

Chemical Fertiliser (NPK) and Its Importance in Agriculture: A Comprehensive Overview

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Abstract

Agriculture is the foundation of any stable economy. In meeting the domestic requirements of food grains and also generating exportable surpluses, chemical fertilizers played significant role. The excess use of chemical fertilizer has become a serious issue in Kerala since the area of land being cultivated is fixed and very limited. Fertilizers are one of the most important variable factors that can be applied to maximize the production of crops. The consumption of the fertilizer is not alike because of the diverse soil types. The main problem is the higher dependence on chemical fertilizers and this dependence has been increasing day by day. There are specific reasons for the increased uses of chemical fertilizers in Kerala with severe consequences. The present study analyses the problem with the following objectives.

- To analyse the importance of fertilizer in agriculture.
- To analyse the major factors leading to sharp increase in fertilizer use.

Keywords: Chemical fertilizers, Fertilizer consumption, HYVs, Green revolution

Introduction

Fertilizer is one of the key inputs in crop production. India made rapid growth in fertilizer consumption after the introduction of high yielding varieties in mid-1960s and by 2005, the country became the 2nd largest user of fertilizers in the world in terms of total nutrients. Chemical fertilizers are key element of modern technology and have played an important role in the growth of agricultural production in India. The role of the fertilizers in increasing the growth of agricultural sector, to meet the food-grain requirements of increasing population as well as increasing contribution to exports is clearly undeniable. Some argue that fertilizer was as important as seed in the Green Revolution (Tomich et al. 1995) contributing as much as 50% of the yield growth in Asia (Hopper 1993 and FAO 1998). Others have found that one-third of the cereal production worldwide is due to the use of fertilizer and related factors of production (Bumb, 1995).

The Role of Fertilizers in Increasing Agricultural Productivity

Fertilizers have played a transformative role in modern agriculture, driving substantial increases in agricultural productivity. This transformation, often referred to as the Green Revolution, was marked by the widespread adoption of fertilizers, improved crop varieties, and advanced agricultural practices. The following points highlight the role of fertilizers in enhancing agricultural productivity:

- 1. Increased Crop Yields:** Fertilizers supply essential nutrients to crops, overcoming nutrient deficiencies in soils. As a result, they stimulate robust plant growth, leading to increased crop yields.

Studies by Swaminathan (2008) underscore how the judicious application of fertilizers, coupled with improved crop varieties and irrigation practices, contributed to substantial boosts in food production.

2. **Food Security:** The ability to produce more food per unit of land has been instrumental in addressing global food security challenges. Fertilizers have played a pivotal role in ensuring a stable and sufficient food supply, reducing the dependency on food imports, and mitigating the risk of famine.
3. **Quality Improvement:** Fertilizers not only increase crop quantity but also enhance crop quality. They can improve the nutritional content of crops, making them more nutritious for human consumption. For instance, fertilizers can increase the protein content of grains.
4. **Economic Benefits:** Higher crop yields resulting from fertilizer use translate into increased income for farmers. This economic benefit can have cascading effects on rural livelihoods, leading to improved standards of living for farming communities.
5. **Environmental Considerations:** While the benefits of fertilizers in increasing agricultural productivity are well-established, their environmental impact is a subject of concern. Excessive and improper use of fertilizers can lead to environmental issues such as nutrient runoff, soil degradation, and water pollution. Balancing the advantages of fertilizers with responsible use is essential for sustainable agriculture.

Fertilizers are pivotal components of modern agriculture, supplying essential nutrients that are crucial for plant growth and crop production. The trio of primary nutrients - nitrogen, phosphorus, and potassium - are indispensable for optimizing plant health and yield. Fertilizers have played a vital role in increasing agricultural productivity, enhancing food security, and improving economic outcomes for farmers. However, their use must be managed responsibly to mitigate environmental and sustainability concerns.

Fertilizers have become an integral part of global agriculture, ensuring that the world's growing population has access to a stable and sufficient food supply. Their continued use and management are central to addressing the challenges of feeding a population expected to reach nearly ten billion by 2050 (Alexandratos & Bruinsma, 2012). Thus, understanding the role of fertilizers in agriculture is essential for policymakers, farmers, and researchers alike as they work towards sustainable and resilient agricultural systems.

Fertilizer Consumption

Total fertilizer nutrient consumption (N+P₂O₅+K₂O) was estimated at 29.84 million metric tonnes (million MT) as against 29.80 million MT in the previous year registering a marginal growth of 0.2%. The consumption of N and P₂O₅ at 20.21 million MT and 7.92 million MT during 2022-23 registered increase of 4% and 1.2%, respectively, over 2021-22. However, consumption of K₂O at 1.72 million MT witnessed a sharp decline of 32.2% during the period. In terms of product, All-India estimated consumption (based on DBT sale) of urea at 35.73 million MT, DAP at 10.53 million MT during 2022-23 recorded increase of 4.5% and 13.6%, respectively, over 2021-22. However, consumption of NP/NPK complex fertilizers at 10.07 million MT, MOP at 1.63 million MT and SSP at 5.02 million MT witnessed decline of 12.2%, 33.6% and 11.7%, respectively, during the period. Total consumption of all fertilizer products at 63.92 million MT during 2022-23 showed a decline of 0.03% over 2021-22. All-India NPK use ratio widened from 7.7:3.1:1 during 2021-22 to 11.8:4.6:1 during 2022-23. Per hectare

use of total nutrients (N+P₂O₅+K₂O) improved marginally from 141.0 kg in 2021-22 to 141.2 kg in 2022-23.

Table-1 Production, import and Consumption of Fertilizers
(Thousand tons of nutrients)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23'
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
A Nitrogenous fertilizer										
Production	12378	12394	13416	13354	13386	13344	13687	13715	13839	7666
Imports	3920	4766	5068	3385	3588	4701	5191	5633	5359	2126
Consumption	16750	16946	17372	16735	16958	17628	19101	20404	19438	NA
B. Phosphatic fertilizers										
Production	3960	4121	4394	4595	4723	4594	4791	4739	4714	2385
Imports	1588	1832	2888	2130	2047	3167	2413	2543	2781	1629
Consumption	5633	6098	6979	6705	6854	6968	7662	8978	7829	NA
C. Potassic fertilizers										
Imports	1926	2537	2053	2325	2895	2629	2280	2670	1630	824
Consumption	2099	2532	2402	2508	2779	2779	2607	3154	2529	NA
D, All fertilizers (NPK)										
Production	16337	16515	17810	17949	18109	17938	18478	18454	18553	10051
Imports	7434	9135	10009	7840	8530	10497	9884	10846	9770	4579
Consumption	24482	25576	26753	25948	26591	27375	29370	32536	29796	NA

Source: Department of fertilizers, Ministry of Chemicals & Fertilizers Note: * Up to September, 2022

The actual production of all major fertilisers during the FY2020-21 and FY2019-20 were 433.66LMT and 425.92 respectively. Its showing an increase of more than 1.8% in comparison of the previous year. The actual production of all major fertilisers during the year 2021-22(during April 2021 to December 2021) is 330.84 LMT. The rapid build-up of fertiliser production in the country has been achieved as a result of a favourable policy environment facilitating investments in the public ,co-operative and private sectors.

Table 2 : Growth Rate of Determinants of Fertilizer Consumption (in per cent)

- Total fertilizer consumption 4.16
- Total imports 5.37
- Total domestic production 3.55
- Central subsidy 14
- Per cent area irrigated 1.42
- Short term institutional credit 17.09
- Annual rainfall 0.33

- Average MSP 7.43

Source: *Computed using data from Fertilizer Statistics 2018-19 and Agricultural Statistics at a Glance 2019.*

Review of literature

India has a rich agricultural heritage dating back thousands of years, with traditional farming practices deeply rooted in local ecosystems and cultural traditions. Historical records and archaeological findings indicate the use of organic fertilizers such as cow dung, ash, and bone meal in ancient Indian agriculture. The Green Revolution of the mid-20th century marked a transformative phase in India's agricultural history, characterized by the widespread adoption of high-yielding varieties (HYVs) of crops and chemical fertilizers to boost agricultural productivity. This period saw a significant increase in fertilizer consumption, government subsidies, and agricultural intensification. However, the Green Revolution also brought about environmental degradation, soil depletion, and socio-economic disparities, prompting calls for sustainable agricultural practices and nutrient management strategies rooted in traditional wisdom and ecological principles (Chakrabarti, 2014).

Fertilizers have played a pivotal role in shaping India's agricultural landscape, contributing significantly to the country's food security and economic development. The evolution of fertilizer usage in India reflects a journey from traditional organic farming practices to the widespread adoption of chemical fertilizers during the Green Revolution and, more recently, a renewed focus on sustainable agricultural practices. This essay explores the historical trajectory of fertilizer usage in India, examining the key factors that have influenced its adoption, impact on agricultural productivity, and the challenges and opportunities for sustainable agriculture (Gupta and Bala, 2003).

The Government of India has recognized the need to promote sustainable agriculture and reduce the dependency on chemical fertilizers through policy interventions, research initiatives, and extension programs. Schemes such as the Paramparagat Krishi Vikas Yojana (PKVY) and Rashtriya Krishi Vikas Yojana (RKVY) aim to support organic farming practices and enhance soil fertility through natural means. Research institutions and agricultural universities are actively engaged in developing innovative technologies and best practices for sustainable soil management (Swaminathan, 2010).

In conclusion, over the centuries, agriculture has transitioned from traditional organic methods to more intensive chemical-based approaches, driven by the need to increase crop yields and meet the growing demands of expanding populations. This transition has been accompanied by significant advancements in fertilizer technology and application methods, leading to increased agricultural productivity and food security in many parts of the world. However, it has also brought about various challenges, including soil degradation, water pollution, and environmental degradation. As we move forward, it is essential to learn from the past and adopt sustainable fertilizer practices that balance the need for increased agricultural output with environmental conservation and long-term soil health.

Table 3. 2021 World Fertilizer Production (1,000 metric tons)

Country	Ammonia	Country	Phosphate Rock	Country	Potash
China	39,000	China	85,000	Canada	14,000
Russia	16,000	Morocco	38,000	Russia	9,000
US	14,000	US	22,000	Belarus	8,000
India	12,000	Russia	14,000	China	6,000

Indonesia	5,900	Jordan	9,200	Israel	2,300
ROW	63,100	ROW	51,800	ROW	6,700

Source: USGS (2022). **Table 1:** Growth rate of fertilizer production in nutrient (Production- thousand tonnes)

High-Yielding Varieties and the Role of Chemical Fertilizers

1. Introduction of High-Yielding Crop Varieties

The Green Revolution ushered in the widespread adoption of high-yielding crop varieties, which played a pivotal role in boosting agricultural productivity (Evenson & Gollin, 2003). Varieties like dwarf wheat and rice, developed through extensive breeding programs, exhibited the capacity to produce significantly higher yields compared to traditional crop varieties (Pingali, 2012). These new cultivars were characterized by their shorter stature, resistance to pests and diseases, and the ability to efficiently convert nutrients into grains.

2. The Complementary Role of Chemical Fertilizers

The success of high-yielding crop varieties in the Green Revolution was intricately linked to the use of chemical fertilizers. These modern crop varieties had increased nutrient requirements, particularly for nitrogen, phosphorus, and potassium (NPK). Chemical fertilizers provided the necessary nutrients to meet these demands, enabling the new crop varieties to express their yield potential (Fan et al., 2012). Nitrogenous fertilizers, such as urea, played a particularly crucial role in increasing crop yields. The adoption of chemical fertilizers allowed farmers to bridge the nutrient gap, significantly enhancing agricultural productivity.

3. Government Support and Fertilizer Subsidies

Recognizing the vital role of chemical fertilizers in the Green Revolution, the Indian government implemented policies to promote their use. Fertilizer subsidies were introduced to make these inputs more accessible and affordable to farmers (Gulati & Bathla, 2016). These subsidies aimed to incentivize farmers to adopt modern agricultural practices, including the use of high-yielding crop varieties and chemical fertilizers. Government support played a critical role in the widespread adoption of chemical fertilizers, ensuring their affordability and availability to a broad spectrum of farmers.

Table 4: Growth rate of fertilizer consumption in India (Consumption- thousand tonnes)

Year	Nitrogen (N)	Phosphorus (P)	Potash (K)	Total Fertilizer
1990-1991	7997	3221	1328	12546
1995-1996	9823	2898	1156	13877
2000-2001	10920	4215	1568	16703
2005-2006	12723	5204	2413	20340
2010-2011	16558	8050	3514	28122
2015-2016	17372	6979	2402	26753
2019-2020	19100.5	7661.8	2607	29369.3

Annual growth rate				
1990-91 to 2019-20	3.02	3.71	3.92	3.27
1990-91 to 1999-00	4.682	4.330	2.804	4.409

2000-01 to 2009-10	4.792	6.419	10.287	5.818
2010-11 to 2019-20	0.35	-1.29	-0.31	-0.21

Source: Indiastat for India, (GOI), Department of fertilizer Department of Agriculture, Cooperation & Farmers Welfare

Implications and challenges

However, while the role of fertilizers in increasing agricultural productivity in Kerala is undeniable, it is essential to consider the broader implications and challenges associated with their extensive use:

Firstly, the long-term use of chemical fertilizers can lead to soil degradation and reduced soil fertility. Continuous application of synthetic fertilizers without proper soil management practices may contribute to nutrient imbalances, soil acidification, and erosion. Sustainable soil management practices are essential to mitigate these challenges.

Secondly, fertilizer runoff can lead to water pollution, affecting local water bodies. Nitrate pollution, in particular, can contaminate groundwater, posing health risks to both humans and ecosystems. Sustainable fertilizer management practices must be implemented to minimize environmental harm.

Thirdly, excessive fertilizer use may result in the accumulation of pesticide residues in agricultural produce, posing health risks to consumers. Ensuring safe and responsible pesticide and fertilizer use is crucial for protecting public health.

Fourthly, the affordability and accessibility of fertilizers can be a challenge for smallholder farmers in Kerala. Government subsidies and support mechanisms may be necessary to make fertilizers more accessible to all farmers and prevent disparities in access.

Lastly, as Kerala increasingly emphasizes sustainable and organic farming practices in response to concerns about the environmental and health impacts of conventional agriculture, balancing the benefits of fertilizer use with sustainable farming practices becomes a critical consideration for the state's agricultural future.

Conclusion

In conclusion, fertilizers have played a central role in increasing agricultural productivity in Kerala, aligning the state with the broader Green Revolution movement that transformed agriculture across India and the world. The adoption of chemical fertilizers facilitated nutrient replenishment, enhanced crop yields, and reduced the state's dependency on food imports, contributing to greater food security and economic growth. However, the indiscriminate use of fertilizers also poses challenges related to soil health, environmental impact, and public health.

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