NITROUS OXIDE EMISSIONS - ENVIRONMENT PRELIMS AND GS III MAINS

Q. What are the factors contributing to the deadly landslides across the world and bring out the adaptation and mitigation measures taken by the government to reduce its impact. (15 marks, 250 words)

News: *Nitrous oxide emissions up 40 % in 40 yrs, mostly from farms, says study*

What's in the news?

- **India ranks as the world's second-largest contributor (after China) to nitrous oxide (N2O),** a potent greenhouse gas (GHG), accounting for approximately 11% of global man-made emissions in 2020 as per data published in the journal Earth System Science Data.

Key takeaways:

The **top five country** emitters by volume of anthropogenic N2O emissions in 2020 were

- China (16.7%)
- India (10.9%)
- United States (5.7%)
- Brazil (5.3%)
- Russia (4.6%)

Key Highlights of the Report on Nitrous Oxide Emissions:

1. Atmospheric Concentrations of N2O and CO2:

a. N2O:

- In 2022, atmospheric N2O reached 336 parts per billion, marking a **25% increase from pre-industrial levels.**

b. CO2:

- In contrast, atmospheric CO2, the primary greenhouse gas after water vapor, measured 417 parts per million in the same year.

2. Increase in Human-Generated N2O Emissions:

- Human-generated N2O emissions have surged **by 40%** (three million metric tons per year) over the past four decades.

3. Dominance of Agricultural Sources:

- Agricultural practices utilising nitrogen fertilisers like ammonia and animal manure accounted for **74%** of total anthropogenic N2O emissions in the past decade.

4. Exceeding IPCC Projections:

- In the past decade, observed atmospheric N2O concentrations have surpassed even the most pessimistic future greenhouse gas trajectories outlined by the IPCC, which could lead to global mean temperatures exceeding 3°C by the end of this century.

5. Long term Effects:

- N2O stays in the atmosphere for longer than the average human lifespan **(117 years),** impacting climate and ozone.

6. Environmental Impact of Nitrogen Fertilisers:

- Inefficient use of synthetic nitrogen fertilisers and animal manure also leads to the pollution of groundwater, drinking water, and inland and coastal waters.

7. Impact of Meat and Dairy Production:

- The growing demand for meat and dairy products has also contributed to an increase in emissions through the increase in manure production, which also causes N2O emissions.
- Increased nitrogen fertilisers used in the production of animal feed have also contributed to the increase.

8. Agricultural and Aquaculture Emission Trends:

- Emissions from agriculture continue to grow, while those from other sectors, such as fossil fuels and the chemical industry, are not growing or declining globally.

9. India's Standing:

- India ranks second in the world concerning N2O emissions from nitrogen fertilizers, which are all subsidised by over 80% in India.

Nitrous Oxide:

- Nitrous oxide (N2O), a **colourless and odourless gas, is a potent greenhouse gas, 300 times more powerful than CO2.**
- Despite its small atmospheric fraction, it ranks third in concentration after CO2 and methane (CH4).
- It's a crucial target for environmental research and efforts to mitigate climate change impacts.

Sources of Emission:

1. Natural Sources:

- N2O is naturally produced in processes such as **microbial nitrogen cycling in soil and water bodies, volcanic activity, and biomass burning.**

2. Anthropogenic Activities:

Human activities significantly contribute to N2O emissions, with the primary sources being:

- **Agricultural practices**, including the use of nitrogen-based fertilizers and animal manure.

- **Industrial processes** such as combustion of fossil fuels and wastewater treatment.
- **Combustion of biomass and waste.**
- Use of nitrous oxide in **medical and dental procedures** (as a sedative) and in food packaging.

Impact of Nitrous Oxide on Climate Change:

1. Greenhouse Gas:

- N2O is a potent greenhouse gas with a global warming potential (GWP) much higher than that of carbon dioxide (CO2).

2. Ozone Depletion:

- In addition to its role in climate change, N2O also contributes to ozone depletion in the stratosphere, further exacerbating environmental concerns.

3. Environmental Pollution:

- N2O emissions can lead to pollution of soil, water bodies, and air, affecting ecosystems and human health.

4. Health Risks:

- While N2O is relatively non-toxic at ambient levels, prolonged exposure or high concentrations can pose health risks, including respiratory issues and neurological effects.

5. Challenge to Food Security:

- Agricultural sector, particularly the use of nitrogen-based fertilisers, is a major contributor to N_2O emissions and the growing demand for food will likely lead to a further increase in N_2O emissions, creating a conflict between food security and climate goals.

India's Policy Initiatives to Curb Nitrogen Pollution

1. Nutrient-Based Subsidy (NBS) (2010):

- This policy encourages the adoption of controlled-release fertilizers to enhance nutrient management efficiency.

2. Soil Health Cards (2015):

- Provided to farmers, these cards offer insights into soil nutrient levels and tailored fertilizer recommendations, promoting balanced nutrient application.

3. Bharat Stage (BS VI) Emission Standards (2016):

- These stringent regulations for vehicles and industries aim to reduce the emission of nitrogen oxides and particulate matter, thereby mitigating air and water pollution.

4. Nano Urea (2021):

- Marketed by the Indian Farmers Fertiliser Cooperative Limited (IFFCO), Nano Urea is a patented fertilizer approved for commercial use, designed to curb excessive and indiscriminate conventional urea use while boosting crop yields.

Measures to Reduce Nitrous Oxide Emissions in Atmosphere:

1. Innovative Agricultural Practices:

a. Precision Agriculture:

- Utilising technologies like soil sensors to optimise fertiliser application reduces unnecessary nitrogen input, thereby minimising N_2O formation.
- A study by Journal Nature found that precision agriculture techniques can decrease N_2O emissions by up to 50%.

b. Nitrification Inhibitors:

- These additives slow the conversion of ammonium in fertilisers to nitrate, a readily available form for N_2O-producing microbes.

c. Cover Cropping:

- Planting cover crops during fallow periods helps retain soil moisture and nitrogen, reducing the risk of N_2O release.

d. Anti-Methanogenic Feed:

- Using Anti-methanogenic feed like 'Harit Dhara' (HD), or developing similar anti-nitrogen feed for cattle will help to reduce methane and nitrogen emissions.
- Additionally, adopting a cyclic method to generate fuel gas from cattle dung, instead of allowing nitrogen emissions from anaerobic degradation, can also minimise N_2O formation.

e. Nano-Fertilisers:

- Nano fertilisers can deliver nutrients directly and slowly to plant roots, minimising excess nitrogen and reducing nitrous oxide emissions.
- They enhance nutrient absorption, potentially requiring less fertiliser overall. By delivering nutrients slowly and directly to plant roots, they can minimise the surplus nitrogen available for conversion

2. Effective Policy Measures:

a. Emission Trading Schemes:

- Implementing a cap-and-trade system for N_2O emissions can incentivise industries and farmers to adopt cleaner practices.
- The successful implementation of such schemes in the European Union for other greenhouse gasses offers valuable lessons.

b. Targeted Subsidies:

- Governments can provide financial support for farmers transitioning to sustainable practices that minimize N_2O emissions.
- China's successful reduction in N_2O emissions since the mid-2010s has been partly attributed to targeted subsidies for improved fertiliser management.

c. Research and Development:

- Increased funding for research on N_2O mitigation strategies, including improved fertilisers and waste management techniques, is crucial for long-term progress.

3. Addressing Emissions from Other Sources:

a. Industrial Processes:

- Implementing stricter regulations and promoting cleaner technologies can minimize N_2O emissions from industrial sources such as nylon production and nitric acid manufacturing can curb rising nitrous oxide emissions.

b. Combustion:

- As per the IPCC Climate Change 2021 report, optimizing combustion processes in vehicles and power plants can help reduce N_2O emissions as a by-product.

c. Waste Management:

- As per the World Bank report, technological advancements in waste-to-energy conversion and the effective treatment of wastewater and agricultural waste can significantly decrease N_2O emissions from these sources.