AMMONIA EMISSIONS - GS III MAINS

Q. Without any management strategies, the authors calculated that ammonia emissions could rise by between 4.6% to 15.8% by 2100, Critically analyse the impacts of ammonia emissions in the above regard. (10 marks, 150 words)

News: *Reducing ammonia emissions through targeted fertilizer management*

What's in the news?

- Based on machine learning, researchers have come up with detailed estimates of ammonia emissions from rice, wheat and maize crops.

Key takeaways:

- The dataset enabled a cropland-specific assessment of the potential for emission reductions, which indicates that effective management of fertilizer in the growing of these crops could lower atmospheric ammonia emissions from farming by up to 38%.

Atmospheric Ammonia:

- Atmospheric ammonia is a key **environmental pollutant** that affects ecosystems across the planet, as well as human health.
- Around 51-60% of anthropogenic ammonia emissions can be traced back to crop cultivation, and about half of these emissions are associated with **three main staple crops** such as
    - Rice
    - Wheat
    - Maize.

Research:

- The researchers found that under the fertilizer management scenario rice crops could contribute 47% of the total reduction potential and maize and wheat could contribute 27% and 26%, respectively.
- Without any management strategies, the authors calculated that ammonia emissions could rise by between 4.6% to 15.8% by 2100, depending on the level of future greenhouse gas emissions.
- The optimised strategy involves placing enhanced-efficiency fertilizers deeper into the soil using conventional tillage practices during the growing season.

Industrial Usage of Ammonia:

1. Fertilizer Production:

- Ammonia is a key component in the production of nitrogen-based fertilizers.

2. Refrigeration:

- Used in industrial refrigeration systems.

3. Chemical Industry:

- Fundamental ingredient in the production of substances like nitric acid, ammonium sulfate, and various nitrogen-based compounds.

4. Household:

- An ingredient in household cleaning products, including glass and surface cleaners.

Ammonia Emissions:

1. Ammonia Emissions in Agriculture:

- Ammonia (NH_3) emissions primarily originate from agricultural activities, particularly livestock farming and the application of synthetic and organic fertilizers.

2. Livestock Farming:

- Livestock, such as cattle, poultry, and swine, produce ammonia through the breakdown of urea in their urine and faeces. Confined animal feeding operations (CAFOs) are major contributors to ammonia emissions.

3. Fertilizer Application:

- Ammonia is released when synthetic fertilizers containing ammonium-based compounds (e.g., ammonium nitrate) are applied to crops. Manure from livestock can also be used as organic fertilizer, contributing to ammonia emissions.

Impacts of Ammonia Emissions:

1. Air Pollution:

- Ammonia emissions can lead to air pollution, especially in areas with intensive agriculture.
- It can react with other pollutants to form fine particulate matter ($PM_{2.5}$) and contribute to the formation of ground-level ozone, which has adverse effects on human health and the environment.

2. Acid Deposition:

- Ammonia can undergo atmospheric transformation and contribute to acid rain, which can harm aquatic ecosystems, forests, and infrastructure.

3. Nutrient Loss:

- Ammonia emissions represent a loss of valuable nitrogen nutrients from agricultural systems.
- This can reduce the efficiency of fertilizer use and contribute to nitrogen pollution in water bodies.

4. Environmental Impact:

- Atmospheric ammonia is a significant environmental pollutant, affecting ecosystems and human health globally.

5. Water Pollution:

- Ammonia runoff from agricultural activities can contribute to water pollution.

6. Health Impacts:

- Irritant: Inhalation of high concentrations can cause irritation of the eyes, nose, and respiratory tract.
- Toxicity: Prolonged exposure to high levels may lead to respiratory and lung issues.

7. Production Challenges:

- The production of ammonia typically relies on the Haber-Bosch process, which consumes a significant amount of energy and relies on fossil fuels.

Acceptable Levels of Ammonia:

1. India:

- The acceptable level of ammonia in ambient air in India is set by the **Central Pollution Control Board (CPCB).**
- The **National Ambient Air Quality Standards (NAAQS)** specify a limit of 400 microgram in air and 5mg/L in sea for ammonia.

2. World:

- Internationally, the World Health Organization (WHO) recommends a guideline value of 25 $\mu g/m^3$ for ammonia in the air.

Regulatory Mechanisms to Control Ammonia Pollution:

Global Level:

1. Montreal Protocol:

- While not directly regulating ammonia, the Montreal Protocol on Substances that Deplete the Ozone Layer is a significant international treaty.
- It aims to phase out the production and consumption of substances harmful to the ozone layer.
- Although ammonia is not an ozone-depleting substance, the protocol's focus on environmental protection has broader implications for ammonia management.

2. Rotterdam Convention:

- The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade addresses the trade and use of hazardous chemicals, including some forms of ammonia.
- The convention facilitates the exchange of information to ensure informed decision-making on the import and export of certain chemicals.

3. International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code):

- Regulated by the International Maritime Organization (IMO), this code addresses the safety aspects of ships using gases such as ammonia as fuel.
- It sets safety standards for the design, construction, and operation of ships to minimize risks associated with the use of low-flashpoint fuels.

Measures taken by India:

1. Environmental Regulations:

- In India, the regulatory framework for ammonia is embedded within environmental laws and standards. The Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981, are crucial legislations addressing ammonia emissions.

2. Occupational Safety and Health Standards:

- The Occupational Safety, Health and Working Conditions Code, 2020, regulate the safety aspects of handling ammonia in workplaces, ensuring the well-being of workers.

The intersection of machine learning and agricultural science presents a promising avenue for addressing environmental challenges. By leveraging technology to precisely estimate and strategically reduce ammonia emissions from key crops, this research offers a blueprint for sustainable agriculture, underscoring the importance of proactive and targeted interventions in safeguarding our planet's health.

Go back to basics:

Ammonia:

Composition:

- Ammonia (NH_3) is a colourless gas with a pungent odour.

Solubility:

- Highly soluble in water, forming a strong alkaline solution.