RESEARCH GUIDE

Environmental

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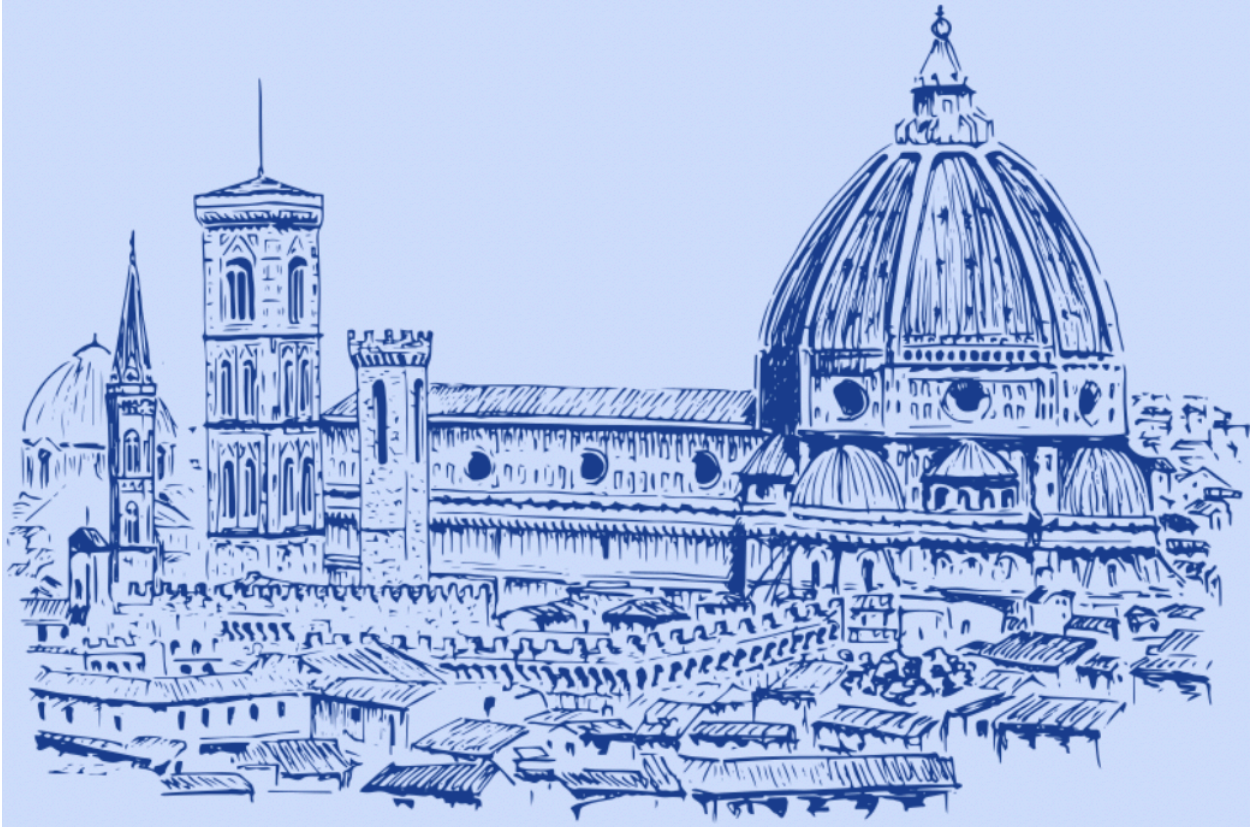

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Committee: Environmental Committee

Topic: (2) Discussing the environmental and health impacts from the overuse of chemical fertilizers

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I. Introduction

Although fertilizers have been used by people for farming since ancient times, the use of chemical fertilizers on a larger scale began in the mid twentieth century in Britain and America. Early nitrogen-based fertilizers were shipped all over the world and quickly gained popularity, thanks to them ensuring food security in many nations. Since then chemical fertilizer usage has only grown, with nitrogen-based fertilizers consisting of more than half of it. Although chemical-fertilizers have guaranteed higher yields globally, when overapplied, excess nutrients are not absorbed and pollute the nearby environment. In fact nearly two thirds of nitrogen applied is not actually absorbed, letting it go into rivers, lakes and other natural environments, causing eutrophication and the creation of "Dead Zones". Another significant downside to chemical substances used in agriculture are the effects that some of them have on human health: irritations and the deposits of heavy metals like lead in organs can often happen when inhaling ammonium nitrate, and nitrogen in water can cause methemoglobinemia, or Blue Baby Syndrome, a rare blood disorder.

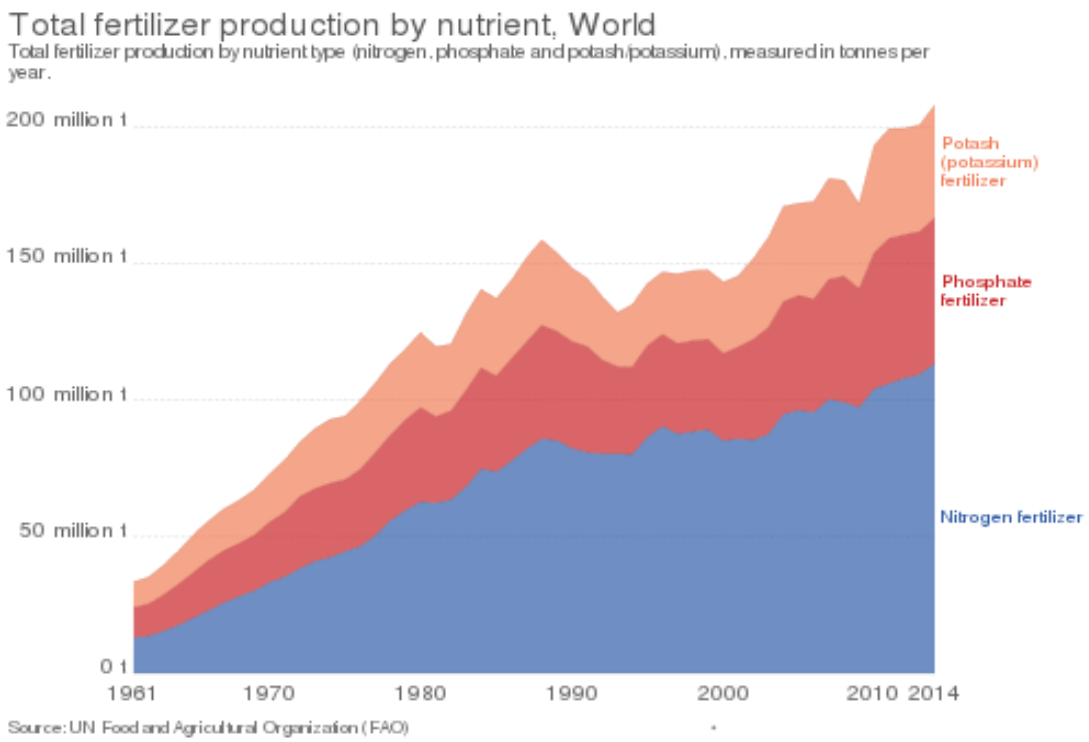

Figure showing world fertilizer production by nutrient.

II. Definition of Key Terms

a) **Fertilizer:**[1] natural or artificial substance containing the chemical elements that improve growth and productiveness of plants. Fertilizers enhance the natural fertility of the soil or replace chemical elements taken from the soil by previous crops.

b) **Overfertilization:**[2] The use of too much fertilizer or the results of this.

c) **Nitrogen Use Efficiency (NUE):**[3] Nitrogen use efficiency (NUE) is the ratio between nitrogen inputs and output. A NUE of 40% means that only 40% of nitrogen inputs are converted into nitrogen in the form of crops. While a low NUE is bad, as it indicates

[1] Fertilizer | Definition, Types, Plant Nutrients, Application, & Facts | Britannica
[2] OVER-FERTILIZATION | English meaning - Cambridge Dictionary
[3] Nitrogen use efficiency, 2014 (ourworldindata.org)

overuse of fertilizer, an extremely high NUE can often mean that the nitrogen is barely being used which can lead to a low crop yield.

d) **Eutrophication**:[4] the process by which a body of water becomes enriched in dissolved nutrients (such as phosphates) that stimulate the growth of aquatic plant life usually resulting in the depletion of dissolved oxygen

e) **Methemoglobinemia:**[5] Methemoglobinemia is a condition with life-threatening potential in which diminution of the oxygen-carrying capacity of circulating hemoglobin occurs due to the conversion of some or all of the four iron species from the reduced ferrous (Fe2+) state to the oxidized ferric (Fe3+) state.

f) **Precision Agriculture**:[6] Precision Agriculture is a management strategy that gathers, processes and analyzes temporal, spatial and individual plant and animal data and combines it with other information to support management decisions according to estimated variability for improved resource use efficiency, productivity, quality, profitability and sustainability of agricultural production

III. General Overview

The overuse of chemical fertilizers refers to the overabundance of an artificial chemical fertilizer beyond the needs of the crop itself. This can happen for various reasons, such as the pressure on farms to provide a bountiful harvest, the inefficiency of national regulations and laws, or just the incompetence of individual farmers. Yet the problem goes beyond a waste of resources: overfertilization has a lot of impact on the environment and human health, making it an important problem for the entire planet.

[4] Eutrophication Definition & Meaning - Merriam-Webster
[5] Methemoglobinemia - StatPearls - NCBI Bookshelf (nih.gov)
[6] Precision Ag Definition | International Society of Precision Agriculture (ispag.org)

Historical Background

i. The rise of chemical fertilizers began in the late nineteenth and early twentieth centuries with ammonium sulfate and ammonium phosphate.
ii. Although 1908 saw the birth of ammonia production, a new nitrogen compound that can be absorbed by plants from the soil, in the Pre-Green Revolution era of the early twentieth century, chemical fertilizers weren't often used, limited to certain crops and territories and weren't popular until after WWII, when production of nitrogen-based fertilizers surged.
iii. The Green Revolution, in the 1960s, aimed to address worldwide food shortages: during this time the use of chemical fertilizers grew immeasurably.
iv. Today the use of chemical fertilizers is indispensable for food security worldwide. The most common type of fertilizer is nitrogen-based, consisting of more than half of fertilizers produced globally.

Negative Effects on the Environment

i. *Eutrophication*: Precipitation causes nitrogen to run into rivers, lakes and seas. While nitrogen is an important nutrient and about 78% of the air we breathe, its overabundance in bodies of water can be fatal; in fact it can lead to hypoxic conditions (lack of oxygen) and eutrophication, creating "dead zones" and tearing holes through ecosystems. Eutrophication also has a large impact on fishing and fish farming as it kills fish in any body of water, thus threatening food security.
ii. *Soil Degradation*: Excessive use of fertilizers declines soil organic matter, hardens the soil, reduces its fertility, increases pests and overall does much to stunt plant growth, resulting in smaller yields, and ultimately makes the field harder to cultivate.
iii. *Greenhouse Gas Emissions*: when nitrogen is administered to plants, it is absorbed through the soil inside a compound called ammonia. The use of

ammonia has doubled crop production since its invention in the early twentieth century and has become indispensable for the sustainment of the world population, quickly becoming the second most commonly produced chemical in the world. Unfortunately its production is very energy intensive, contributing to as much as 2% of CO_2 emissions. Aside from its production, ammonia, when broken down by microbes in the soil, releases nitrous oxide, a rare but extremely powerful greenhouse gas.

Negative Effects on Human Health

i. Exposure to ammonium nitrate can cause oronasal irritations as well as irritations on skin and in lungs. For this reason health and safety are extremely important when handling chemical fertilizers.
ii. Many chemical fertilizers also contain small amounts of heavy metals like lead, mercury, cadmium and uranium. These can deposit in organs like kidneys and lungs, causing various health problems.
iii. The presence of nitrogen in drinking water can lead to a rare blood condition called methemoglobinemia, or "Blue Baby Syndrome" (cyanosis) that is characterized by a blue or violet skin color. The skin takes this appearance due to the lack of oxygen in the patient's blood flow.

IV. Major Parties Involved and their Views

a) The People's Republic of China

China, as well as being the single largest CO_2 emitter in the world, is also the largest user of fertilizer per square hectare and uses almost 30%[7] of the world's nitrogen fertilizers. Of course this large consumption is necessary for feeding half a quarter of the world's

[7] Opportunity and shift of nitrogen use in China - ScienceDirect

population, and China's NUE has increased in recent years by about 28%[7]: a change for the better caused by new laws and advances in irrigation.

b) The United States of America (USA)

The USA is also one of the largest CO_2 emitters on Earth, due to its huge network of power plants and large manufacturing sector. The US's withdrawal from the Paris Agreement under the Trump administration in 2017 has had many worried about their commitment to the battle against climate change until the US rejoined in 2019 under president Joe Biden.

c) Brazil

In 2022, Brazil had emitted 17.18 billion tons of carbon dioxide as a whole[8]. Although Brazil, like China, uses a large amount of fertilizer per square hectare, they continue to believe in the importance of reducing global warming.

d) The European Union (EU)

The European Union is also one of the largest CO_2 emitters, with the largest emitting member states being Germany, Italy, Poland and France, with about 600 to 300 million tons each but, in recent years, EU countries have lowered their emissions noticeably. The EU has various regulations on intensive farming and the current agenda plans to make the EU fully climate neutral (net-zero emissions) by the year 2050 and to reduce EU emissions by 55% by 2030.

e) The Russian Federation (RF)

Russia is a nitrogen-mining country that makes a significant profit from its export of nitrogen and fertilizer. The current war in Ukraine has had effects on Russian nitrogen exportation and has therefore caused some shortages in fertilizer and crops around the world. The Russian Federation is also a member of the Paris Agreement.

[8] Brazil: CO2 Country Profile - Our World in Data

V. Relevant UN Documents and Articles

1. Paris Agreement
   https://digitallibrary.un.org/record/827098

2. UNEP: Environmental and Health Impacts of Pesticides and Fertilizers and Ways of Minimizing Them
   https://www.unep.org/resources/report/environmental-and-health-impacts-pesticides-and-fertilizers-and-ways-minimizing

3. SDG n. 13: Climate Action
   https://www.un.org/sustainabledevelopment/climate-change/

4. SDG n. 14: Life Below Water
   https://www.un.org/sustainabledevelopment/oceans/

5. Terms of Reference of the UNEP Working Group on Nitrogen
   https://wedocs.unep.org/handle/20.500.11822/41611

VI. Possible Solutions and Mitigation Strategies

- Moving away from fertilizers altogether is unfortunately impossible for sustaining the current world population, and would lead to hunger and starvation all over the world as well as the economic collapse of countries that rely on chemical fertilizers and agriculture such as Qatar, Singapore, Malaysia and Switzerland.

- One possible solution could be precision agriculture: a system that uses information technology (IT) to determine the needs of various plants using sensors, soil sampling, weather monitoring and agricultural mapping, to predict the correct amount and distribution of chemical fertilizer to apply to crops, thus reducing excess fertilizer pollution and allowing farmers to better manage their resources.

- It is also important to note how much proper irrigation can benefit crop yield: irrigation that can properly reach the plants is crucial to large harvests and much research has been done in that area in recent years.

VII. Questions to Consider

- What measures should be taken to reduce overfertilization on an international level without lowering crop yield?

- How does overfertilization affect the population of rural areas?

- How much does the world rely on fertilization as a means of food production and are there alternatives to maintain the population well-fed?

- How does the accumulation of nitrogen in bodies of water affect fishing and fish farming?

- Does soil degradation affect food security? In what ways?

- How helpful are international treaties like the Paris agreement for reducing greenhouse gas emissions and pollution?

- How does eutrophication affect biodiversity?

VIII. Conclusion

While mankind has greatly benefited from the use of chemical fertilizers, which have allowed the world's human population to grow massively in the last century, it is fundamental to consider that the overuse of chemical fertilizers, especially nitrogen-based ones, has a significant effect on health, the environment and biodiversity. It is imperative that countries find either an alternative fertilizer that is cheap and eco-friendly, or a better way of organizing the application of chemical fertilizers in a way that allows for the right amount to be given to the crops. Measures must also be taken to prevent the washing of these fertilizers into bodies of water, leading to eutrophication and causing massive losses to underwater ecosystems.

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Can we reduce fertilizer use without sacrificing food production? - Our World in Data

Impacts of Agricultural Nitrogen on the Environment and Strategies to Reduce these Impacts - ScienceDirect

Harmful Effects of Chemical Fertilizers on Human Health • Drugwatcher.org

Overfertilization - Climate Hero

The Impact of Heavy Rainfall Variability on Fertilizer Application Rates: Evidence from Maize Farmers in China - PMC (nih.gov)

Nitrogen and Water | U.S. Geological Survey (usgs.gov)

Chemical Fertilizers and Their Impact on Soil Health | Request PDF (researchgate.net)

Fertilizer and Climate Change | MIT Climate Portal

How a century of ammonia synthesis changed the world | Nature Geoscience

Blue Baby Syndrome: Causes, Symptoms, and More (healthline.com)

Most Fertilizer Dependent Countries In The World - WorldAtlas

Governments can curb over-fertilization (phys.org)

Nitrogen use efficiency of terrestrial plants in China: geographic patterns, evolution, and determinants | Ecological Processes | Full Text (springeropen.com)

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Climate change: what the EU is doing - Consilium (europa.eu)