

# Environmental Impact of Fertilizer Runoff

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## INTRODUCTION

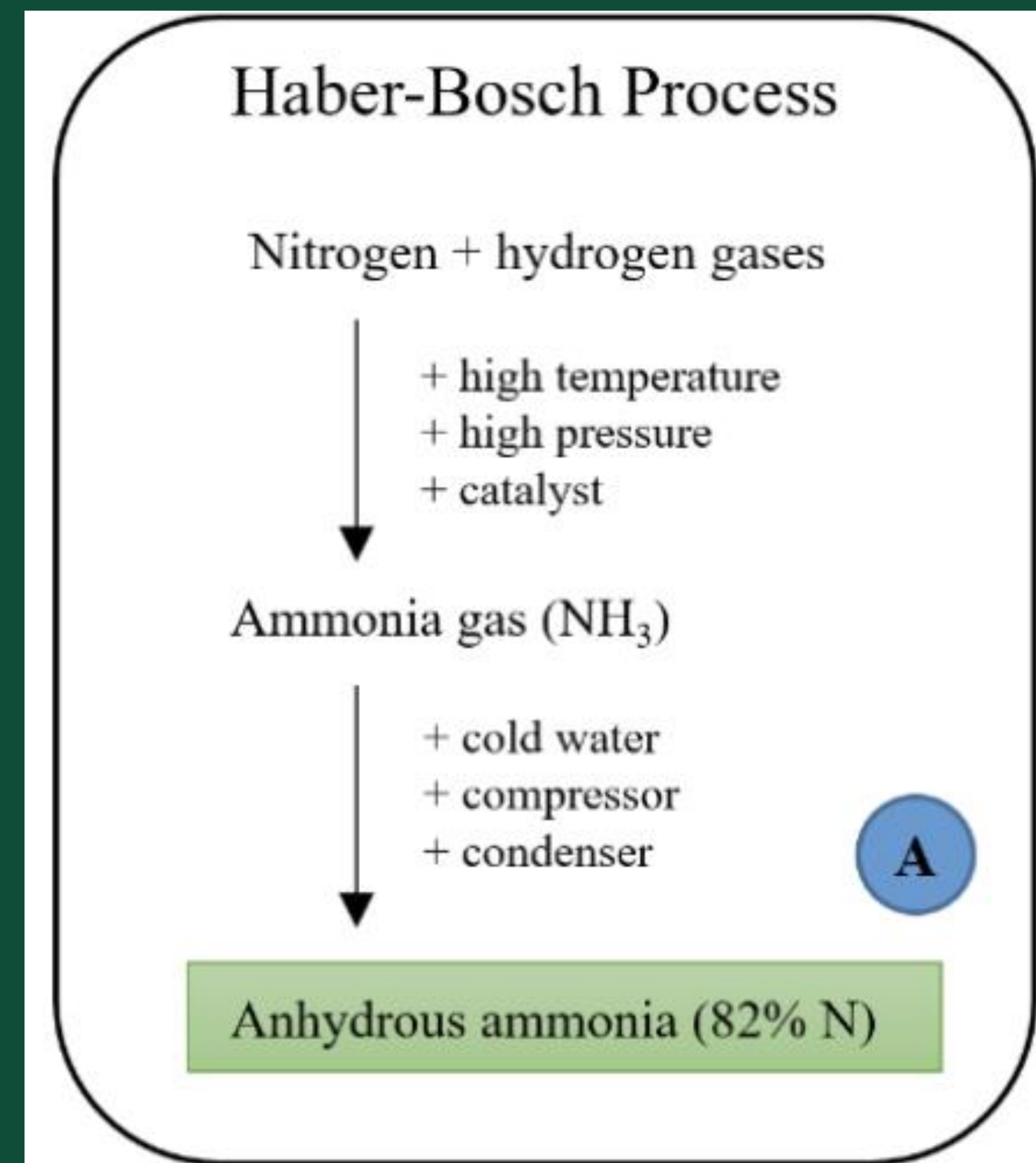
- Synthetic fertilizers rich in Nitrogen have contributed to the industrialization of agriculture. The subsequent increase in crop yields allow humanity to support its rapidly expanding population.
- However, these fertilizers are hard to contain and have catastrophic effects on the food chain when leached into the surround ecosystems.<sup>2</sup>
- Ultimately while these the practice of mass fertilization allows humanity to supply itself with enough food, they are unsustainable and it is becoming apparent new methods need to be implemented.

## METHODS

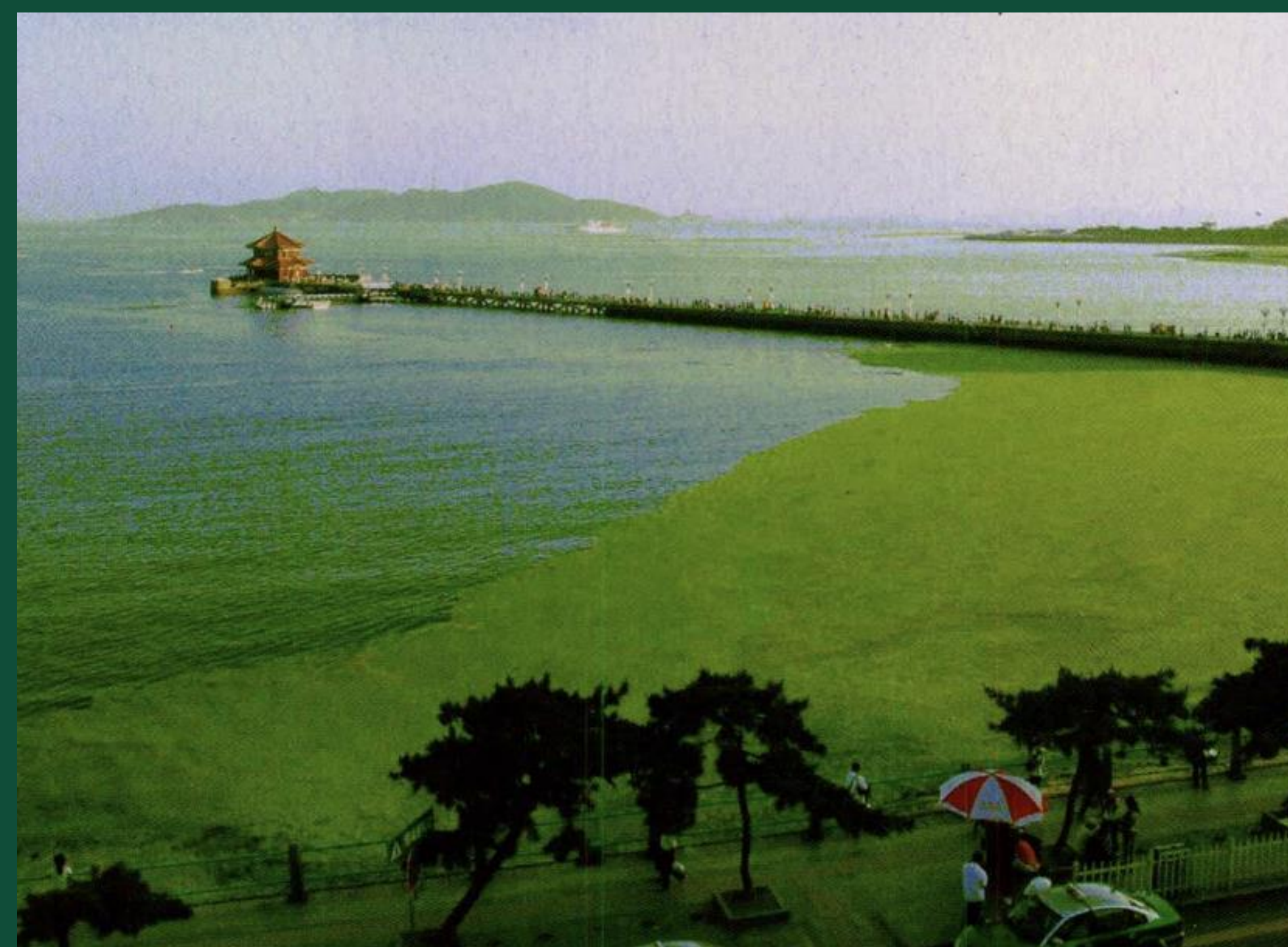
- Nitrogen makes up roughly 72% of the atmosphere in the form of N<sub>2</sub>, however this kind of nitrogen can not be processed by living organisms who need it to support their growth.
- In nature nitrogen is typically made available by bacteria that are able to convert N<sub>2</sub> into NH<sub>3</sub> which is able to be absorbed by plants and subsequently incorporated into the environment.
- This conversion has been mimicked synthetically through the Haber-Bosch process (Figure 1.)<sup>1</sup>
- Increased amounts of nitrogen lead to expedited growth which is why it is so valuable to farmers.
- Dissolved nitrogen is carried in the runoff from the farm and contaminates the surrounding watershed.

## RESULTS

In addition to contaminating the water supply of local communities, the leached nitrogen has catastrophic effects on the surrounding ecosystems, particularly aquatic ones. Large influxes of nitrogen into an aquatic ecosystem causes unprecedented algae blooms (Figure 2.)<sup>2</sup> which consume all of the available dissolved oxygen creating hypoxic zones. This process is called eutrophication and results in the organisms suffocating and causing a cascade up the food chain.



(Figure 1) from reference 3



(Figure 2) from reference 2

## CONNECTION TO CHEMISTRY:

- Haber-Bosch Process Chemical Equations:
  - $3 \text{H}_2 (\text{g}) + \text{N}_2 (\text{g}) \rightarrow 2 \text{NH}_3 (\text{aq})$
  - Uses iron oxide catalyst
- Catalyst accelerates the rate of reaction by providing an alternative pathway that requires a lower amount of activation energy and accelerates the rate of reaction.
- The iron oxide catalyst is an intermediary in the reaction and there for is used and released in the same form, and therefor does not need to be included into the overall chemical equation.
- Eutrophication from fertilizer runoff causes sharp fluctuation of pH because of interrupted rates of decomposition and respiration.

## CONCLUSIONS

- Fertilizers that contains Nitrogen are helpful when it comes to agriculture due to its ability of being able to produce crops at a faster rate. However, it has been found that the nitrogen in fertilizers infects the water around the farm and creates toxic environments for many organisms.
- There should be new solutions moving forward to prevent water being affected.
- Using crop rotations to enrich the soil rather than synthetic fertilizers.
- Installing natural barriers around farms such as trees, shrubs, etc in order to mitigate runoff.

## REFERENCES

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- 3 Jiao, Hongxia. "Synthetic Nitrogen Fertilizer in the U.S." *Farmdoc Daily*, University of Illinois, 14 Apr. 2023, [farmdocdaily.illinois.edu/2021/02/synthetic-nitrogen-fertilizer-in-the-us.html](https://farmdocdaily.illinois.edu/2021/02/synthetic-nitrogen-fertilizer-in-the-us.html).
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