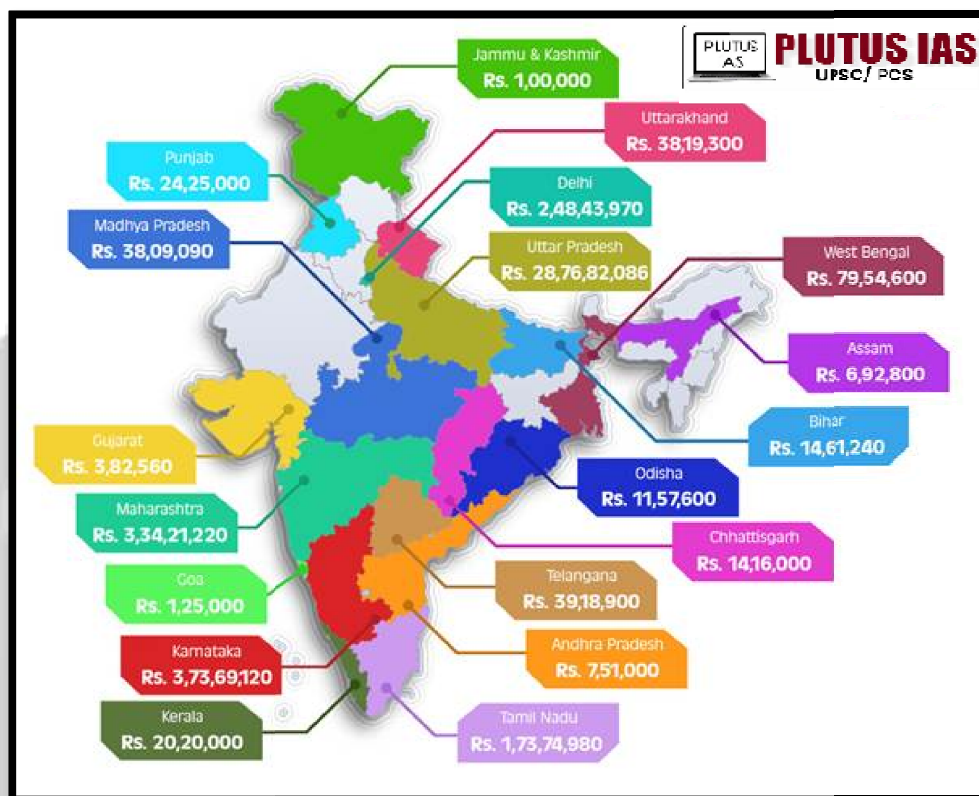
These hubs were selected through a rigorous competitive process, and each hub focuses on a specific quantum domain, driving advancements in Quantum Computing, Quantum Communication, Quantum Sensing & Metrology, and Quantum Materials & Devices.



Hub-Spoke-Spike Model: Each T-Hub will follow the Hub-Spoke-Spike model, fostering a cluster-based network where research projects (Spokes) and individual research groups (Spikes) operate alongside central hubs. This structure enhances collaboration among research institutions, allowing them to share resources and expertise more effectively.



State-wise Funds Allocation: The four T-Hubs selected under NQM collectively involve 152 researchers from 43 institutions nationwide, fostering a collaborative ecosystem to drive research and innovation in quantum technologies. The activities carried out by these hubs include Technology Development, Human Resource Development, Entrepreneurship Development, Industry Collaboration, and International Collaboration.



SIGNIFICANCE OF NATIONAL QUANTUM MISSION

- 1. Technological Advancement:** The NQM propels India into the global race for quantum supremacy, fostering innovation in computing, communication, and security.
- 2. Economic Growth:** With a budget of ₹6,003.65 crore, the mission can drive investments, create jobs, and boost the tech sector.
- 3. Cybersecurity & National Security:** Quantum encryption can significantly enhance data security, making cyber communication unbreakable.
- 4. Scientific Innovation:** Encourages indigenous research, fostering advancements in quantum computing, materials science, and precision sensing.
- 5. Industry & Start-up Ecosystem:** Strengthens partnerships between academia, industry, and startups, driving the commercialization of quantum technologies.
- 6. Global Competitiveness:** Positions India as a key player in the quantum revolution, fostering international collaborations and technology exports.
- 7. Interdisciplinary Impact:** Advances in quantum science benefit healthcare, clean energy, finance, and logistics through enhanced computational and analytical capabilities.
- 8. Human Resource Development:** Establishes a skilled workforce in quantum technology, promoting education and research across premier institutions.

CHALLENGES OF NATIONAL QUANTUM MISSION

- 1. Technological Barriers:** Developing stable qubits and error correction mechanisms remains a significant challenge.
- 2. High Cost of Implementation:** Quantum technology requires substantial investment in infrastructure, research, and skilled professionals.
- 3. Limited Skilled Workforce:** A shortage of trained quantum scientists and engineers could slow progress.
- 4. International Competition:** Leading nations like the US, China, and the EU are investing heavily in quantum research, creating intense competition.
- 5. Scalability Issues:** Building quantum computers with more qubits while maintaining stability and coherence is complex.
- 6. Data Security Risks:** While quantum encryption enhances security, adversaries may also develop quantum capabilities to break existing cryptographic protocols.
- 7. Industry Readiness:** Indian industries need awareness and investment to integrate quantum solutions into real-world applications.
- 8. Infrastructure Constraints:** Establishing quantum labs, computing centers, and network systems across the country requires significant infrastructural development.

WAYS TO MAKE INDIA SELF RELIANT

- 1. Strengthening Research & Development:** Increase funding for quantum research, establish dedicated R&D centres, and promote academic-industry collaborations.
- 2. Skill Development Programs:** Launch specialized quantum computing courses, fellowships, and training programs to build a strong talent pool.
- 3. Encouraging Startups & Entrepreneurship:** Provide grants, tax incentives, and incubation support to quantum technology startups.
- 4. Public-Private Partnerships:** Facilitate collaborations between government, academia, and private enterprises to accelerate innovation.
- 5. Building Quantum Infrastructure:** Invest in quantum labs, high-performance computing facilities, and secure communication networks.
- 6. Enhancing Global Collaborations:** Partner with leading quantum research nations to exchange knowledge, technology, and best practices.
- 7. Regulatory & Policy Support:** Develop national policies for quantum technology adoption, ethical AI, and cybersecurity frameworks.
- 8. Commercialization of Quantum Technologies:** Focus on developing market-ready quantum solutions for industries such as finance, healthcare, defence, and logistics.

CONCLUSION

The National Quantum Mission (NQM) is more than just a technological initiative—it is a strategic step towards securing India's future in the quantum era. With significant investments, world-class research collaborations, and dedicated innovation hubs, the mission is set to propel India to the forefront of the global quantum revolution. This initiative underscores India's commitment to scientific excellence, economic resilience, and national security in a world where quantum technologies are poised to reshape industries and societies.

PRELIMS QUESTIONS

Q. With reference to the National Quantum Mission (NQM), consider the following statements:

1. The mission was approved by the Union Cabinet in 2022.

2. It aims to establish satellite-enabled quantum-secured communication over 2000 km within India.
3. The mission focuses only on quantum computing and does not include quantum communication or sensing.

How many of the above-given statements are correct?

- A. Only one
B. Only two
C. All three
D. None

Answer: A

MAINS QUESTIONS

Q. Discuss the significance of the National Quantum Mission (NQM) in the context of India's technological and economic growth. Highlight the challenges and suggest measures to make India self-reliant in quantum technology (250 words, 15 marks)

LEFT-WING EXTREMISM IN INDIA.

WHY IN THE NEWS?

Recently, at least 30 Maoists and a policeman were killed in twin encounters in the Bijapur and Kanker districts of Chhattisgarh. These operations, involving nearly 2,200 security personnel from the District Reserve Guard (DRG), Special Task Force (STF), Central Reserve Police Force (CRPF), CoBRA, and Border Security Force (BSF), mark a significant escalation in anti-LWE efforts. This incident pushes the total Maoist casualties in Chhattisgarh beyond 100 for the year, highlighting the intensification of counter-insurgency measures. Security forces recovered a large cache of AK-47 rifles, automatic and semi-automatic weapons during the operation. The increasing success of such operations underscores the impact of coordinated intelligence-based strikes and the government's commitment to eradicating LWE.



DATA ON LWE AND THE RED CORRIDOR

The 'Red Corridor' refers to regions in India where LWE has a strong presence. This corridor primarily includes parts of states such as Chhattisgarh, Jharkhand, Odisha, Maharashtra, Andhra Pradesh, Bihar, and West Bengal. The Ministry of Home Affairs (MHA) has identified LWE-affected districts, categorizing them based on the intensity of violence and Maoist influence.

1. In 2010, around 223 districts were affected by LWE. However, by 2023, the number had reduced to approximately 70, with only 25 districts witnessing significant activity.
2. According to MHA reports, LWE-related violence has declined by nearly 77% since 2010, and civilian and security force casualties have also dropped substantially.
3. The states most affected remain Chhattisgarh, Jharkhand, and Odisha, with Bastar in Chhattisgarh being a key Maoist stronghold.
4. As per the latest data from the Press Information Bureau (PIB), as of December 2024, there are now only 38 LWE-affected districts in the country, marking a significant reduction.
5. Over the past five years, 60 districts have been freed from LWE influence, reflecting the success of government interventions.
6. Between 2014 and 2023, LWE-related incidents declined by over 52%, while overall deaths decreased by 69%. Security forces' casualties reduced by 72%, and civilian deaths dropped by 68% compared to the period from 2005 to 2014.
7. For the first time in three decades, LWE-related casualties fell below 100 in 2022, underscoring a notable improvement in counter-insurgency operations.

CAUSES OF LEFT-WING EXTREMISM

The persistence of LWE can be attributed to a mix of socio-economic, political, and administrative factors:

- 1. Economic Disparities:** Poverty, landlessness, and lack of employment opportunities in tribal and rural areas have fueled discontent. Exploitation of natural resources without adequate compensation or rehabilitation has further alienated local communities.
- 2. Political Alienation:** Tribal and marginalized communities often feel ignored by mainstream political parties and institutions. The failure of local governance in providing basic services has pushed people towards extremist ideologies.
- 3. Administrative Lapses:** Weak law enforcement and lack of adequate security infrastructure have allowed Maoists to operate with impunity in remote areas. Corruption in government schemes has deprived locals of essential benefits.
- 4. Social Injustice and Human Rights Violations:** Police excesses and displacement due to infrastructure and mining projects have intensified grievances. The absence of proper rehabilitation measures for displaced communities has made them susceptible to Maoist propaganda.
- 5. Failure of Land Reforms:** Land ownership disputes and the absence of effective land redistribution policies have fueled discontent among landless farmers and tribal communities. Illegal land acquisition by corporations and influential individuals has further deepened grievances.
- 6. Exploitation by Middlemen and Contractors:** Tribals and rural poor often fall prey to exploitative middlemen in agricultural, forest, and labor markets. The lack of institutional financial support makes them dependent on moneylenders, leading to cycles of debt and exploitation.
- 7. Weak Law Enforcement and Security Gaps:** The remoteness and difficult terrain of affected areas make law enforcement ineffective. Lack of sufficient police presence and slow response times allow Maoist groups to operate with relative impunity.

GOVERNMENT POLICIES TO ADDRESS LWE

The Indian government has adopted a multi-pronged approach to counter LWE, focusing on security measures, developmental initiatives, and rehabilitation programs.

1. Security Measures: Operation SAMADHAN: Launched by the MHA, this strategy involves aggressive anti-Maoist operations, intelligence gathering, and coordination between central and state police forces. Deployment of Central Armed Police Forces (CAPF) such as CRPF and special battalions like the CoBRA (Commando Battalion for Resolute Action) to combat Maoists. Establishment of fortified police stations in vulnerable regions.

2. Developmental Initiatives: Special Infrastructure Scheme (SIS): Focuses on enhancing road connectivity, mobile towers, and essential services in affected regions. Aspirational Districts Programme: Aims at improving education, healthcare, and livelihood opportunities in backward districts. Skill Development and Employment Generation: Schemes such as MGNREGA and various state-led programs target job creation.

3. Surrender and Rehabilitation Policies: Incentives are provided for surrendered Maoists, including financial aid, vocational training, and reintegration into society. States like Chhattisgarh and Jharkhand have specific policies offering attractive rehabilitation packages.

4. National Policy and Action Plan (2015): Approved in 2015, this comprehensive strategy addresses LWE through security measures, development interventions, and ensuring the rights and entitlements of local communities.

5. Expansion of Road Networks: To improve connectivity in LWE-affected areas, the government has constructed 13,620 km of roads, facilitating better access and economic development.

6. Enhancement of Telecommunication Connectivity: A total of 13,823 mobile towers have been sanctioned, with over 3,700 already commissioned, to improve communication in affected regions.

7. Financial Inclusion Initiatives: To integrate local populations into the financial system, 4,903 new post offices, 955 bank branches, and 839 ATMs have been established in 30 most LWE-affected districts since April 2015.

8. Establishment of Security Camps: Since 2019, security forces have established 175 new camps in LWE-affected areas, reducing security vacuums and weakening extremist influence.

9. Choking of Funds: Efforts have been intensified to disrupt financial networks supporting LWE activities, targeting illegal funding sources to weaken their operations.

CHALLENGES IN LWE ELIMINATION

Despite significant progress, several challenges hinder the complete eradication of LWE:

1. Geographical and Terrain Challenges: Maoists operate in dense forests and hilly terrains, which provide natural cover and make security operations difficult. The absence of proper roads and communication networks in these areas hampers counter-insurgency efforts.

2. Local Support and Ideological Appeal: Maoists continue to find support among marginalized and tribal communities who feel alienated from mainstream governance. Socio-economic grievances such as land displacement, unemployment, and lack of basic amenities fuel Maoist recruitment.

3. Security Personnel Casualties and Resource Constraints: According to MHA data, over 12,000 people, including civilians and security personnel, have lost their lives in LWE-related violence since 2000. Improvised Explosive Devices (IEDs) remain a significant threat, with a majority of security personnel casualties attributed to such attacks. The need for better coordination between state and central forces remains a challenge, as jurisdictional conflicts sometimes hinder operations.

4. Financial and Logistical Support to Maoists: Maoists continue to fund their activities through extortion, illegal mining, and levies on contractors and businesses. Despite efforts to cut off their funding sources, Maoists have adapted by using covert channels and digital transactions.

5. Slow Implementation of Developmental Projects: Government initiatives aimed at uplifting affected regions often face delays due to corruption, bureaucratic inefficiency, and lack of accountability. The Aspirational Districts Programme and other schemes need to be implemented more effectively to win the confidence of local communities.

6. Use of Advanced Warfare Techniques by Maoists: The adoption of modern guerilla warfare tactics, including drones, encrypted communication, and cyber-propaganda, poses new challenges for security agencies. There is an increasing need for intelligence-based operations and technology-driven counter-insurgency strategies.

7. Human Rights Concerns and Excessive Use of Force: Reports of civilian casualties, wrongful detentions, and police excesses have led to criticism and sometimes even strengthened Maoist propaganda. A balanced approach that ensures security operations do not alienate the local population is crucial to maintaining legitimacy.



RECENT TRENDS IN LW

1. Declining Influence: A significant reduction in Maoist violence and territorial control has been observed over the past decade. Several top Maoist leaders have been arrested or neutralized, weakening their operational capabilities.

2. Shift in Strategy: Maoists have increasingly relied on IEDs (Improvised Explosive Devices) to target security forces instead of direct confrontations. There has been an effort to radicalize youth and use digital platforms for propaganda and recruitment.

3. State Success Stories: Andhra Pradesh and Telangana have largely curbed Maoist influence through effective governance and security strategies. Jharkhand and Odisha have significantly weakened insurgent networks with sustained operations and development work.

4. Targeting Infrastructure and Government Projects: Increased attacks on road construction projects, mobile towers, and railway networks indicate an effort to prevent government penetration into strongholds. Destruction of schools and health centers in some affected districts shows resistance to developmental activities aimed at winning over local communities. Extortion from contractors and businesses continues to be a major source of funding for LW groups.

5. Growing Surrender and Rehabilitation Numbers: More Maoist cadres are surrendering due to government amnesty policies and an improved security presence. State governments have successfully rehabilitated surrendered extremists with livelihood opportunities and social integration measures. The

internal divisions within Maoist factions have also led to desertions, further weakening their operational strength.

FURTHER COURSE OF ACTION

1. Strengthening Security Measures: Enhancing inter-state coordination for intelligence sharing and joint operations. Investing in modern technology such as drones, satellite imagery, and AI-driven surveillance for better tracking of insurgent movements. Expanding the presence of special counter-insurgency forces in key Maoist strongholds while ensuring minimal collateral damage.

2. Accelerating Development Initiatives: Ensuring effective implementation of government schemes with transparency and local participation. Promoting local governance and empowering Panchayati Raj institutions to address grievances at the grassroots level. Establishing more residential schools, healthcare centers, and vocational training institutes to bridge developmental gaps.

3. Winning Hearts and Minds: Engaging with local communities to build trust and reduce Maoist influence. Expanding educational opportunities and skill training programs tailored to the needs of affected populations. Strengthening civil society participation in governance and decision-making processes to ensure inclusion and representation.

4. Reinforcing Rehabilitation Programs: Improving incentives for Maoists willing to surrender. Providing long-term employment opportunities to prevent recidivism. Creating specialized support groups for rehabilitated individuals to ensure their smooth reintegration into society.

5. Addressing Root Causes of Radicalization: Establishing independent monitoring bodies to ensure the protection of human rights in counter-insurgency operations. Providing alternative leadership opportunities for youth in affected regions to divert them from extremist ideologies. Strengthening laws and policies to prevent exploitation of local resources by corporations without fair compensation to the affected communities.

CONCLUSION

Left-Wing Extremism remains one of India's most persistent internal security challenges, but significant progress has been made in its containment. A combination of strong security action, targeted developmental programs, and community engagement has yielded positive results. However, to achieve complete eradication, the government must continue its efforts to address the root causes while maintaining a balance between force and welfare. The future course must involve holistic development, inclusive governance, and technological advancements in counter-insurgency operations to ensure lasting peace and prosperity in affected regions.

PRELIMS QUESTIONS:

Q. Consider the following statements regarding Left-Wing Extremism (LWE) in India:

1. The term "Red Corridor" refers to regions with a high presence of Maoist activities.
2. LWE is primarily concentrated in northeastern states of India.
3. The number of LWE-affected districts has decreased over the years due to government interventions.

Which of the statements given above is/are correct?

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

ANSWER: B

MAINS QUESTIONS:

Q. Discuss the role of security forces and community engagement in countering LWE. How can a balanced approach between force and development be achieved? (250 words, 15 marks)



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