TREND OF PRODUCTION AND CONSUMPTION PATTERN, SUBSTITUTE OF CHEMICAL FERTILISERS AND ENVIRONMENTAL IMPLICATIONS OF EXCESS USE OF FERTILIZER AND MANURE ON WATER QUALITY IN INDIA

DR. P.T. BHARATHI
Associate Professor, Dept. of Geography,
Maharaja College, University of Mysore, Mysuru – 570 005

ABSRACT

The Fertilizer can be used in poor soil to make it fertile immediately. They add a sufficient amount of nutrients needed by the plant. Chemical fertilizers are made with synthetic ingredients designed to stimulate plant growth. Commercial chemical fertilizers have the advantage of predictability and reliability. Formulations are blended with accuracy and one can buy different blends for different types of plants. When it comes to the advantages of using fertilizers in agriculture, it's all about efficiency. Though chemical fertilizers increase crop production; their overuse has hardened the soil, decreased fertility, strengthened pesticides, polluted air and water and released greenhouse gases, thereby bringing hazards to human health and environment as well. Use of excessive quantity of synthetic fertilizers is harmful for human health. High levels of nitrates and nitrites in chemical fertilizer may cause some disease like hemoglobin disorders, Alzheimer's disease and diabetes mellitus. Some of these impacts include algae blooms causing the depletion of oxygen in surface waters, pathogens and nitrates in drinking water, and the emission of odors and gases into the air. In this context this article is intended to study the production and consumption pattern, substitute of chemical fertilizers and environmental implications of excess use of fertilizer and manure on water quality in India.

Key words: synthetic, ingredients, stimulate, fertilizers, Alzheimer's

INTRODUCTION

Chemical Fertilizers are chemical substances supplied to the crops to increase their productivity. These are used by the farmers to increase the crop yield. Modern chemical fertilizers include one or more of the three elements that are most important in plant nutrition: nitrogen, phosphorus and potassium. The secondary importance is the elements sulfur, magnesium, and calcium. Fertilizers work by providing essential nutrients to developing flowers, trees and vegetables as a kind of multi-vitamin or meal replacement for the plant world. Many fertilizers also improve the way the soil works by helping it to retain water better and allowing air to flow freely, which is good for roots.

The important chemically-synthesized inorganic fertilizers include ammonium nitrate, potassium sulfate and superphosphate or triple superphosphate. The three major types of commercial fertilizer used by the farmers are nitrogen, phosphate, and potash. Nitrogen (N) is found primarily in an organic form in soils but can also occur as nitrate. When it comes to the advantages of using fertilizers in agriculture, it's all about

efficiency. Chemical fertilizers allow growers to maximize their crop yield on a specific piece of land. Fertilizer works to ensure that each piece of land produces as efficiently as possible. One of the problems with chemical fertilizers is they also contaminating the surface water via runoffs and its consequent effects seep through the soil into the groundwater and other water sources, leading to contamination. Now, NPK in small quantities is non-toxic, but a lot can kill the balance of nature in various ways.

Difference between Manures and Fertilizers

Manures	Fertilizers
Manure is obtained naturally by the decomposition of dead plants and animals.	Fertilizers are chemical substances and not typically natural.
It is not very rich in nutrients.	It is rich in soil nutrients like nitrogen, phosphorous and potassium.
It is slowly absorbed by the plants.	It is easily absorbed by the plants.
It provides a lot of humus to the soil.	It does not provide any humus to the soil.
They are prepared naturally in the fields.	They are prepared in the factories.
These do not improve the physical conditions of the soil relatively	These improve the physical condition of the soil.
Does not adversely affect the plant or the soil if supplied in large quantities.	Adversely affects the soil and the plant if supplied in large quantities.

Advantages of Chemical Fertilizers

- Inorganic or chemical fertilizers can be used immediately to rescue dying plants because the nutrients present in them are easily absorbed by the plants and unlike.
- They are easily available at most gardening stores and hence, are quite convenient to use.
- Making inorganic fertilizers can take a little time as well as effort.
- Can make the desired ratio of nutrients
- Lower cost.

Advantages of Organic Fertilizers

- Renewable source of nutrients Sustain soil health Supplement chemical fertilizers.
- Replace 25-30% chemical fertilizers Increase the grain yields by 10-40%. Decompose plant residues and stabilize C:N ratio of soil
- Improve texture, structure and water holding capacity of soil
- No adverse effect on plant growth and soil fertility.
- Stimulates plant growth by secreting growth hormones. Secrete fungistatic and antibiotic like substances Solubilize and mobilize nutrients
- Eco-friendly, non-pollutants and cost effective .

Disadvantages of Chemical Fertilizers

The problem of leeching, i.e. the fertilizer and the nutrients getting washed away, is much more prevalent when inorganic fertilizers are used. This is because in inorganic fertilizers, the nutrients are already in their most basic components, and hence, can be washed away easily, if the plant roots are over watered or watered with force. Another disadvantage of inorganic fertilizers is that besides the essential nutrients

required by plants, they contain certain compounds and salts which a plant is unable to absorb and hence, are left behind in the soil. With time, these compounds build up in the soil and can even change its chemistry. This can render the soil less than ideal for future plantations. Lastly, over usage of inorganic fertilizers can prove to be detrimental for the plants. Too much of it can burn or destroy the plant structures, including the roots, which can hamper the plant's over all development and later degradation of soil takes place.

Disadvantages of Organic Fertilizers

The effects of Organic fertilizers can get delayed and by that time a plant can die completely. The nutrients present in organic fertilizers do not need to be broken into primary nutrients for absorption by plants.

OBJECTIVES

- To study the trend of production and consumption pattern of fertilizer in India
- To analyze the substitute of chemical fertilizers
- To analyze the environmental implications of excess use of fertilizer and manure on water quality in India

METHODOLOGY

The study is conducted is based on the data gathered from secondary sources. Secondary data has been collected from the records, books, journals and websites. The relevant information and data have been organized, classified, tabulated and graphed using simple statistical methods.

TREND OF PRODUCTION AND CONSUMPTION OF FERTILIZER IN INDIA

Table: 1 **PRODUCTION OF CHEMICAL FERTILIZER**

PRODUCTION OF CHEMICAL FERTILIZER (Production in million metric tonnes)					
Fertilizer	**1999-2000**	**2004-05**	**2009-10**	**2014-15**	**2018-19**
N	11.10	12.03	104.10	114.67	262.20
P	03.35	05.50	04.68	03.44	4.48
K	-	-	84.44	91.26	148.17
TOTAL	14.45	17.53	193.22	209.37	414.85

Source: Pib.Gov.in > Press Release Page

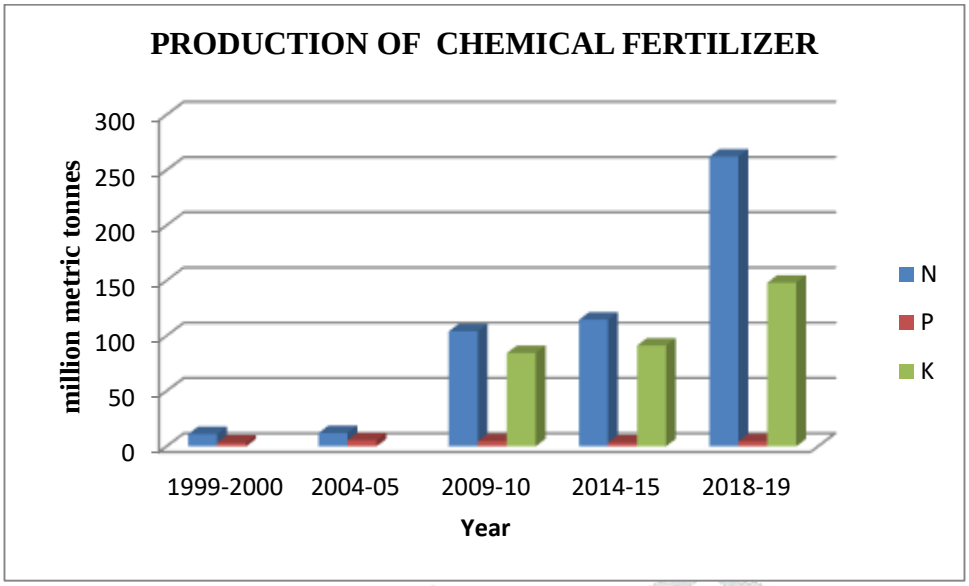
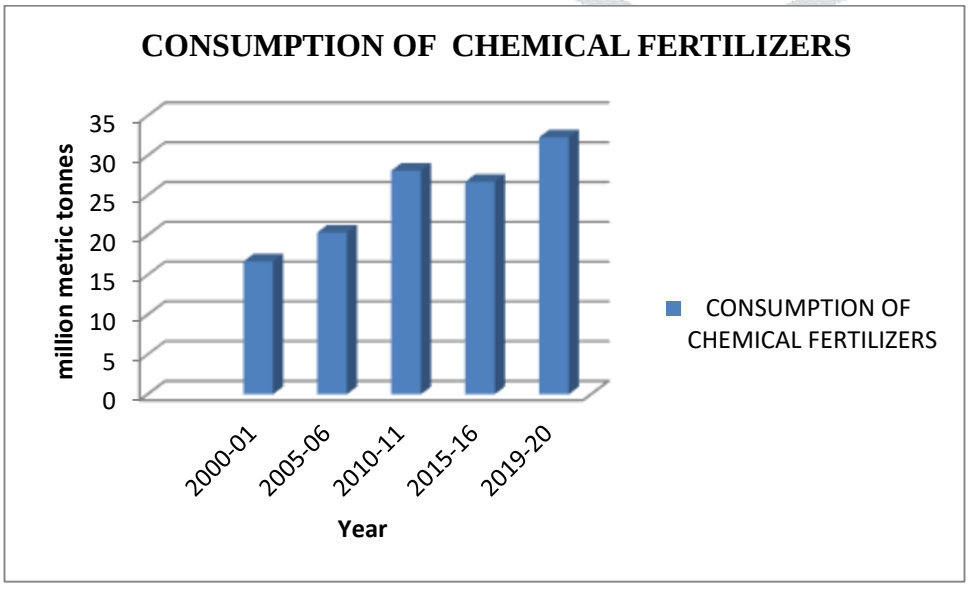


Table: 2 **CONSUMPTION OF CHEMICAL FERTILIZER**

YEAR	CONSUMPTION OF CHEMICAL FERTILIZERS (NPK) in million metric tonnes
2000-01	16.70
2005-06	20.34
2010-11	28.12
2015-16	26.72
2019-20	32.31

Source: Fertilizer Association of India (FAI)



The actual production of all the Fertilizers during the year 2018-19 was 414.85 LMT showing an increase of more than 11.40% in comparison of the previous year. The estimated Production of all the Fertilizers during the year 2019-20 is expected to be 462.15 LMT. In 2019-20 actual production of nitrogenous fertilizer was 1.9%, phosphorous 16.7% and 4.4%. The production of fertilizers was increased enormously 2010. The consumption of chemical fertilizers since 2000 is steadily raised up to 2010-11 but decreased during 2015-16. In 2019-20 it again increased to 32.31million tones.

SUBSTITUTE OF CHEMICAL FERTILIZERS

Nowadays, using compost as a substitute to chemical fertilizer has become a global consensus. The application of compost could promote soil productivity and to

Improve the crop quantity (for certain extent) and quality. It also helps to increase the income of the farmers as well as sustainability of the soil.

Substitute for Urea (Nitrogenous fertilizer)

Urea is a nitrogenous fertilizer. So technically speaking, any material that supplies nitrogen to crop could be used to substitute of urea. This can be other nitrogen containing fertilizers, such as ammonium Sulphate, ammonium nitrate, calcium etc, or organic fertilizers such as animal manures, green manures, composts, oil cakes, etc. However, urea has about 46% nitrogen while the other chemical fertilizers have less nitrogen content and organic fertilizers have far less nitrogen content. Urea can replace urea with organic fertilizer or in other words cow dung. Organic fertilizers (cow dung manure, compost etc) were in use in a limited way some 75 years back or so, in the Indian subcontinent but productivity was low and food shortages and famines were common. It should be used in the proper way. Ideally cow dung which is shade dried is to be used. But we get mostly cow dung dried in scorching heat. That's not good. The inherent friendly flora and fauna would be gone then.

How to Create Urea Fertilizer

Organic urea is available in urine of all animals including humans. Urea is nothing but pure nitrogen in the most easily absorbable form and available in the urine. It is actually quite simple to create our own urea **fertilizer** at home. There is a method to making the fertilizer. Mix 1 tsp. of baking soda per gallon of urine. The baking soda neutralizes the acid in the urine. Add at least 10 times as much water as urine you've collected (example: 10 gallons water for 1 gallon urine) to neutralize the **nitrogen** in the urine. So replacement of urea is possible and probably desirable.

Substitute for Potassium fertilizer

Potassium is a very active element. It is lighter than water. Potassium forms water-soluble salts with many anionic (negative) ions, such as chloride, sulfate, nitrate, acetate, carbonate, phosphate, etc. Potash - a naturally available nutrient Potash is found in plant-available form as potassium (K) salts such as potassium chloride, sulphate, nitrate etc. Potash in manures is also mainly (70-90%) in water soluble form, with a small amount bound into the organic material which is released into the soil solution as the organic matter is mineralized.

Potassium fertilizer is sometimes called potash fertilizer. Potash is a naturally occurring substance that occurs when wood is burned away or can be found in mines and the ocean.

Plants that look tired or unhealthy may need a potassium kick. Yellowing leaves may indicate an underlying root problem, speckled foliage can indicate a pest problem and young plants need help putting down new roots. With all of its benefits, potassium is one of the most useful nutrients to include in garden's fertilizer.

Most soils contain very large quantities of potassium - up to 100 t/ha - but most of this is not available to the plant. Even under ideal management however, the natural release of potassium is unlikely to be sufficient to maintain the necessary available nutrient levels in the soil and extra supplementation from the natural sources listed below will be required.

Wood Ash: The original source of potash fertilizers, hardwood ashes can be used directly as a fertilizer (about a 5-gallon bucket per 1000 square feet) or added to your compost pile to increase the potassium content. Wood ash also raises soil pH, so be sure to do regular soil testing to make sure it stays balanced.

Kelp Meal: Available dried or liquid, kelp and seaweed offer potassium to the soil in a fairly quick-release form.

Greensand: Mined from ancient sea beds and is rich in a number of minerals including potassium. It is used both as a fertilizer and a soil conditioner, or it can be mixed with compost.

Muriate of Potash (potassium chloride)**:** Mined from ancient deposits, this commercially available product can be used as natural sources of potassium, though the chlorine found in it can harm soil microbes.

Sulfate of Potash (potassium sulfate)**:** More expensive than muriate of potash but safer, since it doesn't contain chlorine. Not all potash products are considered organic, so make sure the product you use is approved by the Organic Materials Review Institute (OMRI).

Sul-Po-Mag: A variation of potash, Sul-Po-Mag is actually a naturally-occurring mineral called langbeinite (sulfate of potash-magnesia). Sul-Po-Mag is water soluble and convenient, although it shouldn't be used unless your soil also needs sulfur and/or magnesium.

Granite Dust: Available from granite quarries, granite dust is a relatively inexpensive way to add potassium and tract minerals to the soil. Since its ground-up rock, this product is very slow to release its minerals and is not a quick fix.

Baking soda

Baking soda is bicarbonate of sodium, which is a good replacement for bicarbonate of **potash** (potassium).

Banana peels

To make potash naturally, cut **potassium**-rich banana peels into small pieces, then mix into your compost pile. Place more banana peel pieces into a spray bottle filled with warm water. Allow peels to ferment in the water for two weeks, then spray the liquid on plant soil.

Substitute for Phosphorous fertilizer

Plants cannot survive without phosphorus. It forms the backbone of many crucial molecules (such as DNA) and is a key player in energy transfer reactions. Low availability of phosphorus is a major environmental stress for plants and can lead to great losses in crop production. The function of phosphorus in plants is very important. It helps a plant convert other nutrients into usable building blocks with which to grow. Phosphorus is one of the main three nutrients most commonly found in fertilizers and is the "P" in the NPK balance that is listed on fertilizers. Plants that don't get enough P have spindly, thin-stems that are weak. Their growth is stunted or shortened and their older leaves turn a dark bluish-green. The ability of phosphorus deficient plants to produce seeds, flowers and fruits is diminished. Phosphorus (P) is vital to plant growth and is found in every living plant cell. It is involved in several key plant functions, including

energy transfer, photosynthesis, transformation of sugars and starches, nutrient movement within the plant and transfer of genetic characteristics from one generation to the next. Excessive soil phosphorus reduces the plant's ability to take up required micronutrients, particularly iron and zinc, even when soil tests show there are adequate amounts of those nutrients in the soil.

There are many naturally occurring sources of phosphorus that can be used in the garden, human urine, bat guano (or feces), banana,bone meal, crab and shrimp waste, burned cucumber skins, hair and mushroom compost.

Human Urine

Fifty to 60 percent of the phosphorus in human waste is in urine, which is typically very low in pathogens. A year's worth of urine from just one person contains enough phosphorus to produce at least half of their annual food requirement. To get phosphorus from urine mix two tablespoons of finely-powdered charcoal and two tablespoons of powdered cinnamon into the urine and stir. Pour the urine/charcoal dust and cinnamon mixture into a glass retort with a glass tube leading into a second beaker filled with plain water.

Bat guano (or feces)

As manure, guano is a highly effective fertilizer due to its exceptionally high content of nitrogen, phosphate, and potassium: key nutrients essential for plant growth. Guano mining also involved the poor treatment and enslavement of workers such as Chinese immigrants, Native Hawaiians, and African Diaspora.

Banana

Bananas are very high in potassium and also high in phosphorus. The levels of phosphorus in banana fruits ranged from 31.62 to 42.45 mg 100 g^{-1}, with differences between cultivars and fertilizer rates. To make phosphorus fertilizer in banana, cut the banana skins in to small pieces put these in the oven for few minutes and grind it in to fine powder and use it.

Bone meal

Bone meal is an excellent high-phosphorus fertilizer with an average N-P-K ratio of 3-15-0. The phosphorous in bone meal takes a few months to become available to plants via microbial processes in the soil. It also contains calcium, another essential plant nutrient.

To make phosphorus fertilizer, the easiest way is to make your own bone meal. You can use scraps saved from your kitchen table so that you have one less thing going to waste. Dig a trench 2 feet deep and lay wood inside. Lay wood only a foot high so that you still have a foot of trench above it.

Shrimp and crab waste

Shrimp waste, crab waste, shellfish wastes and inorganic nutrients are available to make Phosphorus fertilizer and Forage Production.

Substitute for Sulfur fertilizer

Sulfur is an essential ingredient in some amino acids. A deficiency results in a lower production of proteins and an enlarged pool of free amino acids. The use of most organic residues or any sulfur-containing fertilizer is necessary to satisfy other nutrient requirements. Sulfur is the Junior Partner to nitrogen; it is an essential ingredient in some amino acids, but not all. However, amino acids which contain sulfur are necessary for all proteins, and a deficiency of sulfur will block the synthesis of proteins. The result will be an accumulation of free amino acids and a decrease in plant activities. Sulfur is not as mobile in plant tissue as nitrogen. The result is that a deficiency affects a plant in a different way. Both cause leaves to turn yellow. The difference

is that a nitrogen deficiency first affects the older leaves and a sulfur deficiency to the younger leaves. A deficiency of sulfur is unusual but possible in an acidic soil with low organic content but Alkaline soils are usually dry and leaching of sulfur (or any nutrient) is minimal.

At one time, all sulfur came from animal manure. There will always be some sulfur in the air from natural sources, such as volcanic activity, sea spray and the release of hydrogen sulfide gas from swamps and bogs. Atmospheric sulfur can be absorbed by the soil, but it can also be taken up directly by plant leaves. Owing to the variable nature of the causes of atmospheric sulfur, however, the quantity actually deposited is unpredictable.

Like nitrogen and phosphorus, sulfur is needed by soil organisms. The organic matter in an average soil contains about 1/8 as much sulfur as nitrogen. A soil that can be expected to release about 50 lbs of nitrogen/acre should release about 6 lbs of sulfur/acre.

Animal manures: Animal manure is an excellent source of sulfur and are well-balanced with respect to nitrogen. Crop residues such as hay and straw are also good. Among the inorganic fertilizers, sulfate of potash magnesia is a natural fertilizer, langbeinite. Gypsum is calcium sulfate.

Gases and coal: Pure sulfur for agricultural purposes is obtained from naturally-occurring deposits as a byproduct of the desulfurization of various gases and coal.

Epsom salts: Epsom salt is magnesium sulfate, either crystallized from natural deposits or synthesized. Potassium sulfate and ammonium sulfate are synthesized products.

Gypsum: Gypsum also improves plant growth in an acid soil. The reason is not clear, but some acid soils are highly leached and possibly low in sulfur. Pure sulfur is used to acidify an alkaline soil.

Sulfur is rarely deficient in the soil so long as some sulfur-containing materials are spread. Deficiencies occur when the use of concentrated, sulfur-free fertilizers stimulates plant growth and because the removal of soil sulfur without compensation.

Environmental Implications of Excess use of Fertilizer and Manure on Water Quality

When nutrients and other pollutants associated with animal manures and commercial fertilizers are not managed properly, they can affect plant and animal life (including humans) negatively. Some of these impacts include algae blooms causing the depletion of oxygen in surface waters, pathogens and nitrates in drinking water and the emission of odors and gases into the air.

Nutrients from manure and fertilizers enter lakes and streams through runoff and soil erosion. Runoff water from fields with high soil-test N and P may contain a high level of these dissolved nutrients, increasing the risk of contaminating streams, wetlands and lakes.

In addition, erosion carries fine particles of soil that are enriched with nutrients. Eroded soil particles with attached nutrients will accumulate as sediment in water resources and serve as a source of available nutrients during long periods of time. Due to this following affects may appear.

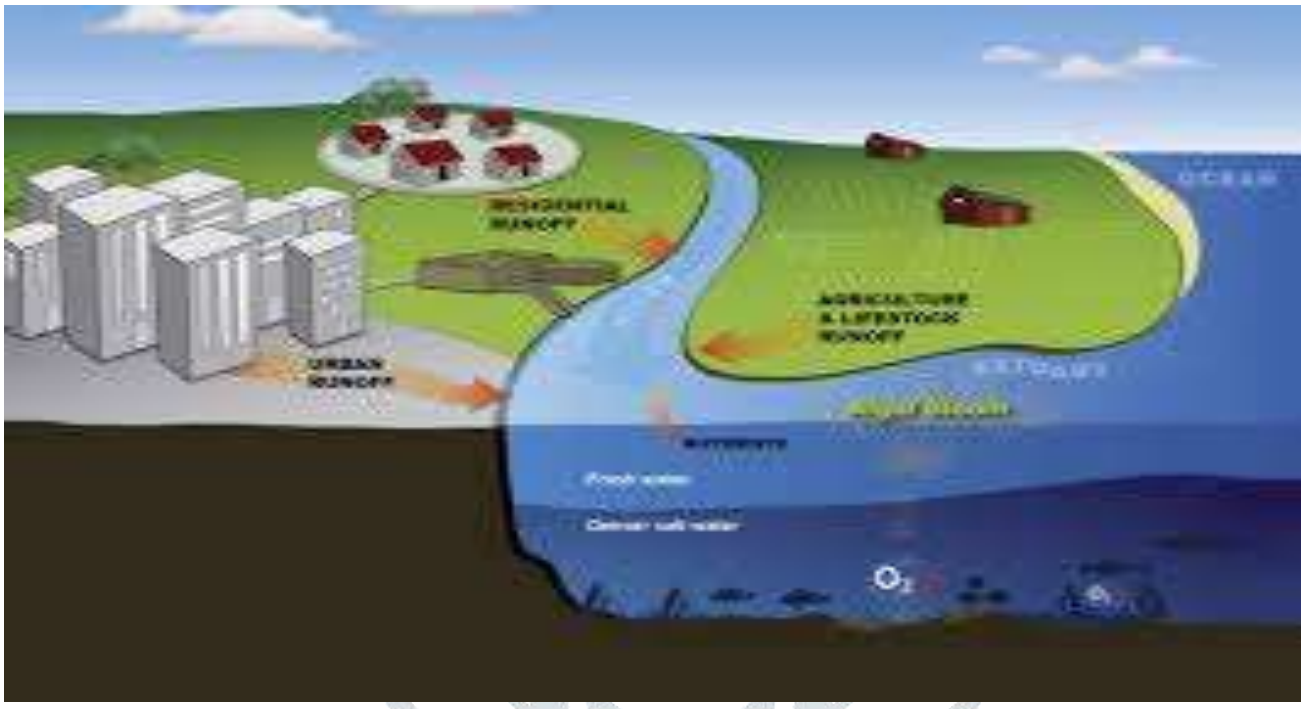
1. Oxygen Depletion
2. Weed Growth and Algae Blooms
3. Ammonia Toxicity
4. Fecal Organisms

5. Nitrates
6. Odors and Gases

1. Oxygen Depletion

If manure or commercial fertilizers enter surface water, the nutrients they release stimulate microorganism growth. The growth and reproduction of microorganisms reduce the dissolved oxygen content of the water body.

Without sufficient dissolved oxygen in surface water, fish and other aquatic species suffocate. The resulting dead fish and other aquatic species degrade the water quality and cause unpleasant odors.



Oxygen Depletion

2. Weed Growth and Algae Blooms

The number of plants and algae in a lake, pond or other water body increase with an increased supply of nutrients, particularly N and P. N and P are present in manure in sufficient quantity to be used as fertilizer for crop growth and will have a similar effect on algae and aquatic plants. As with crops, nutrient availability is the critical factor in the growth of aquatic plants and algae.

The nutrient present in the least amount for growth will limit the production in the aquatic system. Introduction of even small amounts of the limiting nutrient to crops or aquatic systems can increase production substantially. In the case of agricultural crops, this is a good practice.

However, increased production of aquatic plants and algae is not healthy for water resources. Eutrophication is the term used to describe the natural or human-accelerated process whereby a water body becomes abundant in aquatic plants and low in oxygen content.

If aquatic plants die due to the increased entry of nutrients to the water, microorganisms use the organic matter as a food source and the microorganisms grow and reproduce and use up the oxygen in the water.

Any increase in the amount of aquatic plant growth ultimately will result in a reduced dissolved oxygen content of the water body, eventually suffocating fish and other aquatic species.

Weed growth in Kukkarhalli lake,
Located in the heart of the Mysuru city

Algae blooms in Kukkarhalli lake,
located in the heart of the Mysore city

In addition to oxygen depletion, the potential exists for the algae to be toxic. Blue-green algae (cyanobacteria) can cause rashes, nausea and respiratory problems in humans and has been documented that it kills livestock that drink from affected water storages.

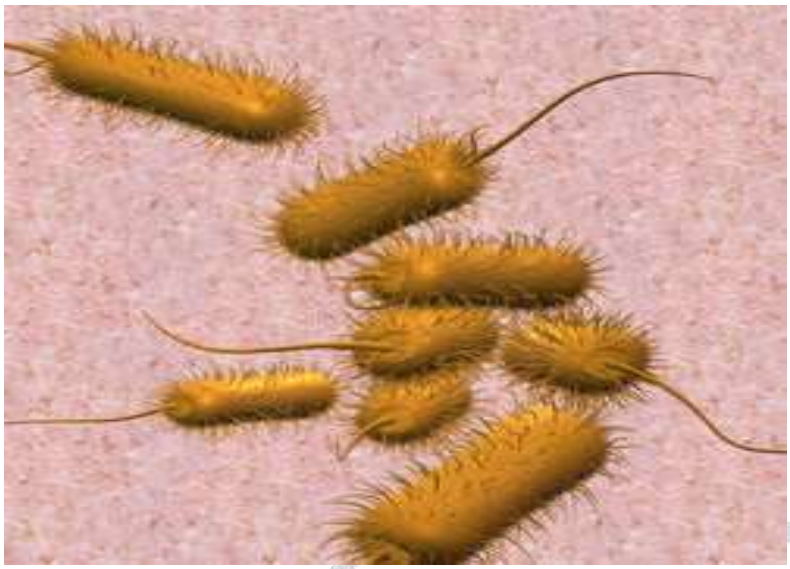
3. Ammonia Toxicity

Yamuna river

Ammonia in Delhi drinking water canal

Ammonia-contaminated runoff from fresh manure application sites is toxic to aquatic life. At high levels, ammonia in surface water will kill fish. Fish are relatively sensitive to ammonia in water. Concentrations as low as 0.02 parts per million (ppm) may be lethal. Surface water that manure impairs also may experience changes in species diversity because of ammonia toxicity.

4. Fecal Organisms



Fecal Coliforms in water (freedrinkingwater.com)

The fresh manure from warm-blooded animals has countless microorganisms, including bacteria, viruses, parasites and fungi. Some of the organisms are pathogenic (disease causing), and some of the diseases that animals carry are transmittable to humans, and vice versa.

If manure applications are mismanaged near wells, the risk of bacterial contamination of the groundwater via the well is greatly increased. Therefore, avoid surface application of manure where it can come into direct contact with a well or other drinking water supply. In addition, when grazing near surface water sources, take measures to restrict livestock use.

5. Nitrates

Level of nitrates exceeding permissible limits in more than 50% districts of India

High levels of nitrates can be toxic to livestock and humans. In some instances, stored or land-applied manures or nitrogen fertilizers have caused high concentrations of nitrates in water. Nitrates are not absorbed

by soil materials. It will freely leach down through the soil profile, nitrogen that is not used for crop or plant growth can reach the groundwater easily.

Nitrate in itself is not toxic to animals, but at elevated levels, it causes a disease called nitrate poisoning. High levels of nitrates in drinking water are known to cause methemoglobinemia (blue-baby syndrome) in human infants and other warm-blooded animals. In humans and livestock, nitrates interfere with oxygen uptake in the circulatory system.

6. Odors and Gases

Lake restoration and lake aeration (clean-flo.com)

Manure odors can be a nuisance for nearby neighbours and communities. Constant nuisance odors can degrade the quality of life for anyone subjected to them. In addition, people have a wide range of susceptibility to health effects from odors.

Gases are emitted from facilities throughout the year but are released at the highest rates during agitation, pumping and application of liquid manure systems or during cleanout and application of solid manure systems. Volatilization of ammonia to the atmosphere may become a water quality problem near animal production facilities when it is returned to the earth dissolved in rainfall.

Bengaluru's Bellandur lake spills toxic foam

Bellandur Lake, which is one of the largest of the 262 lakes in Bengaluru, has now become infamous for the gigantic clouds of froth that accumulate on its surface, spilling over into the many busy roads that skirt its shores several times a year.

Taking cognizance of it, the National Green Tribunal had earlier in April formed a committee to inspect the lakes in the city. The highly polluted river also catches fire in the summer. The flow of untreated sewage and industrial waste has rendered the lake's water unusable for even irrigation.

Bengaluru's Bellandur lake spills Ammonia toxic foam

Summary

In the early days of synthetic fertilizers, superphosphate and ammonium sulfate supplied whatever a crop needed. When these sources lost favor after the development of concentrated, sulfur-free fertilizers, industrial pollution came to the rescue. Now with the drive for clean air, this last resort is vanishing, or at least we hope it is and concern for sulfur nutrition of plants is growing. Animal manures are excellent source of sulfur and are well-balanced with respect to nitrogen. Crop residues such as hay and straw are also good. Among the inorganic fertilizers, sulfate of potash magnesia is a natural fertilizer, langbeinite. Gypsum is calcium sulfate.

If managed properly, fertilizers and animal manures benefit crop production without causing environmental problems. In any management scenario, the manager must be aware of the possible negative consequences of mismanagement.

References

1.Anonymous, 2008-09, Fertilizer Statistics, Fertilizer Association of India, New Delhi.

2. Anonymous, 2009-10, Annu. Revw., Fertilizer Statistics, Fertilizer Association of India, New Delhi.

3. Rahanul Hasan and Tiwari, K.N., 2002, Available potassium status of soils of India. Fert. Knowledge, No. 1.

4. Rahanul Hasan, Potassium Status of Soils in India. Better Crops Int., 16, No 2, pp. 3-5. Tandon,

5. H.L.S. and Tiwari, K.N., 2007, Fertilizer use in Indian Agriculture- An Eventful Half Century, Better Crops India, pp. 3-4.

6. Tandon, H.L.S., 2007, Soil Nutrient Balance Sheets in India: Importance, Status, Issues and Concerns, Better Crops India, pp. 15-17.

7. Tewatia, R. K., 2010, Potassium Nutrition for Balanced Fertilization in India: Need of appropriate policy intervention from Govt. and Fertilizer Industry, Fert. Assoc. India, New Delhi.

8. http://www.quora.com/profile/Kurian-Padappananickal