DYNAMICS OF FERTILIZER CONSUMPTION AND ITS MARKETING: A COMPARATIVE STUDY IN TWO STATES OF SOUTH INDIA

By

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(2019-11-193)

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COLLEGE OF AGRICULTURE

VELLANIKKARA, THRISSUR- 680 656

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THESIS

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2021

DECLARATION

I, hereby declare that this thesis entitled **"Dynamics of fertilizer consumption and its marketing: a comparative study in two states of South India"** is a bonafide record of research work done by me during the course of research and the thesis has not been previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of other University or Society.

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Certified that this thesis entitled **"Dynamics of fertilizer consumption and its marketing: a comparative study in two states of South India"** is a record of research work done independently by **Ms. Ankitha Thakur (2019-11-193)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship, or associateship to her.

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- Bhagavad Gita 2.47

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LIST OF ABBREVIATIONS

GVA	: Gross Value Added
GoI	: Government of India
GoK	: Government of Kerala
GoT	: Government of Telangana
HYV	: High yielding variety
DAC&FW	: Department of Agriculture and Farmers Welfare
FAO	: Food and Agriculture Organization
N	: Nitrogen
P	: Phosphorous
K	: Potassium
FAI	: Fertilizer Association of India
Approx.	: Approximately
IFFCO	: Indian Farmers Fertilizer Cooperative Limited
KRIBHCO	: Krishak Bharati Cooperative Limited
FACT	: The Fertilisers and Chemicals Travancore Limited
NFL	: National Fertilizers Limited
DBT	: Direct Benefit Transfer
NBS	: Nutrient Based Subsidy
PoS	: Point of Sale
AeFDS	: Aadhaar enabled Fertilizers Distribution System
iFMS	: Integrated Fertilizer Management System

PACS	: Primary Agricultural Co-operative Society
MRP	: Maximum Retail Prices
TS MARKFED	: Telangana State MARKFED
DCMS	: District Cooperative Marketing Society
TSAIDCL	: Telangana State Agro Industries Development Corporation Limited
ARSK	: Agro Rythu Seva Kendra
MT	: Million tonnes
LMT	: Lakh metric tonnes
CAGR	: Compound Annual Growth Rate
NEP	: New Economic Policy
RDF	: Recommended dose of fertilizer
SAU	: State Agricultural University
SWOC	: Strengths, Weaknesses, Opportunities, Challenges
ha	: Hectare
Kg	: Kilogram

INTRODUCTION

Chapter I

INTRODUCTION

Agriculture in India provides subsistence for more than half of the population. According to the Economic Survey 2020-21, for the year 2019-20, agriculture and allied sectors accounted for 17.8 per cent of the country's Gross Value Added (GVA) at current prices. Agriculture and allied industry GVA growth has been inconsistent over time. However, although the overall economy's GVA decreased by 7.2 per cent in 2020-21 when compared to 2019-20, agriculture's GVA grew by 3.4 per cent (GoI, 2020-21).

To sustain the constantly increasing masses, the country's most difficult issue presently is to maintain a balance between the rising population and agricultural productivity. The options for increasing agricultural production are limited due to land and water constraints. Agricultural productivity is also influenced by several elements. Agricultural inputs such as land, water, seeds, fertilizers as well as access to agricultural loans and crop insurance, guarantee of remunerative prices for agricultural produce, warehousing and adequate marketing are few of the factors that determine agricultural productivity. One method of raising production through increasing land productivity is to provide plants with nutrients from chemical fertilizers.

The Department of Fertilizers, GoI defines fertilizer to be a chemical product either mined or manufactured material containing one or more essential plant nutrients that are immediately or potentially available in sufficiently good amounts. Together with seed and irrigation, chemical fertilizer has been highlighted as one of the three most significant variables for increasing agricultural production and ensuring food self-sufficiency in India (Chand and Pandey, 2009).

Chemical fertilizers and agricultural productivity

Technology, paired with high-yielding variety (HYV) seeds, fertilizers, and irrigation, has been at the forefront of increasing agricultural output. In nearly all the states of the country, there is a strong link between fertilizer growth and crop productivity. Recent agricultural history also shows that no input has seen as much increase in their usage as that of fertilizers (Chand and Pandey, 2009). India has raised its fertilizer consumption and output over the last three decades, and it is now the world's second largest consumer (after China) and third largest producer (after China and The United States of America). Regardless of India's position in the world fertilizer consumption, it has recently slowed significantly, owing mostly to supply-side restrictions.

The composition of fertilizer use has also led to significant imbalances in the use of major plant nutrients and this could have a negative impact on soil health and crop output in the long run. Also, the demand-supply gap for fertilizers in India has widened in recent years, intensifying reliance on imports. Agriculture and the fertilizer sector both flourish at the same time. Following the Green Revolution in 1967-68, the increased demand for fertilizer prompted the formation of new fertilizer manufacturing units in the home nation rather than relying on imports.

Chemical fertilizers are responsible for most of the rise in food grain productivity over the first two decades of the green revolution (Desai and Vaidyanathan 1995). As a result, increasing fertilizer usage in the country is critical for increasing agricultural production and meeting the country's future needs. This would necessitate enhanced technology and a greater use of yield-increasing plant nutrients.

Fertilizer scenario in India

During the 1973-74 oil crisis, high grain and fertilizer prices in foreign markets added fuel to programmes aimed at boosting the country's fertilizer supplies and food security (FAO, 2005). Furthermore, in today's globalised economy, where the agriculture sector has become more commercial and production has become more export oriented, fertilizer use has increased. Fertilizer has been a critical component in increasing agricultural output in India. Fertilizer use is significantly higher in areas with high rainfall than in areas with low rainfall, indicating that fertilizer use in India is severely imbalanced (Prasad, 2012).

The three basic elements that make up the bulk of chemical fertilizers are nitrogen (N), phosphorous (P) and potassium (K). According to the Annual report-2019-20 by the Department of Fertilizers, GoI, in terms of urea manufacturing capacity, the country has achieved 80 per cent self-sufficiency. Consequently, India can now meet its large need for nitrogenous fertilizers through its domestic sector rather than relying on imports. In the case of phosphatic fertilizers, 50 per cent indigenous capacity has been established to meet domestic demand but the raw materials are mostly imported. Because there are no sustainable sources/reserves of potash (K) in the country, imports are used to meet the whole demand. In the year 1950-51, the all-India consumption of N, P_2O_5, K_2O fertilizers was 55.0, 8.8 and 6.0 thousand tonnes respectively which rocketed to 18.8, 7.4 and 2.64 million tonnes in 2019-20 (FAI, 2019).

Chemical fertilizers are one among the prime inputs for agriculture, and has contributed to the increase in food grain production 52 million tonnes in 1951-52 to 308.65 million tonnes in 2020-21 (GoI, 2020-21). The higher yield can be attributed to the use of fertilizers. With constrained arable land resources and a growing population, the advancements in technology and the optimal use of existing technologies and inputs will continue to be critical in ensuring India's food security. It is estimated that if the use of farmland for commercial/non-agricultural purposes is not controlled, India's accessible arable land could go below the existing level of 140 million hectares (Approx.). Hence, the recommended method to boost food production is to raise crop accompanied by the methodical application of fertilizers, as well as other inputs such as high yielding variety seeds, irrigation, among other factors.

In India, there are three primary players in the fertilizer industry: public, private, and cooperative. IFFCO, KRIBHCO, FACT, Nagarjuna Fertilizers & Chemicals Ltd., Coromandel, NFL *etc.* are major fertilizer firms in India. Fertilizer production in India has also increased dramatically from 22.2 million tonnes in 1990-91 to 42.7 million tonnes in 2019-20. (FAI, 2019). IFFCO and KRIBHCO are the two fertilizer cooperatives present in India. IFFCO is a multi-unit cooperative association that has been manufacturing fertilizers since 1967. KRIBHCO is also a leading national-level Indian cooperative society that produces and distributes fertilizer. NFL and FACT are public-sector units and are among the top fertilizer producing companies in India.

Fertilizer plants and installed capacity

India's first fertilizer plant was established in 1906 at Ranipet. The single super phosphate (SSP) manufacturing unit had a 6000 MT annual capacity. Following that, to achieve food grain self-sufficiency, the Fertilizer and Chemicals Travancore of India Ltd. (FACT) in Cochin, Kerala, and the Fertilizers Corporation of India (FCI) in Sindri, Bihar were established in the nineteen forties and fifties.

With the introduction of high yielding varieties (HYV) in 1960s during the green revolution the demand for chemical fertilizers increased rapidly. Demand and consumption of fertilizers also increased and presently the consumption is 28.9 million tonnes in 2019-20 (FAI, 2019) and total installed capacity currently stands at 207.54 LMT of urea, 80.89 LMT of DAP, 70.33 LMT of complexes and 120.85 LMT of SSP (Fertilizer Scenario, 2018).

It is in this backdrop that the study entitled 'Dynamics of fertilizer consumption and its marketing: a comparative study in two states of South India' is taken up and it aims to analyse the trend in production and consumption of major chemical fertilizers in India and to compare the consumption pattern of fertilizers in Kerala and Telangana. The study also looks into the marketing strategies of the leading fertilizer cooperative in the country.

Specific objectives of the study

- To analyse the trend in production and consumption of major chemical fertilizers in India
- To compare the consumption pattern of fertilizers by paddy farmers in the states of Kerala and Telangana
- To study the marketing system of fertilizers in the two states
- To conduct a SWOC analysis of the leading fertilizer cooperative in India

Scope of the study

Chemical fertilizers have contributed significantly to the food grain self - sustainability in India. It has been a critical input for the development of Indian agriculture. Fertilizers should be made available to farmers at reasonable prices to maintain agricultural growth and promote balanced nutrient application. The availability and quality of fertilizers as an input to farmers at reasonable rates is critical for the country's agricultural sector to thrive. Chemical fertilizers were first applied on sugarcane and paddy. The Indian Fertilizer Industry is controlled and supervised by the

Government of India. A better understanding of the country's fertilizer consumption pattern can be known only if the individual farm level consumption is studied. The growth trend in the chemical fertilizer production and consumption would also provide various insights and help in shaping policies and providing a rigid framework for designing strategies.

The studies on chemical fertilizer consumption are of prime importance in today's world as the area under agriculture is reducing drastically. This accompanied by the increase in population will only result in food shortage in near future. Hence, in order to increase food grain production, use of HYV's supplemented with proportionate chemical fertilizer application is one of the options.

Limitations of the study

Due to lack of time and resources, the selection of study area is restricted to one district in each state. The study is based on primary data which is collected from a finite number of respondents and the COVID-19 situation restricted personal data collection to some extent. Primary data from the traders were collected through telephonic interviews. The recall bias in the primary data collection from farmers was also a limitation. Even though the estimates are based on recall memory due to the lack of farm records, great care has been made to obtain reliable data to the extent possible. A lot of care has also been taken to avoid the fallacies which are innate in social science surveys, though one cannot completely do away with them. However, because the figures offered are in averages, the degree of difference, if any, would be small.

Presentation of the thesis

The entire study has been presented in five chapters. The first chapter consists of 'Introduction' and the scope of the study'. Also, the specific objectives of the study are mentioned.

Chapter II includes the literature review of different research done with respect to the objectives of the study.

Chapter III deals with the 'methodology' which showcases the methods employed to get results from the objectives in the study done.

Chapter IV is devoted to present the 'results and discussion' of the study and its interpretation.

Chapter V is the ‘summary and conclusions’ which sums up the significant findings and the suggestions drawn from the study.

REVIEW OF LITERATURE

Chapter II

REVIEW OF LITERATURE

An extensive review of literature is crucial for better insight into the study. A review of the past studies in related fields helps in conceptualizing the research methodology and in operationalizing the concept. It showcases the progress within a particular field of study and provides us with various policy implications regarding the study. It will also help in finding out the lacunae in the concerned research and in understanding new perceptions and findings with regard to the proposed research. The review of literature done in line with the objectives are presented under the following sub heads:

2.1 Trend in consumption and production of fertilizers in India

2.2 Consumption pattern of fertilizers in different states

2.3 Marketing systems of fertilizers

2.4 Strengths, Weaknesses, Opportunities, Threat (Challenges) (SWOC) analysis

2.1 <u>Trend in consumption and production of fertilizers in India</u>

Hossain and Singh in the year 2000 examined the trend in fertilizer consumption and the changes in the policies in relation to fertilizers and found that consumption of fertilizer is dependent on the demand for food grains. A striking difference between developed and developing countries with regard to fertilizer consumption has been noted by the authors. The declining fertilizer consumption in developed countries is attributed to the more stable population growth and the increasing demand for quality food. On the other hand, increasing trend in the population growth resulted in increased demand for food grains in developing countries leading to increased fertilizer consumption.

In his study titled 'Potassium fertilizer situation in India: Current use and perspectives', Kinekar (2011) stated that imbalanced use of fertilizer is one of the main reasons for the food grain production to be very low in India. Even though there is an increase in fertilizer use, the target of increased food production, has not been achieved.

A study was conducted by Sharma and Thaker (2011) to determine the demand for fertilizer in India and also the outlooks for 2020. The study states that India is self-sustained in N and P and the requirement of other nutrients is met by the imports of the country. But during the 2000's, the trend got reversed wherein even for meeting the domestic requirement of N and P, imports were made. It was around 2 million tonnes in 2000 which further rose to 10.2 million tonnes of fertilizers in 2008-09.

Jaga and Patel (2012) conducted a study on the overview of fertilizer consumption in India to know the determinants and outlooks for the year 2020. The study concluded that in order to enhance agricultural production, chemical fertilizers have played an important role. It was also stated that despite the sharp rise in imports, the average use of fertilizer in India is comparatively low. The study also distinguishes how price factors and non-price factors determine the fertilizer use. Affordable fertilizer price and price incentives were found to be the key determinants of fertilizer use.

A research work titled "Access to rural credit and input use: An empirical study" was conducted by Satyasai (2012) wherein credit availability and fertilizer consumption were related and it was found that as the credit increases, the ability to purchase fertilizer also increases. Distinction was made between marginal, small and large farmers and the results indicated that with every ₹100 increase in credit, fertilizer use could be increased by 0.38 kg and 1.469 kg by marginal and large farmers respectively. The elasticity of fertilizer use was calculated and it was found between 0.20 and 0.24 on marginal and small farms and 0.52 and 0.54 on medium and large farms respectively.

Singh and Puri (2013) in their paper on demand projection of chemical fertilizer consumption in India highlighted the outlooks and determinants for the year 2020. They concluded that even though there is an extensive use of chemical fertilizers in the country there might exist a demand and supply gap in the future. India stands second in the consumption of fertilizers in the world, but the average intensity of fertilizer consumption is low and is highly skewed with distinguishable inter-regional, inter-state, and inter-district variations. The result indicated that by the year 2020 the demand for fertilizer in the country would become 41.6 MT, and in order to make the availability of fertilizer more feasible, a shift of focus from high output prices to affordable prices is necessary. Also, consumption growth rate is expected to grow at a faster pace in the

Eastern and Southern India compared to Western and Northern India.

Mishra *et al*. (2014) used ARIMA modelling technique in analysing and forecasting fertilizer statistics in India, and found that for the production data of N and P fertilizers, ARIMA (1,1,1) was the most suited model. For the consumption data of N, ARIMA (1,1,2) was observed to be better suited. The ARIMA (1,1,1) model is best suited for the consumption data of P fertilizers. They also concluded that the ARIMA (1,0,0 and 0,0,5) is the best fitted model for forecasting the consumption of potassic fertilizers in India. The study also inferred that there has been striking growth in the production and consumption of fertilizers in India.

Chand and Pavithra in 2015 opined that the change in the fertilizer consumption in India was characterized by three important happenings. The first episode took place in the year 1974-75 when the total nitrogen consumption increased to 68.64 per cent. This was due to the fact that the global fertilizer prices increased which showed more prominence in the changing price of nitrogenous fertilizers compared to potassic or phosphatic fertilizers. The next major step was in the year 1992 when the government decided to curb the imbalance in fertilizer use and accordingly, the price of K and P fertilizers were decontrolled and hence the share of K and P prices increased. This policy-induced change in relative prices of N, P and K led to reversal of the trend towards reduction in share of N in total fertilizer. The third major policy implemented was the NBS (Nutrient Based Subsidy) policy which aimed at promoting and ensuring balanced application of fertilizers. The NBS policy was made in favour of K and P fertilizers and not N and this policy again distorted the prices of N fertilizers but unlike previous years, a 11 per cent gain was seen in the share of N fertilizers. The authors concluded that the policy reforms made to reduce the fertilizer imbalances in fact resulted in a contradictory effect.

Suryawanshi (2015) worked out the growth of chemical fertilizer consumption in India and the issues relating to it. He analysed the trend of consumption of chemical fertilizers and mentioned that there exists a demand-supply gap which has eventually led to the increase of imports in the country. The study also indicated that during the years 1983-84, the annual growth rate of consumption of fertilizers reached a maximum level of 22 per cent and during 1991-92 it fell to a negative percentage of 1.5.

Chakraborty (2016) stated that the demand for fertilizers arise due to both price and non-price factors. The regression analysis revealed that the non-price factors strongly influence the fertilizer use more than the price of the fertilizer. Contrary to the belief that the domestic production of fertilizer is dependent on the import price, it doesn't seem so. In addition to this, the consumption of the fertilizer is determined by the subsidy and prices in the country.

Kumar *et al.* (2017) analysed the trends and pattern of energy consumption in Indian agriculture by dividing the years from 1960 to 2013 into VI phases and found that the consumption pattern of NPK has shown a surge from Phase I (1960-69) to Phase VI (2010-13). For the period from 1960 to 2013, the Compound Annual Growth Rates (CAGR) were calculated and it was found that the CAGR were 8.97, 9.93 and 8.72. Also, the total NPK consumption per hectare grew from 4.61 kg/ha in phase I to 108.08 kg/ha in phase VI.

In their study on trends in fertilizer consumption and the food grain production in India, Kumar *et al.* (2017) observed that the co-integration test revealed a long run relationship between the two components that is fertilizer consumption and food grain production. Also, the Granger causality test showed that fertilizer consumption significantly impacted food production but food production does not have an impact on fertilizer use but it surely affects the income levels of the farmers. It was also observed that with the introduction of the New Economic Policy (NEP), Indian economy opened its doors to privatization and globalization which carved the way for more imports and exports which also paved the way for increase in fertilizer consumption.

Praveen *et al.* (2017) examined the fertilizer subsidies and the distribution of fertilizers in the country and found that on comparing the use of different nutrients, nitrogenous fertilizers are used more followed by phosphatic and potassic fertilizers. In the year 2011-12, around 24 tonnes of fertilizers were consumed and the, per hectare usage was highest in sugarcane, followed by wheat, cotton and rice.

About 70 per cent of the total N consumption is mainly seen in five major crops *i.e.*, rice, wheat, maize, sugarcane, and cotton. In addition to this, Uttar Pradesh, Maharashtra, Punjab, Gujarat, and Madhya Pradesh account for 50 per cent of the total N consumption. Main reason attributed was the various policies and regulations that were implemented in the 1970s and 1990s. The current consumption of N is 89.7 kg per hectare which is actually low and hence there is a lot of scope to enhance the growth of Nitrogen consumption in India. Also, the estimated demand and supply for 2030 stand at 23.45 and 18.76 MT, which leaves a gap of 4.69 MT (Tewatia and Chanda, 2017).

2.2 Consumption pattern of fertilizers in different states

Jha and Sarin (1980) examined the fertilizer consumption and growth in semi-arid tropical India-a district-level analysis. The study revealed that the average consumption of NPK was more in the irrigated semi-arid tropical districts compared to unirrigated districts. Two-thirds of the total cropped area is covered by the SAT districts and it also accounts for 72 per cent of the national consumption of plant nutrients. It is even higher for phosphatic fertilizers. In addition to this, a lot of variation was observed within the irrigated and unirrigated SAT districts. The growth of consumption of plant nutrients was found to be more in the irrigated SAT districts.

Devi *et al.* (1991) investigated the fertilizer consumption and agricultural productivity in Kerala and they found that during the year 1986-87, average NPK fertilizer consumption ratio in Kerala was 7:5:6 which was different from the recommended rate *i.e.*, 4:2:1. The reason for the increase in the consumption of plant nutrients was attributed to the various government policies like the GMF Campaign, High Yielding Variety Programme, *etc.* In Kerala the growth in fertilizer consumption is mainly associated with the intensification of cropping and not because of the change in cropping area.

Hossain and Singh (2000) in their paper on fertilizer use in Asian agriculture: implications for sustaining food security and the environment stated that the response of the crop to varying levels of fertilizer application is one of the key determinants in identifying the fertilizer demand. Farm earnings show a rise with input use when the marginal product is greater than the marginal cost of fertilizers and hence is one of the reasons for farmers to raise the fertilizer application rate. Even though fertilizer trials on different crops have been done and a variety of outcomes have been obtained, the farmer field yield response might actually show a deviation. This is caused due to poor management practices, uneven application levels, uneconomic combinations of the various complementary inputs like labour, irrigation, pesticides.

Rani (2004) carried out a study regarding the consumption of fertilizer in the state of Haryana. It was noticed that due to the increase in the dependency of the country on imports of fertilizers, there exists a demand-supply gap. This gap has further increased because of the increase in agricultural production. During the study period of the study, they observed growth in the fertilizer consumption in Haryana.

Suma *et al* (2009) in their paper on growth and consumption pattern of chemical fertilizers in Karnataka opined that the annual growth rate for the consumption of NPK in Karnataka was 5.03 per cent. The whole study period was divided into two periods, pre-WTO period (1985-86 to 1994-95) and post-WTO period (1995-96 to 2004-05). The state showed maximum consumption during the post-WTO period. Among all the divisions, Gulbarga, Belgaum and Bangalore divisions were the ones which consumed the highest plant nutrients.

Pramanik (2010) studied the fertilizer consumption pattern in districts of northern Telangana region of Andhra Pradesh which include the districts of Adilabad, Karimnagar, Warangal and Khammam from 1977-78 to 2007-08. On observing discontinuity in the data, sub periods were formed and fertilizer consumption was measured. Three independent variables that is gross cropped area, total cropped area and rainfed area were included in the regression model and gross cropped area was identified to affect the fertilizer consumption significantly in all the cases except in Adilabad district where the total rainfed area played a key role in determining the fertilizer consumption. The spline model outperformed all other models in the study for projecting the fertilizer use. Among all the traditional models and the ARIMA models, the spline model was best suited for forecasting the fertilizer consumption.

Doosa (2012) examined the fertilizer consumption pattern in relation to rainfall in the districts of southern part of Telangana region of Andhra Pradesh comprising of Mahbubnagar, Medak and Nalgonda districts. Identification of the correlation values by making use of cluster analysis examined the fertilizer consumption in the three districts in connection to the rainfall pattern. The study found that N, P, K and NPK use in all the three districts increased significantly. In the districts of Medak and Nalgonda, potash consumption grew at a rapid rate.

Makadia and Patel (2014) conducted a study on regional spatio-temporal growth and instability of fertilizer consumption in Gujarat state. They used district-wise fertilizer consumption data and analysed the exponential growth function. The period from1960-61 to 2009-10 were divided into VI phases. The results indicated that the N consumption increased significantly during the phases I, IV and VI. Also, the NPK consumption showed an increasing trend through the years and the state of Gujarat showed lot of variability in their consumption patterns.

In his paper on the suggested and actual application of chemical fertilizers in the agricultural sector of Kerala, Karunakaran (2016) found that in comparison to other states, fertilizer use in Kerala is high. Out of the six crops under study paddy, coconut, arecanut, rubber, cashewnut and banana, banana and rubber were the crops that used maximum chemical fertilizers. The study indicated that farmers growing paddy, arecanut and coconut crops were not following the recommended dose of fertilizers as suggested by the scientists. It was also observed that the use of organic manure and lime was least in these crops. Additionally, there seem a lot of deviation from the recommended dose of fertilizer (RDF) in the state.

Shashank *et al.* (2016) analysed the knowledge level of paddy farmers on nutrient management in Nalgonda district of Telangana state. A comparison was made between state agricultural university (SAU) recommendation followers and farmer practice followers (FP). The findings of the study revealed that 57.8 per cent of the SAU recommendation followers had a good degree of expertise about nutrient management practices. However, 40 per cent of the FP followers had a lower level of knowledge. Agriculture expertise, extension contact, information seeking and awareness about nutrient management strategies were significantly difference between the SAU and FP followers.

Shashank *et al.* (2016) studied the adoption of nutrient management packages by paddy farmers of Nalgonda district of Telangana and it was found that 68.9 per cent of the SAU recommendation followers had medium degree of nutrient management package implementation. Majority of the farmers cited the high cost of the fertilizers as the primary reason for non-adoption of recommended dose of fertilizers. As a result, government must provide subsidies and crop loans to farmers to rescue them from the high cost. The second factor affecting adoption is the high cost of cultivation and less availability of the inputs. Other factors include the lack of awareness about the green manure and bio-fertilizers.

The state of Telangana has seen considerable increase in the fertilizer usage for the past thirty years. The per ha consumption in 1985-86 was 51 kg and it climbed to 221 kg per hectare in the year 2014-15. The compound annual growth rate (CAGR) for the time period was calculated and it was found to be 5.52 per cent. The per hectare consumption of NPK has shown deviation from the recommended dose of fertilizers and the main reason for this is the excess usage of fertilizers. (Devi *et al.,* 2017)

Chavan *et al*. (2019) carried out a study in the Raichur district of Karnataka where they assessed the economic efficiency of paddy farmers. Data Envelopment Analysis (DEA) was applied to the data and it was found that, for paddy cultivation among small farmers results of technical, allocative and economic efficiency indicated that 36.67 per cent, 16.67 per cent and 10 per cent of small farmers had efficiency scores above 0.9 per cent in production of paddy, about 26.67 per cent and 16.67 per cent of the farmers were technically efficient with score ranges between 0.7-0.8 and 0.8-0.9. Similarly in large farmers 33.33 per cent, 26.67 per cent and 10 per cent of technical, allocative and economic had efficiency scores above 0.9 in the production of paddy.

2.3 Marketing systems of fertilizers

Goi (1970) in his paper titled Marketing mix: A review of 'P' observed that marketing mix is a systematic approach that highlights the primary decisions that marketing executives make in structuring their designs to meet customers’ wants, rather than a management theory. The instrument of the marketing mix can be used to create long-term decisions as well as short term goals of the business. The 4 Ps were originally studied keeping in view the company’s interest and were driven by company goals. But, in reality the 4 Ps are driven by consumer actions with an end result of integrating customers into the company’s ideals.

Yeledhalli (1991) studied the various problems which are faced by the players involved in the marketing of different agricultural inputs. Coming to the private dealers of fertilizers, issues related to transportation and fierce competition among the retailers and the traders were few of the many problems mentioned. Co-operatives which deal with agricultural inputs face problems like limited storage facilities, insufficient retail locations and inadequate transit facility.

Gururaj (2007) while studying Biopesticide marketing and usage in north Karnataka observed that lack of efficiency of bio-pesticide consequent to weather factors was a key consideration in the purchase and use of bio-pesticide. In addition, lack of technical assistance and difficulty with the storage of bio-pesticide were also identified as major problems. Farmers growing cotton (33 per cent) and cabbage (27 per cent) also paralleled adulteration to be a big concern. Coming to the dealers of bio-pesticide, it was told that bio-pesticide selling is a risky business with no assured returns and the lack of market for them is due to the poor knowledge the farmers have about bio-pesticides.

Sharma and Thaker (2010) conducted a study on subsidy in India: who are the beneficiaries? They gave the conclusions that the importance of fertilizers in agricultural productivity has made fertilizer a central subject and it has been given priority in all the national strategies and policies. Fertilizer has been subsidized by many developing countries including India. The main aim of subsidy in regard with fertilizer is to encourage farmers to use more fertilizers, resulting fertilizer in higher yields. Also, with increase in use of HYV, which heavily relied on fertilizers, the same aim is served. As a result, with increase in fertilizer use, fertilizer subsidy has also increased. Fertilizer subsidy in India expanded rapidly after the reforms and skyrocketed in the second half of the 2000s. From ₹ 4,389 crores in 1990-91 to ₹ 75,849 crores in 2008-09, the fertilizer subsidy has grown. This shows an increase in per centage of GDP from 0.85 per cent in 1990-91 to 1.52 per cent in 2008-09.

According to Pingali and Kaundinya (2004), farmers prefer to purchase pesticides from town outlets even if their village had a business that sold them. This is because urban stores provided quality fertilizer products, credit, and variety.

Dhaliwal and Kaur (2014) conducted the financial analysis of two co-operative marketing federations, MARKFED in Punjab and HAFED in Haryana. They have mentioned that co-operative marketing groups play a critical role in India's agricultural marketing system. The analysis based on secondary data for the period 2000-01 to

2010-11 conducted using standard statistical tools revealed that financial positions of MARKFED and HAFED were found to be significantly different. The MARKFED is more focused with the day-to-day operations of the federation, whereas the HAFED is more involved with the preservation of assets for the long term. MARKFED's financial situation is better than HAFED's, according to the report.

Gulati and Banerjee (2015) in their working paper studied the key issues and policy options regarding rationalising fertilizer subsidy in India and observations pertaining to the price trend of main fertilizers that is urea, DAP and MOP have been made. Urea is priced at a lower rate than DAP. The decontrolling of the prices of N & P resulted in the increase in the price of MOP. After the introduction of the NBS policy in the year 2010-11, the prices of both DAP and MOP have increased manifold. This in turn resulted in the imbalance in the use of fertilizers.

Kumar and Reinartz (2016) in their study on creating enduring customer value have highlighted that in order to generate customer loyalty and profitability, one of the most critical factors in marketing is to create and deliver value to the customers. The authors say that customer value is a two-dimensional proposition. To begin with, firms must provide with recognized value for the customers in order to be remain effective after which the marketers must measure customer perceived. Secondly, the customers provide the firms with different forms of involvement and the marketers should then access the worth of the customers.

Varkey and Sahu (2016) conducted a study of Marketing process and implementation of IFFCO in Durg District of Chhattisgarh and observed that a scientific conceptual framework is required to ensure timely access and availability of fertilizers as fertilizer is a critical input for increasing crop production The authors had highlighted the marketing management philosophy of IFFCO which focusses on customer satisfaction and the efficient integration and synchronization of all business operations. They also brought out the importance of farmer training and fertilizer use promotion.

Praveen (2017) in his article on Indian fertilizer policies: revisiting the odyssey and lessons from abroad stated that in India, fertilizers have played a key role in enhancing food production and several policies exist which have been changed from time to time. These policies help in regulating fertilizer manufacturing, pricing, imports marketing. But for a more strategic effect, future policies have to be different. Various examples from different countries like China, Brazil, Russia, Thailand and Philippines have been mentioned which provides an overall insight into where India is lagging. Few of the strategies include subsidizing the inputs which are required in fertilizer manufacturing, small packets of fertilizer to be brought into the market, better import of the raw materials and tax management. This coupled with the idea of a balanced soil in terms of nutrients can be useful in revolutionizing fertilizer industry in India.

Kumar and Kapoor (2017) examined the extensiveness of farmers' buying process of agri-inputs in India: implications for marketing and their findings revealed that farmer's trait influence their purchasing decisions and this influence was particularly seen in cases where agri-inputs were regularly purchased. Farmer's education and agricultural experience were two factors which majorly contributed to the buying behaviour. All aspects of the farmers' purchasing process was found to be positively correlated to the purchase decision time, number of information sources used, number of suppliers considered, and number of conversations with suppliers. The findings of the study also provide vital insights to agri-input companies about their customer's behaviour, allowing them to rethink their approach to markets in India.

Chaudhari and Kshirsagar in the year 2019 conducted a study on effect of marketing strategy on sale of fertilizer in Shrirampur and Nagar tahasil which reflected on the different marketing strategy used for the disbursement of the fertilizer. According to the findings of the study, more than 60 per cent of the farmers buy fertilizer at a low or reasonable prices. The marketing plans of various organizations have been the focal point for achieving overall performance.

Kishore *et al*. (2021) while studying the development of balanced nutrient management innovations in South Asia opined that even though there was a spectacular rise in the price of P and K fertilizers in India, field-level data in paddy cultivation showed that it did not affect the application levels of the two nutrients in it. Though the relative prices of nitrogenous, phosphatic and potassic fertilizers has been changing through years, it doesn't seem to show significant response by the farmers. The authors further conclude that this lack of response advocates the necessity of rationalizing subsidies on one hand but does not completely affect the balanced application of nutrients in India on the other.

2.4 <u>Strengths, Weaknesses, Opportunities, Threat (Challenges) (SWOC) analysis</u>

Panagiotou (2003) in his paper on bringing SWOT into focus has written that organizations struggle to thrive in a highly dynamic and varied environment marked by fierce regional, domestic and worldwide competition. Economic and political revolutions, increasing industry borders, competitive challenges, cooperative engagements, and a wide range of philosophies all impose a variety of restraints on businesses. Constantly changing technologies, deregulation, and ever-increasing customer needs and expectations put pressure on businesses and put them at risk. SWOC analysis is the most well-known tool for auditing and analysing a firm's overall strategic position and its environment.

Strengths, Weaknesses, opportunities and Threats (SWOT) analysis is frequently touted as a quick way to get a consensus on a strategy. It can certainly assist in the development of new strategic initiatives, but the strategic development process also necessitates extensive research and testing of such ideas before their acceptance. SWOT analysis can thus be viewed as an infusion rather than a procedure in itself. SWOT analysis has an antiquated air to it, yet it is a time-tested framework that can easily include ideas from contemporary methodologies like resource and competency-based management and case development. (Dyson, 2004)

Coman and Ronen (2009) diagnosed the strengths and weakness of SWOT and the major issues in the examination of strengths and weaknesses were shown. Three tools can be used to solve major challenges in the examination of strengths and weaknesses. The three tests include focused current-reality tree (fCRT) analysis for the identification of core-problems; and core-competence tree (CCT) assessment for the detection of core competencies and event-factor analysis is used as a reliable source of strengths and weaknesses

Helms and Nixon (2010) mentioned the various uses of SWOT to be still prevalent in academic peer-reviewed journals. SWOT analysis as a planning technique has been validated by research. SWOT analysis has centred on examining firms for proposed strategic actions throughout the last decade. SWOT analysis has been expanded beyond firms to organizations and regions as a framework for market position, and it is employed in practically every published business plan presented for business studies. Advisors, instructors, and educators can use SWOT as a teaching tool. The paper summarises the various advantages of SWOT in research analysis and offers future research directions.

Ghazinoory *et al.* (2011) conducted a study on SWOT methodology and the results revealed that agriculture and its allied fields are the areas in which SWOT is utilised the most, which is unexpected given that corporate areas and sectors are more likely to engage in strategy development and implementation. It's worth noting that these papers are largely from developing countries (especially India), and they frequently analyse the state of agriculture in a specific geographic region rather than the strategic stance of a certain business. SWOT in agriculture has been popular from 2002, with numerous articles released since then.

Padma and Rathakrishnan in the year 2013 conducted a study on SWOC analysis on precision farming system in the western and north-western zones of Tamil Nadu. More than 80 per cent of respondents cited increased crop yield, increased area under cultivation, reduced water use, high economic efficiency, proper and effective pest management, bulk purchasing of inputs, technical assistance from stakeholders, and information exchange with members of the community as major strengths. Increased initial investment costs, additional maintenance expenses, a lack of technical know-how, no strategy for evaluating in-field differences, variability in PF technology use (72.50 per cent), and the need for skilled labour, among other issues, were identified as weaknesses by nearly three-quarters of the sample. Opportunities included the accessibility of bank loans, subsidies, higher agricultural commodity prices, more leisure time, engaging farm youth, and improving extension services. More than half of the respondents voiced concern about the high cost of water-soluble fertilizers, as well as the longer time it takes to see a return on investment.

Namugenyi *et al.* (2019) studied design of a SWOT analysis model and its evaluation in diverse digital business ecosystem contexts and found that it has many uses in different facets of agriculture. One among them is the fertilizer industry. SWOT analysis of fertilizer industry showed many policy-oriented results. The internal structure of fertilizer firms and solid management practise are strengths. Fertilizer businesses are ineffective due to outdated technologies, insufficient research and development, uncertain supply networks, and poor management. In regions where soil quality is poor, unpredictable rain and irrigation patterns limit fertilizer use. New opportunities include worldwide quality circles and farmers, robotic farming, international marketization through internet markets, and a distribution system between demand. Fertilizer market conditions are disordered and unreliable due to a market crash, the supply of low-quality fertilizers, rigorous government controls, fierce rivalry.

Radadiya and Shukla (2019) studied the strength, weakness, opportunity and challenges in agriculture markets. Strong ties with the government, which provides subsidies, are examples of strength. Weaknesses include aspects such as farmer's strong affinity to existing local merchants. Opportunity includes the benefit to the farmer will be that the entire auction process will be based on the quality of the produce and will be completely transparent. Challenges involve topics such as bringing all of the APMCs together in one integrated market place which is a difficult task.

- After reviewing various studies on fertilizer use in India, a study that analyses the consumption and production of fertilizers in India and as well as forecasting of consumption and production of fertilizers is needed. Kerala and Telangana were chosen for the study because the fertilizer use pattern in both the states show distinctive contrasts. Telangana is one of the states with high fertilizer use and on the other hand, farmers in Kerala apply comparatively less quantities of fertilizer. Also, paddy crop was chosen for the study because rice is the staple food grain cultivated as well as consumed in both the states. Comparing the use of fertilizers in Kerala and Telangana will also help to know the fertilizer use behaviour of farmers in both the states. Studying the marketing system of fertilizers presents an idea of the various brands available for the farmer and also helps to understand the fertilizer marketing in both the states. SWOC analysis provides an idea of the position of IFFCO and its contribution to the fertilizer industry in India.

METHODOLOGY

Chapter III

METHODOLOGY

This chapter consists of the description of the study and the various methods that are employed to carry out the research. It deals with the details of the study area, nature and sources of the data, sampling procedure and the statistical tools used to analyse the data, all of which are explained in this chapter.

The methodology adopted has been explained under the following heads:

3.1 Location of the study area

3.2 Nature and sources of data

3.3 Sampling technique

3.4 Analytical tools

3.5 Various terms and concepts

3.1 Location of the study area

The study entitled 'Dynamics of fertilizer consumption and its marketing: a comparative study in two states of South India' was conducted in two states of South India that is, Kerala and Telangana.

3.1.1 Kerala

Kerala is located to the south of India and is surrounded by the Arabian sea to the west and the Western Ghats to the east, covering 38,863 sq. km. Kerala's shoreline stretches about 580 kilometres, while the state's width varies from 35 to 120 kilometres. The geography consists of a hot and humid coastal plain that progressively rises in height to the Western Ghats' highlands. Kerala is located between the 08°17'30'' N and 74°27'47'' E. The climate is predominantly wet and maritime tropical, with the monsoon's seasonal heavy rains having a significant impact. Kerala has a humid tropical wet climate like that of most of the world's rainforests. Kerala receives 3055 mm of yearly rainfall on an average. Parts of Kerala's lowlands may receive about 1250 mm of annual precipitation, while the cold hilly eastern foothills of Idukki district which is considered Kerala's wettest region receives over 5,000 mm. The neighbouring states of

Kerala are Tamil Nadu and Karnataka.

Kerala has a tropical environment due to its location at an altitude of 80 degrees above the equator. Kerala has three distinct seasons: June-September, October-November, and December-March. During the months of October-December Kerala receives the South-West monsoon (Edavappathy). In comparison to other regions of India, the winter season in Kerala is mild throughout the months of December and February. Kerala's climate is characterised by gentle winds and heavy monsoon rains. Kerala's topo-lithosequence, combined with variations in rainfall, temperature, and alternate wet and dry conditions, especially from the western coast to high mountains in the east and swift-flowing rivers, leads to the creation of various types of natural vegetation and soil. The soils of Kerala can be broadly grouped into coastal alluvium, mixed alluvium, acid saline, kari, laterite, red, hill, black cotton, and forest soils. Rubber, coconut, arecanut, tapioca, coffee, cardamom, and tea are among of the state's most well-known commodities. Kerala is also the country's major producer of a variety of other crops such as cashews, ginger, and turmeric. In addition to all these crops rice still stands as the primary food source in Kerala. In Kerala, Palakkad is the district which contributes to highest area and production of rice and hence it has been purposively selected for the study.

3.1.2 Palakkad

Palakkad is one of Kerala's few districts without a coastline. The Palakkad Gap, which spans 32 to 40 kilometres, connects the state to the rest of the country. The district's overall area is 4,475 sq. km, accounting for 11.5 per cent of the state's total area and making it Kerala's largest district. It is located between 10°20'00" N and 76°20'00" E. It is called the ‘granary of Kerala’. Palakkad has a tropical climate with both wet and dry seasons. Temperatures are mild throughout the year, with the exception of the hottest months of March and April. Palakkad receives a lot of rain, mostly due to the South-West monsoon. The wettest month is July, with a yearly rainfall of roughly 83 inches (210 cm). Every year, the district receives an average of 2362 mm of rain.

Many small and medium stream tributaries of the Bharathapuzha River run through the region. Several dams have been erected across these rivers, with the

Table 3.1 Land utilization pattern of Palakkad district

S. No	Category	Area (in ha)
1	Gross cropped area	272195
2	Net cropped area	206139
3	Cropping intensity	132
4	Land put to non-agricultural uses	48460
5	Current Fallow (up to 1 yr.)	8838
6	Other fallow land (1 to 5 yrs.)	10918
7	Cultivable waste	19200

Source: Agricultural Statistics 2018-19, Department of Economics and Statistics, Government of Kerala.

Table 3.2 Cropping pattern of Palakkad district

S. No	Crop	Area (in ha)	Production (in tonnes)
1	Paddy	77121	215285
2	Cholam/Jower	205	168
3	Ragi/Finger Millet (Koovaraku)	152	141
4	Maize	80	85
5	Small Millet (Thina/Chama)	48	35
6	Tur/Red gram	266	438
7	Gram	101	75
8	Sugar Cane	67	495
9	Pepper	2654	1095
10	Ginger	193	742
11	Turmeric	475	1428

Source: Agricultural Statistics 2018-19, Department of Economics and Statistics, Government of Kerala.

Malampuzha dam being the largest. The major soils present in Palakkad include red soils, loamy soils, clayey soils and loamy sands. The main source of irrigation is through the canals. The main crop cultivated in the region is paddy and highest area under paddy for the year 2018-19 was in Kuzhalmannam and Thenkurissi panchayats and therefore they were selected for the study.

3.1.3 Telangana

Telangana is India's 29th state, formed on June 2, 2014. The state covers 1,12,077 square kilometres and has a population of 3,50,03,674. Telangana is bordered on the north by Maharashtra and Chhattisgarh, on the west by Karnataka, and on the south and east by Andhra Pradesh. Hyderabad, Warangal, Nizamabad, Nalgonda, Khammam, and Karimnagar are the state's major cities with the capital being Hyderabad. It lies between 18.1124° and 79.0193° E. The state is divided into 33 districts. The largest is Bhadradri Kothagudem, while the smallest is Hyderabad.

It is primarily located in Deccan upland region (peninsular India). The Telangana Plateau in the north and the Golconda Plateau in the south take up a large portion of its surface area. Telangana is notable for its rich agricultural fields, which receive sufficient water from the region's two major rivers basins, the Godavari River basin in the north and the Krishna River basin in the south. Manjira, Bhima, Maner, and Musi are some of the state's smaller rivers. The southwest monsoons bring yearly rainfall of 900 to 1500 mm in northern Telangana and 700 to 900 mm in southern Telangana. The climate is predominantly hot and dry. Summers begin in March and end in May, with typical high temperatures in the 42-degree Celsius (108-degree Fahrenheit) range. The monsoon season begins in June and lasts through September, with an average rainfall of 755 mm (29.7 inches). With little humidity and average temperatures in the 22–23 °C (72–73 °F) range, a dry, mild winter begins in late November and lasts until early February. Red sandy loams (Chalaka), red loamy sands (Dubba), lateritic soils, salt-affected soils, alluvial soils, shallow to medium black soils, and very deep black cotton soils are some of the soil types found in Telangana.

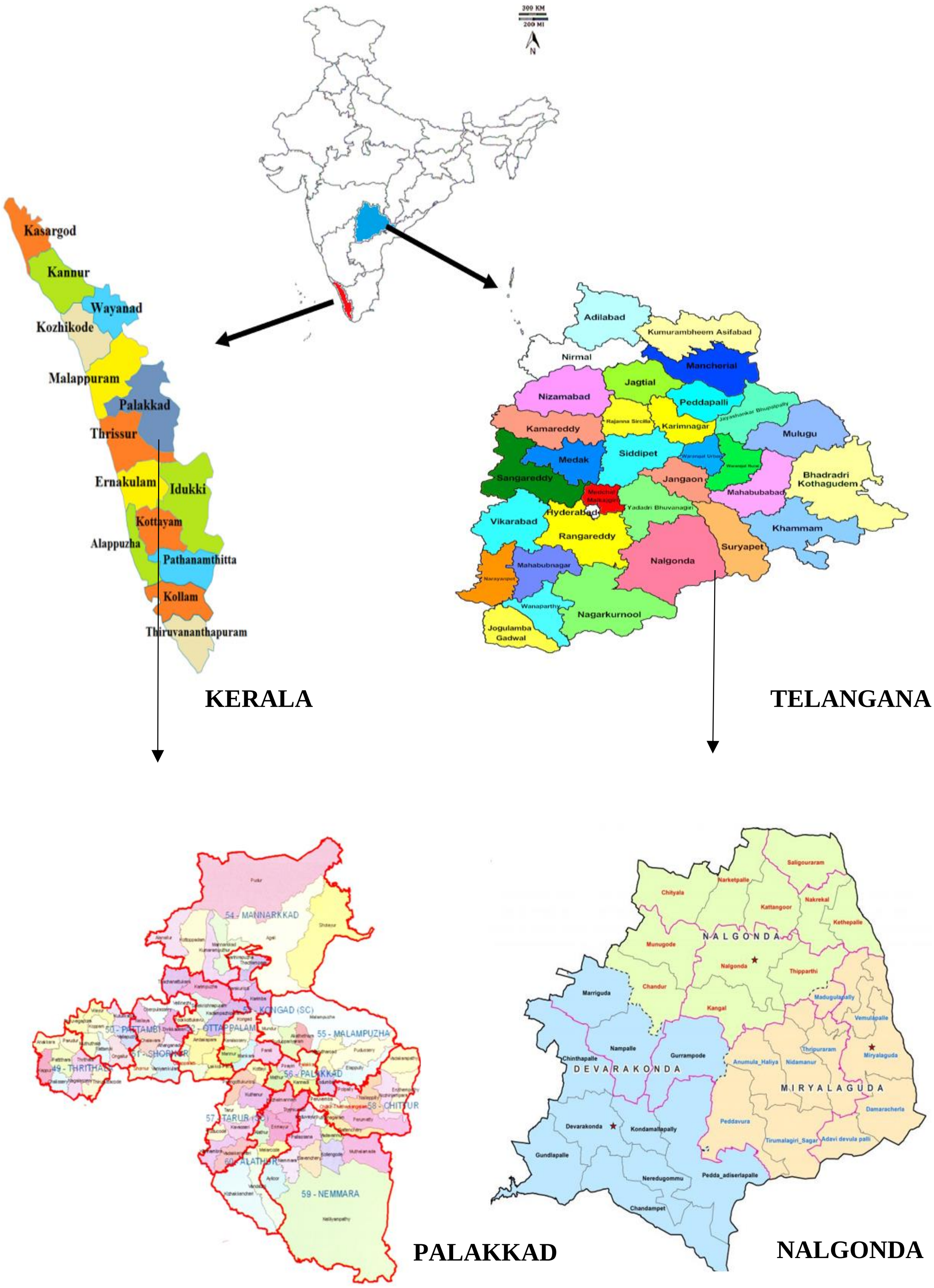


Fig 3.1 Location of study area in Kerala and Telangana

Rice is the main food and staple crop of Telangana. Maize, tobacco, mango, cotton, and sugar cane are among major crops. Among all the districts, Nalgonda has the highest area under paddy and hence, it has been purposively selected for the study.

3.1.4 Nalgonda

Nalgonda is mostly a farming district with abundant irrigation and suitable weather conditions. Around 75 per cent of the population is dependent on agriculture, either directly or indirectly. Paddy and cotton are the two most important crops. The climatic conditions are ideal for paddy and groundnut seed production, and the district has made a significant contribution toward establishing Telangana as India's seed bowl. The district is located at 17°19'N latitude, 79°20'E longitude, and 420 m elevation.

Table 3.3 Land utilization pattern of Nalgonda district

S. No	Particular	Area (in ha)
1	Reporting Area for Land Utilisation Statistics	1424000
2	Forests	83073
3	Area under Non-Agricultural Uses	128360
4	Barren and Un Culturable Land	121351
5	Permanent Pastures and Other Grazing Lands	64294
6	Culturable Waste Land	29146
7	Fallow Lands Other than Current Fallows	138606
8	Current Fallow	160464
9	Net Area Sown	691314
10	Total Cropped Area	880758
11	Area Sown More than Once	189444

Source: Statistical Report- Nalgonda District, 2018 Government of Telangana.

It is bordered on the north by Medak and Warangal districts, on the south by Guntur and Mahbubnagar districts of Andhra Pradesh, on the east by Khammam and Krishna districts of Andhra Pradesh, and on the west by Mahbubnagar and Ranga

Reddy districts.

The district's summers are scorching hot. Several rivers run through the region. The river Krishna flows from the district's southern boundary to the southern mandals (blocks). River Musi enters from the north-west, travels 64 kilometres before connecting the Alair River, then flows 153 kilometres before joining the Krishna River. The district of Nalgonda is divided into 59 Mandals. Of all the mandals in the district, Miryalguda has the highest area under paddy and therefore it is purposively selected as the study area. For a thorough study of fertilizer consumption pattern, two panchayats were selected from the Miryalaguda area which had highest area under paddy. The two panchayats were Nandipahad and Kothaguda.

3.2 Nature and sources of data

The study involves both primary and secondary data which were collected to carry out the objectives of the study.

Primary data

The primary data was collected from the farmers who cultivated paddy. It was done with the help of a pre-tested and structured schedule and through personal interview method. Thirty farmers each from two panchayats of Miryalaguda mandal (block) in Nalgonda district and two panchayats of Kuzhalmannam block in Palakkad were purposively selected. In addition, ten traders from each block were also interviewed through the telephonic method with the help of an interview schedule.

Secondary data

To analyse the trend in production and consumption of major chemical fertilizers in India, secondary data was collected from Fertilizer Association of India (FAI). The time series data ranges from 1950-51 to 2019-20 and therefore it has been divided into periods.

Pre green revolution period - (1950-51 to 1966-67)

Post green revolution period

Phase I - (1967-68 to 1980-81)

Phase II – (1981-82 to 1991-92)

Post reform period

Before New Pricing Scheme (1992-93 to 2002-03)

After New Pricing scheme (2003-04 to 2019-20)

This division into subgroups is done for a better understanding of the implications of the government policies that were implemented. Annual reports from FAI, and fertilizer companies like IFFCO (Indian Farmers Fertilizer Cooperative Limited), FACT (The Fertilizers and Chemicals Travancore Limited), NFCL (Nagarjuna Fertilizers and Chemicals Limited) and other major fertilizer companies, were also studied to know the marketing strategies.

3.3 Sampling technique

The study was done in two states of south India that is Kerala and Telangana. One district each from the states having the highest area under paddy cultivation was purposively selected. In Telangana it is Nalgonda and in Kerala it is Palakkad. From each district one block (in Telangana it is called a mandal) with the same criterion was selected. Miryalaguda in Telangana and Kuzhalmannam in Kerala were chosen as they have the highest area under paddy. From each block two panchayats that is Nandipahad and Kothaguda panchayats in Telangana and Kuzhalmannam and Thenkurissi panchayats were randomly selected. Random sampling method was used to select 30 sample farmers from each panchayat and in total 120 farmers was the final sample size. Random sampling method was employed to interview 10 traders each from the two blocks.

3.4 Analytical tools

3.4.1 Statistical measures for secondary data

3.4.1.1 Compound Annual Growth Rate (CAGR) analysis

3.4.1.2 Cuddy-Della Valle Instability index

3.4.1.3 Trend analysis

3.4.1.4 Time series Forecasting

3.4.1.5 Exponential smoothing methods

PLATE 1: Survey in the study area

3.4.2 Statistical measures for primary data

3.4.2.1 Frequency and percentage analysis – Descriptive statistics

3.4.2.2 Linear and second order polynomial regression

3.4.2.3 Box and whisker plots

3.4.2.4 Kendall's coefficient of concordance

3.4.2.5 Garrett ranking technique

3.4.1 Statistical measures for secondary data

3.4.1.1 Compound Annual Growth Rate (CAGR) analysis

To assess the trend in the production and consumption of major chemical fertilizers in India, compound annual growth rate was calculated. Time series data ranging from 1950-51 to 2019-20 was used after dividing the whole data into different periods.

It was estimated by using the exponential growth function of the form:

$$Y_t = AB^t e^{ut}$$

Where, Y_t = consumption/ production of chemical fertilizers disbursed during time t

A = intercept term

B = Regression coefficient

t = Time period for consumption/ production of fertilizers

ut = error term for the year 't'

The compound annual growth rate values were calculated using the LOGEST function in MS excel. It is a helpful tool because rather than computing the growth rate only on the basis of the beginning and concluding values, this function uses the least squares method to produce a yearly rate of growth that best matches the historical trend. When calculating the CAGR, the LOGEST function takes annual changes into consideration and therefore it has been used in the study.

3.4.1.2 Cuddy-Della Valle Instability index

The Cuddy-Della Valle Instability (CDVI) index helps to find the instability in a non-trended, linear or exponentially trended time series data. The advantage is that it is derived from the formula of coefficient of determination and can be used in any time series data. It is a modification of the coefficient of variation that accounts for data trends, which are common in economic time series. This technique outperforms standard deviation and other scale-dependent measurements.

CDVI is calculated as follows:

$CDVI = CV\sqrt{X}$

Where, $X = 1 - \bar{R}^2$

CV = coefficient of variation

$\bar{R}^2$ = adjusted coefficient of determination

CDVI was used to know the uniformity in the consumption and production of chemical fertilizers in India. In the given regression equation, when the estimated parameter is not significant, then the coefficient of variation itself is the instability index. The ranges of CDVI are given as follows:

Low instability = between 0 and 15

Medium instability = greater than 15 and lower than 30

High instability = greater than 30

3.4.1.3 Trend analysis

Trend analysis is a technique used in technical analysis that aids in anticipating future movement based on present trend data. Trend analysis involves collecting information from various time periods and plotting the information on a horizontal line for later review. The purpose of this analysis is to find operational patterns in the information presented.

In order to analyse the trend in production and consumption of major chemical fertilizers in India, data was obtained and changes in the pattern of production and consumption was found. Also, the reasons for the changes have been summarized.

‘3.4.1.4 Time series forecasting

Time series forecasting is the process of using statistical data and models to analyse time series data to make predictions and provide information for strategic decisions. Time series forecasting is usually combined with time series analysis. Time series analysis involves developing models to understand the data and understand the root cause. Forecasting involves adopting models that fit historical data and using them to predict future observations. For prediction of future values, a procedure is followed. Firstly, the whole data set is divided into a training data set and a validation data set. The original data set which helps to train the model is the training model. It is through this data that the model sees and learns. The data used for providing an unbiased evaluation of a model fit and also tuning of the model parameters is known as a validation dataset. Test data set can be applied for unbiased evaluation of a final model fit.

To forecast the data regarding consumption and production of major chemical fertilizers in India, univariate time series data from 1950-51 to 2019-20 for consumption and 1955-56 to 2019-20 for production were analysed. The data from 1950-51 to 2014-15 and 1955-56 to 2014-15 for consumption and production were first used to build the corresponding model (training period). After verifying the model for the remaining years, a suitable model was fitted to all of the data to predict the consumption and production of major fertilizers in India for the next 6 years from 2020-21 to 2025-26. Expert modeler in SPSS statistical package was used to forecast the future values.

Time series forecasting has multiple applications. There are several forecasting methods; the choice of method depends on the intent and importance of the forecast, and the cost of the method involved. There are two basic properties of a time series.

1. Sequentially measuring the data which is equally spaced in time.

2. At least one data measurement is present in the time unit.

3.4.1.5 Exponential smoothing methods

Exponential smoothing is a time series forecasting method which is used for univariate time series data estimation. The Box-Jenkins ARIMA method which is usually used in time series algorithms creates a model in which the prediction is a weighted linear sum of recent past observations or lags. The approach of the exponential smoothing methods is also similar to ARIMA, a forecast is a weighted sum of previous observations but the model utilises an exponentially diminishing weight.

Exponential smoothing time series forecasting methods are of three categories. There's a basic method that assumes no structured approach, the next which specifically covers trends, and the most complex technique that includes seasonality support.

1. Single Exponential smoothing/ simple exponential smoothing

2. Double Exponential smoothing/ Methods which uses two parameters

    (a) Brown's Linear method with single parameter

    (b) Holt's Linear method with two parameters

3. Winter's Exponential smoothing model/ method which uses three parameters

    (a) Winter's Multiplicative Method

    (b) Winter's Additive Method

3.4.1.5.1 Simple Exponential Smoothing Model

Simple exponential smoothing is the most basic of the exponentially smoothing approaches (SES). This strategy works well for projecting data that doesn't have a clear trend or seasonal pattern. This strategy assumes that the most recent observation is the only one that matters, and that all previous observations are useless for predicting the future.

$$Y_{T+h/T} = Y_T$$

For h = 1,2,3….

The forecasted values are averages of the observed data.

$$Y_{T+h/T} = \frac{1}{T}\sum_{t=1}^{T} YT$$

For h = 1,2,3…. therefore, the technique is based on the assumption that all observations are of equal value and therefore gives equal weights to the predicted values. Frequently, a compromise is made between the extremes. For example, it might make sense to give more weight to current observations than to findings from the past. This is exactly how simple exponential smoothing works. Weighted averages are used to make forecasts, with the weights decreasing exponentially as more data are added from the past.

$$Y_{T+1/T} = \alpha Y_T + \alpha (1-\alpha) Y_{T}-1 + \alpha (1-\alpha)^2 Y_{T-2} + \cdots$$

Where, $0 \leq \alpha \leq 1$ is the smoothing parameter.

T+1 = weighted average of all of the observations in the series

α = The rate at which the weights decrease is controlled

3.4.1.5.2 Holt's Exponential Smoothing Model

Holt (1957) expanded simple exponential smoothing to enable the predicting of data with a trend. A forecast formula and two smoothing equations are used in the method (one for level and the other for trend).

Level of the series at time 't' and coefficient α

$$L_t = \alpha Y_t + (1-\alpha) [L_{t-1} + T_{t-1}]$$

Trend of the series at time 't' and coefficient γ

$$T_t = \gamma [L_t - L_{t-1}] + (1-\gamma) T_{t-1}$$

Forecast for k step ahead

$$F_{t+1} = L_t + kT_t$$

L_t = estimate of level of series at time t

T_t = estimate of trend of series at time t

α = smoothing parameter for the level, $0 \leq \alpha \leq 1$

γ = smoothing parameter for the trend, $0 \leq \gamma \leq 1$

L_t is a weighted average of observation F_{t+1} and the one-step-ahead training projection for time t, which is given by $L_{t-1} + T_{t-1}$ in the level equation. T_t is a weighted average of the projected trend at time t and $L_t - L_{t-1}$ and T_{t-1}, the prior estimate of the trend, according to the trend equation.

3.4.1.5.3 Brown's Exponential Smoothing Model

Brown's Exponential Smoothing model is a method for generating a linear equation. It runs two simple exponential smoothing projections before adjusting for the data's linear trend. The purpose is to establish a linear trend, similar to Double Exponential Smoothing, but it accomplishes so without providing additional parameters to the equation.

3.4.2 Statistical measures for primary data

3.4.2.1 Frequency and percentage analysis

The number of times each response was chosen by the respondents is shown in a frequency analysis. This gives the profile of the respondents.

3.4.2.2 Linear and second order polynomial regression

By fitting a linear equation to observed data, linear regression seeks to examine the relationship between two variables. One variable is regarded as an explanatory variable, while the other is regarded as a dependent variable. The equation for a linear regression line is

Y = a + bX, with X as the explanatory variable and Y as the dependent variable. The intercept (the value of y when x = 0) is 'a', while the slope of the line is 'b'. in the study Y was taken as yield and b_1, b_2, b_3 as consumption of N, P, K.

When evaluating the strength of a relationship between the two variables, a scatter plot can also be useful. If the suggested explanatory and dependent variables appear to have no relationship (*i.e.*, the scatter plot shows no increasing or decreasing trends), then fitting a linear regression model to the data is unlikely to yield a useful model. The correlation coefficient, which would be a value between -1 and +1 showing the strength of the link of the observed data for the two variables, is a useful quantitative measure of linear relationship between two variables.

The second order polynomial regression model is used for quantifying the uptake of the nutrients *i.e.*, nitrogen, phosphorous and potassium and its corresponding effect on the yield for both the states. The regression equation was fitted for the consumption of the plant nutrients for both the states and it is as follows.

$$Y = b_0 + b_1 N + b_2 P + b_3 K + b_4 N^2 + b_5 P^2 + b_6 K^2 + b_7 NP + b_8 NK + b_9 PK$$

Where b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9 are the regression coefficients

And N, P, K are the independent variable and denote the uptake, Y is the dependent variable which is yield

3.4.2.3 Box and whisker plots

A Box and Whisker Plot (also known as a Box Plot) is a visual representation of data distributions using quartiles. The "whiskers," that are parallel lines extending from the boxes, are used to illustrate variability outside of the upper and lower quartiles. Individual dots in conjunction with whiskers are also used to represent outliers. Box plots can be made horizontally or vertically. Box plots were drawn comparing the consumption of N, P, K and the yield in the two states.

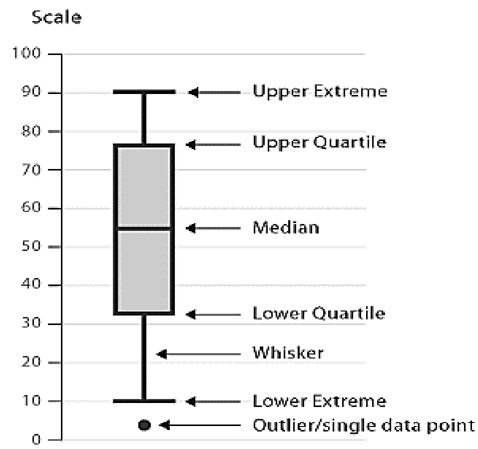


Fig 3.2 Diagram of a box plot

By viewing a box-plot the following inferences can be made: the important values like averages and median, presence of outliers and values, the nature of the information, degree to which grouping of data is seen and the presence of skewness in the data set.

3.4.2.4 Kendall’s coefficient of concordance

To know the most preferred fertilizer company by the farmers of both Kerala and Telangana so that a conclusion on the various fertilizer companies could be made, the study also makes use of the Kendall’s coefficient of concordance. The total respondents were 120 farmers and their agreement on 8 different fertilizer companies were studied. The ranks were obtained after running the Kendall's W statistics in SPSS and the most preferred company was given the rank 1, the next company was 2 and so on.

Kendall's W statistic (Kendall's coefficient of Concordance) is a non-parametric statistic that goes from 0 to 1 which is used to examine agreement among different variables. A score of zero indicates no agreement between respondents, whereas a score of one indicates full agreement. Either an interval or an ordinal scale is used to generate the W statistic. It is a normalisation of the Friedman test statistic. Kendall's W makes no assumptions about the structure of the probability distribution and can handle any large number of separate outcomes, whereas tests utilising the usual Pearson correlation coefficient assume normally distributed values and compare two sequences of events at the same time.

The formula of the Kendall's coefficient of concordance is as follows:

$$W = \frac{12\,S}{m^2\,(n^3 - n)}$$

Where:

S = sum of squared deviations

$$S = \sum_{i=1}^{n} (R_{i} - \bar{R})^2$$

Where, R_i is the sum of ranks in each row and $\bar{R}$ is the average value of sum of ranks

m = number of respondents

n = total number of fertilizer companies being ranked

3.4.2.5 Garrett ranking technique

Garrett ranking technique was employed to rank the constraints in purchasing the fertilizers and also the reasons as to why the fertilizer company is preferred. The farmers were asked to rank the constraints and preferences. The ranks are then converted to percentages using the formula:

$$\text{Percent position} = \frac{100\,(R_{ij} - 0.5)}{N_{ij}}$$

Where R_{ij} = Rank given for the ith constraint or the preference by the jth farmer

N_{ij} = Number of variables ranked by jth farmer

The rankings are then converted to scores by making use of the Garett ranking tables given by Garrett and Woodworth (1969). For each factor the scores are added and then it is divided by the total number of farmers that is respondents. The mean scores which are obtained are ranked and accordingly the lower the mean value the lower is the constraint faced by the farmer for purchasing the fertilizers.

3.5 Terms and concepts

Chemical Fertilizers

The term "chemical fertilizers" refers to a wide range of synthetic compound chemicals designed to boost crop yield. For example, some chemical fertilizers are "nitrogenous," meaning they contain nitrogen, whereas others are phosphate-based. Potassium is another fertilizer. Ammonium phosphate, nitro phosphate, potassium, and other nutrients are commonly found in complex (or blended) chemical fertilizers.

Nitrogenous fertilizers

Nitrogen fertilizers are at the top of the fertilizer list and crops adapt to nitrogen better than other nutrients. Nitrogenous fertilizers, mainly urea, account for more than 80 per cent of the fertilizers used in the country.

Phosphatic fertilizers

Phosphatic fertilizers are chemicals that contain phosphorus in an easily absorbed form (Phosphate anions) or release after transformation in the soil.

Potassic fertilizers

Chemical fertilizers containing potassium in the absorbed form (K^+) are known as potassium fertilizers. Muriate of potash (MOP) and sulphate of potash (SOP) are two potassium fertilizers (K_2S0_4). They are necessary for plant growth and are water soluble in nature.

Marginal, small and large farmers

Table 3.4 Marginal, small and large farmers and land holding

Sl. No.	Category	Size-Class
1.	Marginal	Below 1.00 ha
2.	Small	1.00-2.00 ha
3.	Semi- Medium	2.00-4.00 ha
4.	Medium	4.00-10.00 ha
5.	Large	10.00 ha and above

Source: Ministry of Agriculture & Farmers Welfare, 2019

Public sector companies

Public sector companies in the study refers to the fertilizer companies which come under the public domain or the Government of India.

Co-operative sector companies

Fertilizer companies such as IFFCO, KRIBCO work on the basis of co-operative structure. These are among the largest cooperatives in India and produce a large quantity of fertilizers and have links with both PACS and the private outlets.

Distributor

A distributor acts as a link between a product's manufacturer and another party in the distribution channel or supply chain, such as a retailer or a value-added reseller (VAR). The distributor serves many of the same responsibilities as a wholesaler, but with a greater degree of involvement.

Dealer

In this study fertilizer dealer refers to a person involved in the buying and selling of fertilizers through retail outlets to the farmers.

Marketing channel

A marketing channel is a mechanism that ensures the distribution of goods from producers to consumers by passing them via numerous tiers of intermediaries. It's also referred as distribution channels.

RESULTS AND DISCUSSION

Chapter IV

RESULTS AND DISCUSSION

In accordance with the research objectives, the data collected from different sources are studied and interpreted and the results are listed under the following headings

4.1 Trend in the production and consumption of major chemical fertilizers in India

4.1.1 Fertilizer policy environment in India

4.1.2 Trend in fertilizer production- All India analysis

4.1.3 Trend in fertilizer consumption- All India analysis

4.1.4 Trend in Fertilizer imports- All India analysis

4.1.5 Assessment of gap in growth rates of domestic production and consumption

4.2 Forecasting of fertilizer production and consumption in India

4.2.1 Forecasting of production and consumption of N, P and total fertilizers

4.2.2 Forecasting the consumption of potassic fertilizers

4.3 Comparing the consumption of fertilizers in Kerala and Telangana

4.3.1 Profile of the respondents

4.3.2 Impact of fertilizer consumption on yield in Kerala and Telangana

4.3.3 Brand preference of fertilizer by the farmers

4.3.4 Factors which influence farmer's preference of fertilizers

4.3.5 Constraints encountered by farmers while purchasing fertilizers

4.4 Marketing systems in Kerala and Telangana

4.4.1 Marketing of fertilizers in India

4.4.2 Marketing channels and distribution of fertilizers in Kerala and Telangana

4.5 SWOC analysis of IFFCO

4.5.1 Public sector fertilizer companies in India

4.5.2 Strengths, weaknesses, opportunities and challenges of IFFCO

For better understanding of the production and consumption of fertilizers in India, the fertilizer policy environment is studied so that reasons can be given for the changes in the pattern of production and consumption of chemical fertilizers in India.

4.1 Trend in the production and consumption of major chemical fertilizers in India

4.1.1 Fertilizer policy environment in India

The socio-political goals of making fertilizer available to farmers at affordable costs and promoting fertilizer usage have largely guided India's fertilizer policy. The fertilizer industry has been tightly regulated by the government. A price and distribution management system were deemed important not only to assure fair prices and equitable distribution throughout the country, but also to create incentives for increased fertilizer use. Government policy in the fertilizer sector has gone through three phases: a period of less control (1950s and 1960s), a period of tight controls (1970s and 1980s) and a period of post reforms (1990s to present) (Sharma and Thaker, 2009).

The Fertilizer Control Order (FCO) was enacted under Section 3 of the Essential Commodities Act, 1955 to regulate, trade, price, quality, and distribution of fertilizers in the country to ensure adequate availability of highest quality fertilizers at the right time and at the right price to farmers. Straight fertilizers were not subjected to price regulations or distribution restrictions until 1970. In October 1970, India's fertilizer policy was reviewed, and in 1973 (Fertilizer Movement Control Order), pricing and distribution controls were implemented, and fertilizer movement was brought under the Essential Commodity Act (ECA). It also restricted the export of fertilizers from the states unless specified.

In the year 1977, Retention Price Scheme (RPS) was implemented to reconcile the uniform sale price with the varying cost of production across manufacturing plants. By guaranteeing a 12 per cent post-tax return on net worth to fertilizer manufacturers, the government encouraged investment in the sector. The RPS established a farm-gate price for urea and other fertilizers, as well as a retention price for manufacturers, with the difference between the two being handed to the manufacturer as a subsidy. The

Retention Price Scheme (RPS) for fertilizer industry remained in force till 31st March 2003. Under the RPS, retention price was fixed for each unit by the government. The difference between the retention price of urea and the maximum retail price of urea was paid as subsidy. This aided in reaching fertilizer self-sufficiency, but at a considerable cost, as the RPS gave no incentive for businesses to increase efficiency and failed to penalize inefficient producers.

The 1991 economic reforms were India's first significant attempt at fertilizer reform, and they paved the way for considerable policy changes in the industry. Prices, distribution, and movement of phosphatic and potassic fertilizers were deregulated by the government in August 1992. In June 1994, the low-analysis nitrogenous fertilizers were also deregulated. As a result of the decontrol, the prices of phosphatic and potassium fertilizers skyrocketed in the market, putting downward pressure on demand and consumption. It resulted in an imbalance in the use of N, P, and K (Nitrogen, Phosphorous, and Potash) nutrients, as well as a decrease in soil productivity. Because of the negative consequences of deregulating P & K fertilizers, the Department of Agriculture and Cooperation established a Concession Scheme for deregulated phosphatic and potassic (P&K) fertilizers. Subsidies for DAP, MOP, and NPK Complex fertilizers were established under the Concession Scheme. From 1993 to 1994, this program was also extended to SSP. State governments gave concessions to manufacturers/importers based on funding supplied by the Department of Agriculture and Cooperation in 1992-93 and 1993-94. Following that, DAC began making concession payments to fertilizer businesses on a 100 per cent basis, based on certificates of sales provided by state governments.

In 1997-98, the Department of Agriculture and Cooperation began indicating a standard Maximum Retail Price (MRP) for DAP/NPK/MOP across India. The obligation for indicating MRP for SSP fell to the state governments. In 1997, the Special Freight Subsidy Reimbursement Scheme was established for the supply of fertilizers in remote areas such as Jammu and Kashmir and the North-Eastern States. The difference between the delivered price of fertilizers at the farm level and the MRP was remunerated by the Government as a subsidy to the manufacturers/importers for selling the fertilizers at the MRP suggested by the Government. This subsidy was given even though the total delivered cost was more than the MRP outlined by the government.

The government's plans to initiate fertilizer reforms in general, especially urea among the various fertilizers, have resulted in the formation of several committees, including the High-Powered Fertilizer Pricing Policy Review Committee (1997-98), the Y.K. Alagh Committee (2000), the Expenditure Reforms Commission (2000), and the Group of Ministers (GoM, 2002). In the year 2002, based on the Tariff Commission's recommendations, the government implemented a new system for calculating complex fertilizer subsidies. The GoM's recommendations were used to create the New Pricing Scheme (NPS), which was introduced in 2003 and attempts to encourage urea units to become more efficient while also introducing openness and clarity to subsidy management. From 2003-04 to 2007-08, concessions were paid to DAP production units into groups, based on the raw material source (rock phosphate/phosphoric acid). From 2009, changes to some parts of the Concession Scheme were made to align concession scheme parameters with international price dynamics and rationalize 'N' pricing group-wise as well as the payment mechanism. Since 2002 to 2010, the MRPs of P & K fertilizers, as determined by the Government/State Government, have remained stable.

In the year 2010, a nutrient-based subsidy (NBS) system for fertilizers was implemented based on the recommendation of Soumithra Chaudhary panel of the Planning Commission. NBS main agenda is to tie subsidies to nutrient composition rather than specific items. Fertilizers are distributed to farmers at subsidized rates under the NBS program depending on the nutrients (N, P, K, and S) included in the fertilizers. The government announces the subsidy on Phosphatic and Potassic (P&K) fertilizers on an annual basis for each nutrient on a per kg basis under this policy. These rates are calculated based on the international and domestic pricing of P & K fertilizers, the exchange rate, the country's inventory level, and other factors. One of the drawbacks of NBS is that urea still remains outside the NBS scheme, and it has only been used in other fertilizers. As a result, farmers are using more urea than before, worsening the fertilizer imbalance. The subsidy is distributed to fertilizer firms according to NBS rates so that they can provide fertilizers to farmers at a reasonable cost.

In 2015, the New Urea Policy (NUP) was introduced for existing gas-based urea units, with the goals of:

1. Increasing domestic urea output
2. Increasing efficiency in urea production
3. Reducing the government's subsidy burden

With effect from October 2016, the government has implemented a Direct Benefit Transfer (DBT) mechanism for fertilizers. Under the fertilizer DBT scheme, fertilizer firms receive a 100 per cent subsidy on various fertilizer grades based on real demand.

4.1.1.1 Fertilizer subsidy policy in India

Subsidies which were given by the central government has shown an increase from ₹ 891 crore during the 1980s to ₹ 22,452 crores during 2006-07. The level of increase of subsidies in real terms was more than double in the last fifteen years which was attributed to an increase in fertilizers use and rise in the subsidy content per unit of fertilizer. Also, inflation was one of the major reasons for this increase (Chand and Pandey, 2008).

Monetarily, the increase in subsidies was more than increase in crop output. According to Chand and Pandey (2008), the share of subsidies in the value of agriculture sector output at current prices amounted to 2.87 percent of the value of crop output in the second half of the 1980s. In the next ten years, the subsidy ratio climbed to 3.03 percent, and in recent years, it has approached 4 per cent. The quantity of fertilizer subsidies distributed to various states is determined by the size of the state, as measured by the area under cultivation, the amount of fertilizer used per hectare, and the composition of the fertilizer used. One disadvantage of this measure as a measure of subsidy discrepancy is that it ignores variations in production caused by differences in fertilizer use. Punjab and Haryana, for example, are among the most productive states and have the highest per hectare subsidy. The per kg subsidy rates (in ₹) is as follows (Table 4.1):

Table 4.1 Subsidy rates (per kg) of N, P, K and S

Per Kg Subsidy rates (in ₹)			
N (Nitrogen)	**P (Phosphorus)**	**K (Potash)**	**S (Sulphur)**
18.789	45.323	10.116	2.374

Source: Ministry of Chemicals and Fertilizers, 2021

4.1.2 Trend in fertilizer production- All India analysis

During the fiscal year 2018-19, total fertilizer production was 41.56 million tonnes. In contrast to the previous year, total fertilizer production was 42.75 million tonnes in 2019-20. This represents an increase of more than 10 per cent. The rapid expansion of fertilizer production in the country has been made possible by a favourable governmental environment that encourages investments in public, private as well as co-operative domains. The sector-wise production of urea, DAP and complex fertilizers in 2018-19 and the estimated production during 2019-20 is shown in Table 4.2. The estimated production is highest by the private sector followed by co-operatives and the public sector for all the three fertilizers.

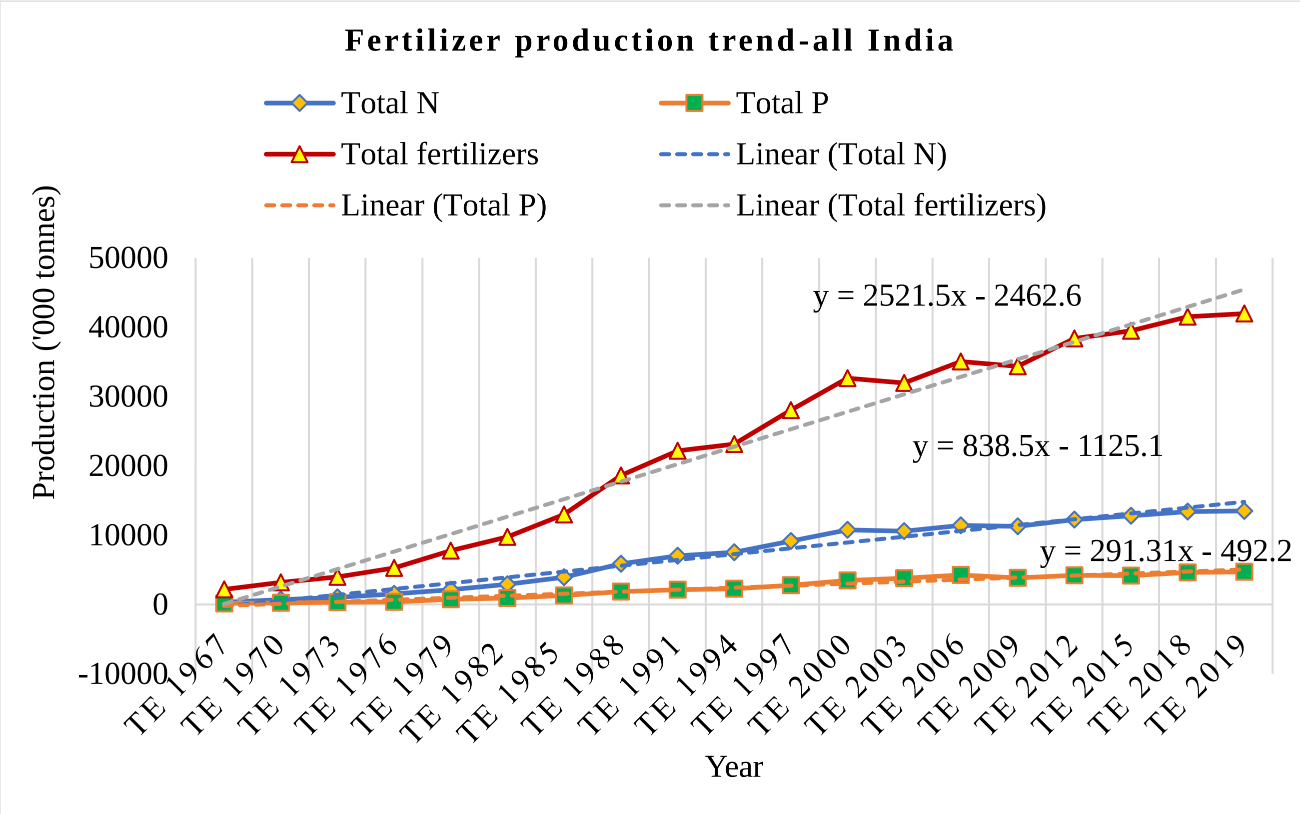
Table 4.2 Sector-wise production of urea, DAP and complex fertilizers in 2018-19 and estimated production during 2019-20

(Fig. in LMT)

S. No	Sector	2018-19			2019-20 (Estimated)		
		Urea	DAP	Complex fertilizers	Urea	DAP	Complex fertilizers
1.	Public Sector	70.16	-	12.22	69.00	-	15.55
2.	Cooperative Sector	69.04	14.19	21.58	69.64	18.94	22.57
3.	Private Sector	100.80	24.80	56.18	110.61	25.94	54.36
Total		240.00	38.99	89.98	249.25	44.88	92.48

Source: Department of Fertilizers-Annual Report, 2019-20

Fertilizer production ($N+P_2O_5$) in India has increased at a rapid rate, rising from very low levels after independence (38.7 thousand tonnes in 1951-52) and still low levels in the 1960s and early 1970s (1.24 million tonnes) to a total production of about 15.9 million tonnes in 2006-07, then declining in the following two years to 14.3 million tonnes in 2008-09. Following this, in the year 2010-11 it rose to 16.54 million tonnes. The production further has shown an increasing trend from 2010-11. It was 17.9 million tonnes in 2015-16 and in 2019-20 the production was estimated to be 18.51 million tonnes. In 2019-20, nitrogen (N) production climbed by 2.9 per cent to 13.722 million tonnes, while phosphate production increased by 4.4 per cent to 4.790 million tonnes. In terms of products, urea, DAP and complex fertilizer production increased by 2.3 per cent, 16.7 per cent, and 4.1 per cent respectively in 2019-20 with the actual values being 24.45 million tonnes, 4.55 million tonnes, and 4.24 million tonnes, respectively. Complex fertilizer production fell by 3.5 per cent to 8.6 million tonnes in 2019-20, depicting a downward trend.



Source: Fertilizer Association of India, 2019-20

Fig 4.1 Fertilizer production trend in India from 1966-67 to 2019-20

4.1.2.1 Growth rate analysis of production of nitrogenous (N) fertilizers in India

Fertilizer production in India mainly consists of production of nitrogenous and phosphatic fertilizers. The nitrogenous fertilizer production in 2019-20 was estimated to be 13.7 million tonnes. The growth rates are depicted in Table 4.3. It peaked during the first phase of post-green revolution (13.47 %) and this was higher when compared to the second phase (9.87 %). In the post-reform period, before the introduction of NPS, the growth rate registered was 4.54 per cent. After the introduction of NPS, a 1.57 per cent was seen. The CDVI index for the production of nitrogenous fertilizers is 14.67 per cent and it can be inferred as low instability and a uniformity in the rate of production is observed.

Table 4.3 Compound annual growth rate of production of fertilizers in India

(In percentage)

Periods	Total N	Total P	Total Product (all fertilizers)
Post green revolution period	**12.19**	**11.83**	**10.06**
Phase I - (1967-68 to 1980-81)	13.47	12.46	9.68
Phase II – (1981-82 to 1991-92)	9.87	0.02	9.38
Post reform period	**2.00**	**2.52**	**2.09**
Before NPS (1992-93 to 2002-03)	4.54	6.95	4.39
After NPS (2003-04 to 2019-20)	1.57	1.20	1.73

Table 4.4 Instability of production of fertilizers in India

S. No	Fertilizer	CV	CDVI
1.	Nitrogenous (N)	73.35	14.67
2.	Phosphatic (P)	76.40	18.714
3.	Total fertilizers (N+K)	70.27	14.054

4.1.2.2 Growth rate analysis of production of phosphatic (P) fertilizers in India

According to the Annual report 2019-20, Department of Fertilizers, there exist 19 units producing DAP and complex fertilizers. During the first phase of post-green revolution period which was accompanied by the use of HYVs, technology transmission and new methods of cultivation, a high growth rate was observed (12.46 %). But it fell to a very low percentage in the second phase (0.02 %). The post reform period with new policies registered a growth of 2.52 per cent. The production in the last period after initiation of NPS has been quite stagnant resulting in a growth rate of only 1.20 per cent. For the production of phosphatic fertilizers in India, the CDVI index obtained is 18.714 per cent and it shows medium instability and no much variation in production of phosphatic fertilizers in India is observed.

4.1.2.3 CAGR and instability of production of total fertilizer products (N+P) in India

The estimated production of total fertilizer products in India for the year 2019-20 is 42.75 million tonnes. In both the phases of post-green revolution period the growth rate was more or less the same (9.68 % and 9.38 % respectively).

The cumulative percentage was around 10 per cent and low growth rate was observed in the post reform periods (2.09 %). The growth rate after the initiation of the New Pricing Scheme (NPS) was found to be 1.73 and therefore this provides more scope for increasing the domestic production of fertilizers by installing more plants and raising the capacity of these fertilizer plants. The CDVI index for the production of total fertilizers in India is 14.05 which shows low instability in the production.

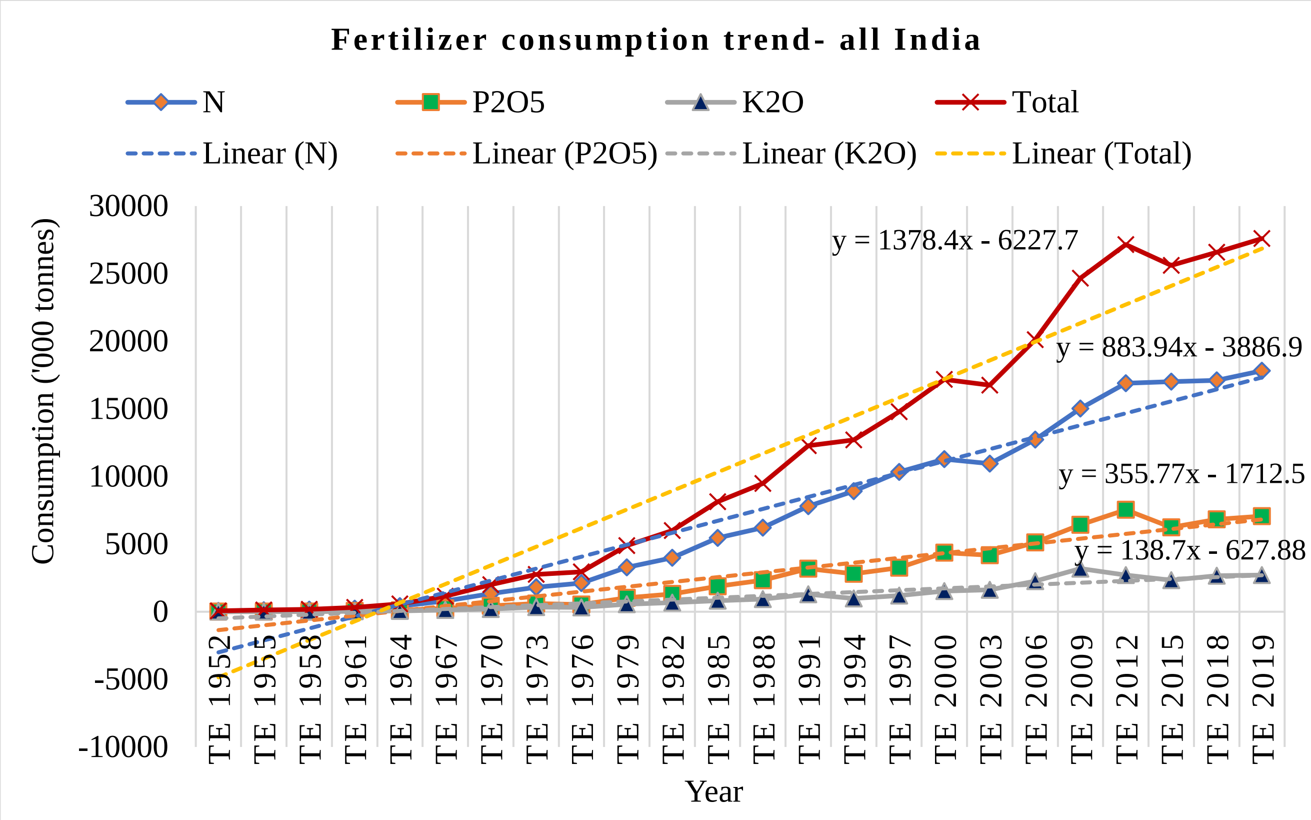
4.1.3 Trend in fertilizer consumption- All India analysis

India is the world's second largest consumer of fertilizer nutrients, trailing only China. However, India's fertilizer use per hectare is lower than that of many other countries, including its neighbours. The distribution of fertilizers is likewise uneven.

Figure 4.2 shows the trends in fertilizer usage in terms of total quantities in the country. Nitrogen, phosphorus, and potassium (N+P+K) consumption has increased from 69.8 thousand tonnes in 1950-51 to 28.9 million tonnes in 2019-20. Fertilizer usage peaked in the mid-1960s at roughly 78 thousand tonnes, then rapidly increased in the late 1960s and 1970s. Fertilizer consumption was at one million tonnes during the start of the green revolution in 1966-67. Total fertilizer use climbed to 2.26 million tonnes in 1970-71, then to 12.73 million tonnes in 1991-92. The massive development of irrigation, the spread of HYV seeds, the initiation of the Retention Price Scheme, the disbursement of fertilizers to farmers at reasonable prices, the augmentation of the dealer's network, enhanced fertilizer access, and virtually no change in farm gate fertilizer prices for a decade (1981-1991) were all major factors in the rise in fertilizer consumption between 1971 and 1990. The study by Jaga and Patel (2012) also explains that in order to understand the fertilizer use behaviour it is important to know the various factors that influence the fertilizer consumption in the country.

In the 1990s, the total fertilizer consumption varied between 12.15 and 16.8 million tonnes. The main reasons attributed to this increase were the deregulation of the prices and distribution of phosphatic and potassic fertilizers. Further, this deregulation was extended to nitrogenous fertilizers. In 1999, the fertilizer consumption transcended beyond 18 million tonnes. This was because of the fixation of MRP for fertilizers in 1997-98. It crossed 20 million tonnes for the first time in the year 2005-06 after the initiation of the New Pricing Scheme (NPS) in 2003. In 2007-08, the total consumption was 22.5 million tonnes. After the year 2005-06, it never fell below 20 million tonnes. In 2010-11, with the introduction of a nutrient-based subsidy (NBS) system for fertilizers, the consumption of fertilizers was the highest with more than 28 million tonnes.

The New Urea Policy (NUP) initiated in the year 2015 with the aim of rationalizing subsidies and increasing domestic urea production proved to be very beneficial. Also, the Ministry of Chemical and Fertilizers mandated that all domestic urea producers produce 100 per cent neem-coated urea. In 2019-20, fertilizer consumption increased significantly. The total estimated nutrient consumption ($N+P_2O_5+K_2O$) was 29.04 million tonnes, recording a 6.7 per cent growth than that of last year which was 27.23 million tonnes.



Source: Fertilizer Association of India, 2019-20

Fig 4.2 Fertilizer consumption trend in India from 1950-51 to 2019-20

During 2019-20, N, P_2O_5, and K_2O consumption increased by 6.6 per cent, 9.2 per cent, and 0.7 per cent, respectively, to 18.80 million tonnes, 7.54 million tonnes, and 2.70 million tonnes. All-India NPK use ratio showed a positive expansion from 6.6:2.6:1 in 2018-19 to 7.0: 2.8:1 in 2019-20. The per hectare use of total nutrients ($N+P_2O_5+K_2O$) rose to 144.9 kg in 2019-20 from 135.9 kg in 2018-19 (Annual Review of Fertilizer Production and Consumption 2019-20, FAI).

4.1.3.1 Growth rate analysis of nitrogenous (N) fertilizers in India

The compound annual growth rate along with the Cuddy-Della Valle Instability (CDVI) index is presented in Table 4.5 and Table 4.6 respectively. The growth rate for all major fertilizers was studied for three periods, that is pre green revolution period (1950-51 to 1966-67), post green revolution period (1967-68 to 1991-92). This period was further divided into two phases, phase 1 (1967-68 to 1980-81) and phase 2 (1981-82 to 1991-92). The third period is the post reform period which is divided into two phases, Before the New Pricing Scheme (NPS) (1992-93 to 2002-03) and after the NPS

(2003-04 to 2019-20). The results revealed that during the pre-green revolution and the post green revolution periods the consumption of nitrogenous fertilizers had a high positive growth and in the post reform period also, a positive growth was observed with the growth rate being very low compared to the other periods.

Table 4.5 Compound annual growth rates of consumption of fertilizers in India

(In percentage)

Periods	N	P_2O_5	K_2O	Total
Pre-green revolution period - (1950-51 to 1966-67)	17.72	26.60	21.33	19.41
Post-green revolution period	**9.01**	**10.30**	**8.81**	**9.28**
Phase I - (1967-68 to 1980-81)	9.97	9.34	10.43	9.90
Phase II – (1981-82 to 1991-92)	7.13	9.84	7.26	7.78
Post reform period	**2.92**	**3.88**	**4.25**	**3.27**
Before NPS (1992-93 to 2002-03)	2.70	5.73	6.95	3.77
After NPS (2003-04 to 2019-20)	2.75	2.53	1.04	2.51

In the pre-green revolution period (1950-51 to 1966-67), nitrogenous fertilizer use showed a growth rate of 17.72 per cent, as seen in the table. During the first phase of the post-green revolution period a growth rate of 9.97 per cent was observed. The increase in the usage of HYVs accompanied by more area under irrigation and the higher use of fertilizers resulted in more food grain production during this period. Compared to the first phase, the second phase of the post-green revolution period showed a lesser growth rate which was 7.13 per cent. In the post reform period, new policies were introduced in the fertilizer sector such as the NPS, NBS and DBT and consequently a significant setback was seen. The growth rate recorded during the whole phase from 1992-93 to 2019-20 was the least for nitrogenous fertilizers (2.92 %). Before the introduction of the NPS, the growth rate observed was 2.70 per cent and after NPS, it was found to be 2.75 per cent. The Cuddy-Della Valle Instability index for the consumption of nitrogenous fertilizer in India is 20.075 per cent and it shows medium instability and more or less uniformity in the consumption as over the years the consumption of N has been increasing steadily.

Table 4.6 Instability of consumption of fertilizers in India

S. No	Fertilizer	CV	CDVI
1.	Nitrogenous (N)	89.78	20.075
2.	Phosphatic (P)	97.17	30.727
3.	Potassic (K)	95.69	35.803
3.	Total fertilizers (NPK)	91.71	24.26

4.1.3.2 Growth rate analysis of phosphatic (P) fertilizers in India

The consumption of phosphatic fertilizers in India has shown an accelerating growth rate from 1950-51 till the present year. In the pre-green revolution period from 1950-51 to 1966-67 the growth rate was 26.60 per cent. The overall growth rate in the post- green revolution period was 10.30 per cent, owing to the fact that the post green revolution period intensified the fertilizer use. Both the phases showed more or less the same growth rate (9.34 % and 9.84 %). During the post reform period the phosphatic fertilizers were decontrolled and this resulted in the reduction in the usage of fertilizers. Therefore, the growth rate recorded was 3.88 per cent for the whole period. The period before NPS showed a growth rate of 5.73 per cent and after the introduction of NPS, it was 2.53. The CDVI index calculated is 30.727 per cent which shows medium instability of the consumption of phosphatic fertilizers in India.

4.1.3.3 Growth rate analysis of potassic (K) fertilizers in India

The bulk of potassic fertilizers in India is imported. There is no domestic production of potassic fertilizers in India. During the pre-green revolution period, the growth rate of consumption of potassic fertilizers was estimated as 21.33 per cent. About 8.81 per cent growth rate was seen during the overall period of the post-green revolution period. The first phase registered a growth rate of 10.43 per cent which was the highest among all the three major fertilizers *i.e.*, N, P_2O_5 and K_2O. This may be because of the high imports during the green revolution period. The post reform period gave rise to many new policies and one of them was decontrolling phosphatic and potassic fertilizers and therefore a reduction was seen in their usage and the growth rate seen was 4.25 per cent. During the two phases of the post green revolution period, a 6.95 and 1.04 per cent growth rate was observed. The main reason for the stagnant consumption of potassic fertilizers is because of lower imports during the last few years. During 2018-19 the muriate of potash (MOP) was 4.22 million MT and in 2019-20 it was 3.67 million MT (All India production, import and consumption of fertilizer products 2018-19 and 2019-20, FAI). For the consumption of potassic fertilizers in India, the CDVI index is 35.803 per cent which can be interpreted as high instability and hence a non-uniformity in the consumption pattern is observed. The main reason attributed for this is that the bulk of potassic fertilizers is imported as India doesn't have any natural source of raw material for potassic fertilizer manufacturing.

4.1.3.4 Growth rate analysis of NPK fertilizers consumption in India

In the pre-green revolution period, fertilizer use climbed by more than 19 per cent, as seen in the Table 4.5 (1950-51 to 1966-67). Fertilizer consumption show high growth rates during the pre-green revolution period because consumption in the base year (1950-51) was very low. This considerable increase in overall fertilizer use boosted per hectare fertilizer use from less than one kg in 1951-52 to around seven kilos in 1966-67. During the first phase of the green revolution (1967-68 to 1980-81), when the distribution of high yielding cultivars was limited to primarily Punjab, Haryana, the western half of Uttar Pradesh, as well as some southern regions, fertilizer use climbed by 9.90 per cent. Fertilizer use per hectare grew from 9.4 kg in 1967-68 to 31.9 kg in 1980-81. Total fertilizer consumption increased during the second phase of the green revolution (1981-82 to 1990-91) as technology extended throughout the country. An annual growth rate of 7.78 per cent was achieved. Fertilizer consumption also doubled, from 34.3 kg in 1981-82 to 69.8 kg in 1991-92.

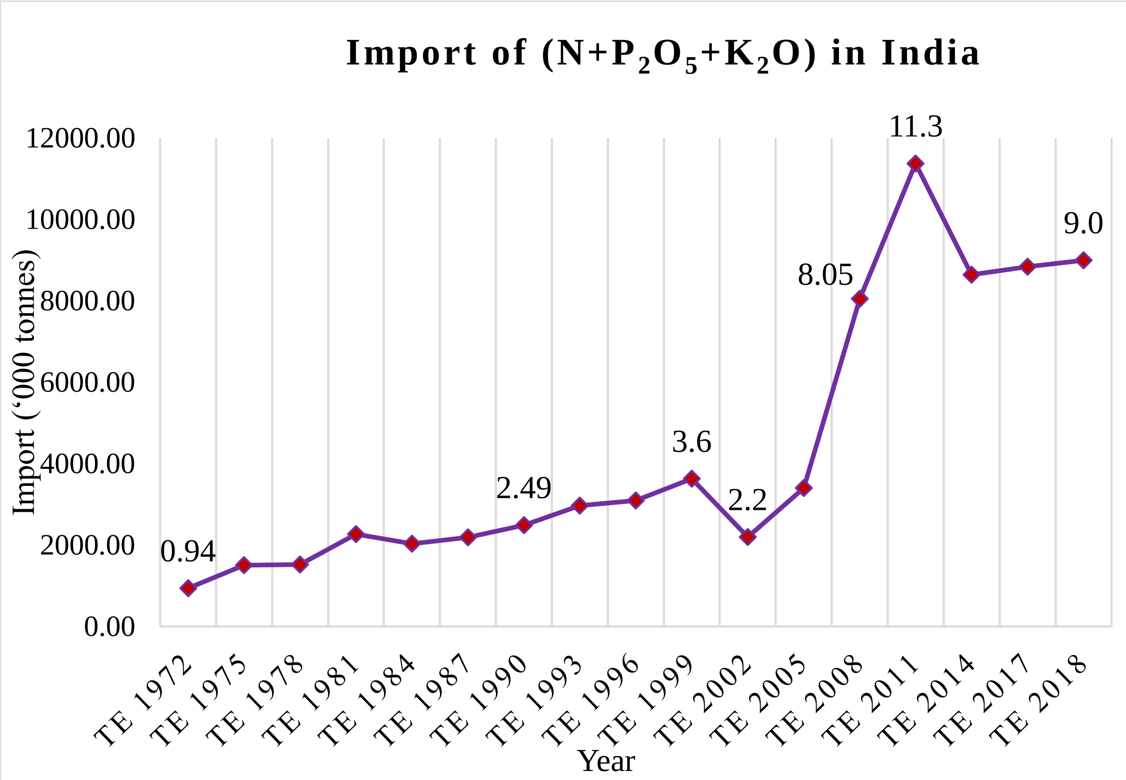
However, as part of economic changes in 1991-92, certain policy measures in the fertilizer sector were implemented. Potassic and phosphatic fertilizers have been deregulated since the year 1992. Low-analysis nitrogenous fertilizers, such as calcium ammonium nitrate, and ammonium sulphate, have been decontrolled multiple times. In the post-reform period, these policy actions resulted in a significant decrease in fertilizer usage. The total amount of fertilizer consumed fell from around 12.7 million tonnes in 1991-92 to 12.1 million tonnes in 1992-93. Fertilizer use per hectare also decreased from 69.84 kg in 1991-92 to 65.45 kg in 1992-93. In the case of phosphatic and potassic fertilizers, the decline was more pronounced.

After the initiation of the concession scheme for decontrolled potassic and phosphatic fertilizers in 1992-93, fertilizer consumption began to rise and it reached a level of 18.1 million tonnes in 1999-2000, further it fell to 16.7 million tonnes in 2000-01 and remained below this level till 2003. The fertilizer consumption growth rate which was observed during the post-reform period (3.27 %) was less than half of what was attained in the post-green revolution period (9.28 %). The Cuddy-Della Valle Instability index for the consumption of total (NPK) fertilizers in India is moderately unstable (24.26 %).

4.1.4 Trend in Fertilizer imports- All India analysis

Except for a few years, India's fertilizer demand has consistently outpaced domestic output of both nitrogenous and phosphatic fertilizers. Because India lacks commercially viable potash sources, the whole requirement for potassic fertilizers is fulfilled by imports. India basically imports urea, DAP, and MOP. Imports of nitrogenous fertilizers are controlled by state-owned firms. Fertilizer imports increased dramatically in 1966-67 as a result of the introduction of high yielding wheat and rice cultivars in the mid-1960s. In the 2000s, imports surged significantly. In the year 2007-08, India imported 7.767 million tonnes of NPK fertilizer nutrients, compared to 1.931 million tonnes in 2000-01. Imports grew slowly in the 1980s and 1990s before picking up the pace in the 2000s.

During the 1950s and 1960s, imports which were supplied was used to meet two-thirds of the domestic demand for nitrogen fertilizers. With very few exceptions, imports were minimal during the 1980s and 1990s. However, imports have expanded considerably in years after 1990s because of modest domestic production combined with growing need for fertilizers. The rise in global fertilizer prices and the increased supply of fertilizers to major food grain producing countries also had a negative impact on India's cost of imported fertilizers.



Source: Fertilizer Association of India, 2019-20

Fig 4.3 Fertilizer import trend in India from 1972-73 to 2018-19

The import of fertilizers in India has been shown in the Fig 4.3. It can be noticed that after the green revolution the imports in the country increased but at a slower pace from 0.94 million tonnes in 1972 to 2.49 million tonnes in the year 1990. Prior to the green revolution very less import of fertilizers has been noticed. After the initiation of the NPS and many reforms during the period after 1992, a boost in the imports is noticed. In the year 2011-12, the highest imports in the country were observed (11.3 million tonnes). The rapid surge in imports during the post reform period was also because of the expansion of agriculture increasing the productivity by manifold. Following this, imports have been very stagnant. In the year 2018 the import of fertilizers was 9 million tonnes. As India is also increasing its domestic production the reliability on imports has been decreasing.

4.1.5 Assessment of gap in growth rates of domestic production and consumption

An assessment of the gap was also done and the results are shown in Table 4.7. The pre green revolution period has not been considered because of data unavailability.

In real terms, the consumption and production of N and P fertilizers in the year 2010-11 were 24.6 and 16.5 million tonnes and a deficit of 8.05 million tonnes was seen. Similarly, in 2018-19 the consumption ($N+P_2O_5$) was 25.4 million tonnes whereases the production was 17.9 million tonnes leading to a deficit of 6.62 million tonnes. During the post green revolution period the consumption and production growth rate was 9.01 and 12.19. This period yielded a gap of 3.18 per cent but as the production of fertilizers was more compared to the consumption a positive gap is noticed.

Table 4.7 Gap in growth rates of domestic production and consumption of fertilizers

(In percentage)

Periods	**N (C)**	**N (P)**	**Gap**	**P_2O_5 (C)**	**P_2O_5 (P)**	**Gap**	**Total (C)**	**Total (P)**	**Gap**
Post green revolution period	9.01	12.19	3.18	10.3	11.83	1.53	9.28	10.06	0.78
Phase I - (1967-68 to 1980-81)	9.97	13.47	3.50	9.34	12.46	3.12	9.9	9.68	**-0.22**
Phase II - (1981-82 to 1991-92)	7.13	9.87	2.74	9.84	0.02	**-9.82**	7.78	9.38	1.60
Post reform period	2.92	2.00	**-0.92**	3.88	2.52	**-1.36**	3.27	2.09	**-1.18**
Before NPS (1992-93 to 2002-03)	2.70	4.54	1.84	5.73	6.95	1.22	3.77	4.39	0.62
After NPS (2003-04 to 2019-20)	2.75	1.57	**-1.18**	2.53	1.73	**-0.8**	2.51	1.20	**-1.31**

A positive gap of 1.53 per cent and 0.78 per cent in growth rates is observed during the same period for phosphatic and total fertilizers respectively. During the phase I, deficit of 0.22 per cent is observed for potassic fertilizers. During the post reform period the nitrogenous, phosphatic and total chemical fertilizers showed a deficit of 0.92, 1.36 and 1.18 per cent. The increase in the consumption of nutrients by farmers during the period also led to widening the gap. Another reason is the introduction of several new policies, subsidies and the increase in the number of manufacturing units which gave a boost to domestic production. Even though the domestic production skyrocketed, it was not able to compensate for the increasing usage of fertilizers by farmers which led to large quantity of imports. For instance, even though production of N+ P_2O_5 fertilizers for the year 2018-19 was 17.92 million tonnes, import of an additional 10.52 million tonnes was observed (FAI, 2019-20). The total potassic fertilizers are still imported from various countries across the world. During the post reform period the application of nitrogenous and phosphatic fertilizers increased drastically

4.2 Forecasting of fertilizer production and consumption

4.2.1 Forecasting of production and consumption of N, P and total fertilizers

The data from 1965-66 to 2014-15 and 1950-51 to 2014-15 has been taken as the training period for forecasting the production and consumption of N, P and total fertilizers in India respectively. The model chosen by the expert modeler in SPSS was Holt's exponential smoothing model. After validation of the model, the data was used to predict the values for the next five years from 2015-16 to 2019-20. This was also done using Holt's exponential smoothing model. The results of the forecast are mentioned in Table 4.8, it shows a very high R square value for all the fertilizers. Thus, to forecast the production and consumption of N, P and total fertilizers from 2020-21 to 2025-26, Holt's exponential smoothing model could be used.

Table 4.8 Model statistics of Holt's exponential smoothing model

Fit statistic	N (P)	P(P)	Total (P)	N (C)	P (C)	Total (C)
R^2	0.992	0.967	0.988	0.995	0.978	0.992
RMSE	802.997	287.824	1420.601	379.778	355.763	802.997
MAPE	61.471	11.823	7.738	10.945	14.567	61.471
MAE	563.138	176.803	1045.507	235.374	198.941	563.138
BIS	13.505	11.629	14.674	12.008	12.012	13.505

(C denotes consumption and P denotes production)

Table 4.9 Validation of predicted production of N, P & total fertilizers in India from 2015-16 to 2019-20 using the Holt's model

('000 tonnes)

Years	Nitrogen		Phosphorous		Total Fertilizers	
	Actual	Forecasted	Actual	Forecasted	Actual	Forecasted
2015-16	13475.9	12722.35	4425.8	4118.45	41597.7	39585.77
2016-17	13376.8	12995.35	4552.7	4124.78	41427.8	40434.77
2017-18	13422.6	13268.35	4724.4	4122.93	41560.8	41283.76
2018-19	13336.8	13541.34	4590.5	4112.60	41564	42132.76
2019-20	13722.2	13814.34	4790.7	4093.48	42752.2	42981.76

Table 4.10 Validation of predicted consumption of N, P & total fertilizers in India from 2015-16 to 2019-20 using the Holt's model

('000 tonnes)

Years	Nitrogen		Phosphorous		NPK (Total)	
	Actual	Forecasted	Actual	Forecasted	Actual	Forecasted
2015-16	17372.3	17314.9	6978.8	6418.14	26752.6	26022.5
2016-17	16735.9	17680.2	6705.5	6569.16	25949.9	26463.7
2017-18	16959.3	18045.5	6854.4	6720.23	26593.4	26904.9
2018-19	17637.8	18410.8	6910.2	6871.26	27228.2	27346.1
2019-20	18863.9	18776	7464.8	7022.19	28969.6	27787.3

By comparing the actual and predicted production and consumption of N, P and total fertilizers in India for the years from 2015-16 to 2019-20, a perusal of the validation of the model developed is shown in Tables 4.9 and 4.10.

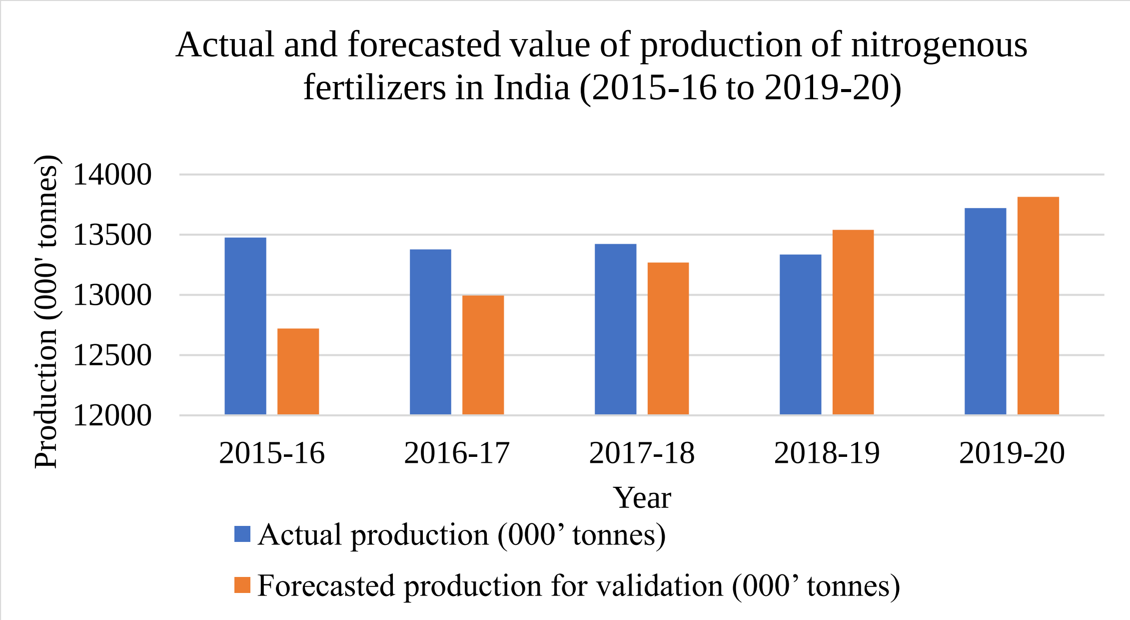


Fig 4.4 Validation of forecasted values of production of nitrogenous fertilizers in India from 2015-16 to 2019-20

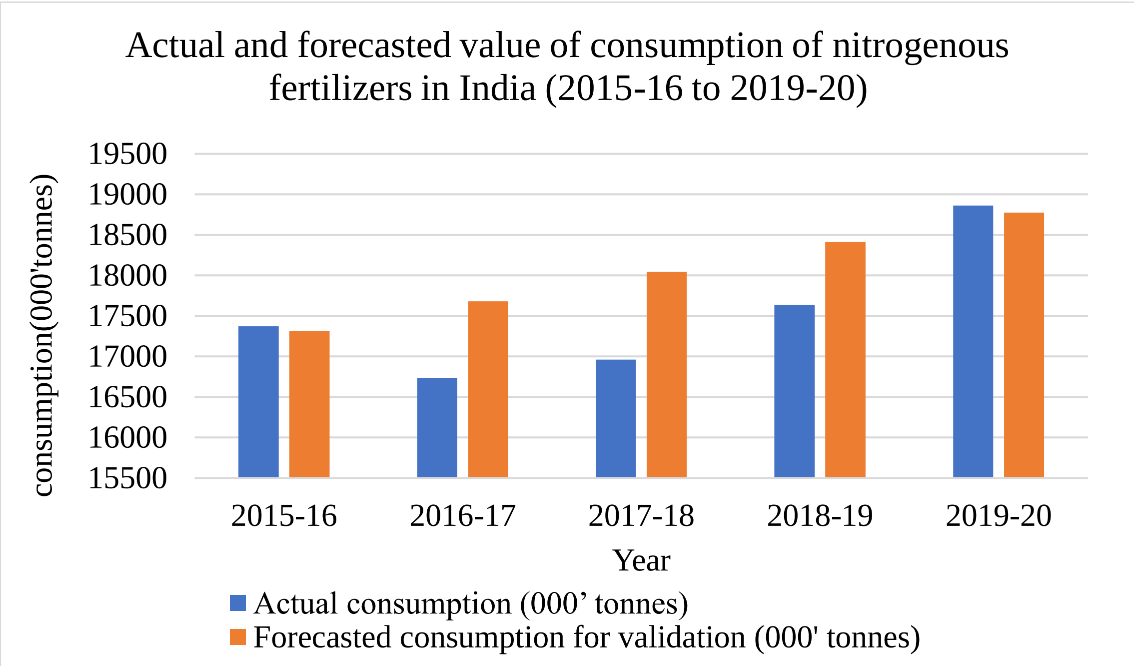


Fig 4.5 Validation of forecasted values of consumption of nitrogenous fertilizers in India from 2015-16 to 2019-20

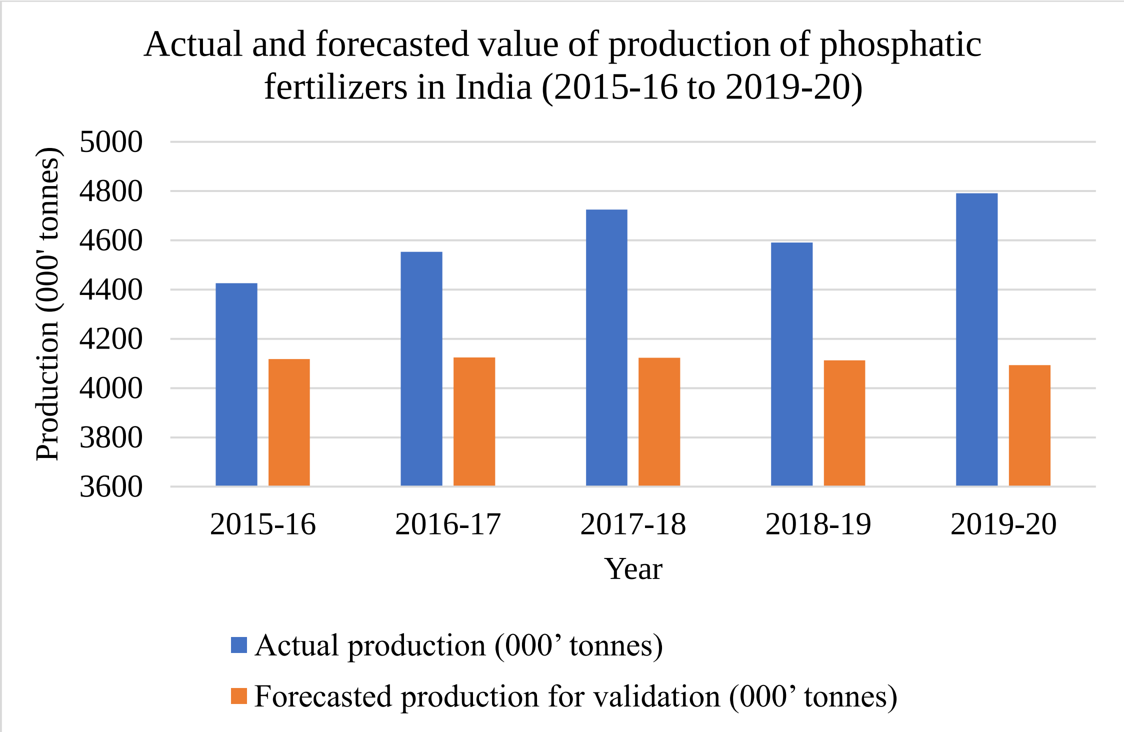


Fig 4.6 Validation of forecasted values of production of phosphatic fertilizers in India from 2015-16 to 2019-20

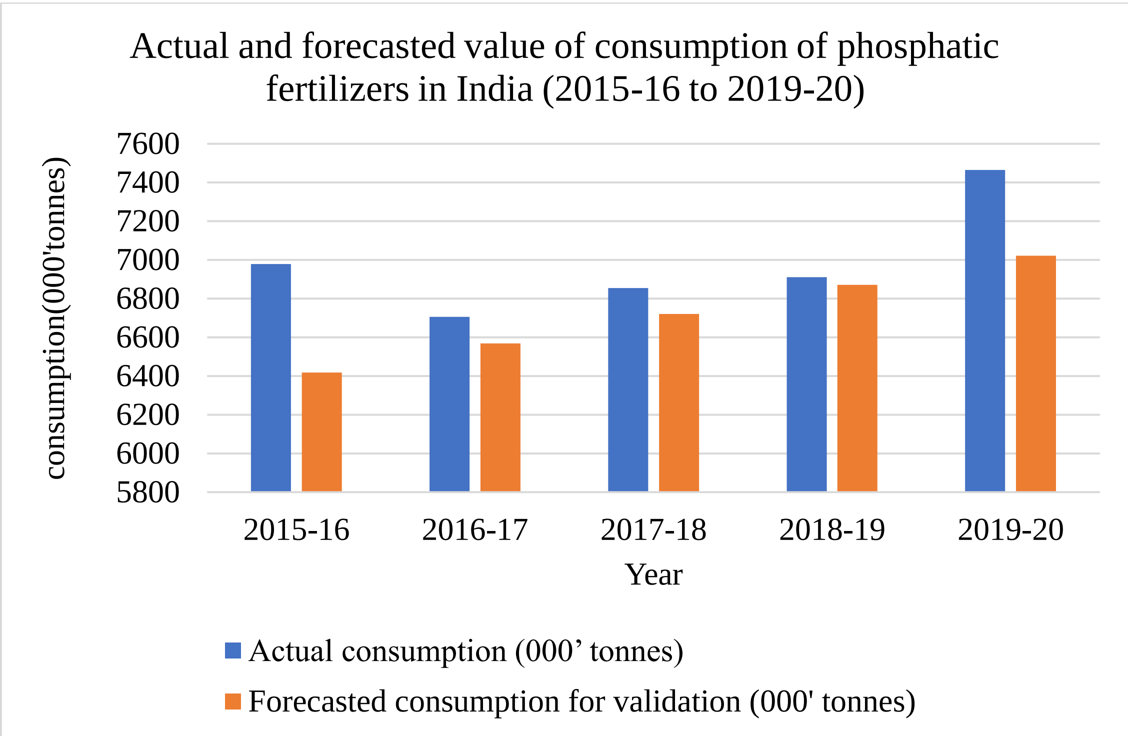


Fig 4.7 Validation of forecasted values of consumption of phosphatic fertilizers in India from 2015-16 to 2019-20

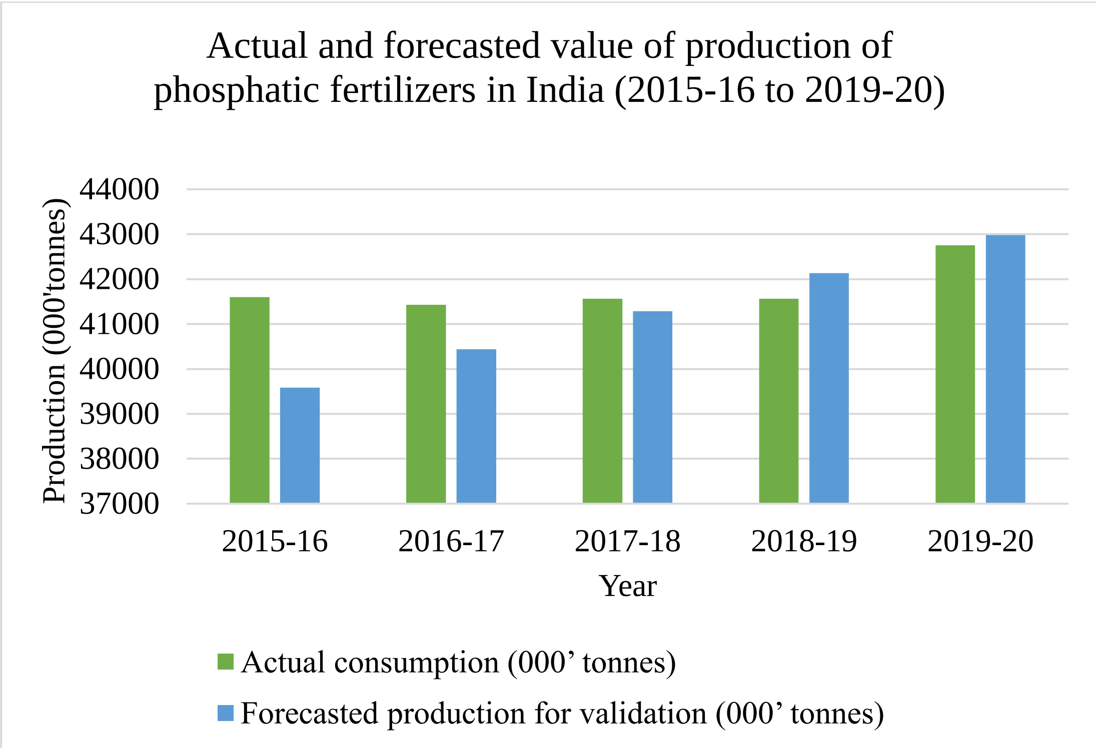


Fig 4.8 Validation of forecasted values of production of total fertilizers in India from 2015-16 to 2019-20

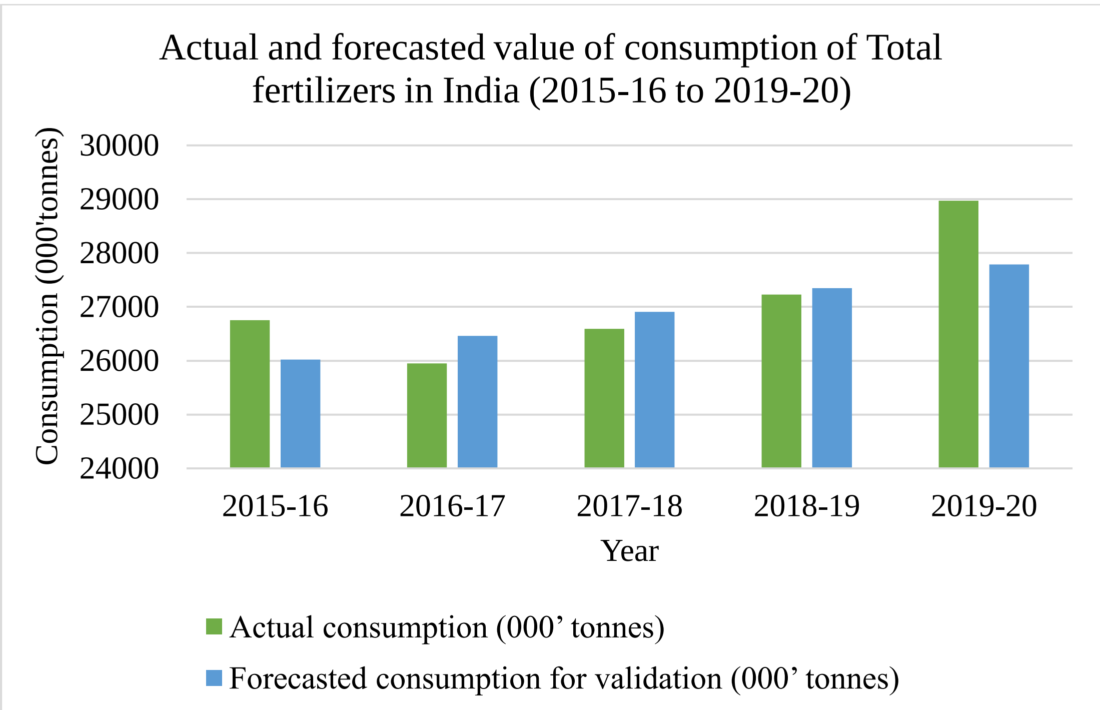


Fig 4.9 Validation of forecasted values of consumption of total fertilizers in India from 2015-16 to 2019-20

Holt's model was chosen by the expert modeler to forecast the values of production and consumption of N, P and total fertilizers from 2020-21 to 2025-26. Table 4.11 outlines the parameters of exponential smoothing coefficients of the Holt's model on the production and consumption of N, P and total fertilizers from 2020-21 to 2025-26.

Table 4.11 Holt's exponential smoothing model parameters to forecast consumption of nitrogenous fertilizers in India for the years from 2020-21 to 2025-26

	N (P)		**P (P)**		**Total (P)**		**N (C)**		**P (C)**		**Total (C)**	
	α	**Γ**	**α**	**γ**	**α**	**γ**	**α**	**γ**	**α**	**γ**	**α**	**γ**
Estimate	0.905	0.003	0.52	0.001	0.922	0	1	0.1	1	0.001	1	0.001
SE	0.137	0.021	0.121	0.019	0.138	0.019	0.125	0.062	0.123	0.018	0.124	0.011
t	6.585	0.156	4.305	0.069	6.67	0.012	7.977	1.597	8.133	0.052	8.089	0.089
Sig.	0	0.877	0	0.946	0	0.991	0	0.115	0	0.958	0	0.929

(C denotes consumption and P denotes production)

The calculated level and trend and forecast formula are presented in Appendix I.

The residuals of ACF and PACF plots of the Holt's exponential smoothing model for the production and consumption are given in Appendix II.

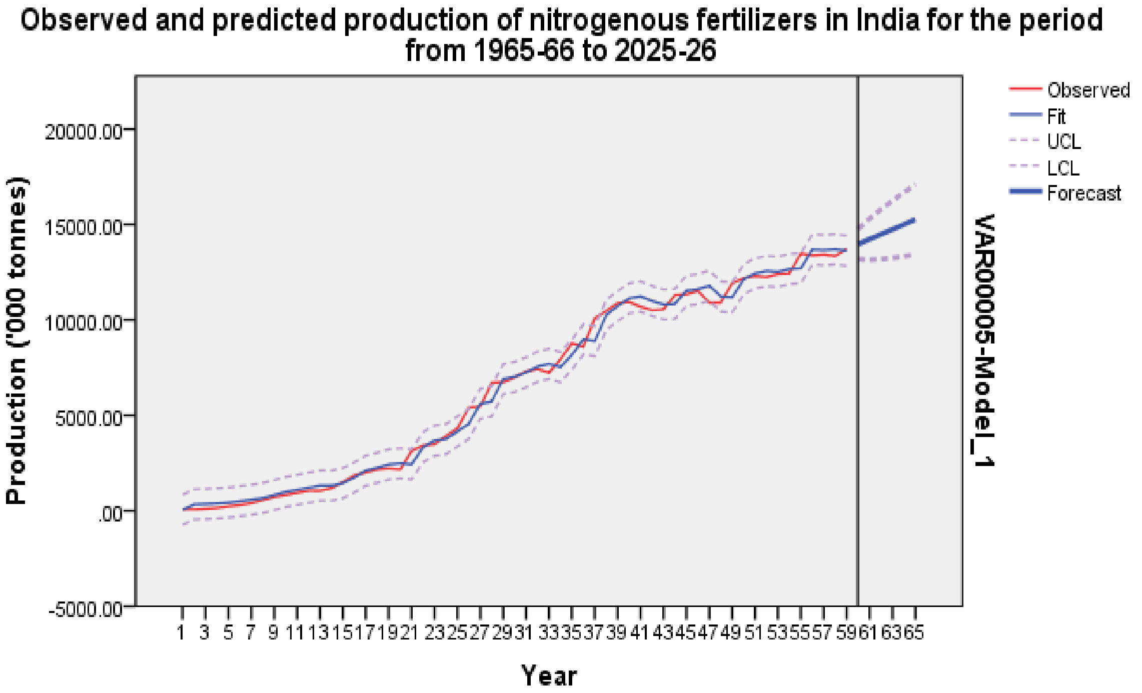


Fig 4.10 Observed and forecasted production of nitrogenous fertilizers in India

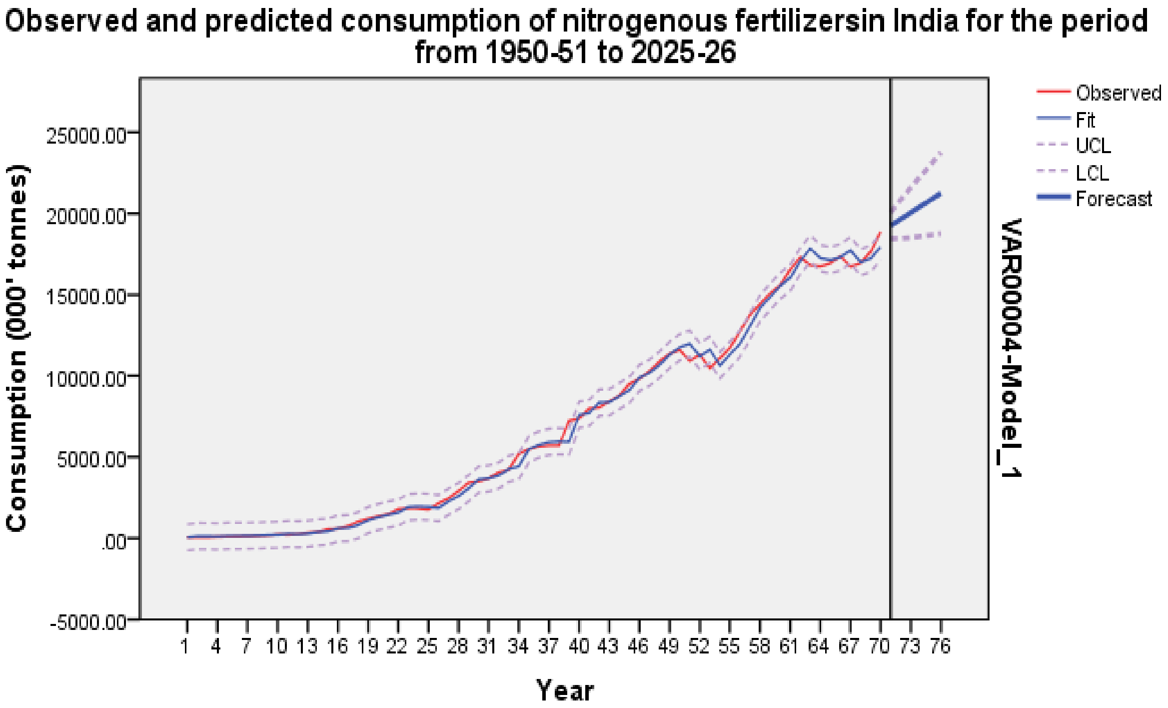


Fig 4.11 Observed and forecasted consumption of nitrogenous fertilizers in India

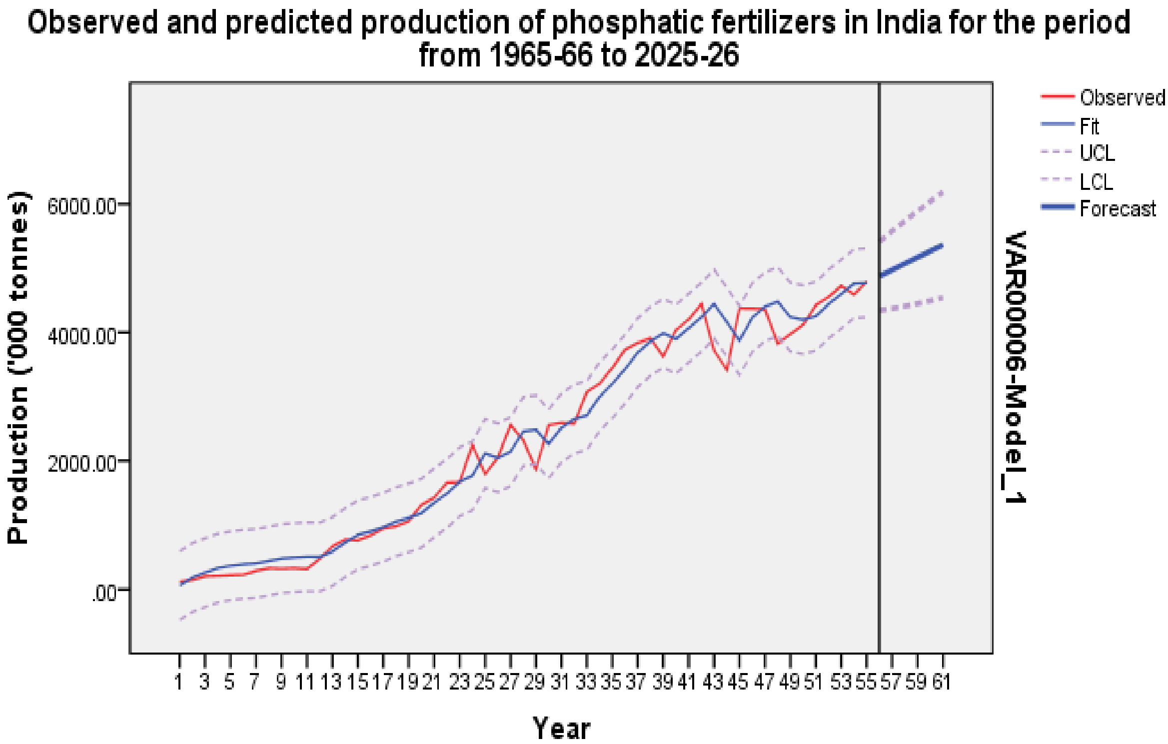


Fig 4.12 Observed and forecasted production of phosphatic fertilizers in India

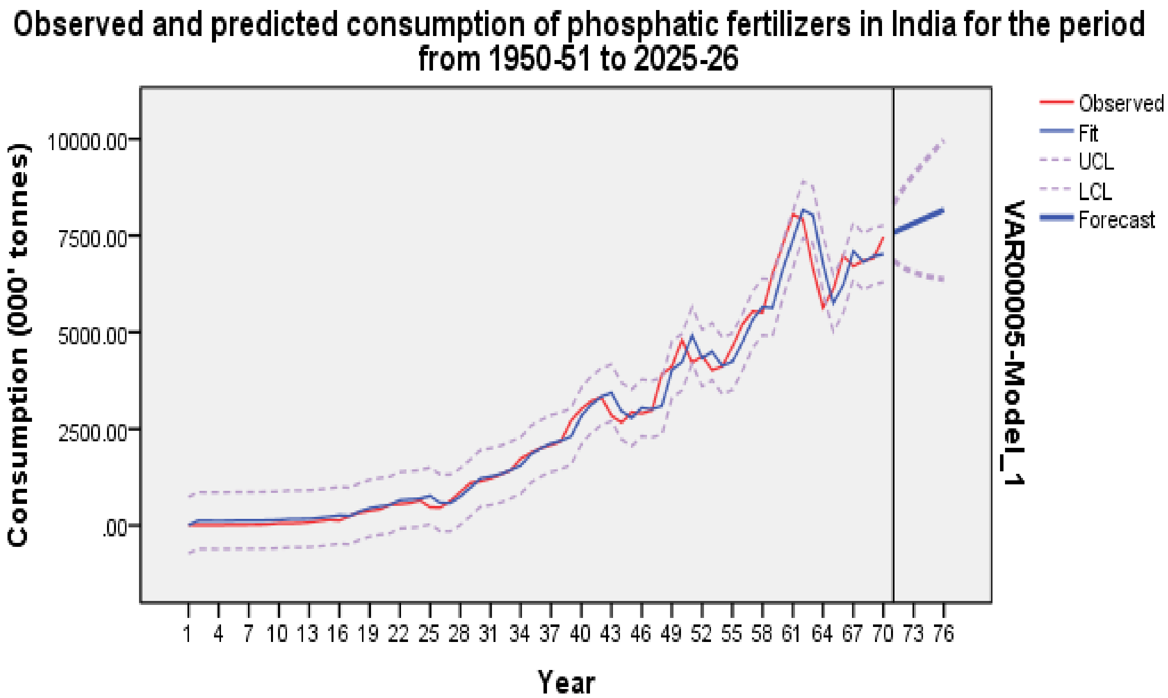


Fig 4.13 Observed and forecasted consumption of phosphatic fertilizers in India

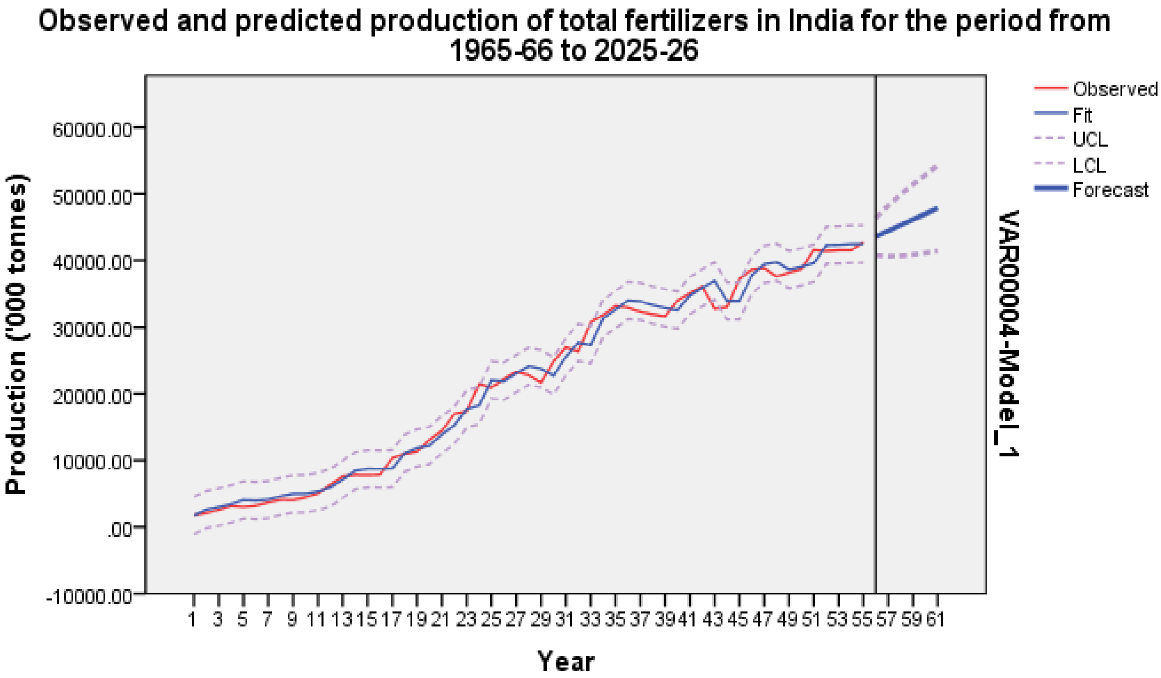


Fig 4.14 Observed and forecasted production of total fertilizers in India

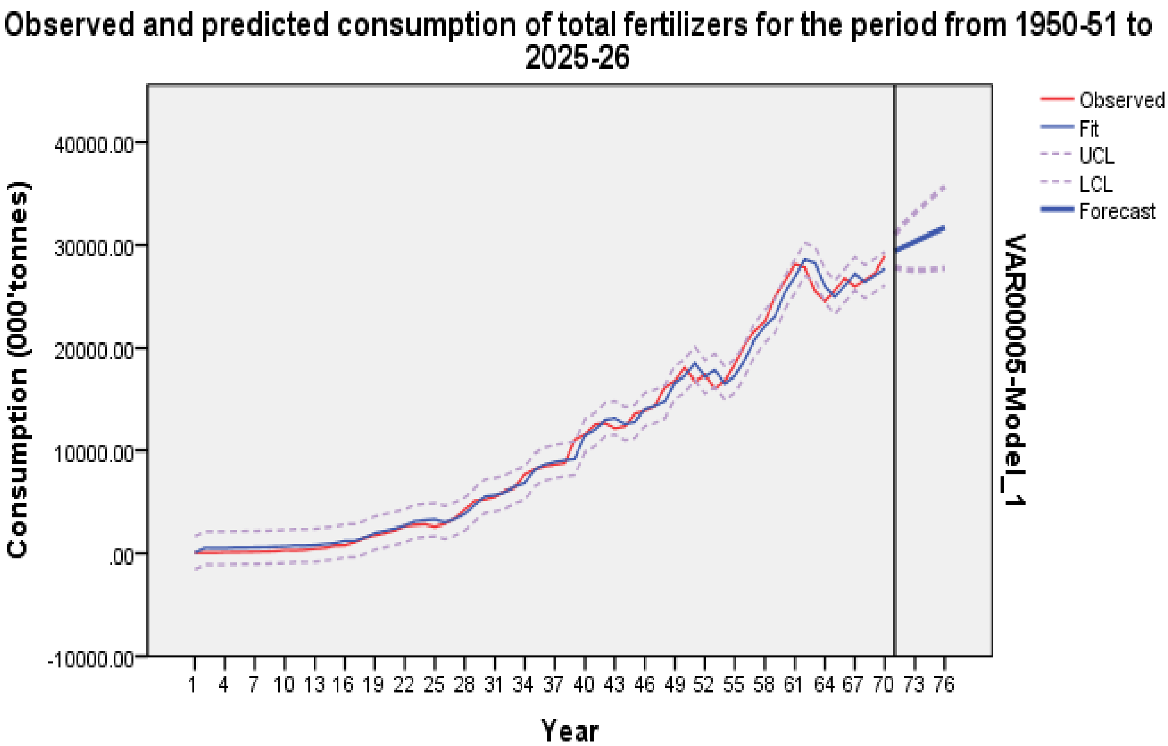


Fig 4.15 Observed and forecasted consumption of total fertilizers in India

Validation of the model which was developed to predict the production and consumption of N, P and total fertilizers in India can be observed by the closeness of the two curves in the figures above.

The forecast values for the period from 2020-21 to 2025-26 are obtained and show an increasing trend in the production as well as consumption of N, P and total fertilizers in India. The results are showcased in Table 4.12.

Table 4.12 Forecast values of the production and consumption of N, P and total fertilizers in India (2020-21 to 2025-26)

('000 tonnes)

	Year	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**
Production	N	13989.61	14264.08	14538.55	14813.02	15087.49	15361.96
	P	4877.71	4975.02	5072.32	5169.63	5266.93	5364.23
	Total	43587.35	44442.93	45298.51	46154.09	47009.67	47865.25
Consumption	N	19262.45	19661.12	20059.79	20458.46	20857.12	21255.79
	P	7581.98	7699.17	7816.36	7933.54	8050.73	8167.91
	Total	29423.75	29877.90	30332.05	30786.21	31240.36	31694.51

4.2.2 Forecasting the consumption of potassic fertilizers in India

The training period from 1950-51 to 2014-15 was selected and it was used to forecast the future values. The expert modeler of SPSS selected the simple model for both the validation and also the forecast. After validation of the data, the data set was used to predict the values from 2015-16 to 2019-20. Table 4.13 shows the various parameters of the exponential smoothing coefficient of simple model for the consumption of potassic fertilizers. The alpha ($\alpha = 1.00$) has been outlined.

Table 4.13 Parameters of simple exponential smoothing model of the consumption of potassic fertilizers in India for the period from 1950-51 to 2014-15

	Estimate	SE	t	Sig.
Alpha (Level)	1.000	0.130	7.689	0.000

Table 4.14 Model statistics of simple exponential smoothing model

Fit statistic	Simple model
R^2	0.947
RMSE	220.078
MAPE	16.007
MAE	120.502
BIS	10.853

Table 4.15 Validation of predicted consumption of potassic fertilizers in India from 2015-16 to 2019-20 using the simple model

(‘000 tonnes)

Year	2015-16	2016-17	2017-18	2018-19	2019-20
Actual consumption (000’ tonnes)	2401.5	2508.5	2779.7	2680.3	2640.9
Forecasted consumption for validation (000’ tonnes)	2532.90	2532.90	2532.90	2532.90	2532.90

Table 4.14 outlines the results of the forecast. It shows a high R square value. The values of RMSE, BIS, MAPE and MAE are also given. Thus, to forecast the consumption of potassic fertilizers from 2020-21 to 2025-26, the expert modeler

selected the simple exponential smoothing model.

By comparing the actual and predicted consumption of potassic fertilizers in India for the years from 2015-16 to 2019-20, a perusal of the validation of the model developed is shown in Table 4.15

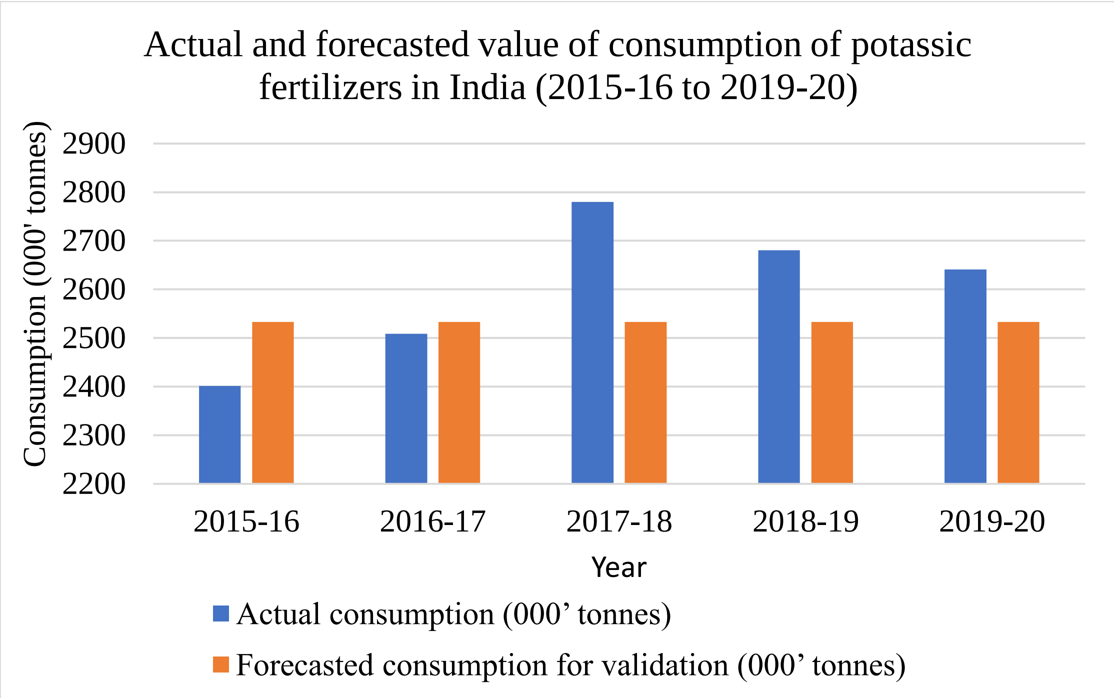


Fig 4.16 Validation of forecasted values of consumption of potassic fertilizers in India from 2015-16 to 2019-20

Simple model was chosen by the expert modeler to forecast the values of consumption of potassic fertilizers from 2020-21 to 2025-26. Table 4.16 outlines the parameters of exponential smoothing coefficients of the simple model on the consumption of potassic fertilizers from 2020-21 to 2025-26. The coefficient of the model obtained is $\alpha = 1.00$.

Table 4.16 Simple exponential smoothing model parameters to forecast consumption of potassic fertilizers in India for the years from 2020-21 to 2025-26

	Estimate	SE	t	Sig.
Alpha (Level)	1.000	0.120	8.305	.000

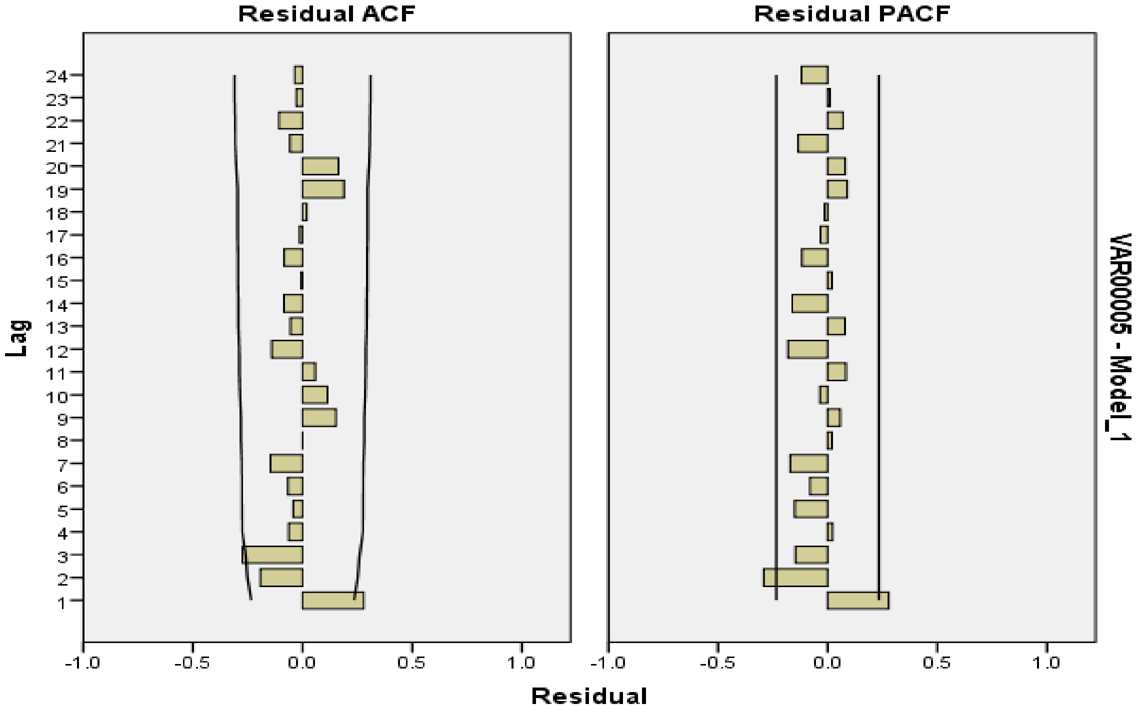


Fig 4.17 Residuals of ACF and PACF plots of the simple exponential model

From Fig 4.17, it can be inferred that the residuals are within the confidence limits in the ACF and PACF plots. Validation of the model which was developed to predict the consumption of potassic fertilizers in India can be observed by the closeness of the two curves.

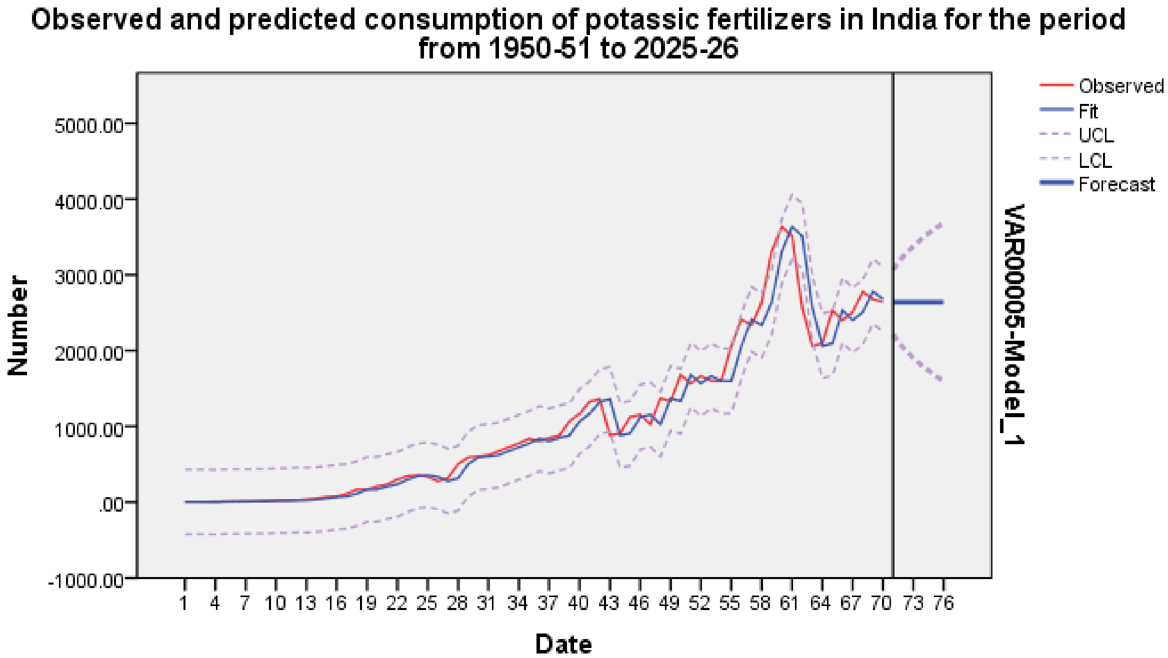


Fig 4.18 Observed and forecasted consumption of potassic fertilizers in India

The forecast values for the period from 2020-21 to 2025-26 are obtained and show a stagnant trend in the consumption of potassic fertilizers in India *i.e.*, 2640.90 million MT. The results are showcased in Table 4.17.

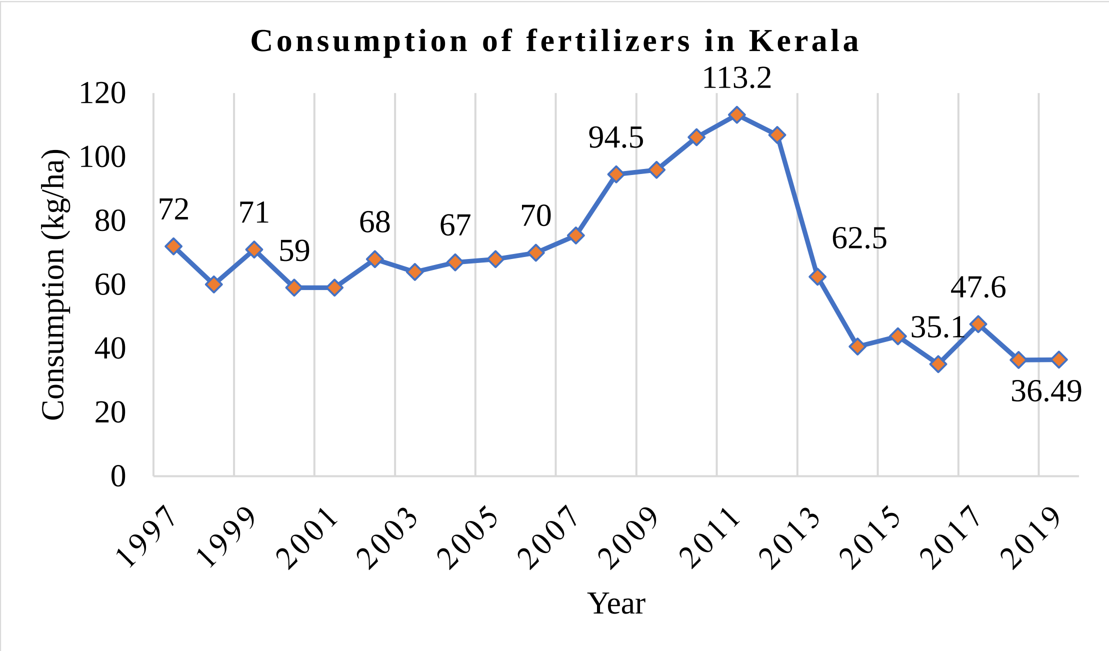
Table 4.17 Forecast values of the consumption of potassic fertilizers in India for the years from 2020-21 to 2025-26

('000 tonnes)

Year	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26
Consumption (000' tonnes)	2640.90	2640.90	2640.90	2640.90	2640.90	2640.90

4.3 Comparing the consumption of fertilizers in Kerala and Telangana

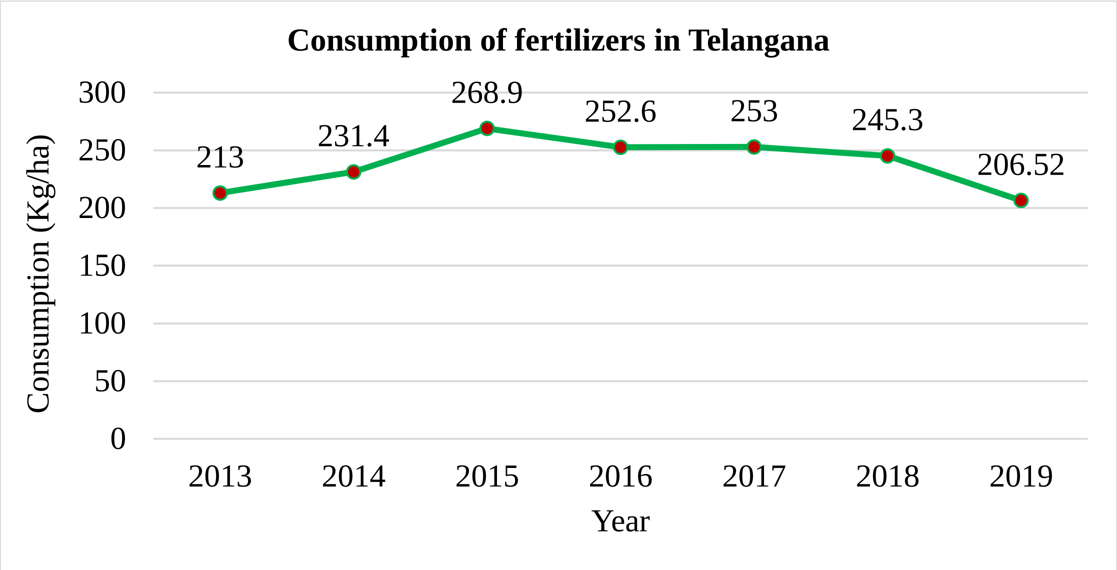
Primary survey was conducted in Palakkad district of Kerala and Nalgonda district of Telangana. The total respondents were 120 farmers. Two panchayats each from the districts were selected.



Source: Fertilizer Association of India, 2019-20

Fig 4.19 Consumption of fertilizers (kg/ha) in Kerala

The consumption of fertilizers in the two states is depicted in the Figures 4.19 and 4.20. The consumption of fertilizers in Kerala has been showing a downward trend for the past few years from 2011 onwards. The main reason is the decrease in the area of food grains. In the 1990s the average paddy land area in Kerala was 5.59 lakh ha. During 2010-11, the area under rice declined to 2.13 lakh ha and the production of rice also declined to 5.22 lakh MT from 5.98 lakh MT in 2009-10 (Economic Review, 2011-12). In the year 2012-13 it fell to 1.97 lakh ha but increased to 2.03 lakh ha in 2018. Presently in 2019, it stands at 1.98 lakh ha (Agricultural Statistics 2018-19, Department of Economics and Statistics, Government of Kerala). The State government's policy initiatives, which encouraged paddy production such as enhanced subsidies, a bonus over the minimum support price (MSP), and increased purchase, were critical in preventing a further drop in the area planted with paddy. The government has taken a number of initiatives to increase paddy production, area, and productivity in a sustainable manner. Royalty to paddy land owners at the rate of ₹2000/ha for conserving the paddy lands instituted by the government in 2020 also gave a further fillip to paddy cultivation in Kerala. The initiatives of the government to promote paddy in Kerala has been beneficial and hence an increase in fertilizers has been noticed as seen in Fig 4.19.



Source: Fertilizer Association of India, 2019-20

Fig 4.20 Consumption of fertilizers (kg/ha) in Telangana

Table 4.18 consumption of fertilizers (per ha) in Kerala and Telangana- 2017-18

Consumption (per ha)	Kerala	Telangana
N	26.83	170.52
P	8.41	66.37
K	11.74	27.76
Total	46.97	264.65

Source: Fertilizer Scenario, 2018

The state of Telangana is one of the states with the highest consumption of fertilizers in the country. In the year 2019 the consumption was 206.52 kg/ha. The fact that paddy production in Telangana is one of the highest in the country accompanies the high consumption of fertilizers. The consumption (per ha) has been shown in Table 4.18. It can be noticed that the per ha consumption of N, P and K is very high in Telangana. The use of N fertilizers in the highest. In Kerala very low levels of fertilizers usage is noticed and it is very evident from the table that the use of P fertilizers is the least.

4.3.1 Profile of the respondents

The socio-economic details of the respondents of an area reflect the economic conditions of that particular area and are a crucial part of social science studies. Various particulars like age, gender, land area, education level, annual income, source of income *etc.* were studied and a comparison between Kerala and Telangana has been made.

4.3.1.1 Age of the respondents

One of the most crucial factors determining a respondent's maturity is their age. The comparison of the different age groups studied in both the states has been shown in Fig 4.21.

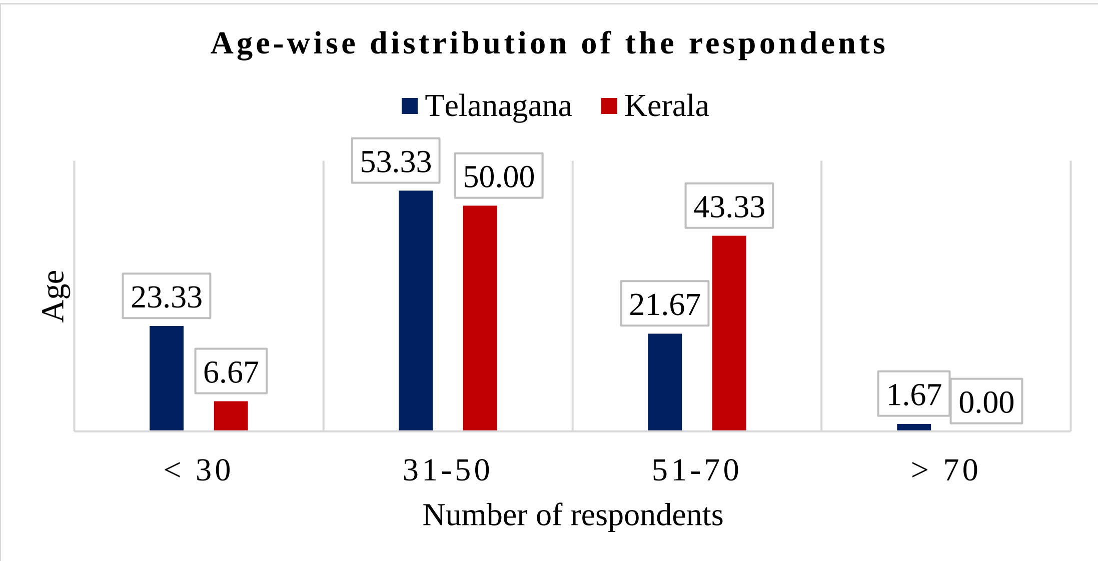


Fig 4.21 Age-wise distribution of the respondents

In Kerala, the maximum number of respondent paddy farmers were in the age group of 31-50 years (50 %). Also, a majority of respondents (43.33 %) come under the age group 51-70 years which is followed by 6.67 per cent of the farmers in the age group of < 30 years in Kerala. In Telangana the percentage of respondents belonging to the age group of <30 and 51-70 years of age are more or less equal (23.33 % and 21.67 %). The lowest percentage (1.67 per cent farmers in Telangana) belong to the category of > 70 years of age *i.e.*, The results by Coelli and Battese (1996) also explained that those farmers who are older are more likely to have more farming expertise and so be more efficient. They are, however, more conservative and thus less eager to accept new approaches, perhaps leading to increased inefficiencies in agricultural productivity.

4.3.1.2 Gender of the respondents

Table 4.19 Gender-wise distribution of the respondents

State	Male	Female	Total
Kerala	51 (85)	9 (15)	60 (100)
Telangana	48 (80)	12 (20)	60 (100)

Note: Figures in parenthesis denotes percentage to total

Table 4.19 furnishes the distribution of the farmers based on their gender. The table reveals that in the state of Telangana and Kerala paddy cultivation is dominated by males *i.e.*, 80 per cent and 85 per cent respectively. Out of the total respondents, only 12 were females in Telangana and 9 in Kerala. This accounts for 20 and 15 per cent respectively. According to Satapathy *et al* (2001) paddy cultivation needs a lot of effort and a long period of time. Women do not engage in activities such as ploughing. But they do engage in more tedious work and minor tasks such as transplanting, weeding, and so on. Tilling, puddling, harvesting, and transplantation take a lot of time for agricultural laborers hence, the need for better instruments to save time and money is seen.

4.3.1.3 Land area distribution of the respondents

Fig. 4.22 shows a comparison in the land area owned by the farmers in the two states. In Telangana, majority of the respondents, 76.67 per cent farmers have area of 0-5 acres which is followed by 15 per cent farmers having 6-10 acres of land. Only 6.67 per cent were large farmers with land area between 11-15 acres. On the other hand, farmers in Kerala were mostly marginal and small farmers with a majority of them owning land between 0-5 acres (88.33 %). In addition, there were 11.67 per cent farmers having land holdings between 6-10 acres. The average land holding in Telangana is found to be 4.08 acres and in Kerala it is 2.8 acres.

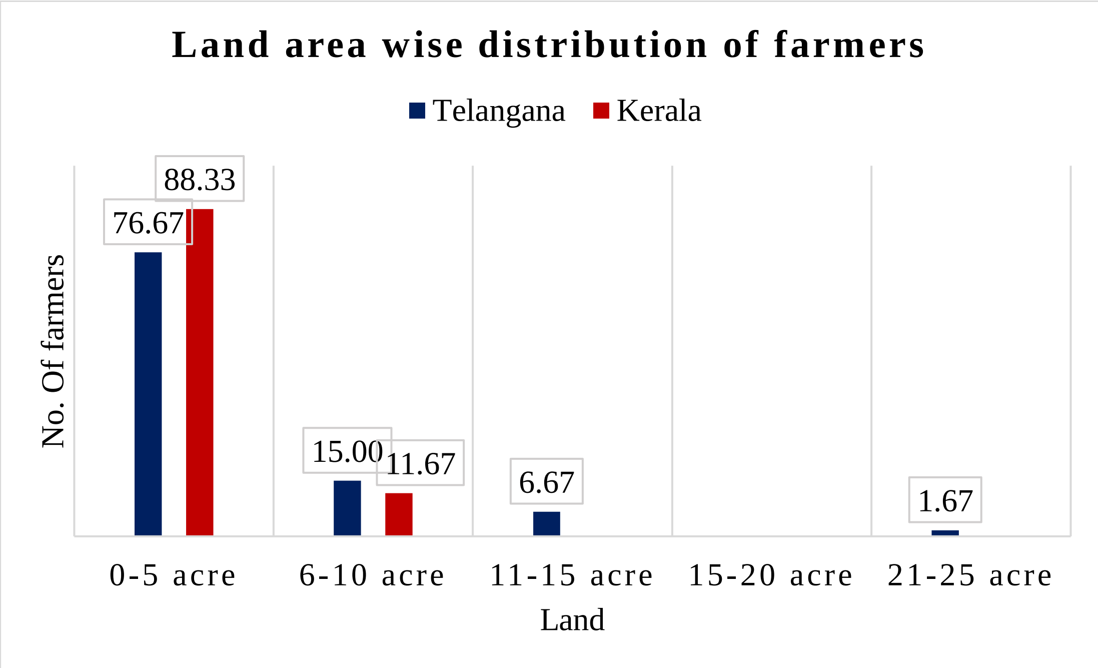


Fig 4.22 Land area-wise distribution of the respondents in Kerala

4.3.1.4 Educational status of the respondents

The education level of the respondents of the two states is presented in Table 4.20. Education is considered to be one of the prime factors determining the efficiency of the famers to adopt and acclimatize to new technologies. The farmer's education level also has a substantial impact on paddy farming efficiency as told by Suresh and Reddy (2006). The higher the level of education the more is the farmers' acceptance towards innovations. It can be noticed from the table that 28 per cent of the respondents have an intermediate level of education in Kerala. Majority of the respondents had high school level of education in Kerala (41.67 %).

In Telangana 30 per cent of the respondents have a high school level of education which is followed by respondents having a graduation level of education. A very small percentage of farmers also had post-graduation as their level of education in both the states, (3.33 % and 5 % in Telangana and Kerala respectively). This finding demonstrates that the majority of farmers have been active in agriculture since childhood and they had rich experience and involvement in paddy cultivation.

Table 4.20 Education-wise distribution of respondents

S. No	Education level	Kerala	Telangana
1	Below high school	8 (13.33)	9 (15.00)
2	High school	25 (41.67)	18 (30.00)
3	Intermediate	17 (28.33)	8 (13.33)
4	Diploma	0 (0.00)	6 (10.00)
5	Graduation	7 (11.67)	17 (28.33)
6	Post-graduation	3 (5.00)	2 (3.33)
	Total	60 (100)	60 (100)

Note: Figures in parenthesis denotes percentage to total

4.3.1.5 Income level of the respondents

Paddy is a crop that requires a high amount of financial input. The income levels of the farmers have been discussed in Table 4.21 and depicted in Fig 4.23. In Kerala, majority of the respondents earned around ₹ 50,000- ₹ 2 lakh *i.e.*, 45 per cent in the range of ₹ 50,000 to ₹ 1 lakh and 41.67 per cent in the range of ₹ 1 lakh to ₹ 2 lakh per annum.

Table 4.21 Income-wise distribution of farmers in Telangana and Kerala

Annual income (₹)	Kerala	Telangana
50,000-1 lakhs	27 (45.00)	10 (16.67)
1 lakh- 2 lakh	25 (41.67)	27 (45.00)
>2 lakh	8 (13.33)	23 (38.33)
Total	60 (100)	60 (100)

Note: Figures in parenthesis denote percentage

Coming to Telangana, as the land holding and yield is more for the farmers

38.33 per cent farmers earned more than ₹ 2 lakh per annum. In addition, 45 per cent of the respondents earn in the range of ₹ 1 lakh to ₹ 2 lakh per annum. The perusal of the income level of respondents is indicative of the need for adopting better technology for productivity enhancement if the income level of farmers has to be improved. Siddick (2019) also observed that rice cultivation with appropriate technologies for rainfed low-land farmers is critical for increasing yields and income.

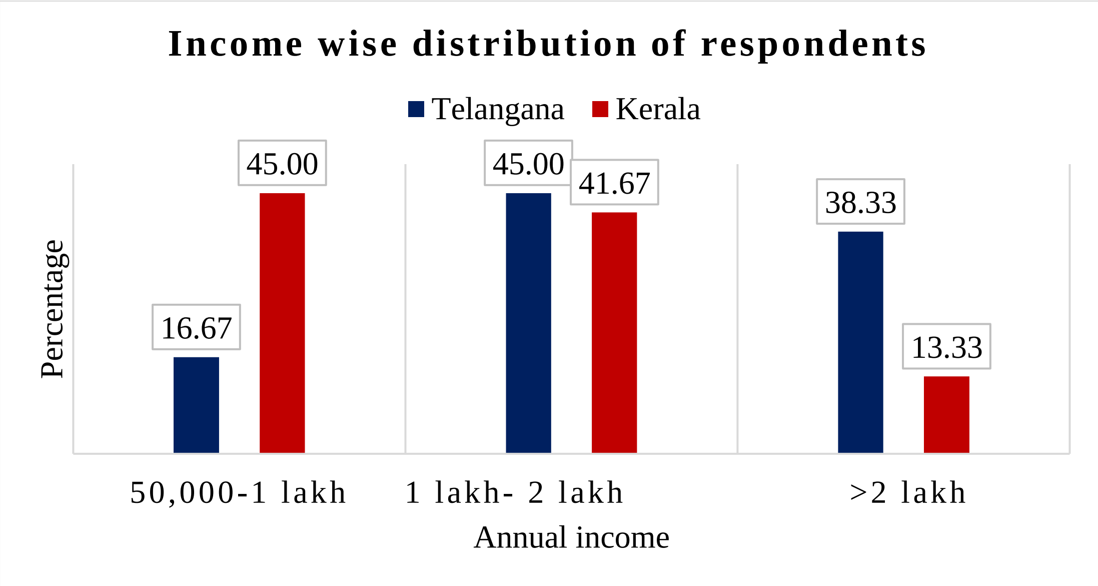


Fig 4.23 Income-wise distribution of the respondents

4.3.1.5 Sources of income of the respondents

Table 4.22 furnishes the source of income of the respondents of the two states. 68.33 per cent of the respondents in Telangana and 50 per cent in Kerala were having farming as the sole source of income. The percentage of respondent farmers having farming and allied activities were comparatively higher in Kerala (41.67 %) than in Telangana (20 %). Due to the smaller land holdings by the farmers in Kerala, 41.67 per cent were also carrying out allied activities such poultry, dairy, cultivation of vegetables, fruit trees *etc*. Only 3.33 per cent and 1.67 per cent of the farmers had a business along with farming in Telangana and Kerala respectively. The percentage of respondents with a job was more in both states *i.e.*, 8.33 per cent in Telangana and 6.67 per cent in Kerala. Farming plus allied activities provide the farmer with a higher income and more income security. This can be substantiated by the findings of Nurhayati *et al.* (2016) that integrated farming systems such as paddy cum fish culture increase the productivity of the paddy fields.

Table 4.22 Source of income of the respondents in Telangana and Kerala

Source of income	Kerala	Telangana
Farming	30 (50.00)	41 (68.33)
Farming+ allied activities	25 (41.67)	12 (20.00)
Farming+ business	1 (1.67)	2 (3.33)
Farming+ job	4 (6.67)	5 (8.33)
Total	60 (100)	60 (100)

Note: Figures in parenthesis denotes percentage

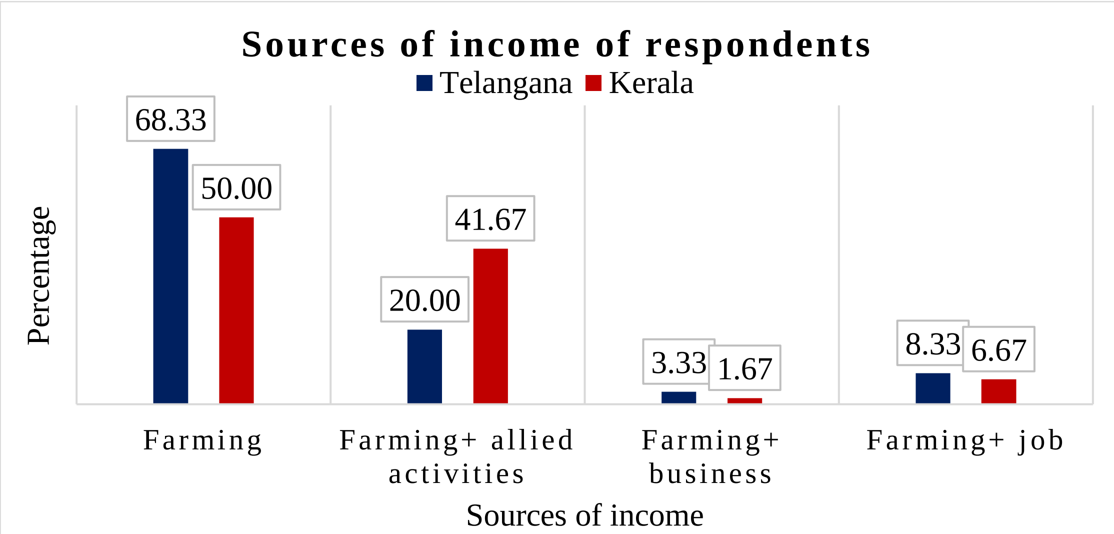


Fig 4.24 Sources of income of the respondents

The National Sample Survey (NSS) 77th round (2019) for assessing the situation of the agricultural households and land and holdings of households in rural areas indicated that at all-India level the average household area owned per household is 2.19 acres. According to the Agricultural Action Plan 2019-20 the average land holding size in Telangana is 2.8 acres and according to the report of the 10th Agricultural census (2015-16), the average land holding size is 0.45 acres in Kerala. The average land holding size in the study area (Nalgonda) is 4.08 acres in Telangana and 2.8 acres in Kerala (Palakkad) which is higher than the all-India average. According to the NSS report (2019), the average monthly paid out expenditure for crop production per agricultural household involved in crop production in India is ₹ 2,959 (₹ 35,508 annually) and the average monthly paid out expenditure for animal farming is ₹ 1,267 (₹ 15,204 annually). The average income that the farmer receives from paddy cultivation in both the states is higher than the expenditure incurred.

The procurement of seed in the two states is also different. Paddy farmers in Telangana mostly procure seeds from the seed dealers or use the seeds saved from the previous crop. In Kerala to encourage paddy farming, farmers are organised into Padasekhara Samitis, or paddy farmer collectives, which serve as an institution and help the paddy farmers in many ways. Padasekhara Samitis and Krishi Bhavans, which are the agricultural support institutions run by the Department of Agriculture, Kerala and working under the panchayats played a key role in the revival of rice farming in Kerala. Through Padasekhara Samitis, Krishi Bhavans provide farmers with subsidised seeds and fertilizers. Each panchayat has a Krishi Bhavan which looks into the matters of the farmers in that particular panchayat.

Coming to the marketing aspect of paddy, different scenarios are noticed in the two states. In Telangana, the Civil Supply Department of Telangana (TSCSC) has opened paddy procurement centres (PCC) to procure the paddy produced by the farmers. The paddy is then procured based on the Minimum Selling Price (MSP) in the yards. The Procurement of rice through the State Civil Supplies Corporation is the major tool for ensuring a fair price for paddy farmers. The second channel is through the State Agencies to effectively intervene in paddy procurement. In Kerala, the farmers gain substantially from Supplyco's paddy procurement. Every agricultural season, the farmer deposits the produced crop with Supplyco-approved procuring agencies (mostly mills in the area). Supplyco distributes money to the farmers' bank account based on the paddy receipts issued by the agents. Farmers are given loans by public sector banks based on deposits made by Supplyco or its agents. The MSP of paddy for the year 2019-20 was ₹ 1,868 per quintal of paddy. While Telangana followed the MSP declared by the GoI, in Kerala the government declared a higher procurement price of ₹ 2,748 per quintal. The difference in price is borne by the state as an incentive to the farmers and the procurement price is the highest in the country.

One striking difference between the paddy farmers of Kerala and Telangana is that, the farmers of Kerala are holders of Kisan Credit Card (KCC) and most of them avail loans from co-operative banks whereas in Telangana it is through commercial banks. Fertilizers are also bought from wholesalers and retailers in Telangana. Out of the total respondents, 21 of them purchased fertilizers from the local fertilizer shops and 39 of them from wholesale shops. The Recommended Dose of Fertilizer (RDF) for paddy in Kerala is 90 kg/ha of N, 45 kg/ha of P_2O_5 and 45 kg/ha of K_2O. The average consumption of N, P_2O_5 and K_2O in the study area is 105 kg/ha, 48 kg/ha and 70 kg/ha respectively. An excess application of 15 kg/ha, 3 kg/ha and 25kg/ha were observed for N, P_2O_5 and K_2O. Similarly, the RDF for transplanted paddy in Telangana is 120 Kg/ha of N, 50 kg/ha of P_2O_5 and 40 kg/ha of K_2O but the farmers apply 155 kg/ha N, 75 kg/ha of P_2O_5 and 62.7 kg/ha of K_2O in the study area. A deviation of 35 kg/ha of N, 25 kg/ha of P_2O_5 and 22.7 kg/ha of K_2O is observed from the RDF. There is an over usage of fertilizers in Telangana.

4.3.2 Impact of fertilizer consumption on yield in Kerala and Telangana

To know the impact of fertilizer consumption on yield and the difference in the consumption of N, P and K fertilizers and yield in both the states, a second-order polynomial regression, f-test were done and box plots were drawn.

4.3.2.1 Second-order polynomial regression

To know the fertilizer consumption in the two states regression analysis was done and the actual yield and the predicted yield were graphically studied. As the nutrient supply increases, an increase in the yield is also noticed up to a maximum level but, if the nutrient supply is further increased, the yield gets affected in a negative way. Therefore, a second-degree polynomial regression was done with yield as the dependent variable and consumption of N, P, K as the independent variables and it is of the form

$$Y = b_0 + b_1 N + b_2 P + b_3 K + b_4 N^2 + b_5 P^2 + b_6 K^2 + b_7 NP + b_8 NK + b_9 PK$$

The regression yielded a set of predicted yields. This was then compared to the actual yields that the farmer got. The R square value that was obtained for the second-degree polynomial regression for Kerala and Telangana are 0.947 and 0.961 respectively. This suggests that 94.7 per cent and 96.1 per cent of the N, P, K values are able to indicate the variation in the dependent variable yield in Kerala and

Telangana. Linear regression was also carried out and the actual yield, predicted yield from the second-degree polynomial regression and predicted yield from the linear regression were compared.

Table 4.23 Parameter estimates of second-order regression of Telangana and Kerala

Parameter	Kerala		Telangana	
	Estimate	Std. Error	Estimate	Std. Error
b_0	5.342	6.022	-13.577	11.709
b_1	.403	.486	-.087	.313
b_2	.202	1.127	-.206	1.051
b_3	.191	.479	2.486	1.060
b_4	.007	.004	.000	.000
b_5	.046	.031	.029	.024
b_6	-.004	.008	-.050	.020
b_7	-.039	.022	-.021	.010
b_8	.011	.013	.027	.012
b_9	-.012	.026	-.004	.030

Table 4.24 Coefficients of linear regression for Kerala

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.304	3.840		-.079	.937
	N	.226	.108	.300	2.098	.040
	P	.732	.255	.500	2.875	.006
	K	.239	.177	.174	1.350	.183
a. Dependent Variable: Yield						

Table 4.25 Model Summary (Kerala)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.963[a]	.927	.923	15.93011
a. Predictors: (Constant), N, P, K				
b. Dependent Variable: Yield				

Table 4.26 Coefficients of linear regression for Telangana

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.830	5.107		-.358	.722
	N	.018	.038	.045	.483	.631
	P	.565	.267	.445	2.114	.039
	K	.729	.298	.491	2.448	.018
a. Dependent Variable: Yield						

Table 4.27 Model Summary (Telangana)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.976[a]	.954	.951	26.99857
a. Predictors: (Constant), N, P, K				
b. Dependent Variable: Yield				

The r square values obtained from the linear regression were also compared with the r-square values obtained from second-degree regression. The R square value obtained for Kerala and Telangana is 0.927 and 0.954 as shown in the Table 4.25 and Table 4.27. This is less than the R-square value of second-degree polynomial regression and hence to know the consumption of N, P, K and its effect on yield, second-degree polynomial is a better fit. This proves that the consumption of N, P, K have a very considerable effect on the yield. The actual yield and the predicted yields from both the regression were plotted and the graphs are shown. It can be concluded that the actual yield and the predicted yield follow more or less the same pattern.

4.3.2.2 Actual and predicted yield- comparison

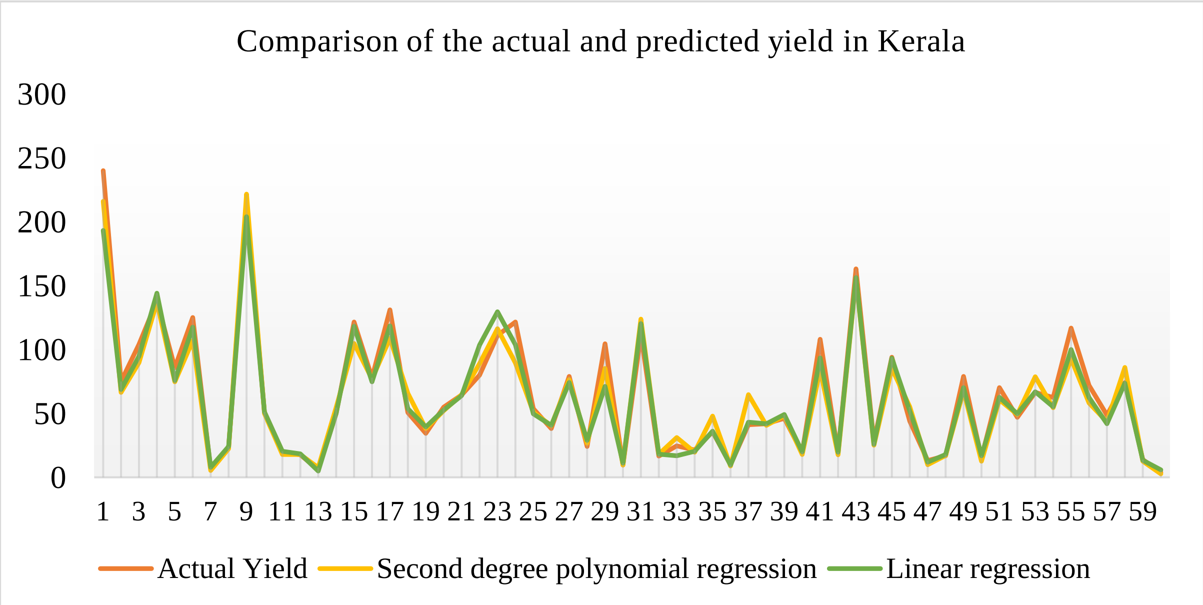


Fig 4.25 Comparison of the actual and predicted yield in Kerala

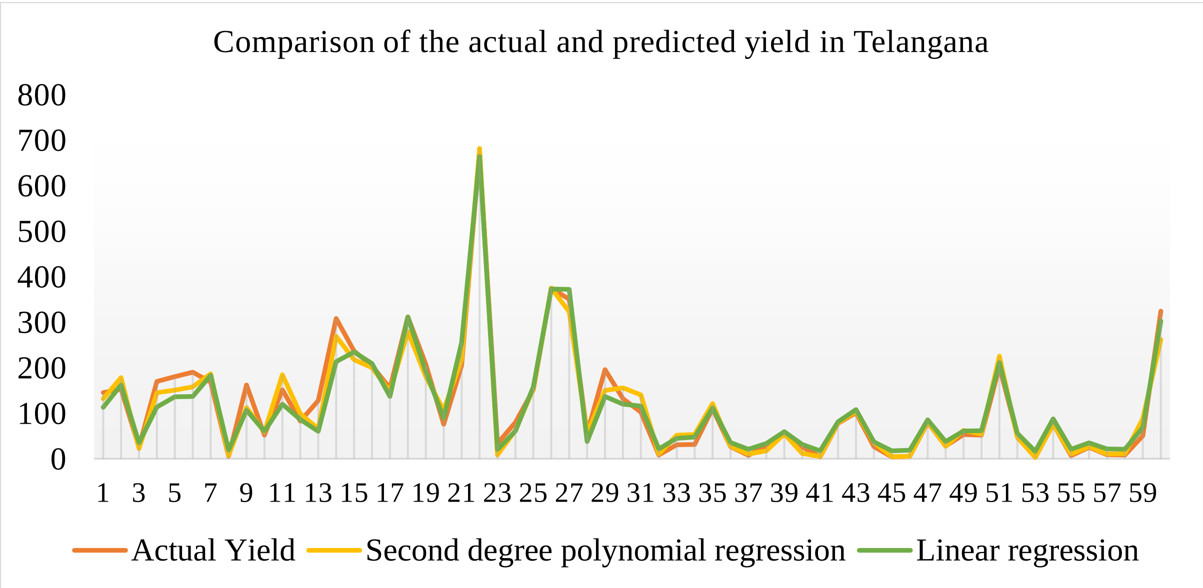


Fig 4.26 Comparison of the actual and predicted yield in Telangana

In Kerala the average yield in the study area during autumn was 2250 kg/acre and during the winter season was 2550 kg/acre. The average actual yield in the study area of Telangana was found to be 2550 kg/acre during Kharif and 2850 kg/acre during the rabi season. Paddy is taken up only twice in both the study areas and the yield is found to be higher in Telangana. The gross income in Kerala was found to be ₹ 61,830 for autumn paddy and ₹ 70,074 for winter paddy. In Telangana it is ₹ 47,634 for the kharif season and ₹ 53,238 for the rabi season. The income is more in Kerala because the procurement price in Kerala is higher than that in Telangana.

4.3.2.3 Fisher's t test

Fisher's t test was also performed to know whether there is any significant difference between the consumption of N, P, K and yield in the two study areas.

Table 4.28 Descriptive statistics

	Two samples	N	Mean	Std. Deviation	Std. Error Mean
N	1.00	60	272.7283	301.13816	38.87677
	2.00	60	103.5583	76.26463	9.84572
P	1.00	60	98.1867	96.14394	12.41213
	2.00	60	50.4827	39.11229	5.04937
K	1.00	60	80.4115	82.21688	10.61415
	2.00	60	61.4750	41.72117	5.38618
Yield	1.00	60	113.2670	121.05890	15.62864
	2.00	60	74.7000	57.24651	7.39049

(Sample 1 denotes consumption in Telangana and 2 denotes consumption in Kerala)

To test the validity of the assumption, F-test is used to know if the variances are homogenous. All the variances were found to be homogenous. The Fisher's t test was done and the consumption of nitrogen, phosphorus and the yield were found to be significant as the $t_{cal} > t_{table}$ the t value obtained for the consumption of N, P and yield was 4.218, 3.560 and 2.231 and it is greater than 1.96 and hence it was significant. Therefore, we reject the null hypothesis that the consumption of N, P and yield is different in the two states. The consumption of K was found to be non-significant; t value was 1.591. As it is less than 1.96, we accept the null hypothesis that the consumption of K in both the states was almost the same.

Table 4.29 Fisher's t test summary

	F	Sig	t
N	30.652	.000	4.218
P	16.961	.000	3.560
K	9.729	.002	1.591
Yield	15.826	.000	2.231

4.3.2.4 Comparison of box plots for consumption and yield

Box plot was also drawn to compare the fertilizer consumption in the two states. The box plot is depicted based on the minimum and maximum values and the three quartiles of the data *i.e.*, Q1, Q2, Q3. From the Fig 4.27 it can be deciphered whether the data is normally distributed or if there is skewness present in the data. The median for the consumption of nitrogenous fertilizers in Telangana is closer to the lower quartile. This explains the fact that the data is positively skewed. The box plot for nitrogenous fertilizer consumption in Kerala also shows a median which is closer to the lower quartile hence presence of positive skewness can be established.

The interquartile range (IOR) explains the variability in the data set. If the distribution is stretched or squeezed, then the extent of dispersion in the data can be explained. When the data shows a skewness, the interquartile range is considered to measure variability rather than the standard deviation. The two box plots are seen to be squeezed which explains that the data points are close to each other or more compressed. Outliers in the data set can also be identified using the box plots. From the Figure 4.27 we can notice that outliers are present beyond the upper whisker. The box plots are helpful for the identification and removal of the outliers which are the extreme data points. It can also be identified that nitrogen consumption is more in Telangana compared to Kerala.

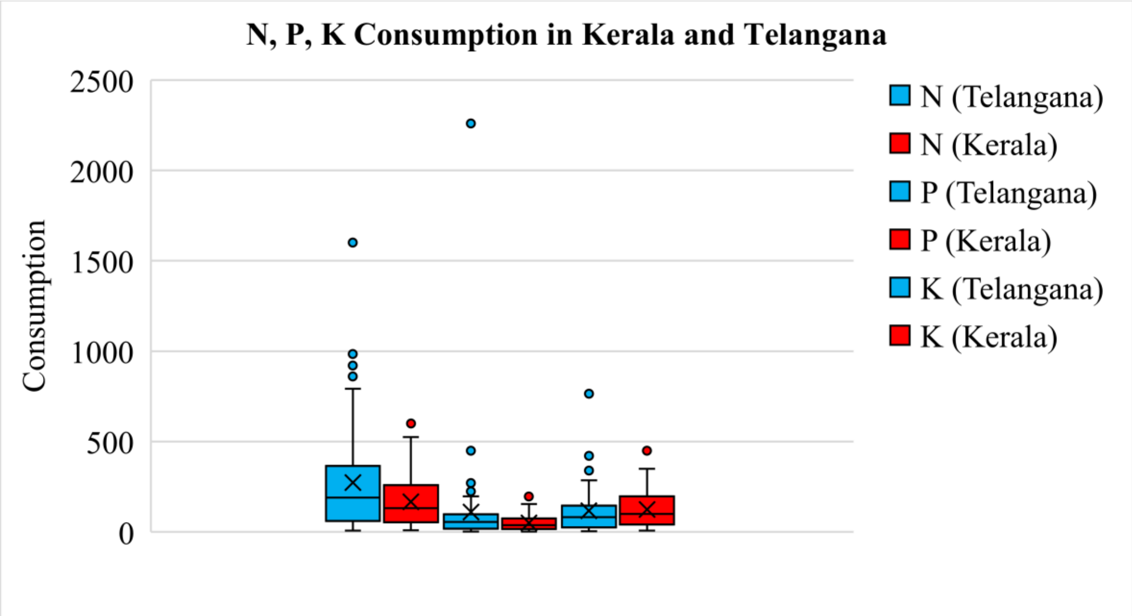


Fig 4.27 Box-plot comparing the consumption of nitrogen, phosphorus and potassium in two states

The box plots for the consumption of phosphatic fertilizers are also shown in Fig 4.27 The median in both the box plots are closer to the lower quartile and this shows that positive skewness is present in the data set. Examining the IQR for the box plots we identify that the box plots are also very compressed and hence we can say that the data points are close to each other. Outliers are present beyond the upper whisker for both the box plots which explain the extreme values in the data set. We can also infer from the box plot that the consumption of phosphatic fertilizers is more in Telangana when compared to Kerala but the difference is not much. The median in the box plots for the consumption of potassic fertilizers in Kerala is closer to the lower quartile and this shows that positive skewness is present in the data set. The box plot for Telangana shows that the median is in the centre and the data set is normally distributed.

Examining the IQR for the box plots we identify that the box plots are also compressed and hence we can say that the data points are close to each other. Outliers are present for both the box plots. For the state of Kerala only a single outlier is present beyond the upper whisker. Also, the consumption of potassium in Kerala is higher compared to that of Telangana.

The box plots for the yield in the two states is are shown in Fig 4.28. The median in the box plot for the yield in Telangana is closer to the lower quartile and this shows that positive skewness is present in the data set. The box plot for Kerala shows that the median is in the centre and the data set is normally distributed. Examining the IQR for the box plots we identify that the box plots are also compressed and hence we can say that the data points are close to each other. Outliers are present for both the box plots. Also, yield in Telangana is higher compared to that of Kerala.

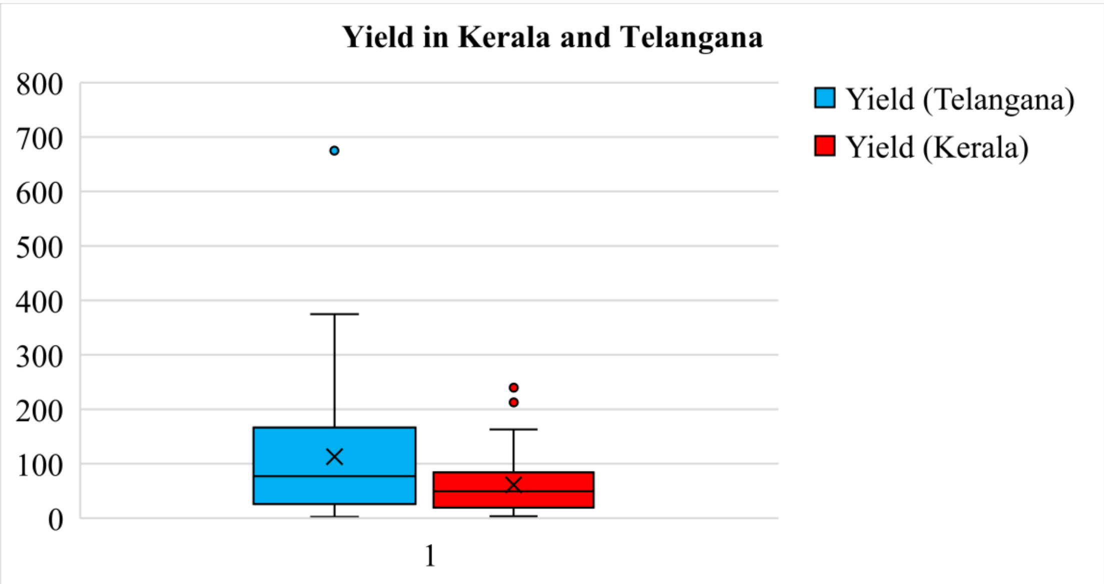


Fig 4.28 Box-plot comparing the yield in two states

4.3.3 Brand preference of fertilizers by the farmers

For understanding the most preferred fertilizer companies in the two states, the farmers were asked to give ranks to various fertilizer companies. The total number of companies considered was 8. Accordingly, rank 1 was given to the most preferred company and rank 8 to the least preferred company. From Table 4.30 it can be understood that in the state of Telangana the most preferred fertilizer brand is Indian

Farmers Fertilizer Cooperative Limited (IFFCO) with a mean rank of 1.27 which is followed by Nagarjuna Fertilizers and Chemicals Limited (NFCL) (mean rank- 1.81). The third most preferred company is the Coromandel International Limited which sells fertilizers under the brand name of GROMOR (mean rank- 3.23).

IFFCO is mostly preferred by the farmers because of its widespread and timely availability and ease of application. IFFCO being a cooperative venture, ensures the regular supply of fertilizers in sufficient quantities through the various PACS present in the study area. The PACS also receive supplies from various other fertilizer companies. One reason for the more prevalence of the IFFCO fertilizers is their brand image. The NFCL is also a very well-known brand among the farmers as it was first started in the state of Telangana. The 5th and 6th positions are occupied by the Southern Petrochemical Industries Corporation Ltd (SPIC) and the National fertilizers limited (NFL) with the mean ranks of 4.40 and 6.84.

Table 4.30 Mean rank obtained for various fertilizer companies in Telangana

S. No	Companies	Mean Rank	Rank
1	IFFCO	1.27	1
2	NFCL	1.81	2
3	GROMOR	3.23	3
4	IPL	4.29	4
5	SPIC	4.40	5
6	NFL	6.84	6
7	KRIBCO	7.05	7
8	ZUARI	7.11	8

Table 4.31 gives the mean ranks of the various companies preferred in Kerala. The Fertilizers and Chemicals Travancore Limited (FACT) is the most preferred company among the farmers with a mean rank of 1.43 followed by IFFCO with a mean

rank of 1.57. Both the companies had almost the same level of respondents. In Kerala, IFFCO used to be a popular company a few years but because of many governmental policies and FACT being a public fertilizer, registered an increase in production as well as usage. This is followed by IPL and SPIC in the 3rd and 4th place with mean ranks of 3.43 and 3.58. For potassic fertilizers IPL and SPIC are the preferred companies. The least preferred companies are KRIBHCO and ZUARI by the farmers of Kerala.

For Kerala, Kendall's W statistic is 0.954 with Chi-square value of 382.453. As the coefficient of concordance is quite close to 1, it can be told that the respondents have a high degree of agreement among themselves while ranking the various fertilizer companies present in the area. Results of the ranking indicate that FACT and IFFCO are the two most prominent companies which are used by the farmers in the regions of Kerala. The prevalence of these two fertilizers companies is more because of their brand image and also support from the government. FACT is a public fertilizer company that was the first large-scale producer of fertilizers in India. Initially, it was a private company but in 1960 it came under the public domain. Though FACT's journey in the fertilizer industry has a lot of ups and downs, it has finally triumphed in the public sector as one of the leading fertilizer companies.

Table 4.31 Mean rank obtained for various fertilizer companies in Kerala

S. No	Companies	Mean Rank	Rank
1	FACT	1.43	1
2	IFFCO	1.57	2
3	IPL	3.43	3
4	SPIC	3.58	4
5	GROMOR	5.45	5
6	NFL	5.55	6
7	KRIBHCO	7.40	7
8	ZUARI	7.60	8

The value of Kendall's W statistic is found to be 0.911 for Telangana with Chi-square value of 382.453. As the coefficient of concordance is quite close to 1, it can be told that the respondents have a high degree of agreement among themselves while ranking the various fertilizer companies present in the area. Results of the ranking indicate that IFFCO and NFCL are the two most prominent companies which are used by the farmers in the regions of Telangana. One of the main reasons for this is the farmers' perception about the fertilizers of the two companies and also its brand image.

Table 4.32 Test statistics obtained for Kendall's coefficient of concordance

Test Statistics		
State	**Kerala**	**Telangana**
N	60	60
Kendall's W	0.954	0.911
Chi-Square	400.531	382.453
Df	7	7

4.3.4 Factors which influence farmers' preference for fertilizers

The ranks of the factors which influence the farmers' preference for fertilizers are furnished in Table 4.33. Farmers appear to rely largely on their own past experience, next fellow farmers, and finally the business selling agri-inputs when seeking information on the purchasing of inputs. The farmer's choice of retailer and product brand is influenced by these sources. Farmers examine the availability of quality brands for inputs where quality is a concern when picking the store where they will buy their inputs. The distribution of fertilizers in both the states are different.

In Kerala the procurements of fertilizers by paddy farmers are mostly through the co-operative banks. Only a small number of farmers purchase fertilizers from private dealers. In Kerala the most important factor that determines the farmers, preference toward fertilizers is also the influence of other farmers. The second and third are the soil type and fertilizer composition. Information regarding the fertilizer composition is given to them from the Krishi bhavans present in each panchayat. Next is the availability of fertilizers in villages. Fertilizer shortages are seen and hence those fertilizers which are readily available in the co-operatives are purchased. Cropping pattern and size of the bag are at the 5th and 6th position. Cropping pattern in the study area is the same as the whole Padashekara Samithi works as a single institution but differences are seen among different Samitis. The size of the bag is also another factor that determines farmers preferences.

The 7th and 8th rank, from the table is for the brand image and credit facilities. Credit facilities in Kerala are given to the farmers via the co-operative banks and commercial banks. Cost of fertilizers is also another factor. The farmer tends to purchase fertilizers at a low price. Promotional activities by the fertilizer companies like distribution of new kits, exhibition, seminars also influence the farmers preference for purchasing fertilizers. Packaging and storability of the fertilizers are ranked 11th and 12th. New products from the fertilizer companies are ranked last because when a new product is released by the company it takes time for the farmer to know about its use and also the way in which it works.

In the state of Telangana, the farmers mostly purchase fertilizers from wholesale and retail outlets. In order to know the factors which, influence this purchase, ranks were given to the factors based on the response from the farmers. Among all the factors, the influence of the fellow farmers was ranked 1st. This is because most of the farmers use only those fertilizers which others have previously used and given good feedback about it. The next is based on the cropping pattern, paddy farming in Telangana is done by the traditional transplanting method and also using the Drum Seeder (DS). The DS method of paddy cultivation requires application of micronutrients and therefore more fertilizers are used compared to the traditional puddling method and hence 2nd rank is given to cropping pattern.

The 3rd factor which mostly affects the farmers preference is the credit facilities. Fertilizers are sold to the farmers at subsidized rates which are fixed by the government and credit facilities or loaning from the dealer shops is prevalent. 4th and 5th ranks are the soil type and brand image of the fertilizer company which have a substantial effect on farmers preference. The brand which is very well known among the farmers is the one which the farmer buys. The reasons for the brand image could be company run campaigns, melas, exhibitions *etc.*

Table 4.33 Ranks of the factors which influence farmer's preference for fertilizers

S. No	Reasons	Kerala (N=60)			Telangana (N= 60)		
		No of farmers	Percentage of farmers	Rank	No of farmers	Percentage of farmers	Rank
1	Cost of fertilizers	36	60	9	45	75	6
2	Availability in villages	51	85	4	44	73.34	7
3	Brand image	45	75	7	50	83.34	5
4	Influence of fellow farmers	55	91.67	1	57	95	1
5	Promotional activities	34	56.67	10	38	63.34	9
6	Cropping pattern	50	83.34	5	55	91.67	2
7	Credit facilities	40	66.67	8	53	88.34	3
8	Size of bag	47	78.34	6	30	50	10
9	Fertilizer composition	52	86.67	3	41	68.34	8
10	Soil type	53	88.34	2	52	86.67	4
11	Storability	26	43.34	11	25	41.67	12
12	Packaging	25	41.67	12	30	50	11
13	New products	15	25	13	24	40	13

The 6^{th} and 7^{th} ranks are the cost of the fertilizers and availability of fertilizers in villages. Fertilizer composition is ranked 8th as the farmers are not well educated to know the composition of a particular fertilizer. At the 10th and 11th rank are the size and storability of bag respectively which influence the farmers preference for fertilizers. This is followed by the packaging of the fertilizers which was agreed upon by 25 respondents. The last was the new products in the markets with a mere 15 respondents who agreed to it.

4.3.5 Constraints encountered by farmers while purchasing fertilizers

A comparison of the constraints faced by the farmers in the two states has been given in Table 4.34. Garrett ranking method was used to rank the constraints. In both the states lack of clarity on composition and application was the major constraint. This was followed by lack of subsidies and insufficient credit in the study area in Telangana. Credit is one of the major factors which determines the quantity of input a farmer can purchase. Fertilizers are a costly input and require more credit.

Table 4.34 Constraints encountered by farmers while purchasing fertilizers

S. No	Constraints	Kerala		Telangana	
		Garrett score	Rank	Garrett score	Rank
1	Insufficient Credit	62.93	3	62.74	3
2	Lack of clarity on composition and application	77.13	1	78.6	1
3	Access to outlets	33.95	7	24.7	8
4	Problem of hoarding	44.90	5	49.6	4
5	Timely availability	67.93	2	40.8	6
6	Government policies	26.45	8	44.9	5
7	Lack of subsidies	40.65	6	66.67	2
8	Price volatility	47.05	4	33	7

Most of the farmers in Telangana avail loans from commercial banks and only a small percentage of farmers get loans from co-operative banks. Farmers who avail loans from PACS have a fairer chance of getting fertilizers through it. In order to get a higher price, the distributors and dealers of fertilizers in the state create artificial shortages which is also a constraint for the farmers. In Kerala timely availability and insufficient credit are also constraints for the farmers while procuring fertilizers. Availability of fertilizers is the prime requirement for the farmers. Price of the fertilizers is also a challenging factor for the farmers of the study area.

4.4 Marketing systems in Kerala and Telangana

4.4.1 Marketing of fertilizers in India

Government regulations have monitored fertilizer marketing in India for a long time. Fertilizers are governed by the Essential Commodities Act (ECA) and the Fertilizer Control Order (FCO). Under these laws, fertilizer can only be sold under a generic name, not a trade or commercial name. The "Central Fertilizer Pool" was founded by the Indian government in 1944 as the official organisation for the disbursement of all available fertilizers at reasonable costs all through the country. All fertilizers, whether manufactured domestically or imported, were collected and disbursed by state agencies. Manufacturers were given permission to sell 50 per cent of their output in 1966.

Domestic producers had been given unlimited marketing freedom by 1969. This, however, was only temporary. Potash marketing was previously managed solely by a single government organisation, IPSA - Indian Potash Supply Agency, in which the largest fertilizer importers were stockholders. Domestic producers (of nitrogen and mixed fertilizers) were confined to regional markets, while IPSA was the only fertilizer business allowed to maintain a countrywide distribution system. IPSA was renamed IPL (Indian Potash Limited) in the 1970s. Apart from IPL, the companies participating in the potassium fertilizer market are a mix of state-owned and private businesses.

Due to fertilizer shortages in the early 1970s, the government passed the Fertilizer Movement Control Order in 1973, putting government control over fertilizer supply. The Essential Commodities Act regulated the supply and distribution of fertilizers in the mid-1970s (ECA). The Retention Price Scheme (RPS) was established in 1977 to balance the consistent sale price with the varied manufacturing costs among factories. The government supported investment in the fertilizer industry by guaranteeing a 12 per cent post-tax return on net worth to fertilizer makers.

A supply plan was devised by the government in which manufacturers were assigned a particular quantity of fertilizers for a state. During the two farming seasons, kharif and rabi, all fertilizers were distributed by the manufacturers according to their ECA allocation. This system was in place until August 1992. All P and K fertilizers were then deregulated. ammonium sulphate, ammonium chloride, and ammonium nitrate were also deregulated. All of these fertilizers were not subjected to distribution restrictions. Only the urea quantity remained under control. The government enacted the "New Fertilizer Policy" on April 1, 2003, allowing urea makers to sell 50 per cent of their production outside of the distribution control system. Based on the recommendations of the Planning Commission's Soumithra Chaudhary panel, a nutrient-based subsidy (NBS) system for fertilizers was established in 2010. The fundamental goal of the NBS is to tie subsidies to the mix of nutrients rather than specific commodities.

4.4.1.1 Nutrient Based Subsidy Policy

The Nutrient Based Subsidy Policy (NBS) was implemented by the Government of India *w.e.f* 1st April 2010. This programme provides a fixed subsidy on fertilizers (excluding urea) based on the nutrient content. After intimation by the Department of Fertilizers, Government of India, fertilizer firms will decide the MRPs of fertilizer products based on the cost of raw materials / finished goods (FGs) in the worldwide market. The state government has a limited role in determining fertilizer MRPs. Subsidies are available for the fertilizers having key nutrients N, P, K, and Sulphur (S). (The per kg subsidy fixed by the Department of Fertilizers, Government of India, is N- ₹ 18.789/-, P- ₹ 45.323/-, K- ₹ 10.116/-, S- ₹ 2.374/- for the year 2020-21, which was also extended for the year 2021-22). Fertilizers containing other secondary and micronutrients receive a per-ton subsidy. This is to encourage the usage of fertilizers in a balanced manner. Boron has an additional subsidy of ₹ 300 per MT, while Zinc has an additional subsidy of ₹ 500 per MT.

4.4.1.2 Sale of Fertilizers

State governments forecast the need for subsidised fertilizers to the Department of Agriculture and Farmers Welfare, which then collaborates with the Department of Fertilizers to finalise the country's fertilizer requirements. To meet the demand for fertilizers forecasted by DAC&FW, the Department of Fertilizers (Movement Wing) produces an approved monthly supply plan in conjunction with manufacturers and importers. The Department of Fertilizers makes and monitors fertilizer availability at the state level according to the supply plan; concerned state governments are responsible for managing intra-state distribution.

In the 2016-17 fiscal year, the Direct Benefit Transfer (DBT) fertilizer subsidy mechanism was piloted in 19 districts in India. From September 2017 to March 2018, the DBT system was rolled out in phases throughout all States and Union Territories.

Through the fertilizer DBT system, fertilizer businesses receive a 100 per cent subsidy on various fertilizer grades based on actual sales made by retailers to the beneficiaries. All subsidised fertilizers are sold to farmers/buyers through Point of Sale (PoS) devices installed in each retailer shop, with beneficiaries identifiable using Aadhaar Cards, KCCs, and Voter Identity Cards, among other methods. According to the Standing Committee on Chemicals & Fertilizers, 2020-21, there are approximately 2.26 lakh retail outlets in India. Dealers must sell subsidised fertilizers through PoS devices under the Aadhaar enabled Fertilizers Distribution System (AeFDS). The web-based Integrated Fertilizer Management System keeps track of fertilizer sales (iFMS).

The degree of fertilizer diversion for non-agricultural use has yet to be determined. To meet peak season needs, agriculture departments in all states and union territories have been encouraged to choose retail locations where a high influx of farmers is anticipated during the season. State governments have been encouraged to set up numerous sale counters with multiple point-of-sale devices at such retail establishments so that big crowds can be handled smoothly without causing any trouble to farmers or retailers.

Fertilizer manufacturers are clearly instructed to print the Maximum Retail Prices (MRP) as well as any applicable subsidies on the fertilizer bags. Any sale that exceeds the printed MRP is illegal under the EC Act. The item is to be thoroughly monitored by all Fertilizer Inspectors. The "Integrated Fertilizer Monitoring System (iFMS), (Formerly mFMS)" continues to track fertilizer distribution and mobility, as well as finished fertilizer imports, fertilizer inputs, and indigenous fertilizer output in India.

Table 4.35 State-wise number of PoS deployed

Sl. No.	State /UT	No of PoS Devices Deployed
1	Andhra Pradesh	9311
2	Telangana	7854
3	Odisha	10556
4	West Bengal	23269
5	Delhi	58
6	Himachal Pradesh	2050
7	Chhattisgarh	3987
8	Jammu and Kashmir	3421
9	Punjab	8451
10	Bihar	20274
11	Madhya Pradesh	10265
12	Uttarakhand	936
13	Jharkhand	3554
14	Uttar Pradesh	46759
15	Karnataka	9830
16	Rajasthan	11044
17	Andaman & Nicobar	15
18	Puducherry	94

19	Tamil Nadu	11692
20	Daman & Diu	1
21	Dadar& Nagar Haveli	1
22	Gujarat	8916
23	Maharashtra	23774
24	Kerala	2587
25	Haryana	6170
26	Assam	1067
27	Manipur	35
28	Mizoram	13
29	Nagaland	4
30	Tripura	155
31	Goa	46
Total		226189

Source: Study of System of Fertilizer Subsidy, Department of Fertilizers 2019-20

Integrated Fertilizer Monitoring System (iFMS)

The Department of Fertilizers has deployed the iFMS (Integrated Fertilizer Monitoring System) to track mobility and accessibility and availability throughout the Distribution Chain, from the manufacturing unit/port to the dealer end. In the current iFMS database, there are 173 fertilizer manufacturers, 24,965 wholesalers, and 2,21,629 retailers (Standing Committee on Chemicals & Fertilizers, 2020-21).

Objectives:

- The iFMS (Integrated Fertilizer Monitoring System) is designed to track fertilizer transfer from the corporation to warehouses, distributors, and dealers.
- The technology will aid in the tracking of Fertilizer consignments as well as their stock levels at multiple warehouses, distributors, and dealers.

- The system will also serve as a tool for government agencies to track and ensure that fertilizers are sent to farmers on schedule.
- It provides a bird's eye perspective of fertilizer availability by product and district at the district, state, and national levels. This is a programme that the Department of Finance uses to keep track of fertilizer supply in the country on a regular basis.

4.4.1.3 Major Fertilizer companies

The fertilizer industry consists of many players. Some of the major fertilizer players are included below:

Public sector companies

1. National Fertilizers Limited (NFL)
2. The Fertilizers and Chemicals Travancore Limited (FACT)
3. Madras Fertilizers Limited (MFL)
4. Hindustan Fertilizer Corporation Limited (HFCL)
5. Rashtriya Chemicals and Fertilizers Limited (RCF)
6. The Fertilizer Corporation of India Ltd

Cooperative sector companies

1. Indian Farmers Fertilizer Cooperative Limited (IFFCO)
2. Krishak Bharati Cooperative Limited (KRIBHCO)

Private sector companies

1. Coromandal International Limited (CFL)
2. Nagarjuna Fertilizers and Chemicals Limited (NFCL)
3. Brahmaputra Valley Fertilizers Corporation Limited (BVFCL)
4. Zuari Industries Limited (ZIL)
5. Chambal Fertilizers & Chemicals
6. Gujarat Narmada Valley Fertilizer and Chemicals Limited
7. Southern Petrochemicals Industries Corporation (SPIC)
8. Gujarat State Fertilizers & Chemicals Limited (GSFC)
9. Mangalore Chemicals & Fertilizers Limited
10. Paradeep Phosphates Limited

4.4.1.4 Fertilizer products and their prices

Fertilizer companies manufacture a wide range of fertilizer products that are mostly grouped under three headings: straight, complex and mixed fertilizers**.** Straight fertilizers contain only one main plant nutrient, such as nitrogen, phosphorus, or potassium. Urea, ammonium sulphate, potassium chloride, and potassium sulphate are a few examples. Two or three primary plant nutrients are present in complex fertilizers, with two of the primary nutrients in chemical combination. The most common type of these fertilizers is found in granular form. Diammonium phosphate, nitro phosphates, and ammonium phosphate are a few examples. Physical mixes of straight fertilizers are known as mixed fertilizers. They have two or three major plant nutrients in them. The materials are fully mixed, either mechanically or manually, to create mixed fertilizers.

Table 4.36 Price of fertilizers of IFFCO, KRIBHCO and FACT

S. No	Product	Company		
		IFFCO	KRIBHCO	FACT
1	Neem Coated Urea	266.5	266.5	-
2	DAP (18-46-00)	1200	1180	-
3	NP (20-20-0-13)	1150	1150	1325.00
4	NPK-I (10:26:26)	1175	-	-
5	NPK-II (12:32:16)	1185	-	-
6	MOP (Imported)	-	-	1000

Note: Compiled from primary survey

4.4.2 Marketing channels and distribution of fertilizers in Telangana and Kerala

The fertilizer industry in India features a historically significant cooperative sector, as well as public and private firms. All sectors are involved in fertilizer distribution, as well as other connected activities such as providing finance for rural agriculture activities. Indian fertilizer businesses both produce and sell imported fertilizers through their wholesale dealer networks spanning across numerous districts and states. Farmers purchase their goods from stores in rural areas. Farmers rely on locally available fertilizers from cooperative banks and other financial organisations, government initiatives, and retailers themselves to fund agricultural inputs.

Marketing channels are critical to the marketing system's overall effectiveness. It is a system of interconnected activities that transports a product from its point of manufacture to the end customer. Unless the correct product is made available at the right location, at the correct time, in the right amount, and at the right price, no selling strategy, promotion, or sales activity will be effective. A myriad of channels, marketing functionaries, and interactions are all part of the distribution system. As a result, selecting the appropriate distribution channel is critical for producers. One of the most crucial choices a farmer can make is which marketing channel to choose, as it has a huge impact on farm profitability. Farmers may be able to optimise profit while limiting risk by using marketing channels to establish distinct value chains and input costs. The market for fertilizer distribution in Telangana and Kerala has been discussed below.

4.4.2.1 Fertilizer distribution channels in Kerala

Fertilizer distribution in Kerala is mainly through cooperatives. For field crops such as paddy, which is cultivated in a group farming basis, major agricultural operations are done collectively. The distribution of fertilizers is through cooperative banks and other inputs like seed is through the Krishi Bhavans.

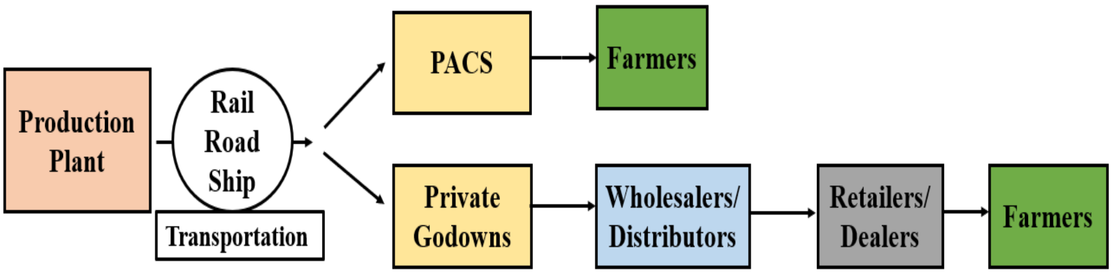


Fig 4.29 Fertilizer distribution channels in Kerala

The cooperative societies such as Primary Agricultural Co-operative Society (PACS) procure the fertilizers from the fertilizer companies. They have a direct link to the fertilizer companies which supply them in bulk. The PACS have the list of the Padashekara Samitis in a particular panchayat and supply the fertilizers to each Samiti. Fertilizer permit system issued by the agricultural officer was practised in Kerala through the group farming samitis till 2016-17. While the DBT system was introduced, the fertilizer permit system was done away with as the subsidy had to be credited to the individual beneficiary account but only the PACS followed it in the initial years. Gradually on the insistence of strict compliance of DBT and PoS system, it was adopted by the private dealers also. Though, it has resulted in minimizing the double subsidy benefit, it has also acted as a limiting factor in incorporating fertilizer inputs support to farmers through group approach in paddy cultivation.

The second channel in Kerala is through wholesalers and retailers. From the private godowns it goes to the wholesalers, which is then procured by the retailers and then supplied to the farmers. There also exists another marketing channel which is mostly seen in plantation crops. The fertilizer companies have agents who directly contact the farmers and supply fertilizers to them.

4.4.2.2 Fertilizer distribution channels in Telangana

The distribution of fertilizers in Telangana is mainly through two channels. One is through the cooperative sector and the other is through the dealers. The Agriculture Department employs a wide range of personnel to carry out numerous programmes aimed at harmonising agricultural production and productivity, as well as providing technical, monitoring, and material assistance to farmers. Facilities include soil testing, seed, fertilizer, and pesticide testing, as well as a farmers training centre. The distribution of urea is always on a 50:50 ratio, 50 per cent through the cooperative and 50 per cent through the private dealer networks.

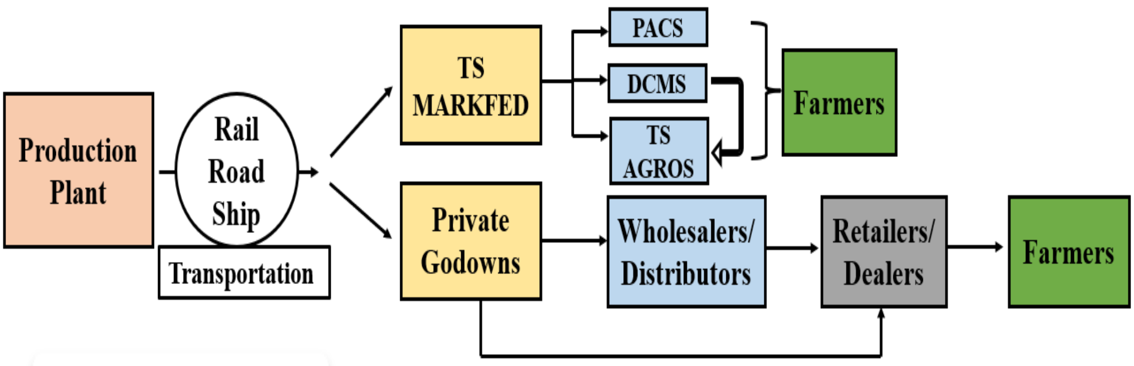


Fig 4.30 Fertilizer distribution channels in Telangana

The marketing channels in Telangana can be categorised into two main channels. One is through the TS MARKFED (Telangana State MARKFED) which acts as an apex institute. The TS MARKFED has around 552 cooperatives in Telangana. It acts as a nodal agency for the procurement and disbursement of fertilizers to the farmers through DCMS, PACS and through the TS AGROS. MARKFED has been allowed to borrow money from banks to purchase fertilizers, with the government agreeing to repay the interest on a quarterly basis. The government has also offered to reimburse MARKFED for unexpected expenses like storage, warehousing, insurance, and transit. From 2008-09 to 2017-18, MARKFED has supplied over 52.68 lakh MT of urea, DAP, and complexes, to farmers through cooperative societies, ensuring fertilizer availability across the State and avoiding any difficulty for producers (TS MARKFED website). Buffer stocks are a reliable source of fertilizer for the state in times of need. The government has designated TS MARKFED as the agency for maintaining 5.00 LMT (4.00 LMT urea + 0.30 LMT DAP + 0.70 LMT complexes) of fertilizer buffers in the state for the years 2021-22 in order to ensure that supplies are available to farmers through societies at MRPs. TS MARKFED has been given the task of maintaining buffers at district headquarters in order to enable timely fertilizer delivery to farmers. (Agriculture Action Plan- 2019-20, GoT)

The MARKFED supplies fertilizers to the farmers through 3 institutions. They are District Cooperative Marketing Society (DCMS), Primary Agricultural Co-operative Society (PACS) and the Telangana State Agro Industries Development Corporation Limited (TSAIDCL) or TS AGROS. The DCMS are the marketing societies which have their outlets present in various villages. The PACS are another very important institution which not only distributes fertilizers to the farmers but also other inputs such as seeds, pesticides, machinery *etc*. The TS AGROS main goal is to sell, buy, export, import all agricultural implements, machinery, fertilizers, pesticides *etc*. The TS AGROS sells all inputs through the Agro Rythu Seva Kendra (ARSK) which are present throughout the state. The DCMS also supplies to the TS AGROS when there is a shortage in the fertilizer supply. The cooperative system in Telangana works as an interconnected network.

The second channel is through the Private wholesalers and retailers. The fertilizer plants send their products to the various private godown present in the state. The wholesale distributors purchase the fertilizers and have to pay the loading, unloading charges and also the transportation charges. From the wholesalers it is sent to the fertilizer dealers who have their outlets present in various villages, towns. The farmer then purchases the fertilizers from the retailers. Sometimes, the retail shops also procure fertilizers from the private godown directly and sell it to the farmers. In the study area, most of the farmers buy fertilizers via the second channel. So, it is suggested that the cooperative sector should strengthen its domain.

4.4.2.3 Sale proceeds of fertilizers in Kerala and Telangana- 2017-18

Table 4.37 Availability and sales of fertilizers in Kerala and Telangana

('000 tonnes)

S. No	Fertilizer	Kerala		Telangana	
		Availability	Sales	Availability	Sales
1	Urea	1.98	1.33	26.55	14
2	DAP	0.77	0.31	5.56	2.52
3	MOP	2.07	1.04	3.64	2.07
4	NPK	3.03	1.16	25.01	10.15

Source: Fertilizer Scenario, 2018-19

Table 4.38 Sales in Nalgonda (study area) for the year 2020-21

('000 tonnes)

District	Urea			DAP			Complex		
	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total
Nalgonda	75064	54833	129897	10425	5581	16007	91583	50825	142408

Source: Agriculture Action Plan- 2019-20, GoT

According to the Fertilizer Scenario 2018-19, the stock and sales in both the states have been given in Table 4.37. The stock and sales in Telangana are higher compared to that of Kerala. The availability of potassic fertilizers is more in Kerala.

Urea is the fertilizer which is used in large quantities in Telangana. The per ha use of fertilizers is more in Telangana when compared to Kerala.

4.4.2.4 Production of Biofertilizers

According to FAO, A biofertilizer is a natural fertilizer that helps to provide all the nutrients required by the plants and to increase the quality of the soil with a natural microorganism environment. Bio-fertilizers are those microorganisms that help in the fixation of atmospheric nitrogen or solubilising phosphorus and helping in plant growth. They also aid in improving the soil health. The production of bio-fertilizers in the two states is shown in Table 4.39.

Table 4.39 Biofertilizer production in Kerala and Telangana (‘000 tonnes)

	Kerala	**Telangana**
Production of bio-fertilizers	6040.10	574.15

Source: Fertilizer Scenario, 2018-19

One of the major drawbacks is that the application of bio-fertilizers provides the soil with less nutrients compared to that of chemical fertilizers. Also, they are plant specific and therefore their application is difficult. What works for one crop doesn’t work for another. The production in Kerala for the year 2018-19 was 60.40 million tonnes as the government promotes organic farming under its good agricultural practices (GAP) agenda. It was also higher compared to the production in Telangana (5.74 million tonnes).

4.5 SWOC analysis of IFFCO

4.5.1 Public sector fertilizer companies in India

The ever-changing field of agriculture provides new platforms for various developments. In such a scenario, cooperatives enable the farmers to control new shortcomings and also provide channels for acquiring inputs. Individually, a farmer has limited impact, but when a group of farmers unite together for a common goal, they may raise market prices for farm products, bring value to agricultural services, and enhance the quality of various inputs purchased by the farmers. Cooperatives minimise supply costs by offering lower-cost products and services to their members, lowering the average market price as a result of price changes in other organisations. Fertilizer co-operatives play a very significant role in providing the farmers with reasonably priced inputs and therefore are an important aspect in the fertilizer industry. India has two major fertilizer cooperatives *i.e.*, IFFCO and KRIBHCO which are the country's leading fertilizer companies. A brief introduction about the two companies as well as FACT, a public fertilizer institution is given below.

Indian Farmers Fertilizer Cooperative Limited (IFFCO)

The Indian Farmers Fertilizer Cooperative Limited, popularly known as IFFCO, is a multi-state cooperative society in India, that manufactures and markets fertilizers. With about 35,000 member cooperatives touching over 50 million Indian farmers, it was founded in 1967 with 57 member cooperatives and is now one of the world's largest co-operatives. IFFCO is also one of India's largest fertilizer companies. The fertilizers manufactured are marketed through a network of cooperatives. In the year 2019-20, 42 per cent of the fertilizers were marketed via the co-operative societies and 28 per cent was sold via state Marketing Federations. IFFCO also has a chain of retail stores (IFFDC) through which 16 per cent of materials was sold. Apart from this, IFFCO e-bazaars centres (7%), Farmers Service Centres run by IFFCO (3%), Associate members (2%) and others (2%) were also involved in the selling of the fertilizers. During the year 2019-20, maximum fertilizer dispatched was through the rails (90 %) and a mere 9 per cent and 1 per cent by road and sea respectively.

Its vision is to increase farmers' incremental income by assisting them in increasing crop productivity through the balanced use of energy efficient fertilizers; to maintain environmental health; and to build economically and democratically strong cooperative societies to provide professional services to the farming community in order to ensure an empowered rural India. IFFCO's mission is to allow Indian farmers to succeed through timely supply of trustworthy, high-quality agricultural supplies and services in an environmentally friendly way, and to undertake additional initiatives to improve their welfare. Few of its agendas include, providing farmers with high-quality fertilizers at the proper time and in sufficient quantities in order to boost crop output. It also focuses on making plants more energy efficient and reviewing various energy conservation techniques on a regular basis. Also, commitment to raising the standard of living in the community by focusing on health, safety, environment, and forestry development is a part of its mission

In total there are 5 production units of IFFCO. They are present in Kalol, Kandla, Phulpur, Aonla and Paradeep. A wide range of products are manufactured by these plants. Few of them are urea, DAP, NPK, NP. Biofertilizers and secondary micronutrients are also produced. To tackle the imbalanced and excess use of conventional urea, IFFCO developed a nanotechnology-based Nano Urea (Liquid) fertilizer. Through a proprietary patented method, this nanofertilizer was produced for the first time in the world at IFFCO - Nano Biotechnology Research Centre (NBRC) Kalol, Gujarat. A plant growth promoter called Sagarika has also been developed. Sagarika is a growth-promoting substance made from red and brown algal sap and based on seaweed extract (28 percent w/w). Sagarika is a metabolic bio stimulant that encourages plants to grow and develop within. It includes minerals, vitamins, plant growth hormones such as auxin, cytokinin, and gibberellins, as well as betaines and mannitol.

Apart from these, IFFCO has several subsidiaries and associations. Few of them are IFFCO-Tokyo General Insurance Company Limited, which is one of the top insurance companies in India. The IFFCO Kisan is another service-oriented initiative. IFFCO has the highest share of 33.99 per cent in Indian Potash Limited, another fertilizer company which trades potassic, phosphatic fertilizers. Oman Indian Fertilizer Company (OMIFCO) is another such joint venture in which IFFCO has a 25 per cent equity stake.

Krishak Bharati Cooperative Limited (KRIBHCO)

Krishak Bharati Cooperative Limited (KRIBHCO) is a leading national-level Indian cooperative society that produces and distributes fertilizer and is governed by the Multi State Cooperative Societies (MSCS) Act of 2002. KRIBHCO was established in April 1980 with the mission of manufacturing and distributing high-quality agricultural inputs, mostly chemical fertilizers, through cooperatives and institutional organisations. 9478 cooperative societies from across the country contributed to

KRIBHCO's paid-up share capital. KRIBHCO is committed to maintaining its cooperative philosophy and heritage while embracing technology to better serve the country.

The production site of KRIBHCO is in Hazira, Gujarat, and the production facility of its wholly-owned subsidiary KRIBHCO Fertilizers Limited (KFL) is in Shahjahanpur, Uttar Pradesh. The production facility of Oman India Fertilizer Company S.O.A.C. (OMIFCO), a joint venture of KRIBHCO, is located in SUR, Oman. Apart from fertilizer production, the society also trades and distributes bulk fertilizers such as DAP, NPK, and MOP. Urea, DAP, NPK, MOP, SSP, Zinc Sulphate, Bio-Fertilizers, Seeds, Compost, Hybrid Seeds, BT Cotton, and other products are among KRIBHCO's offerings. These products are distributed by KRIBHCO through its distribution channels in cooperatives and commercial retails and also through its outlets called KBSK's.

Its vision is to become a global association that serves farmers and maximises their returns through specialisation in agricultural inputs, rural need-based goods, and other dynamic businesses that maximise stakeholders' value. Its purpose is to serve as an accelerator for agriculture and rural development by identifying, financing, and administering projects that are both socially and economically beneficial. Its goals include strengthening the cooperative system, expanding urea installed capacity and market share, maximising the use of existing equipment and gear, and diversifying into other vital areas like as energy, port, and infrastructures *etc*.

The Fertilizers and Chemicals Travancore Limited (FACT)

The Fertilizers and Chemicals Travancore Limited (FACT) was founded in 1943 in Udyogamandal, Kochi, Kerala, as India's first large-scale fertilizer plant. FACT began manufacturing in 1947. FACT began as a private corporation, sponsored by M/s. Seshasayee Brothers, but in 1960 it became a public company, with the Government of India becoming a largest shareholder in 1962. The Department of Fertilizers, Ministry of Chemicals and Fertilizers, Government of India, is in charge of FACT's administration.

FACT has grown and diversified from its humble beginnings into a multidivisional organisation with a wide range of activities. Till 1972, the parent division at Udyogamandal went through four rounds of growth, updating technology and expanding output. FACT formed an Engineering & Consultancy wing, FEDO, in the 1960s, in response to the need to build domestic capacities for the design and construction of Chemical and Fertilizer Plants (FACT Engineering & Design Organisation). In 1966, the Fabrication Division FEW (FACT Engineering Works) was founded. The Cochin Division was established in two stages at the BPCL-Kochi Refineries in Ambalamedu. Phase I included the Ammonia-Urea Complex, which was completed in 1973, and Phase II, which included the Sulphuric Acid, Phosphoric Acid, and Complex Fertilizer Plant, which was completed in 1976-78. During 1990-91, FACT grew further by establishing the Petrochemical Division at Udyogamandal for the manufacturing of Caprolactam, diversifying into the then-burgeoning Petrochemical industry. The new ammonia plant, built at a cost of Rs.638 crore and commissioned in March 1998, was built near Udyogamandal.

The Company's authorised share capital is 100 crore equity shares with a face value of ten rupees each (1000 crore). The total share capital issued and subscribed is Rs.647.07 crore. FACT has had its highs and lows on its way to become one of the country's largest fertilizer firms and an enthusiastic exemplar of the public sector's triumph. There are several products which are manufactured by FACT and few of them are complex fertilizers such as Factamfos, FACT aluminium sulphate, FACT MOP which is imported. Organic and bio-fertilizers are also manufactured. Additionally, FACT gypsum is also produced as a by-product.

4.5.2 Strengths, weaknesses, opportunities and challenges of IFFCO

Strengths

- IFFCO is one of the largest producers of fertilizers in India with a total production of 89.58 Lakh MT in the year 2020-21.
- The Indian Farmers Fertilizer Cooperative Limited (IFFCO) is one of India's largest cooperative societies, with Indian cooperatives owning 100 per cent of the company. Presently it has over 35,282 co-operatives members under its domain.
- There are in total five production units which cater to the needs of the 55 million farmers in India and their production capacity is more than 100 per cent.

- Large network of marketing and distribution because of a greater number of co-operatives involved.
- Large number of IFFCO state offices are present in India and hence widespread availability of fertilizers is observed.
- The IFFCO iMandi was created with the goal of bringing modern retail and information to rural India by integrating the technology and expertise to provide benefits to consumers in the Indian countryside.
- IFFCO has broad-banded its business operations beyond fertilizers to include areas such as general insurance, rural telephony, foreign trade, pesticides and even rural e-commerce. These actions prove to be game changing propelling IFFCO into a new era.
- With joint ventures such as JIFCO in Jordan, KIT in Dubai, OMIFCO in Oman, ICS in Senegal, and IFFCO CANADA in Canada, IFFCO has a global effect. This helps in partnerships with global raw material suppliers and also international fertilizer players.
- Formalising fundamental principles and fostering a culture of teamwork, empowerment, and creativity that will aid in employee growth and enable the fulfilment of strategic goals.
- Making work a fascinating and challenging experience for stakeholders and fostering a culture of trust, transparency, and shared care.
- Obtaining low-cost raw materials for the production of phosphatic fertilizers by forming joint ventures outside of India.
- Ensuring that both core (fertilizers) and non-core (other application) industries grow.

Weakness

- The presence of co-operatives induces a bureaucratic setup in the company.
- Lesser productivity in terms of operations due to many sub-divisions.
- Due to rigid organizational structure decision making is slow.
- Penetration into rural area is less.
- Awareness of various IFFCO products among farmers shows a lower-water mark.
- Slow feedback to the changing needs of the farmers.

Opportunities

- Increasing the installation capacity and opening new plants in different locations.
- Making the present plants more energy efficient, and assess various energy-saving measures on a regular basis.
- Venturing into hydro-electric power generation.
- Bringing new biodegradable products into markets such as bio-fertilizers, bio-pesticide, bio-herbicides and seeds and promoting them.
- Creating value-addition to agri-products and providing markets for the same.
- Provision of financial support to the farmers by means of banking services and paperless transactions.
- Bringing traditional and IT induced agricultural practices under the same roof and aiding in promoting it.
- Institutionalising new retail chains in rural and semi-urban areas.
- New channels for distribution of fertilizers to the co-operative banks and directly to the farmers.
- Addressing the country's need for a sustainable change in the application of conventional fertilizers.
- Understanding, integrating, and adopting technologies that are trustworthy, efficient, and cost-effective.
- Establishing agro-processing units and agro-chemicals projects, as well as the development of novel fertilizer products.
- Expansion in e-commerce, as well as the promotion of venture capital projects.
- Setting up new strategic partnerships for increasing fertilizer export and imports.
- Establishing financial sustainability through a credit rating agency for cooperative societies.
- Strengthening Integrated Nutrient Management (INM) practicing and therefore improving fertilizer efficiency.
- Forward/Backward Integrations for Core Business synergies.

Challenges

- Competition from various other fertilizer companies like KRIBHCO and other private companies.

- Government regulations
- Highly competitive domestic and global markets.
- Maintaining the environmental health.
- Fluctuations in the international price for exports and imports.
- Making co-operative societies commercially and democratically robust in order to provide services to the farming community.
- Manufacturing quality products.

SUMMARY

Chapter V

SUMMARY

Chemical fertilizer is one of the key elements which has helped India reach self-sufficiency in food grain production. It has played a significant role in increasing agricultural productivity. After the green revolution, a boost in the consumption of chemical fertilizers has been noticed. In the 1970s and 1980s, an increase in both food grain production due to use of HYVs and high chemical fertilizer usage was observed. In order to sustain the increasing population accompanied by very limited arable land, only way for enhancing production is the application of chemical fertilizers.

The Government of India has constantly devised policies to promote domestic production of fertilizers so that there is higher supply of fertilizers and also usage. Fertilizer output and use have expanded dramatically during the previous seven decades. With the exception of MOP, India had reached near-self-sufficiency in urea and DAP, allowing it to meet their requirements through indigenous industry. During the post-reform period new policies were implemented and an increase in the fertilizer use has been noticed.

Secondary data was collected from the Fertilizer Association of India (FAI) regarding the fertilizer production, consumption as well as imports. Compound Annual Growth rates were carried out after dividing the whole data set into three periods: pre-green revolution, post-green revolution and the post-reform period. The results indicated that during the pre-green revolution period high growth rates are obtained. The main reason for this is the low rates of consumption during the base year. During the post-green revolution period, the growth rates show an increase in certain periods because of the higher consumption of nitrogenous and phosphatic fertilizers. During this period higher rates of imports in the country are also noticed. In the post-reform period, a decline in the growth rates is seen. During this time many fertilizer reforms were seen and policies were reconstructed. Following the changes, policies were enacted to encourage the sector to become more efficient. The 1991 economic reforms were India's first significant attempt at fertilizer reform, and they laid the groundwork for significant economic changes in the industry. This led to the deregulation of the prices of phosphatic and potassic fertilizers and the use got reduced. Following this, an imbalance in the N, P, K usage was observed.

The fertilizer production in India is mainly concentrated in the private sector followed by cooperative and public sectors companies. The production has been increasing at a very rapid rate due to increase in the number of fertilizer plants and higher efficiencies of the plants. The consumption on the other hand has also been increasing after the introduction of the high yielding varieties during the green revolution. A growth rate of 17.72 per cent was seen in the consumption of nitrogenous fertilizers during the pre-green revolution period. The growth rates were also very high for phosphatic and potassic fertilizers (26.6 % and 21.33 %). During the post-green revolution period a decrease in the growth rates is observed (N- 9.01 %, P- 10.3 and K- 8.81 %). The post-reform period witnessed very low growth because of the increase in the policies. Gap Assessment of the growth rates of the domestic production and consumption yielded considerable results. It is observed that in the post-green revolution period as the production was higher than the consumption, a positive gap or excess of fertilizer is noticed in the country. Coming to the post-reform period deficit in all the three major chemical fertilizers have been noticed.

Forecasting of the production and consumption of fertilizers was also carried out for the years from 2020-21 to 2025-26. In order to know whether such a huge data set is correctly abled to forecast the values, validation was done. Training period from 1965-66 to 2014-15 and 1950-51 to 2014-15 was selected for forecasting the production and consumption of fertilizers respectively. The expert modeler in SPSS chose the Holt's exponential smoothing model for forecasting the values of the training period. After the validation, comparison between the actual and predicted values from the year 2015-16 to 2019-20 was done. The results of the Holt's exponential smoothing model show that the production and consumption of N, P and total fertilizers show an increasing trend. The consumption of K fertilizers was forecasted using the simple model and it shows a stagnant growth because the bulk of potassic fertilizers are imported.

To know the consumption of fertilizers and its relation with the yield, primary survey was conducted in two states of south India *i.e.*, Kerala and Telangana wherein two districts that is Palakkad and Nalgonda were purposively selected. 60 respondents each were randomly selected from two panchayats of each district. The total sample size was 120. In addition, 10 traders from each block were randomly selected. The consumption of fertilizers in Kerala and Telangana varies at a large level. In recent years a decline in fertilizer consumption is noticed in Kerala. The reason is the decrease in the agricultural land in the state. In the state of Telangana, very high use of fertilizers is noticed. It is one of the states of India whose per ha consumption of fertilizers is highest (206.52 kg/ha).

Distinctive difference could be noticed among the respondents from the two states. Age is one of most important factors which determines a person's ability to understand things. In both the states maximum number of respondents belonged to the age group of 31-50 years. Also, it was noticed that 23.33 per cent of the respondents belonged to the category of < 30 years. This indicated that youth are also engaged in paddy farming. In both the states, more or less equal distribution was seen in the number of males and females involved in rice cultivation. The land-area wise distribution of the respondents showed that the land holding size of farmers of Telangana was more compared to that of Kerala. Most of the farmers in Kerala had a land holding in the range of 0-2 acres. The average land holding in Telangana was found to be 4.08 acres and in Kerala it was 2.8 acres. The educational level of the respondents was also studied and the findings indicated that most of the paddy farmers had low levels of education and high involvement in agriculture from childhood.

The income levels of the respondents were also studied and it was found that as the area of the farmers was less in Kerala, the income also was less. The paddy procurement price in Kerala is ₹ 2748 which is the highest in the country. In addition to paddy farming, allied agricultural activities were also taken up by the farmers in Kerala. In Telangana, the MSP of paddy is ₹ 1868. Because of the high land area holding, the farmers gained higher incomes in Telangana. Most of the farmers in Telangana had paddy farming as the sole source of income.

The procurement of seeds and fertilizers in Kerala is through the Padasekhara Samitis and Krishi Bhavans which are the village level agricultural institutes present in each panchayat. Group paddy farming is noticed and hence procurement of inputs and marketing of output is more efficient and easier in Kerala. The farmers also received more subsidies on seed and fertilizers. In Telangana, procurement of fertilizers was from the wholesale and retail shops present in the area. The paddy is marketed via the PPC (Paddy Procurement Centres) which are set up by the Government of Telangana. In both the states, a higher application of fertilizers is observed compared to the Recommended dose of Fertilizers (RDF).

To compare the fertilizer consumption and its impact on yield, a second order polynomial regression and linear regression was done and it was found that the second-order polynomial regression yields a better R-square value. An increase in the nutrient supply increases the yield to a certain level, but a further increase in the nutrient application shows a negative effect on the yield and hence to quantify this relationship, regression was studied with yield as the dependent variable and consumption of N, P, K as the independent variables and it was of the form

$$Y = b_0 + b_1 N + b_2 P + b_3 K + b_4 N^2 + b_5 P^2 + b_6 K^2 + b_7 NP + b_8 NK + b_9 PK$$

For the second-degree polynomial regression, the R square values for Kerala and Telangana were 0.947 and 0.961, respectively. This means that in Kerala and Telangana, respectively, 94.7 percent and 96.1 percent of the N, P, K values were able to show variation in the dependent variable yield.

In Kerala, the average yield in the study area was 2250 kg/acre in the autumn and 2550 kg/acre in the winter. During the Kharif season, the average actual yield in the Telangana study region was 2550 kg/acre, and during the Rabi season, it was 2850 kg/acre. Paddy is planted only twice in both study locations, with Telangana producing higher yields. Kerala's gross income was found to be ₹ 61,830 for autumn paddy and ₹ 70,074 for winter paddy. In Telangana, income obtained during kharif season was ₹ 47,634 while the rabi season it was ₹ 53,238. Because the procurement price in Kerala is greater than in Telangana, the income is higher in Kerala. Fisher’s t test was used to find out if any significant difference can be noticed between the consumption of N, P, K and yield in the two states. The results indicate that there was significant difference in the application of N, P and the yield. The potassic fertilizer application was more or less similar in both the states. The box plots showed that the consumption of nitrogenous, phosphatic and yield was higher in Telangana and the use of potassic fertilizers was higher in Kerala.

The brand preference of fertilizers by the farmers were also studied where different fertilizer companies were ranked and it was found that in Kerala FACT was the most preferred company followed by IFFCO with mean ranks 1.43 and 1.57. This was followed by IPL with a mean rank of 3.43. According to the results of the ranking, IFFCO and NFCL were the two most prominent fertilizer companies used by farmers in Telangana's rural areas. One of the key reasons for this was farmers' perceptions of the two companies, as well as their brand image. Also, the factors which influence the farmers' preference for fertilizers was examined and the results indicated that influence of fellow farmers was the factor that influences farmers' preference in both the states. This was followed by cropping pattern and credit facilities in Telangana and in Kerala soil type and fertilizer composition were ranked 2nd and 3rd. The constraints encountered by farmers while purchasing fertilizers were studied and lack of clarity and on composition and application was the major constraint which farmers face in both the states. Timely availability and insufficient credit were also identified as constraints in Kerala. In Telangana lack of subsidies and insufficient credit were found to be major constraints.

The marketing of fertilizers was studied in the two states and distribution channels of fertilizers were devised. In Kerala the distribution of fertilizers was mostly through the PACS. The PACS have links with the Krishi Bhavans in the area and fertilizers are distributed to farmers via the Padashekara Samitis. The PACS obtained the fertilizers directly from the fertilizer companies. In Telangana, two channels were identified, one, through the cooperative sector and the other, via the wholesalers and retailers. Most of the farmers availed fertilizers from the retail shops which are present in the villages. The sale of fertilizers through the cooperative structure was via Telangana state MARKFED which acts as an apex institution in distribution agricultural inputs like seed, fertilizers via the DCMS, PACS and TS AGROS. The use of bio-fertilizers in Telangana was comparatively less than that in Kerala.

The final objective was to study the strengths, weaknesses, opportunities and challenges of the leading fertilizer co-operative in India which is IFFCO. Few of its strengths included large network of marketing and distribution, high number of IFFCO state offices, joint ventures with foreign raw material suppliers *etc*. The weaknesses were rigid organisation and less awareness about the IFFCO products among the farmers. Slow feedback was also considered to be a weakness. Opportunities included increasing the installation capacity of plants and construction of new plants, making hydro-electric power generation a priority, new products in market. The challenges faced by IFFCO were high competition from various other public and private fertilizer companies, maintenance of environmental health.

Policy recommendations

1. A gap in production and consumption of fertilizer is observed in India. The deficit is covered by imports and the domestic production of fertilizers relies mainly on imports of raw materials. The study also highlighted the availability of fertilizers to be a major constraint for farmers. Hence, for a steady supply of fertilizers, appropriate policies regarding regular imports of raw materials as well as fertilizers is to be formulated.
2. The fertilizer subsidy system in vogue India provides subsidies to the manufacturing companies as the difference between cost of production and the maximum retail price of fertilizers. Literature suggests that policies aimed at subsidies for the raw material required for production rather than final fertilizer products is the current need.
3. Over-usage of fertilizers is noticed in both the states, Kerala and Telangana and hence awareness to farmers on the use of the recommended dose of fertilizers based on soil test is needed. This would also help in reducing the cost of production.
4. The number of farmers holding Soil Health Cards (SHC) and Kisan Credit Card (KCC) is very less in the state of Telangana and hence better extension programs to improve farmer awareness about SHCs, KCCs is suggested.
5. Non-availability of fertilizers has been raised as a constraint by the farmers in Kerala. Appropriate marketing strategies for enhancing the supply of fertilizers and ensuring timely availability to farmers are to be devised.
6. Better awareness on the benefits of using advanced form of fertilizers (complex, customised and nano) may be included in the extension programs of Krishi Vigyan Kendras, Krishi Bhavans and other agricultural institutions working at the village level.

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APPENDICES

Appendix I: Trend, Level and forecast equations for the forecasting of production and consumption of N, P and total fertilizer

- **N production**

Holt's exponential smoothing model:

(Level of the series at time 't' and coefficient $\alpha = 0.905$)

$L_1 = \alpha\ Y_t + (1\text{-}\alpha)\ [\ L_{1\text{-}1} + T_{\ t\text{-}1}]$

(Trend of the series at time 't' and coefficient $\gamma = 0.003$)

$T_1 = \gamma\ [L_t – L_{t\text{-}1}] + (1\text{-}\ \gamma)\ T_{t\text{-}1}$

Forecast for k step ahead

$F_{t+1} = L_t + kT_t$

Level equation $L_1 = 1.00\ Y_t + (1\text{-}0.905)\ [\ L_{1\text{-}1} + T_{\ t\text{-}1}]$

$= 1.00\ Y_t + 0.095\ [\ L_{1\text{-}1} + T_{\ t\text{-}1}]$

Trend equation $T_1 = 0.100\ [L_t – L_{t\text{-}1}] + (1\text{-}0.003)\ T_{t\text{-}1}$

$= 0.100\ [L_t – L_{t\text{-}1}] + (0.997)\ T_{t\text{-}1}$

Forecast equation $F_{t+1} = L_t + kT_t$

Where k = 1,2,3,4,5,6. (forecasting from 2020-21 to 2025-26)

- **P production**

Holt's exponential smoothing model:

(Level of the series at time 't' and coefficient $\alpha = 0.502$)

$L_1 = \alpha\ Y_t + (1\text{-}\alpha)\ [\ L_{1\text{-}1} + T_{\ t\text{-}1}]$

(Trend of the series at time 't' and coefficient $\gamma = 0.001$)

$T_1 = \gamma\ [L_t – L_{t\text{-}1}] + (1\text{-}\ \gamma)\ T_{t\text{-}1}$

Forecast for k step ahead

$F_{t+1} = L_t + kT_t$

Level equation $L_1 = 1.00\ Y_t + (1\text{-}0.502)\ [\ L_{1\text{-}1} + T_{\ t\text{-}1}]$

$= 1.00\ Y_t + 0.498\ [L_{1-1} + T_{t-1}]$

Trend equation $T_1 = 0.100\ [L_t – L_{t-1}] + (1-0.001)\ T_{t-1}$

$= 0.100\ [L_t – L_{t-1}] + (0.999)\ T_{t-1}$

Forecast equation $F_{t+1} = L_t + kT_t$

Where k = 1,2,3,4,5,6. (forecasting from 2020-21 to 2025-26)

- **Total fertilizer production**

Holt's exponential smoothing model:

(Level of the series at time 't' and coefficient $\alpha = 0.922$)

$L_1 = \alpha\ Y_t + (1-\alpha)\ [L_{1-1} + T_{t-1}]$

(Trend of the series at time 't' and coefficient $\gamma = 0.000$)

$T_1 = \gamma\ [L_t – L_{t-1}] + (1- \gamma)\ T_{t-1}$

Forecast for k step ahead

$F_{t+1} = L_t + kT_t$

Level equation $L_1 = 1.00\ Y_t + (1-0.922)\ [L_{1-1} + T_{t-1}]$

$= 1.00\ Y_t + (0.078)\ [L_{1-1} + T_{t-1}]$

Trend equation $T_1 = 0.100\ [L_t – L_{t-1}] + (1-0.000)\ T_{t-1}$

$= 0.100\ [L_t – L_{t-1}] + (1)\ T_{t-1}$

Forecast equation $F_{t+1} = L_t + kT_t$

Where k = 1,2,3,4,5,6. (forecasting from 2020-21 to 2025-26)

- **N consumption**

Holt's exponential smoothing model:

(Level of the series at time 't' and coefficient $\alpha = 1.000$)

$L_1 = \alpha\ Y_t + (1-\alpha)\ [L_{1-1} + T_{t-1}]$

(Trend of the series at time 't' and coefficient $\gamma = 0.100$)

$T_1 = \gamma [L_t - L_{t-1}] + (1- \gamma) T_{t-1}$

Forecast for k step ahead

$F_{t+1} = L_t + kT_t$

Level equation $L_1 = 1.00\ Y_t + (1-1.000) [L_{1-1} + T_{t-1}]$

$= 1.00\ Y_t$

Trend equation $T_1 = 0.100 [L_t - L_{t-1}] + (1-0.1000) T_{t-1}$

$= 0.100 [L_t - L_{t-1}] + (0.9) T_{t-1}$

Forecast equation $F_{t+1} = L_t + kT_t$

Where k = 1,2,3,4,5,6. (forecasting from 2020-21 to 2025-26)

- **P consumption**

Holt's exponential smoothing model:

(Level of the series at time 't' and coefficient $\alpha = 1.000$)

$L_1 = \alpha\ Y_t + (1-\alpha) [L_{1-1} + T_{t-1}]$

(Trend of the series at time 't' and coefficient $\gamma = 0.001$)

$T_1 = \gamma [L_t - L_{t-1}] + (1- \gamma) T_{t-1}$

Forecast for k step ahead $F_{t+1} = L_t + kT_t$

Level equation $L_1 = 1.00\ Y_t + (1-1.000) [L_{1-1} + T_{t-1}] = 1.00\ Y_t$

Trend equation $T_1 = 0.001 [L_t - L_{t-1}] + (1-0.001) T_{t-1}$

$= 0.001 [L_t - L_{t-1}] + (0.999) T_{t-1}$

Forecast equation $F_{t+1} = L_t + kT_t$

Where k = 1,2,3,4,5,6. (forecasting from 2020-21 to 2025-26)

- **Total fertilizers consumption**

Holt's exponential smoothing model:

(Level of the series at time 't' and coefficient $\alpha = 1.000$)

$L_1 = \alpha\ Y_t + (1\text{-}\alpha)\ [\ L_{1\text{-}1} + T\ _{t\text{-}1}]$

(Trend of the series at time 't' and coefficient $\gamma = 0.001$)

$T_1 = \gamma\ [L_t – L_{t\text{-}1}] + (1\text{-}\ \gamma)\ T_{t\text{-}1}$

Forecast for k step ahead

$F_{t+1} = L_t + kT_t$

Level equation $L_1 = 1.00\ Y_t + (1\text{-}1.000)\ [\ L_{1\text{-}1} + T\ _{t\text{-}1}]$

$= 1.00\ Y_t$

Trend equation $T_1 = 0.100\ [L_t – L_{t\text{-}1}] + (1\text{-}0.001)\ T_{t\text{-}1}$

$= 0.100\ [L_t – L_{t\text{-}1}] + (0.999)\ T_{t\text{-}1}$

Forecast equation $F_{t+1} = L_t + kT_t$

Where k = 1,2,3,4,5,6. (forecasting from 2020-21 to 2025-26)

Appendix II: Residuals of ACF and PACF plots of the Holt's exponential smoothing model for the forecasting of production and consumption of N, P and total fertilizer

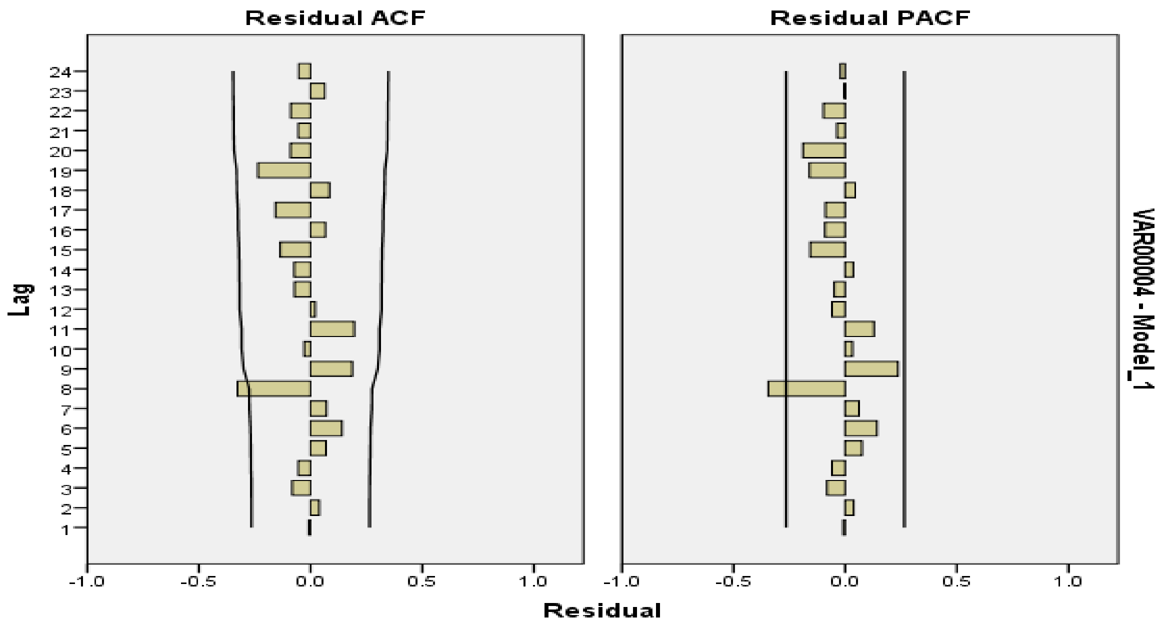

Fig 1 Residuals of ACF and PACF plots of the Holt's exponential smoothing model for N production

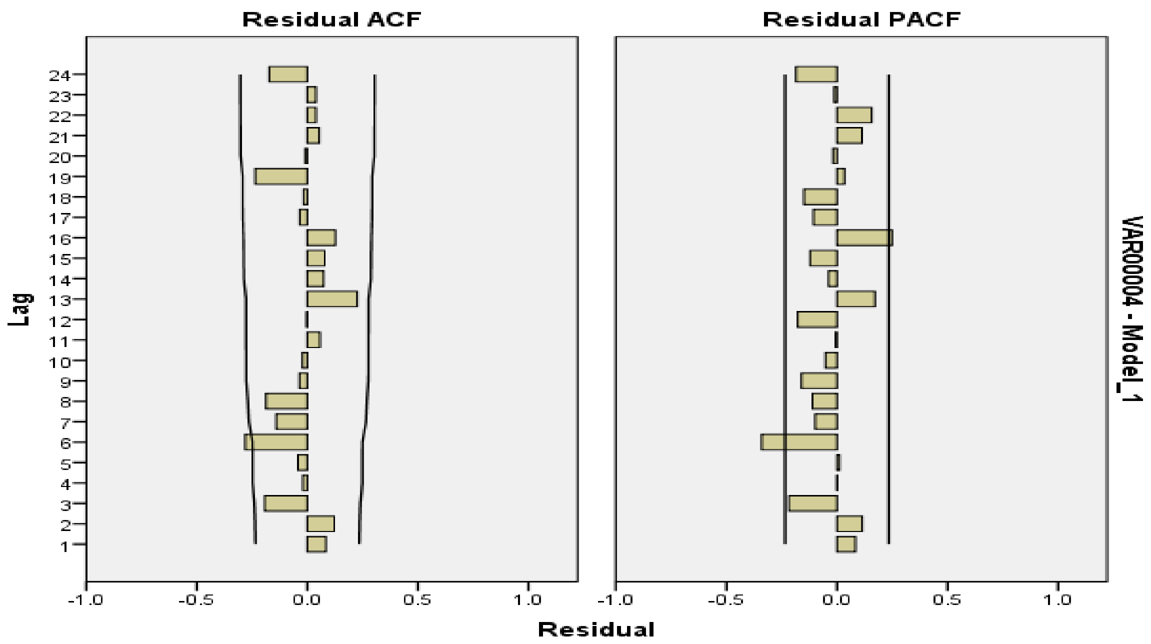

Fig 2 Residuals of ACF and PACF plots of the Holt's exponential smoothing model for N consumption

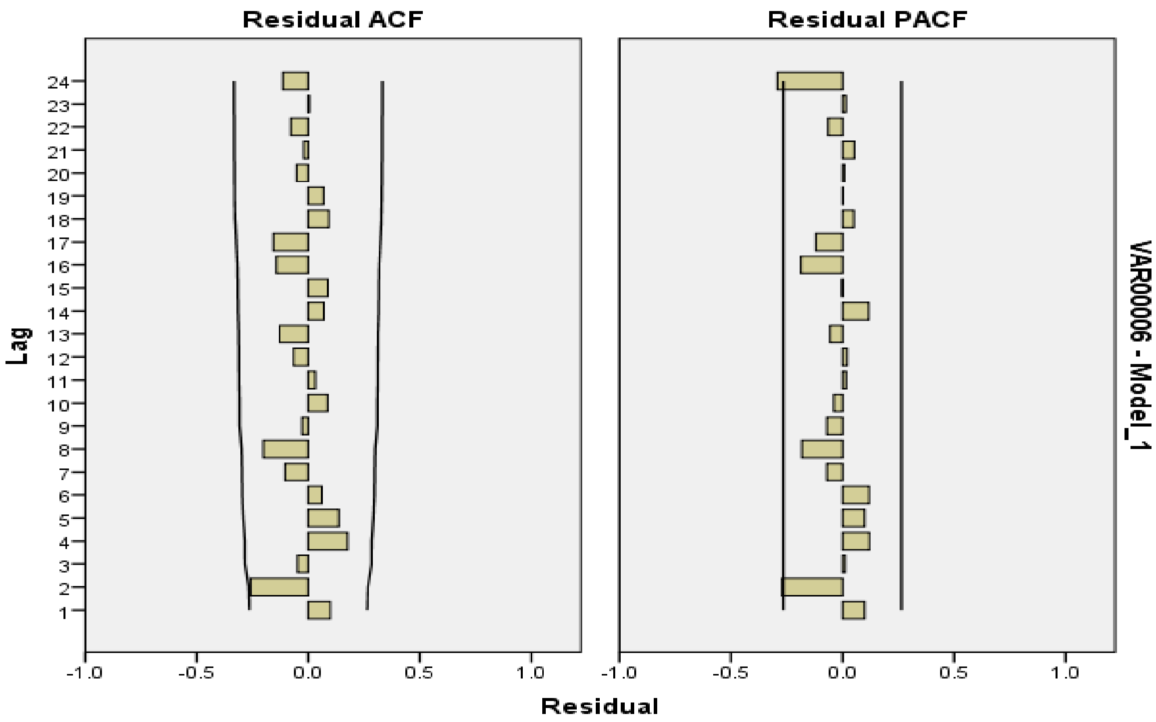

Fig 3 Residuals of ACF and PACF plots of the Holt's exponential smoothing model for P production

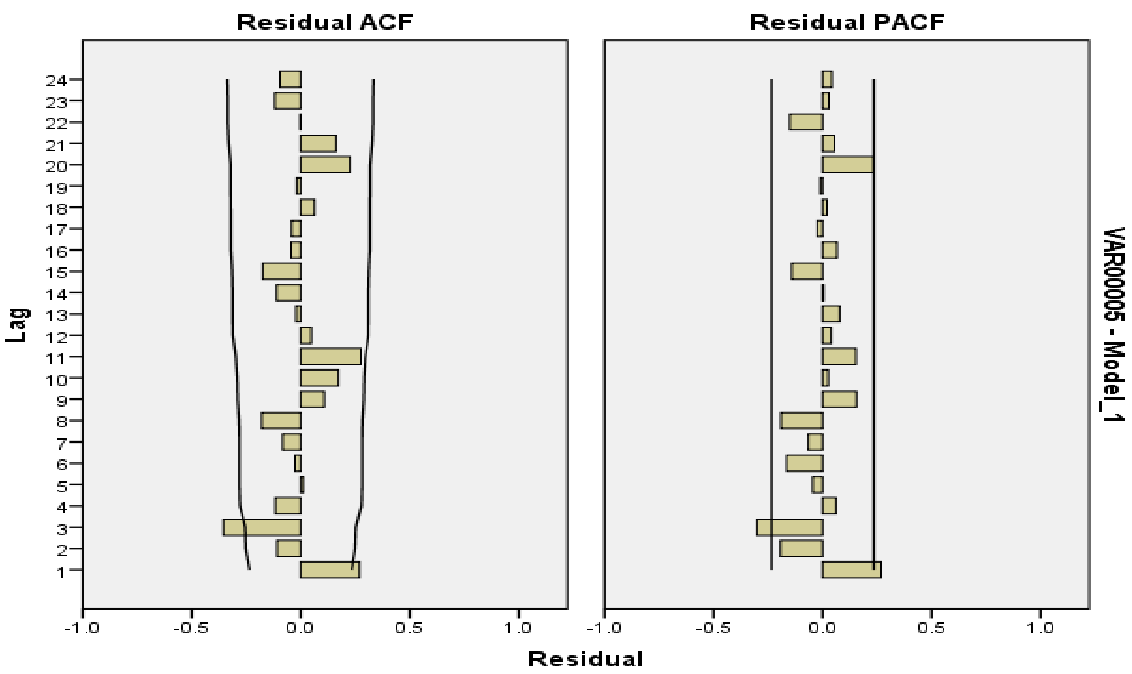

Fig 4 Residuals of ACF and PACF plots of the Holt's exponential smoothing model for P consumption

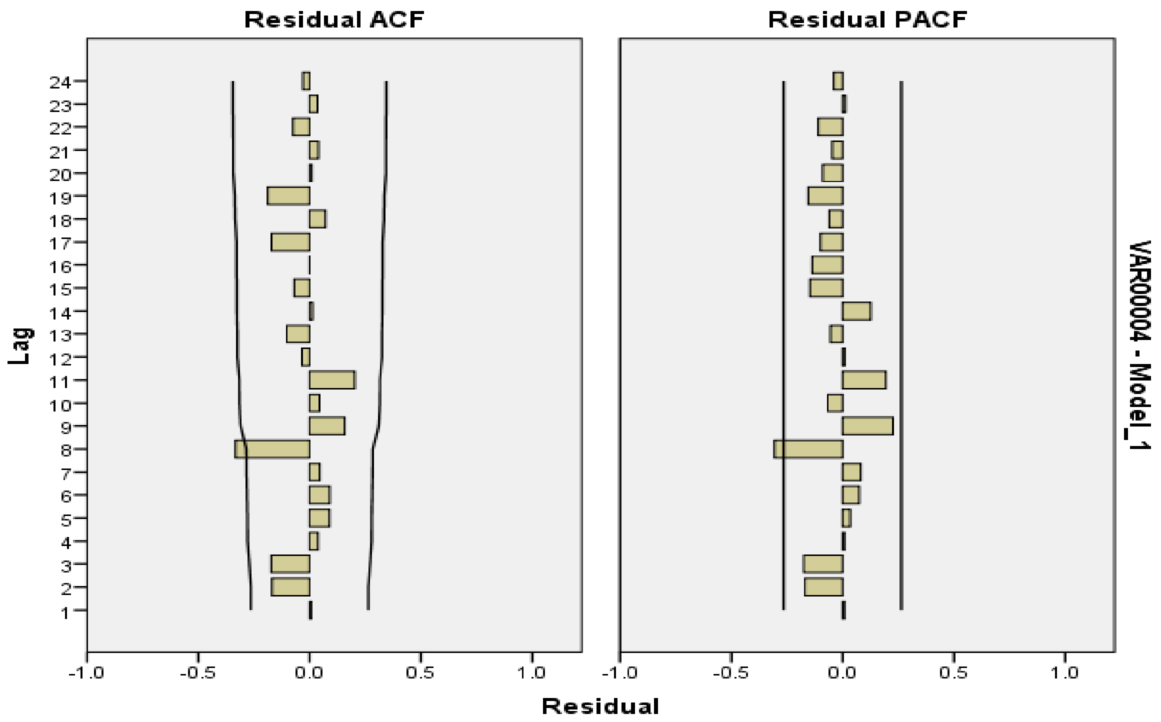

Fig 5 Residuals of ACF and PACF plots of the Holt's exponential smoothing model for total production

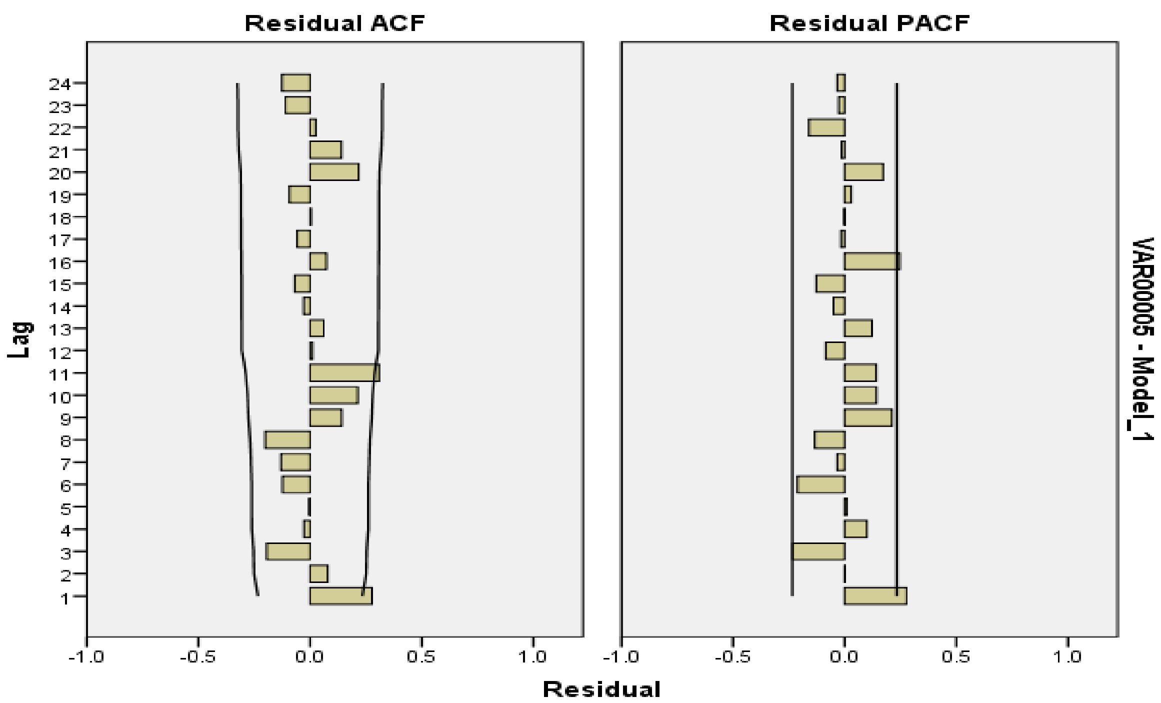

Fig 6 Residuals of ACF and PACF plots of the Holt's exponential smoothing model for total consumption

Appendix III: Interview schedule for farmers

KERALA AGRICULTURAL UNIVERSITY

Dynamics of fertilizer consumption and its marketing: a comparative study in two states of South India

Questionnaire for farmers

Declaration

The information provided will be used only for the research work for thesis for Master's Degree and the identity of the respondent/information provided by them will not be revealed to a third party

District: Block: Panchayat:

Date:

1. Socio-economic background of the farmer:

- Name of the farmer:
- Age:
- Gender:
- Address:
- Contact number:
- Total No. of members in the family:
- Educational details: ☐

1) Below High school 2) High school 3) Intermediate 4) Diploma

5) Degree 6) Post-graduation Any other ______________

2. Income details of the farmer:

- Annual income (₹): ☐

1) >50,000 2) 50,000-1 lakh 3) 1 lakh- 2 lakh 4) >2 lakh

- Source of income: ☐

  1) Farming 2) Farming+ allied activities 3) Farming+ business 4) Farming+ job Any other___________________

3. Land details of the farmer:

S. No	Ownership		Area (in acre)
1.	**Total land(own)**		
2.	**Leased in land**		
3.	**Leased out**		

- Rental value of own land(leased-out) -
- Rental value of the leased-in land -

4. Input requirement details:

Sl. No.	Inputs	Quantity (Per acre)	Unit price (₹)
1	Land preparation		
2	Paddy Seeds		
3	Manures		
4	Fertilizers		
5	Plant protection chemicals		
6.	Weedicides		
8.	Harvesting		

- Source of procurement of seed ☐

1) Own

2) Other farmers

3) Seed dealers

4) Nursery

5) Research station

6) KVK/ krishibhavan

- Is seed treatment practised: 1. Yes 2. No

    a) If yes, do you use biofertilizers for seed treatment: ___________

    b) what biofertilizers do you use? ________________

- Source of irrigation: ☐

    1) Well (own) 2) Bore well 3) Canal 4) Rainfall

- Adequacy of irrigation facility:

    1) Adequate ☐ 2) Inadequate ☐

- Fertilizer requirement:

➢ Quantity of fertilizer used per acre: _______________

➢ Type of fertilizer used: 1) Straight ☐ 2) Mixed ☐

➢ Application of fertilizer:1) Bulk ☐ 2) Rotations ☐

➢ Number of times fertilizer is applied: __________

➢ Technique for application:

1) Broadcasting ☐ 2) Localised placement ☐ 3) Deep placement ☐

- Number of times weeding is done: _________

6. Details of labour employed:

- Availability of labour: 1) Adequate ☐ 2) Inadequate ☐
- Number of labour-days: _______

    a) Wage rate- Male ___________ female ____________

7. Crop details:

- Area under paddy (acres):
- Number of times paddy crop is taken:
- Quantity produced:
- Yield per acre: __________ Price/quintal: ___________
- Method of cultivation of paddy:

  a) Aerobic ☐ b) Anaerobic ☐

8. Marketing details:

- Where do you sell the produce? _______________
- Quantity kept for household consumption:

  Food ___________ Feed ___________ Seed __________

- Do you sell the whole produce in a single lot? 1. Single ________ 2. Gaps __________
- What are the problems faced while marketing? ____________________
- Are you satisfied with the present system marketing of the produce? Yes ☐ No ☐

  a) If no, why? ______________

9. Fertilizer procurement details:

- From where do you purchase fertilizers? ☐

  1) Local fertilizer shop 2) wholesale shop 3) Other

- Do you follow the recommended dose of fertilizers while application? 1) Yes 2) No
- Have you availed any loan? 1) Yes ☐ 2) No ☐

- a) If yes, source:

Sl. No	Particulars	Amount	Period	Interest rate (%)
1	Institutions (Banks)			
2	Cooperatives (DCCB/ PACS)			
3	SHGs			
4	Money lenders			
5	Friends and relatives			
6	Others			

b) Is the loan repayment a challenge for you? __________________

- Do you have any assistance from local body? 1) Yes 2) No
- Did you get any subsidy for the procurement of fertilizer? Yes ☐ No ☐

  a) If yes, how much? _________ From where? _____________
- Are you a KCC holder1) Yes 2) No?
- Do you have a PMJDY account 1) Yes 2) No?
- Has it been beneficial for you __________________
- Are you a member of any Co-operatives/ associations? Yes ☐ No ☐

  a) If yes, name of the cooperative: ________________

  b) Benefits obtained when you are a part of such associations?

  ____
- Do you know about Agro Rythu Seva kendrams/ Eco shops? Yes No

  If yes, do u procure fertilizer from there? ________________
- Do you prefer Government authorised outlets or private outlets?

  1. Government authorised 2. Private outlets

  a) specify the reason:

- Which fertilizer company do you mostly prefer? ____________________

- Order of preference of fertilizer company

S. No	Fertilizer company	Rank
1	Indian Farmers Fertilizer Cooperative Limited	
2	Indian Potash Limited	
3	Coromandel International Limited	
4	Nagarjuna Fertilizers & Chemicals Limited	
5	Kribhco Fertilizers Limited	
6	Southern Petrochemical Industries Corporation Limited	
7	Zuari Agro Chemicals Limited	
8	National Fertilizers Limited	

- Reasons as to why the company is being preferred?

S. No	Factor	
1	Cost of fertilizers	
2	Availability in villages	
3	Brand image	
4	Influence of fellow farmers	
5	Promotional activities	
6	Cropping pattern	
7	Credit facilities	
8	Size of bag	
9	Fertilizer composition	
10	Soil type	
11	Storability	
12	Packaging	
13	New products	

- Constraints faced during the procurement of fertilizers

S. No	Particulars	
1	Insufficient Credit	
2	Lack of clarity on composition and application	
3	Access to outlets	
4	Problem of hoarding	
5	Timely availability	
6	Government policies	
7	Lack of subsidies	
8	Price volatility	

Appendix IV: Interview schedule for traders

KERALA AGRICULTURAL UNIVERSITY

Dynamics of fertilizer consumption and its marketing: a comparative study in two states of South India

Questionnaire for traders

<u>Declaration</u>

The information provided will be used only for the research work for thesis for Master's Degree and the identity of the respondent/information provided by them will not be revealed to a third party

1. Name: Date:
2. Address and Ph. no.:
3. Market name:
4. No. of markets you are operating:
5. Are you a single commodity trader: Yes ☐ No ☐

   If no, specify:

   ____

6. Any variation in number of farmers year to year? Yes ☐ / No ☐
7. From where do you get the market information?

   ____

8. What are the different types of brands you are dealing with?

   ____

9. What is your approximate annual turnover of the shop?

   a) 1 to 2 lakhs b) 10 to 15 lakhs

   c) 5 to 8 lakhs d) Above 10 lakhs

10. What are the fertilizers which are popular in the area?

____

11. What are the problems faced by you during fertilizer procurement?

____

____

12. What are the various questions asked by the farmers during the purchase of fertilizers?

____

____

12. What is the channel through which fertilizer is procured?

S. No.	Particular	
1	Private companies- Distributor- Dealer	
2.	Private companies- Dealer	
3.	Govt. agency- Distributor- Dealer	
4.	Govt. agency- Dealer	
5.	Cooperatives- Distributor- Dealers	
6.	Cooperatives- Dealers	
7.	Any other	

13. What are the important factors that influence sales of fertilizers in the study area?

S. No	Particular	
1.	Price	
2.	Quantity	
3.	Scheme	
4.	Discount	
5.	Quality	
6.	Any other	

14. What are the various products you are selling?

S. No	Company name	Brand name	Selling (Qty.)	Selling Price (₹)	Sales Revenue (margin)
1.					
2.					
3.					
4.					
5.					
6.					

15. What are the expectation you have from the fertilizer company

S. No	Dealer's expectation	Preference
1.	Promotional activities	
2.	New products	
3.	Spot demonstration	

4.	Good quality products	
5.	Farmers’ meetings	
6.	Higher margins	
7.	Less price	
8.	Timely availability	
9.	Good packaging	

DYNAMICS OF FERTILIZER CONSUMPTION AND ITS MARKETING: A COMPARATIVE STUDY IN TWO STATES OF SOUTH INDIA

By

ANKITHA THAKUR

(2019-11-193)

ABSTRACT OF THE THESIS

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DEPARTMENT OF AGRICULTURAL ECONOMICS

COLLEGE OF AGRICULTURE

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KERALA, INDIA

2021

ABSTRACT

More than half of India's population relies on agriculture for survival. According to the Economic Survey 2020-21, agriculture and related industries contributed 17.8 per cent of the country's Gross Value Added (GVA) at current prices in 2019-20, The country's most challenging problem currently is maintaining a balance between population boom and agricultural production.

The fertilizer industry in India has been under strict governmental control for most of the period since independence. The Government of India declared fertilizer as an essential commodity and notified the Fertilizer Control Order (FCO) in 1957. Major controls on prices and distribution of fertilizers were introduced in 1973 under the Fertilizer Movement Control Order. The Retention Price cum Subsidy Scheme (RPS) was introduced in 1977 for encouraging investment in the fertilizer sector. The economic reforms of 1991 paved way for many policy changes and it also resulted in the formation of several committees. Price of fertilizers were deregulated and new schemes like New Pricing Scheme (NPS) and Direct Benefit Transfer (DBT) were introduced. The growth trend in the chemical fertilizer production and consumption was studied. The results showed that in the year 1950-51, the all-India consumption of N, P_2O_5, K_2O fertilizers was 55.0, 8.8 and 6.0 ('000 tonnes) respectively. In the 1990s, the total fertilizer consumption varied between 12.15 and 16.8 million tonnes. In 2007-08, the total consumption outreach was 22.5 million tonnes. The total estimated nutrient consumption for 2019-20 ($N+P_2O_5+K_2O$) was 29.04 million metric tonnes.

Fertilizer production in India has increased at a rapid rate *i.e.*, 38.7 thousand tonnes in 1951-52 to about 17.9 million tonnes in 2015-16. Fertilizer production increased modestly by 3.3 per cent to 18.5 million tonnes ($N+P_2O_5$) in 2019-20. The production of fertilizers accompanied by the imports in the country have resulted in high fertilizer use by the farmers. The gap between the domestic consumption and production was also studied and the results indicated a deficit (1.31) in the total production and consumption. Forecasting for the next 6 years from 2020-21 to 2025-26 was also carried out and it showed an increasing trend in both consumption and production for all the major chemical fertilizers.

A comparative analysis of fertilizers usage and its marketing in Kerala and Telangana was also studied. Two districts with the highest area under paddy was purposively selected. Two panchayats from each block were randomly selected. The sample included 120 farmers and 20 traders. Second order polynomial regression was carried out to analyse the effect of consumption of N, P and K on the yield. Fisher's t test was also performed to know whether there is any significant difference between the consumption of N, P, K and yield in the two study areas. It was found that consumption of N and P fertilizers were different in the two states. Yield was found to be higher in Telangana. The consumption of K fertilizers was more or less equal. A significant value of Kendall's coefficient of concordance showed that there existed strong agreement among the respondents to rank the various brands of fertilizers. It was found that IFFCO fertilizers was preferred in Telangana and in Kerala it was FACT.

The marketing system of fertilizers in India is based on the Direct Benefit Transfer system. All subsidised fertilizers are sold to farmers/buyers through Point of Sale (PoS) devices installed in each retailer shop. Dealers must sell fertilizers through PoS devices under the Aadhaar enabled Fertilizers Distribution System (AeFDS). The web-based Integrated Fertilizer Management System keeps track of fertilizer sales (iFMS).

The marketing channels in the two states were studied and it revealed that fertilizers in Kerala are mostly distributed to the farmers via the co-operative banks (PACS) to Padashekara samithis. The farmers in Telangana mostly purchased fertilizers from retail shops. There also exists another channel wherein the TS MARKFED supplies fertilizers to various institutes through which farmers avail fertilizers.

The fertilizer industry in India is dominated by the co-operative and private companies. IFFCO is one of the largest fertilizer co-operatives as well as producers of fertilizers in India. SWOC analysis of IFFCO showed that the cooperative nature and new venture and businesses of IFFCO are few of its major strengths. Rigid organizational sector and slow feedback are some of its weaknesses. Opportunities include increasing the installation capacity and energy efficient plants. High competition from other private and public companies and government regulations are the major challenges.

Chemical fertilizers have made a substantial contribution to India's food grain self-sufficiency. Only by studying individual farm usage can a clearer picture of the country's fertilizer consumption pattern be identified. In order to increase agricultural growth and encourage balanced nutrient application, fertilizers must be made available to farmers at reasonable prices which in turn lead to enhancement of agricultural productivity.