IMPACT OF CRUDE OIL PRICES ON FERTILIZER PRICES: A STUDY OF LIVELIHOOD OF FARMERS IN PINDIMANA GRAMA PANCHAYATH, KERALA

Dissertation submitted to

St. Teresa's College (Autonomous), Ernakulam

(Affiliated to **MAHATMA GANDHI UNIVERSITY, KOTTAYAM**)

In partial fulfilment of the requirement of the degree of

MASTER OF ARTS IN ECONOMICS

BY

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UNDER THE GUIDANCE OF

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I hereby declare that this dissertation entitled, " **IMPACT OF CRUDE OIL PRICES ON FERTILIZER PRICES: A STUDY OF LIVELIHOOD OF FARMERS IN PINDIMANA GRAMA PANCHAYATH, KERALA** ", submitted by me in partial fulfilment of the requirements for the award of an M.A Degree in Economics is my original work. This work has not previously formed the basis for other academic qualifications.

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ANEETTA PAULOSE

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List of Abbreviations

DAP - Di-Ammonium Phosphate

GDP- Gross Domestic Product

GVO- Gross Value Added

GSDP-Gross State Domestic Product

IMF-International Monetary Fund

IPP-Import Parity Price

MAP-Mono-Ammonium Phosphate

MOP-Muriate of Potash

NBS- Nutrient Based Subsidy Scheme

NPK- Nitrogen, Phosphorus and Potassium

NPS- Nutrient Based Subsidy

OPEC- Organization of the Petroleum Exporting Countries

PDM-Potash Derived from Molasses

RPS-Retention Price Scheme

SSP-Single Super Phosphate

TSP - Triple Super Phosphate

WTI- West Texas Intermediate

CHAPTER 1
INTRODUCTION

1.1 Introduction

Agriculture plays an important role in the Indian economy by providing livelihood opportunities to large number of people (Economic survey,2022-23). Despite of several structural changes that had happened in the economy, agriculture remains as the main source of income in many rural regions of, India So the rising cost of agricultural inputs remains as a major in issue (world Bank,2022).

Crude oil is an important commodity in the world economy. The crude oil prices have been highly volatile, that means that there have been several ups and downs in the crude oil prices. These fluctuations have been associated to several geopolitical tensions, demand, and supply imbalances global economic conditions (World Bank,2022). The several sectors of the economy such as manufacturing, transportation, and agriculture etc. are often affected by these price fluctuations. The fertilizer is an important channel through which these price fluctuations are transmitted to the agriculture sector.

Fertilizer is an important input in agricultural production. After the green revolution of 1960s, the usage of the chemical fertilizers across the country has increased in large amount. The crude oil prices influence the production and distribution decisions of the fertilizers (FOA,2022). Although the government of India has introduced several subsidy schemes to reduce these effects, still the fluctuations in the international crude oil prices causes changes the domestic fertilizer prices through its impact on the production and import cost (Ministry of Fertilizers,2023).

The rising fertilizer costs causes a decline in the profitability of farmers. The real income of farmers declines when the input cost rises faster the output cost (CACP,2022). This issue is severe in regions where the agriculture is vulnerable to small landholding, limited access to alternative income sources, and heavy dependence on external inputs.

In the agricultural context Kerala is often characterized high input cost, labour scarcity and price volatility. In the Pindimana Grama Panchayath agriculture is an important livelihood activity for large number of people. So, the Pindimana Grama panchayath provides a micro-level setting to understand how the rising fertilizer cost impact the farmers. The study shifts from the macro-level perspective to the micro level perspective.

1.2 Review of Literature

There are several literatures that had given considerable attention to the interrelationship between the crude oil prices the fertilizer prices and the agricultural production. As the crude oil act as one of the major inputs in the production and transportation of several fertilizers, the fluctuations that are happening in the international energy markets are often also reflected in the fertilizer markets. this in turn influences the cost of cultivation of farmers. So many literatures have examined the trend and volatility of crude oil prices, the linkage between crude oil prices and fertilizer prices and the impact of rising fertilizer prices on the agricultural cost.

1.2.1 Crude oil price trend and volatility

Many studies have examined volatility of crude oi prices and their macro-economic consequences. Krichene (2008), in the IMF working paper "Crude Oil Prices, Trends, and World Forecast," analysed the global crude oil price trends from 2000-2007 using advanced econometric models found that the crude oil prices exhibit higher volatility due to the demand and supply imbalances. They concluded that due to the macroeconomic and geopolitical developments the crude oil prices are highly unstable.

Similarly, Zavadska et.al (2020) analysed the patterns of volatility of crude oil futures and spot prices over four significant crises- the Gulf War (1990-91), the Asian Financial Crisis (1997-98), the U.S. terrorist attacks (2001), and the Global Financial Crisis (2008-09), the study found out the asymmetrical price movements during economic shocks and also revealed that demand and the supply shocks in the economy have led to the longer volatility persistence. Also, there are many studies which have mentioned the macroeconomic linkages of crude oil prices. Kaushik et.al (2014) and Alam.et.al (2020) in the Indian context studied the relationship between the crude oil prices and the exchange rate and found that the crude oil price fluctuations can influence the currency movements.

These studies establish that the crude oil prices are highly unstable and sensitive to macroeconomic and geopolitical developments.

1.2.2 Transmission of crude oil prices to fertilizer prices

Many studies have examined the linkage between the crude oil prices and the fertilizer prices i.e., how the crude oil price fluctuations influence the fertilizer prices. Babula and Somwaru (1992) investigated about the relationship between the crude oil prices and fertilizer prices from 1962-1990 using VAR (Vector Autoregression Model) and found out that there exist a notable

but time-lagged relationship. Whereas, according to Chen et.al (2010) there exist a strong correlation between the international fertilizer prices and crude oil prices. They used complex econometric models to analyse the weekly observations from 2003-2008.

Sanyal et al. (2015) also observed the international fertilizer prices changes as the crude oil prices change during the period of high volatility. The study also raises concerns about the increasing fertilizer prices affecting the cost of cultivation and farmer profitability and emphasizes the need for strict government action. Several recent studies have also highlighted the influence of crude oil prices on fertilizer prices, for example Tyagi (2023) used ARIMA modelling and found out that there exists a strong positive correlation between the energy prices, fertilizer prices and maize prices. This shows how the fluctuations in the energy prices have been transmitted to the agriculture commodity prices through fertilizer prices. Similarly, according to skalski (2023) identified energy prices especially the natural gas as one of the main causative agents of global crude oil fluctuations.

Thus, the fluctuations in the energy markets are reflected in the fertilizer prices and this causes uncertainty in the agricultural production.

1.2.3 Impact of fertilizer price fluctuations on Farmers

There are also several other studies that were focussed on how the rise in the fertilizer prices affects the farmers population. Ramesh (1978) in a case study in Bangalore district found out that the rising fertilizer cost have an adverse effect on the farmers by raising their input cost which forced the farmers to reduce the fertilizer usage which in turn resulted in reduction in crop productivity. The study emphasizes the role of pricing stability, extension services, and supportive legislation for maintaining constant fertilizer application.

Komerek et al. (2017) analysed the impact of increasing fertilizer prices on the smallholders' farmers through a case study conducted in in Dedza, central Malawi. The study found that the increasing crude oil prices have led to decreased household income, yields, area of cultivation, and fertilizer use. A recent study conducted by Amankwah et.al (2023) revealed the coping strategies such as borrowing, shifting to alternative inputs, reducing the input intensity adopted by the farmers in six Sub-Saharan African nations to deal with the rising fertilizer prices during several crisis.

Brunelle et al. (2015) estimated several fertilizer pricing scenarios until 2050 and found out that the increasing fertilizer prices may lead to significant decline in the crop yield. The study

also raises concerns about the issues related to food security and land degradation that may arise due to the increasing fertilizer prices.

Thus, these studies revealed that how the rising fertilizer prices affects the farmers by influencing their income stability and production decisions.

1.2.4 Policy interventions and Indian context

In India the fertilizer pricing policies are largely influenced by government subsidy policies. Tanpure (2011) examines the development of India's fertilizer policy and its effects on food security and agricultural growth The paper describes how early government-led pricing and subsidy programs, such the Retention Price Scheme (RPS), were designed to encourage the Green Revolution and increase domestic fertilizer output. Policy changes, such as the New Pricing Scheme (NPS) in 2003 and a nutrient-based subsidy policy in 2010, were eventually brought about by worries about fiscal and environmental distortions. The author observed that despite of all these efforts the fertilizer consumption in India remains low and uneven when compared to other neighbouring countries.

Similarly, Mala (2013) examined the fertilizer consumption pattern in India and found out that there are several region disparities existing in the application rates. The study reveals although India is one of the largest consumers of fertilizers the usage of fertilizers is very low in certain parts of the country especially the rain-fed areas. The report highlights that to satisfy India's future food grain needs, fertilizer use, and efficiency must be increased. According to Jagaet.al (2020) non-price factors like increased irrigation and the use of high-yielding crop varieties have a greater impact on fertilizer demand than do price factors. The authors point out that because of expanding agricultural demand and limited domestic production capacity, India's fertilizer imports increased drastically. The researcher emphasizes the significance of reasonable fertilizer prices and a stable policy environment.

These studies indicate that although subsidies have helped to reduce the impact of international crude oil price shocks the global crude oil prices continue to influence the production and import cost thus the domestic fertilizer prices.

1.2.5 Research Gap

Although the previously done studies have given sufficient attention to the crude oil prices volatility, crude oil – fertilizer price linkage very little attention has been given to micro-level analysis on how the crude oil prices affect the fertilizer prices and which in turn affects the

local farmers, particularly in regions of Kerala. Also, there is a lack of integrated studies which analyse the crude oil price trends, crude oil- fertilizer price linkage and investigating its impact on farmers.

1.3 Statement of the Problem

Agriculture in India, especially in Kerala, is heavily dependent on external inputs like fertilizers, pesticides, machinery, and fuel. Many of these inputs are directly or indirectly related to crude oil. The production of fertilizers, particularly nitrogen-based ones, depends on natural gas or oil, so it is sensitive to changes in global crude oil prices. Moreover, transporting agricultural inputs and outputs mainly relies on fuel, which further exposes farmers to fluctuations in the oil market. In recent years, global crude oil prices have experienced sharp changes. These price changes have directly influenced fertilizer prices in India, increasing cultivation costs for farmers and putting financial pressure on them, especially smallholders in places like Pindimana Grama Panchayat. Even small rises in input costs can greatly impact profits and the security of livelihoods, while decreased fertilizer use due to high costs can reduce crop yields. Despite these clear connections, there is little research on how global oil price shocks affect local economic conditions for farmers in Kerala. This highlights the need for a focused study on this matter.

1.4 Objectives

1. To analyse the trend and volatility of international brent crude oil prices over the past 15 years'

2. To examine the relationship between crude oil prices and fertilizer prices in India.

3. To assess the impact of fertilizer price fluctuations on the cost of cultivation and income of farmers in Pindimana Grama Panchayat.

1.5 Theoretical Framework

1.5.1. Cost Push Inflation Theory: Cost-Push Inflation Theory: This theory investigates the situation in which the overall price level of items rises due to rising production input costs rather than an increase in customer demand. In this approach, the "push" comes

from the supply side, notably from critical raw materials and energy sources that serve as the foundation for manufacturing. This theory investigates how fluctuations in global Brent crude oil prices directly increase the costs of making and delivering fertilizer, resulting in an inflationary burden on the agriculture sector.

1.5.2. *Derived Demand Theory*: This theory looks at how the demand for a production input, like fertilizer, is influenced by the demand for the finished agricultural product that it contributes to. Since the input's value is "derived" from its requirement in the production of primary goods like pineapple, paddy, and rubber in Pindimana Grama Panchayat, it has no utility on its own in this framework. This theory looks at how rising production costs, which are influenced by global oil price patterns, can result in less fertilizer being used, which would ultimately affect crop productivity and the farmer's net output.

1.5.3. *Risk and Uncertainty Theory*: This theory looks at how producers decide when they are unable to make a perfect prediction about future pricing or market conditions. According to this concept, farmers have to manage the "risk" of shifting global Brent crude prices, which have an immediate effect on the price of their necessary inputs in the future. This theory looks at how farmers in Pindimana are forced to convert to less input-intensive crops or adopt cautious planting practices due to the volatile nature of the world's energy markets in order to guard against possible financial losses.

1.6 Methodology

The study was conducted in pindimana Grama Panchayat in Kothamangalam block of Ernakulam district, Kerala. In the Pindimana Grama Panchayat large number of people depend on agriculture as the main source of income making it appropriate study area for evaluating the impact of rising fertilizer prices on the farmers. The panchayat consist of 13 wards and the respondents were selected from each of these wards to ensure equal representation. A total of 35 farmers were selected from these wards using simple random sampling technique for primary data collection. Primary data were collected during the period 2025-26 using structured questionnaires and personal interviews. The secondary data was collected from several government reports, statistics, and authenticated publications. the secondary data regarding the global (India basket price) crude oil prices were collected over a period of 2010-2025 to assess the trend and volatility. The selection of 15-year period is useful in analysing the fluctuations

over different economic phases and comprehensive time series analysis. The fertilizer prices (Maximum Retail Prices) of five selected fertilizers namely- MOP, DAP, Ammonium Sulphate, SSP and NPK were collected for a period from 2018-2025, based on the availability of consistent and comparable data. The secondary data was analysed using trend analysis, volatility analysis and statistical tools like correlation and Regression were used. Primary data were analysed using percentage analysis, frequency distribution, valid percentage analysis and weighted ranking score method.

1.7 Limitations of the study

1.7.1. Deeper comparison was limited by the study's inability to gather secondary data, specifically consistent and disaggregated data on fertilizer and crude oil prices for all necessary periods**.**

1.7.2. The volatility measurement was done using standard deviation and coefficient of variation, which provide just a rough indication of price swings and may not capture all**.**

1.7.3. Difficulty in collecting primary data as some respondents were reluctant to provide accurate information.

1.7.4. The small sample size for the primary data collection due to time constraints.

1.7.5. The study did not specifically account for external factors that could affect farmers' income, such as weather, government subsidy programs, and changes in the market price of agricultural products.

1.8 Scheme of Study

This study is divided into four chapters.

Chapter 1 includes an introduction, a review of the literature, a statement of the problem, objectives, theoretical framework, methodology, limitations, and scheme of study.

Chapter 2 provides a complete overview of fertilizer prices and crude oil prices and their linkage.

Chapter 3 conducts a comprehensive analysis of the secondary data collected using Trend analysis, volatility analysis, correlation, and regression analysis.

Chapter 4 conducts analysis of primary data using graphs, weighted mean score method, frequency, and valid percent analysis.

Chapter 5 contains the findings, recommendations, and conclusion.

CHAPTER 2

OVERVIEW OF CRUDE OIL AND FERTILIZER PRICE DYNAMICS

2.1 Introduction

This chapter provides an overview of agriculture sector, global crude oil prices and fertilizer prices and the interlinkage between them. This chapter discusses about the agriculture sector in India and Kerala and its role in ensuring food security. The role of fertilizer in agricultural production, the types of fertilizers used in India, the trends in production, consumption and import of fertilizers and fertilizer subsidy policies in India are also examined. This chapter further explains the nature of crude oil price, global price determination mechanisms, India's dependence on crude oil price imports and major reasons behind these fluctuations. Also, this chapter explores the how the fertilizer prices affect the crude oil prices and how the increasing fertilizer prices impact the farmers by affecting their income and profitability.

2.2Agriculture sector in India

Agriculture sector has been considered as the backbone of Indian economy. Agriculture pays a significant role in determining national income and employment. "The agriculture sector contributes approximately 16 percentage of country's GDP for FY24' (PE) at current prices and supports about 46.1 per cent of population. For the past five years Indian agricultural and allied sector has exhibited a growth rate of 4.4 percent and the growth rate in Q2 of FY 2025-26 was 3.5 per cent. India recorded the highest decadal growth rate of 4.45 per cent (FY16-FY25) when compared to previous years" (chapter 6, Economic survey 2025-26). "The total food grain production in the counter rose from151.2 million tonnes in 1980s to 190.6 million tonnes in 1990s and 212 million tonnes in 2000s" (Ministry of Agriculture). The changes in Indian agriculture began after the late 1960s.

Before that Indian farmer depended on organic farming practices and the output was very less. The Green Revolution of 1960 led to new technologies in agriculture sector especially for wheat and promoted the usage of chemical fertilizers which increased the production. The agricultural growth is very necessary for ensuring inclusive growth and food security. "The agriculture sector in India has shown a steady growth in recent years it is facing several issues such as Fragmented landholdings, inadequate marketing and storage infrastructure, limited access to quality inputs, relatively low levels of investment, and uneven quality of extension services are among the prominent reasons for the low productivity level. However, the government has taken several initiatives to tackle these problems such as Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Rastriya Krishi Vikas Yojana (RKVY), Agriculture Infrastructure Fund (AIF), and Kisan Credit Cards (KCC)" (chapter 6, Economic survey 2025-26).

2.3 Agriculture sector in Kerala

Agriculture plays a crucial role in Kerala Economy as they provide livelihood to approximately two-third of the population. "Kerala is a densely populated state with limited arable land. Kerala, known for its unique ago-climatic conditions, cultivates a broad variety of crops, including rice, spices, coconut, rubber, fruits, vegetables, tuber crops, millets, pulses, flowers, beverage crops, and medicinal plants" (Annual plan 2024-25, Directorate of Agriculture Development & Farmers' Welfare, Kerala).

“Agriculture has a crucial role in food security and rural lives, but its contribution to Kerala's GSDP has decreased significantly over the last decade. In 2011-12, the crop industry contributed 8.64 per cent to the state's GSDP. However, this proportion has decreased to 4.49 per cent in 2023-24, according to the most recent real (constant price) forecasts. The drop does not indicate that the sector has stopped growing, but rather that it has not kept up with the rise of the secondary and tertiary sectors. Rubber accounts for 20 per cent of the sector's GVO, followed by coconut (19%), arecanut (9%), tapioca (7%), and cardamom (7%)” (Agricultural statistics 2023-24, Government of Kerala).

2.4 The role of fertilizer in agriculture

“A fertilizer refers to any natural or synthetic material that contains chemical components which boost the growth and yield of plants. Fertilizers enhance the soil's inherent fertility or restore chemical elements that have been used up by earlier crops. Soil fertility describes the ability of the soil to provide essential nutrients in sufficient quantities and appropriate proportions to support plant growth when other conditions are conducive. When soil fertility is insufficient, fertilizers can be applied to deliver the required plant nutrients” (Britannica Editors, 2026).

Fertilizers are important for plant life in several ways:

- “Fertilizers increase plants' resistance to pests. This reduces their need for pesticides and herbicides, leading to healthier crops. As a result, diseases have declined, adding aesthetic value to the plants.
- Fertilizers improve the water retention of plants and enhance root depth.
- The potassium in fertilizers strengthens plant stems and stalks.
- The phosphorus in fertilizers helps with faster root growth and seed formation in plants.
- Nitrogen in fertilizers boosts plant growth, which can be seen in the green colour of the plants” (Smith,2022).

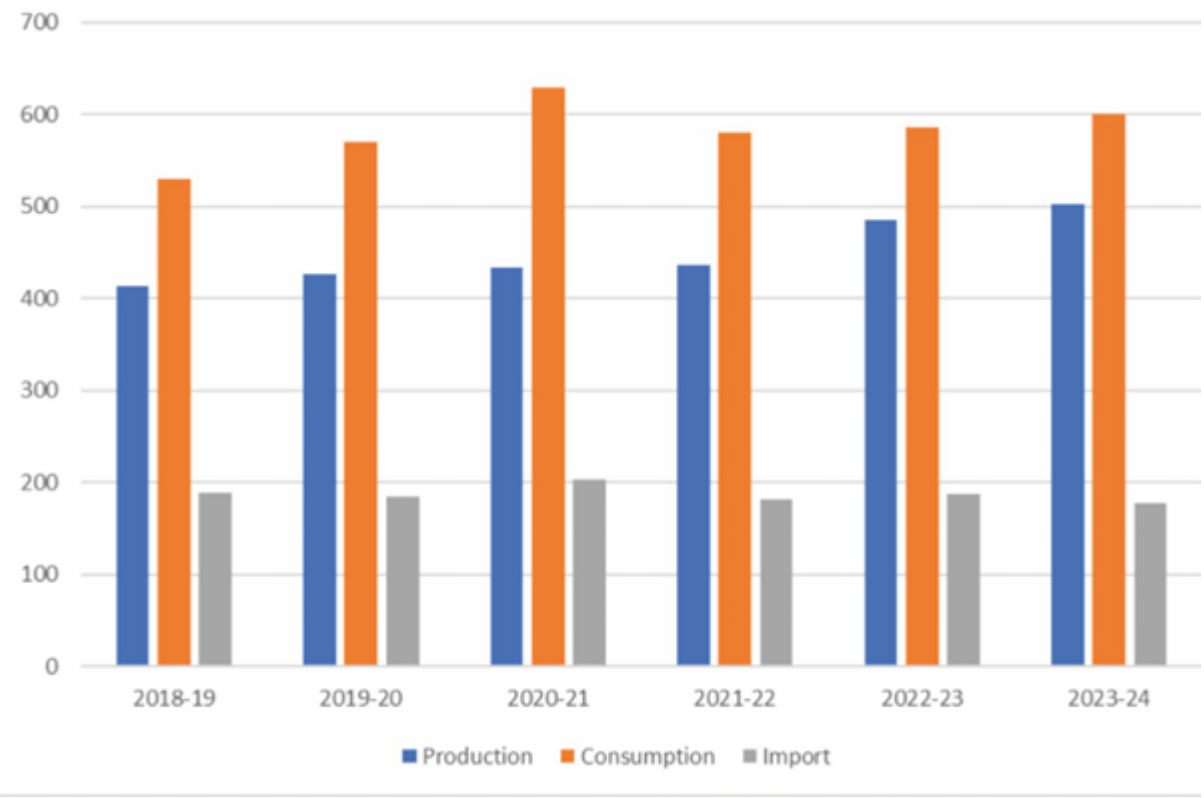
“The fertilizer plays an important role in the growth of agriculture by increasing the output to meet the needs of the growing population and increasing the exports of the country. Some argued that the fertilizer is as important as seed in Green Revolution (Tomich et. Al) contributing as much as 50 percentage of yield growth in Asia” (Hopper 1993 and FAO1998).

Before 1960 s the farmers in India were greatly dependent on organic farming techniques but later after the Green Revolution led to the development of new technologies in agriculture. A major shift had occurred from the organic fertilizers to the chemical fertilizers. India’s fertilizer industry began in 1906 in Chennai and grew rapidly after the 1940s. Now fertilizer is one of the most important inputs in agricultural production. Today, India is the third- largest producer and second largest consumer of chemical fertilizers in the world. The fertilizer usage has risen over the years which lead to an increase in food grain production more than five times since independence, reaching about 273 million tonnes in 2016-17. Fertilizers have played a central role in aligning the states with broader Green Revolution movement that transformed agriculture across India and the world. The adoption of chemical fertilizers has helped in nutrient replenishment, increasing crop yields and reduction in states dependency on imports.

Many government subsidies and schemes have been established to ensure affordability and accessibility of fertilizers to all farmers.

“The government has made a number of initiatives over the past ten years, which has raised the total amount of fertilizer produced from 385.39 LMT in 2014–15 to 503.35 LMT in 2021. In 2023–24, the public sector contributed 17.43 per cent, the cooperative sector 24.81 per cent, the sector 50.77 per cent, and the private sector 24.81 per cent to the total amount of fertilizer produced. The nation's total annual consumption of fertilizer in 2023–2024 was around 60 lakh metric tons, of which 503 lakh metric tons were produced domestically and 17 lakh metric tons were imported”. (Annual report 2023-24, Department of Fertilizers, Government of India)

Figure 2.1 Trends in production, consumption, and imports of total fertilizers in India during 2018-19 to 2023-24 (figures in LMT)



Source: Annual report 2023-24, Department of Fertilizers, Government of India

2.5Types of fertilizers used in India.

Farmers in the country utilise a wide range of chemicals as fertilisers, including urea, Di-Ammonium Phosphate (DAP), Muriate of Potash (MOP), Nitrogen, Phosphorus, Potassium, and Sulphur (NPKS), and Single Super Phosphate (SSP).

Table2.1- Trend in consumption of fertilizers (figures in LMT)

Year	Type of Fertilizers				
	Urea	DAP	MOP	NPKs	Total
2018-19	320.04	87.35	26.98	95.66	530.03
2019-20	336.96	101.01	27.80	105.01	570.78
2020-21	350.51	119.18	34.32	125.82	629.83
2021-22	341.73	92.64	23.93	121.37	579.67
2022-23	357.26	105.31	16.32	107.31	586.20
2023-24	357.81	109.73	16.45	116.80	600.79

Source: Annual report 2023-24, Department of Fertilizers, Government of India

Table 2.2- Trend in production of fertilizers (Figures in 'LMT')

Year	Type of Fertilizer				
	Urea	DAP	NPKS	SSP	Total
2018-19	238.99	38.99	95.15	40.72	413.85
2019-20	244.58	45.50	93.34	42.53	425.95
2020-21	246.05	37.74	100.54	49.35	433.68
2021-22	250.72	42.22	89.67	53.34	435.95
2022-23	284.94	43.47	100.4	56.44	485.25
2023-24	314.09	42.97	101.85	44.44	503.35

Source: Annual report 2023-24, Department of Fertilizers, Government of India

Table2.3- Trend in import of fertilizers

Year	Type of Fertilizer				
	Urea	DAP	MOP	NPKS	Total
2018-19	74.81	66.02	42.14	5.46	188.43
2019-20	91.23	48.70	36.70	7.46	184.09
2020-21	98.28	48.82	42.27	13.90	203.27
2021-22	91.36	54.62	24.60	11.70	182.28
2022-23	75.80	65.83	18.66	27.52	187.81
2023-24	70.42	55.67	28.69	22.17	176.95

Source: Annual report 2023-24, Department of Fertilizers, Government of India

"Domestic production meets about 87per cent of Urea consumption, 90 per cent of NPK consumption, and 40 per cent of DAP consumption. Our country still relies entirely on imports for Muriate of Potash (MOP) (452.5). 90 per cent of fertilizer raw ingredients, including gas, phosphoric acid, ammonia, and rock phosphate, are imported" (Annual report 2023-24, Department of Fertilizers, Government of India).

2.6- Fertilizer subsidy policy in India

In India, the price of fertilizers is controlled by a mix of government subsidy and market forces. Production, imports, and distribution are regulated by the Department of Fertilizers in the Ministry of Chemicals and Fertilizers. Urea prices are controlled by the government under the New Pricing Scheme (NPS), while non-urea fertilizer prices are market-determined but subject to partial subsidy by the Nutrient Based Subsidy (NBS) Scheme.

2.6.1-Urea Subsidy Scheme

"Urea Subsidy is part of the Central Sector Scheme. The scheme is entirely funded by the Government of India through Budgetary Support. The Urea Subsidy Scheme comprises three components: indigenous urea, imported urea, and uniform Freight subsidy. The Government of India has established the minimum retail price (MRP) of urea at Rs. 242 per 45 kg bag (excluding taxes). The urea manufacturing plants receive subsidies through concession rates (Normative Cost of Production under Existing Urea Policies), which include both fixed and variable costs" (Annual report 2023-24, Department of Fertilizers, Government of India).

Table-2.4

MRP of Urea (exclusive of Central/State levies/GST and charges towards neem coating)		
Year	**Rs. Per Bag**	**Rs. Per Quintal**
From 1.11.2012 to 28.02.2018	268 (Per 50 Kg Bag)	536
From 1.3.2018 to till date	242 (Per 45 Kg Bag)	538

Source: Government of India, ministry of chemicals and fertilizers, department of fertilizers

2.6.2 NBS Subsidy scheme

"The Nutrient-Based Subsidy (NBS) Scheme provides subsidized P&K fertilizers with a set level of subsidy based on their nutrient content. This amount is determined annually or biannually. DAP, Mono Ammonium Phosphate (MAP), MOP, Triple Super Phosphate (TSP), three grades of SSP, Ammonium Sulphate (AS), Potash Derived from Molasses (PDM), and the remaining 19 classes of NPKS Complex fertilizers are among the 28 grades for which it is suitable" (Ministry of Fertilizers, Government of India).

Table-2.5 Central subsidy on Fertilizers (2010-11 to 2024-25)

(Rs. Crore)

Year	Urea Subsidy				DBT	Nutrient based subsidy				Total subsidy
	Indigenous	Imported	Freight	Total		Indigenous P & K	Imported P & K	Total P & K	City compost	on all fertilisers
2010-11	15,081	6,454		21,535				40,766		62,301
				[24,337]				[41,500]		[65,837]
2011-12	20,208	13,716		33,924				36,089		70,013
				[37,683]				[36,108]		[73,791]
2012-13	20,000	15,133		35,133				30,480		65,613
				[40,016]				[30,576]		[70,592]
2013-14	26,500	11,538		38,038				29,301		67,339
				[41,853]				[29,427]		[71,280]
2014-15	38,200	12,223		50,423				20,653		71,076
				[54,400]				[20,667]		[75,067]
2015-16	36,000	12,278	2,200	50,478		11,969	9,969	21,938		72,415
2016-17	38,000	7,470 [1]	2,000	47,470	-	11,843	7,000	18,843	0.55	66,313
2017-18	31,974	7,223 [1]	5,000	44,197	26	14,337	7,900	22,237	7.26	66,468
2018-19	32,190	14,318 [1]	-	46,507	7	14,820	9,260	24,080	10.00	70,605
2019-20	43,050	11,699 [1]	-	54,749	7	15,906	10,429	26,335	33.85	81,124
2020-21	68,807	21,732 [1]	-	90,539	10	22,288	15,015	37,304	68.74	1,27,922
2021-22	56,538	44,439 [1]	-	1,00,976	12	31,931	20,795	52,726	43.71	1,53,758
2022-23	1,25,270	39,943 [1]	-	1,65,213	4	50,090	36,033	86,122	1.12 [2]	2,51,340
2023-24 (RE)	1,02,121	26,468 [1]	-	1,28,589	5	32,370	27,930	60,300	7.50 [2]	1,88,902
2024-25 (BE)	1,00,340	18,654 [1]	-	1,18,994	6	26,500	18,500	45,000	102.50 [2]	1,64,103

(RE) = Revised estimate. (BE) = Budget estimate. [ ] = Actual subsidy released.

[1] = Net, after recovery. Note: Totals may not exactly tally due to rounding of figures.

[2] = Additional provision on the scheme for promotion of flagging of merchant ships in India and policy on promotion of organic fertilizers.

Source: 1. Annual Reports, Department of Fertilizers, Government of India. 2. Expenditure Budget, Ministry of Finance, Government of India.

2.7 Pindimana Grama Panchayath

Pindimana is a village which It falls under the jurisdiction of Pindimana Gram Panchayat and the Kothamangalam Block Panchayat in Ernakulam District. It governs a total of 2 villages under its jurisdiction. The Gram Panchayat Pindimana is further subdivided into 13 Wards. Pindimana has a population of 12516, according to the 2011 Census. A considerable population of pindimana Grama Panchayat depends on agriculture, with key crops including bamboo, coconut, cocoa, banana, tapioca, arecnut, fruits, and vegetables.

2.8 Crude oil

“Crude oil is a naturally occurring liquid composed of hydrocarbons and organic compounds derived from ancient plants and animals. These organisms were covered by layers of sand, silt, and rock, subjected to heat and pressure, and finally transformed into a type of fossil fuel that is refined into useable products such as gasoline, diesel, liquefied petroleum gases, and feedstock for the petrochemical industry.

The majority of the world's crude oil reserves are located in places prone to political upheaval or where oil production has been disrupted due to political events. Several large oil price shocks have happened simultaneously with political events causing supply disruptions, most notably the historical events include the Arab Oil Embargo in 1973-74, the Iranian Revolution, the Iran-Iraq War in the 1980s, and the Persian Gulf War in 1990-91.Conflicts and political events in the Middle East, the Persian Gulf, Libya, and Venezuela have recently contributed to global oil supply interruptions, resulting in higher oil prices” (U.S. Energy Information Administration).

2.9 Crude oil price determination globally and in India

The crude oil price determination is not done by a single country, but rather forms through intricate interrelations of the global marketplace. The most widely used crude oil benchmarks are of two types, they are –

Brent crude (North Sea) – most used in Europe and Asia.

West Texas Intermediate (WTI) – widely used in USA.

The key determinants of global crude oil prices are:

- Crude oil Demand and Supply- As a fundamental concept, it remains constant, Increased Demand or decreased supply due to (natural disaster, war, OPEC cuts) leads to price surges.
- Geopolitical conflicts- wars and tensions in oil-producing countries or regions always guarantee supply chain disruption as well as price increase.
- OPEC Decisions- The organization of Petroleum Exporting Countries (OPEC) can lower the price of oil by increasing its production or raises it by cutting production.
- Currency Conditions – Strong and weak dollars impact oil pricing differently. For instance, a weak dollar decreases the global sales price.

- Speculation and Future Trading- Future trading of oil by investors is a pure example of dramatic impact on purchasing the oil in the future. (International Energy Agency (IEA)

2.9.1 Import prices of crude oil for India

Over 85 percentage of India's oil consumption is imported. The country does not have a policy and production for crude pricing domestically. Instead, India adopts Import Parity Pricing (IPP) and is benchmarked to Brent crude pricing. Furthermore, the pricing is affected by the exchange rate of dollar and rupee. Taxes at the centre and state levels, as well as excise duties and commissions paid to dealers, increase the pieces of goods sold at retail store.

During the last two decades, the world crude oil market experienced a series of dramatic price shocks with long-lasting economic impacts. The 2008 world financial crisis caused unprecedented price volatility, with crude oil prices initially spiking to historic levels before dropping precipitously. Oversupply and shifts in OPEC production tactics in the mid-2010s caused another massive decline. Even more recently, the 2020, COVID-19 pandemic triggered an unprecedented collapse of demand, temporarily pushing prices to record lows, before a sudden surge fuelled by supply shortages. The conflict in 2022 between Russia and Ukraine also further boosted global energy price volatility. These are particularly significant to agriculture since they directly impact fertilizer manufacturing costs, transportation costs, and general input prices, eventually determining farmers' revenues and cost structure.

2.10 Crude oil fertilizer price linkage

Crude oil and its byproducts are significantly used in the production of chemical fertilizers, so there is a strong link between global crude oil prices and fertilizer prices. Fertilizers especially nitrogen-based ones are made using natural gas or oil to produce. So, when oil prices change the fertilizer prices are affected.

- Direct production cost -When the oil prices go up, natural gas prices often rise too. Since both are used to make fertilizer, the production cost increases. This makes the fertilizer more expensive for farmers. For example, nitrogenous fertilizers are produced using natural gas or naphtha, both derived from petroleum.
- Agriculture demand- The higher oil prices leads to higher cost of cultivation to farmers, so farmers in order to reduce the cost of cultivation will reduce the fertilizer purchase this can in turn lead to reduction in demand which will affect the prices.
- Transportation cost- if oil prices rise the cost of shipping fertilizer also rises. This makes fertilizer more expensive for farmers.
- Biofuel demand- when oil is expensive, the usage of biofuels become more attractive crops like corn are used to make biofuels. To grow more of these crops' farmers, use more fertilizer which leads to further rise in fertilizer prices (Motorygin, 2024)

2.11 Debt and farmer vulnerability

When fertilizers become expensive due to an oil price increase, farmers, particularly smallholders, have higher cultivation expenses. Numerous smallholders' resort to borrowing to

cover costs, and thus they become more indebted. In areas where farm incomes are uncertain, like Pindimana Grama Panchayat in Kerala, this can lead to long-term financial strain, lower farm investment in quality improvements, and even extreme farmer distress in extreme circumstances.

2.22 Conclusion

This chapter has given an overview of the agricultural industry in India and Kerala, highlighting the importance of fertilizers in farming. It looked at the policies related to fertilizer subsidies and the trends in the crude oil market. The chapter discussed how global crude oil prices are determined and their impact on India. It also examined the relationship between crude oil prices and fertilizer costs. Since India heavily relies on imported crude oil and raw materials for fertilizer, changes in global oil prices greatly affect fertilizer production costs, subsidy spending, and farmers' expenses. Understanding this connection is key to realizing how shifts in crude oil prices affect fertilizer costs and the challenges farmers face, especially in Pindimana Grama Panchayat.

CHAPTER 3

EMPIRICAL ANALYSIS OF CRUDE OIL PRICE FLACTUATIONS AND THEIR IMPACT ON FERTILIZER PRICES

3.1 Introduction

This chapter presents an analysis based on secondary data regarding the movement of international crude oil prices over the past fifteen years and their connection to fertilizer prices in India. Crude oil is a key input in the production, processing, and transportation of fertilizers. So, changes in global energy markets often show up in fertilizer pricing patterns. To explore this, secondary data on international crude oil prices was collected from the Petroleum Planning and Analysis Cell. Fertilizer price was collected from the Department of Fertilizers Government of India. The study focuses on five major fertilizers: DAP, MOP, Ammonium Sulphate, SSP, and NPK. These fertilizers are widely used in Indian agriculture and make up a large portion of fertilizer consumption. In this chapter, trend analysis and volatility analysis are used to study the long-term movements and fluctuations in international crude oil prices during the study period. The correlation and regression analysis are also used to study the relationship between crude oil prices and fertilizer prices. The primary goal of this chapter is to analyse price patterns and variations over time and observe how changes in crude oil prices relate to movements in selected fertilizer prices.

3.2 Trend and Volatility in International Brent Crude Oil Prices for Past 15 Years

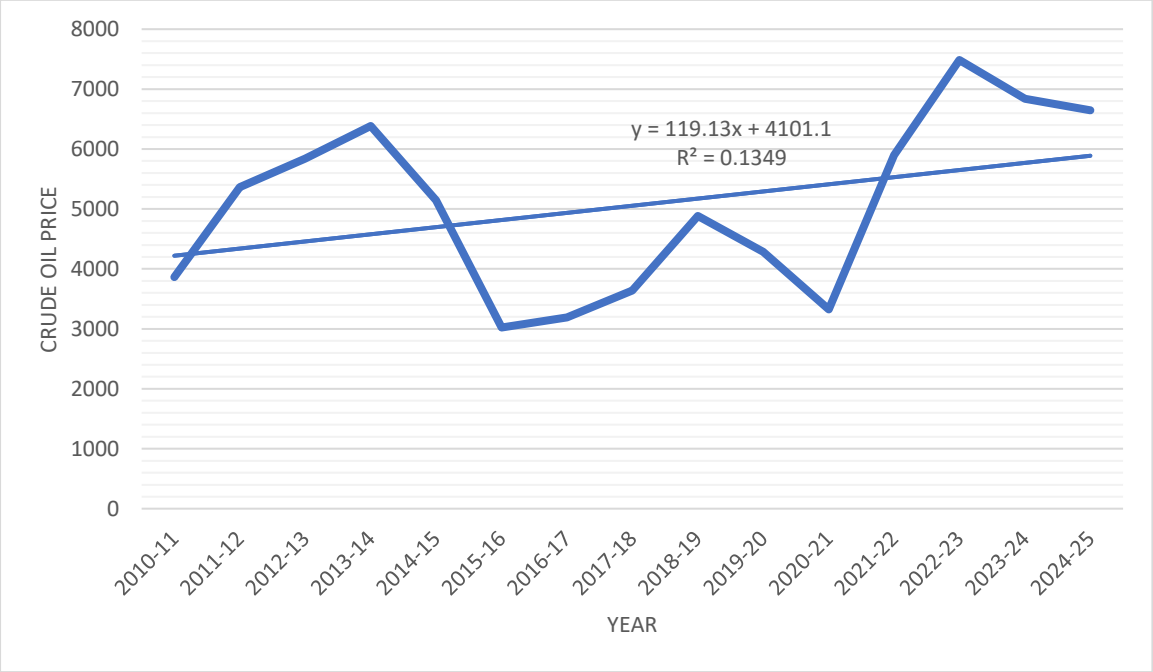
During the past few years, the crude oil prices are showing high volatility. This high volatility is due to multiple factors such as wars, terrorist attacks, geopolitical tensions, natural disasters, financial and economic downturns, OPEC ‘s production decisions, demand and supply shocks etc. some of the major events that have influenced the crude oil prices were the gulf war (1990-91), Asian crisis (1997), US terrorist attack (2001), Global financial crisis (2008), Arab spring (2010-11), COVID-19 pandemic(2020) , Russia-Ukraine war (2022). The data obtained from: Monthly statistical Bulletin, Department of Fertilizers, Government of India is used for this analysis.

TABLE 3.1 Brent crude oil prices from 2010-11 to 2024-25

YEAR	CRUDE OIL PRICES (₹/bbl.)	PERCENTAGE CHANGE (%)
2010-11	3865.587	-
2011-12	5362.096	+38.71
2012-13	5840.677	+8.92
2013-14	6384.162	+9.3
2014-15	5145.621	-19.4
2015-16	3022.394	-41.26
2016-17	3188.830	+5.51
2017-18	3636.987	+14.06
2018-19	4886.214	+34.35
2019-20	4287.200	-12.26
2020-21	3326.910	-22.4
2021-22	5899.324	+77.34
2022-23	7485.983	+26.88
2023-24	6836.777	-8.67
2024-25	6644.262	-2.82

Source: Petroleum planning and analysis cell, crude FOB price (Indian Basket)

Figure 3.1 Trend line analysis of brent crude oil prices over past 15 years.



Source: Petroleum planning and analysis cell, crude FOB price (Indian Basket)

The figure 3.1 reflects the trend of global crude oil prices for the past 15yrs (2010-11 to 2024-25) along with a linear trend line. The graph shows that there are considerable fluctuations in the crude oil prices over the past years reflecting the volatile nature of crude oil prices. The upward trend line indicates the overall increasing tendency crude oil prices in long term. These fluctuations and increasing trend of crude oil prices can be linked to several global events.

The linear trend shows positive slope of 119.13. This means that, on average, crude oil prices have increased annually during this period. However, the R^2 value of 0.1349 indicates that only 13.49 percent of the changes in prices are linked to the time trend. This suggests a weak linear relationship. The model's limited ability to explain the prices highlights the highly volatile nature of crude oil. Crude oil Prices are mainly influenced by external economic shocks, global supply and demand, and geopolitical issues, rather than a consistent time-based trend. Therefore, even with a slight upward movement, overall price changes show significant instability.

The table 3.1 shows the annual average brent crude oil prices (India Basket) and percentage change in the prices each year from 2010-11 to 2024-25.

The percentage change each year are calculate using the formula given below.

$$\text{Percentage change in price} = \frac{current\ year\ price - previous\ year\ price}{previous\ year\ price} \times 100$$

Positive % denote price increase.

Negative % denotes price decrease**.**

The data on Brent crude oil prices from 2010 to 2024 shows a clear pattern of cyclical volatility with a long-term upward trend. Prices rose from ₹3865.587 in 2010 to ₹6384.162 in 2013, reflecting a strong upward phase at the start of the decade. This growth phase ended abruptly during 2014 and 2015, when prices fell sharply, including a drop of 41.26% in 2015, bringing the price down to ₹3022.394. This period marks the largest decline in the series and highlights how sensitive crude oil markets are to changes in global supply and demand. After this drop, prices gradually recovered but faced another decline in 2020 when they fell to ₹3326.910 amid global economic disruption. The most notable event in this dataset is the remarkable increase of 77.34% in 2021, one of the highest annual rises in the whole period, pushing prices to a historic high of ₹7485.983 in 2022. Although a moderate correction occurred in the following years, prices in 2024 (₹6644.262) are still much higher than those at the start of this analysis. Overall, the evidence shows that crude oil prices experience significant volatility, marked by sharp declines and rapid gains instead of smooth adjustments. Despite short-term ups and downs, the long-term trend indicates a consistent upward movement, suggesting ongoing cost pressures for sectors that rely on oil.

3.2.1 Historical Trends and Major Events Influencing Brent Crude Oil prices.

1) Period Before 2010

The oil prices have experienced several fluctuations during the period before 2010. These fluctuations have been influenced by several global events. During the period between 1870-

1940 the crude oi prices rose during the first world war and fell during the great depression. (World Bank,2023).

Later, for a few following years the prices remained almost low and stable. The first major event that have influenced the crude oil price was in 1971 when the Bretton Woods monetary system was abandoned. This has resulted in fluctuations in the US dollar rate which in turn affected the crude oil prices which were in terms of US dollar. This was followed by the Yom Kippur War in 1973 which worsened the situation leading to First oil crisis. During this crisis the global crude oil prices quadrupled. (IMF, n.d; Planete energies, 2025)

Later in the Iranian Revolution in 1978 and Iran-Iraq war in 1980 led to second oil crisis which caused a sharp fall in oil supplies which in turn led to doubling of crude oil prices. (OPEC, 2023)

The rapid industrialization and the globalization in the 2000s led to the third oil crisis in 2003. The major cause of this crisis was the rising demand by the countries such as China, India, and Brazil. Until 2008 the growth of crude oil prices continued, but in 2008 the global economic crisis led to a sharp fall in the crude oil prices. (IMF,2009; World Bank, 2023)

2) Period From 2010-2025

During the period of 2010-2025 there were strong fluctuations in the global crude oil prices due to multiple factors.

In 2010, the world was recovering from the global economic crisis happened in the previous year and there was a strong rise in global demand which led increase in crude oil prices. There was a further increase in in crude oil price in 2011 due to Arab spring upspring which spread across North Africa and Middle East. This led to the fear of disruptions in oil producing regions such as Egypt, Syria and Libya which caused an increase in the crude oil prices (U.S Energy Information Administration, n.d).

During 2012 International sanctions were imposed on Iran. Since Iran was one of the major exporters of crude oil this has caused a severe supply shock. These sanctions caused reduction in the output, so the oil prices remained above $100 per barrel during 2013. In 2013 oil prices remained high because the rising demand for crude oil was very higher than its supply.

During 2014 the US Shale Oil Boom was a turning point which led to huge increase in the global supply of the crude oil. The production of crude oil in US rose which created an oversupply in the market which led to fall in the crude oil price. In 2015 OPEC refused to cut down its production which further worsened the situation which led to further fall in the prices. In 2016 the price even fell below $50 per barrel (OPEC, 2016).

By 2017 the prices started to recover after Saudi Arabia, Russia, Qatar, and Venezuela agreed to freeze the production of crude oil. In 2018 the sanctions on Iran were reimposed by US which reduction in the exports which further led to the reduction in the global supply of crude oil. By 2019 the U.S.-China war resulted in reduction in the demand which further led to reduction in the prices (World Bank,2023, planete energies, 2025).

In 2020 the world was hit by COVID-19 pandemic. Lockdown was imposed in almost all countries. Industrial activities, transportation and tourism nearly stopped in almost all countries. The oil demand was very less which led to the drastic fall in the crude oil prices which even fell below $20 per barrel. During the period the global crude oil prices was the lowest in the two decades (Internation Energy Agency, 2020).

The crude oil prices started to recover in 2021. the demand for crude oil started rising. In 2022 the Russia-Ukraine war happened which led to the imposition of sanctions of Russia by many Western countries, which led to a severe fall in the supply. The oil prices rose above $100 per barrel which created energy crisis in Europe (Internation Energy Agency, 2022).

In 2023 the voluntary production cut was introduced by OPEC which helped in stabilizing the prices. But in 2024 the production increased in non-OPEC countries like US ad Brazil which reduced the price. (OPEC,2023)

By 2025 there is a slight decrease in global crude oil prices due to weak global demand and shift towards sustainable energy sources (planete energies, 2025).

3.2.2 Mean (Average Price From 2010-2025)

$$\text{MEAN} = \frac{\sum Xt}{t}$$

∑Xt = sum of prices of t years

t = number of years

Mean = $\frac{75813.02}{15}$ = **₹5,054.02**

3.2.3 Volatility of Crude Oil Prices

Volatility refers to the amount by which the crude oil prices fluctuate over the given period. Crude oil market often experiences high volatility due to several factors like geopolitical tensions, wars, terrorist attacks, natural disasters, financial and economic downturns, OPEC 's production decisions, demand, and supply shocks etc.

Volatility is an indicator of stability of crude oil prices which helps us to identify the impact of several external events on crude oil prices.

Here the volatility of crude oil prices is measured using standard deviation (S.D) and coefficient of variation.

The entire study period is (2010-11 to 2024-25) is divided into three phases to capture the structural changes occurring in the crude oil prices over the period of time. These three phases represent pre-crash, post- crash adjustments and recent period of high volatility. This classification allows better comparison of volatility of crude oil prices at different period of time.

PHASE I – 2010-11 to 2014-15

PHASE II – 2015-16 to 2019-20

PHASE III – 2020-21 to 2024-25

PHASE- I – 2010-11 to 2014-15

Mean= $\frac{\sum Xt}{t}$

$= \frac{26,598.14}{5} =$ **₹ 5,319.63**

Standard Deviation (S.D) = $\sqrt{\frac{\sum(x-\bar{x})}{n-1}}$

$= \sqrt{\frac{3,550,023.7}{4}}$

$= \sqrt{887,505.925} =$ **942.21**

Coefficient of variation (CV) = Standard Deviation/Mean x 100

CV = $\frac{942.21}{5319.63}$ **x** 100 **=17.71%**

PHASE-II- (2015-16 to 2019-20)

Mean= $\frac{19,021.625}{5}$ **= ₹3804.33**

Standard Deviation (S.D) =

$= \sqrt{\frac{2,421,905}{4}}$

$= \sqrt{605,476.25} =$ **778.12**

Coefficient of variation (CV) =

$=$ $\frac{778.12}{3804.33}$ **x 100 =20.45%**

PHASE- III (2020-21 to 2024-25)

Mean$=\frac{30,193.256}{5}$ **= ₹6038.65**

Standard Deviation (S.D) =

$=\sqrt{\frac{10,468,394}{4}}$

$=\sqrt{2,617,098.5}$= **1,617.98**

Coefficient of variation (CV) =

$=\frac{1,617.98}{6,038.65}$**x 100 =26.79%**

Higher S.D indicates high volatility of crude oil prices.

Lower S.D indicates low volatility of crude oil prices i.e. stable crude oil prices.

During the **PHASE I** the standard deviation was ₹942.21 /barrel, which is highest among the other three phases, but the coefficient variation was lowest as compares to other two phases, so this indicates that although the crude oil prices were very high it remained relatively stable during this period.

During **PHASE II** the mean declined to ₹3804.33 which shows the global crude oil price crash. The standard deviation has declined slightly to 778.12. whereas the coefficient of variation rose to 20.45 per cent which shows greater relative volatility.

During **PHASE III** the global crude oil prices has shown partial recovery in prices. The mean rose to ₹6038.65 This phase shows the highest volatility among all other two phases with a standard deviation of 1,617.98 and coefficient of variation of 26.79 per cent. This indicates severe price instability, which was mainly caused by COVID-19 pandemic and several geopolitical conflicts.

3.3 The relationship between crude oil prices and fertilizer prices in India

The prices of five fertilizers namely MOP, Ammonium Sulphate, DAP, SSP and NPK are used in the study because they are widely used in Indian agriculture, so they reflect fluctuations in the fertilizer prices. Although urea is also, used by large number of farmers in India its prices has remained stable due to India's urea pricing policy.

The fertilizer prices also experience fluctuations due to several production and import related factors. Among the five fertilizers India depends largely on imports to meet its DAP and MOP demand. Although the fertilizers like Ammonium Sulphate, NPK and SSP are domestically produced many raw materials used in the production such as potash, sulphur, Rock phosphate, ammonia, and natural gases are imported. So, the changes in the international market prices, exchange rate fluctuations and global supply disruptions can cause the fluctuations in the crude oil prices. Other than this the transportation and logistics expenditure also contribute greatly to this expenditure.

The fertilizer production and distribution are heavily energy intensive especially in the case of crude oil- based fertilizers. The fluctuating crude oil prices affects the fertilizer prices by influencing the raw material cost, transportation cost, manufacturing cost and importing cost. In India the fluctuating crude oil prices are often reflected mostly in the energy dependent and imported fertilizers.

In this context the prices of fertilizers such as DAP, MOP, SSP, NPK and Ammonium Sulphate are analysed.

3.3.1 Correlation and regression analysis between crude oil prices and fertilizer prices

The relationship between crude oil prices and the fertilizer prices in India was analysed using correlation and regression analysis using the secondary data for the period 2018- 2025(March). The usage of the correlation and regression analysis provides statistical basis for the relationship between the crude oil prices and the fertilizer prices. The theoretical explanations only suggests that there may be a relationship existing between crude oil prices and fertilizer prices, but this relationship can be objectively measured only using these statistical tools. Therefore, these tools are essential for providing empirical validity for the study. The crude oil

price data obtained from petroleum planning and analysis cell, crude Fob price (India basket) and fertilizer price data obtained from: Monthly statistical Bulletin, Department of Fertilizers, Government of India are used for the analysis.

Table 3.2 The crude oil prices (in rupee/bbl.) for the period of 2018-2025(March)

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2018	4267.5	4090.14	4148.061	4543.292	5082.478	5004.879	5046.786	5044.537	5624.372	5896.671	4699.209	4086.322
2019	4192.198	4596.265	4637.008	4929.409	4885.075	4331.211	4378.066	4222.484	4402.949	4241.301	4468.059	4663.261
2020	4586.172	3905.228	2480.246	1517.235	2315.612	3077.073	3250.78	3299.753	3038.77	2986.676	3216.734	3667.897
2021	4005.998	4453.87	4711.841	4721.312	4905.499	5294.921	5480.646	5178.436	5379.746	6151.1	6007.197	5524.716
2022	6302.696	7055.37	8606.082	7842.694	8466.853	9057.542	8397.272	7749.022	7277.515	7550.501	7162.695	6440.532
2023	6627.502	6796.929	6462.904	6869.682	6174.228	6161.627	6602.424	7154.869	7768.208	7497.864	6951.665	6447.414
2024	6584.558	6771.645	7012.209	7459.622	6973.726	6890.762	7034.341	6566.621	6176.236	6312.691	6160.034	6232.62
2025	6918.181	6731.823	6278.34									

Source: petroleum planning and analysis cell, crude Fob price (India basket)

* The composition of Indian Basket of Crude represents Average of Oman & Dubai for sour grades and Brent (Dated) for sweet grade in the ratio of crude processed during previous financial year, e.g. ratio of crude processed as indicated in the table above.

3.3.1.a Correlation and regression analysis between crude oil prices and MOP prices

The MOP prices are largely import dependent, so it is sensitive to global price movements, so it is essential to understand whether fluctuations in the crude oil prices influence MOP prices in India**.** to examine the direction and strength of relationship between crude oil prices and fertilizer prices correlation and regression analysis is used.

Table 3.3-The Mop prices from 2018-2025(March)

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEM-BER	OCTOBER	NOVEMBER	DECEMBER
2018	12314.05	12360.39	12281.57	13114.96	13542.68	13687	13790.74	13911.34	14822.61	17898.63	17997.27	18038.31
2019	17996.66	18388.14	18979.82	18982.04	18983.44	18984.82	18993.36	18983.97	18984.98	18981.69	18986.55	18972.4
2020	18977.32	18976.87	18983	18984.94	18675.86	18120.84	18027.18	17934.27	17647.5	17645.64	17499.81	17472.5
2021	17468.88	174696	17498.16	18306.68	19058.45	19168.7	19485.45	19663.4	19949.7	20186.5	20218.44	28823.16
2022	31729.56	31819.56	31651.49	32328.32	33528.9	33849.5	33857.8	34199	34224.44	34225.73	343774.5	347737
2023	34806.34	34810.45	34823.93	34776.91	34717.96	34644.51	34620.28	34643.95	34676.34	34035.7	33624.02	33342.52
2024	33624.02	32888.06	32889.98	32934.77	32802.82	31692.46	31342.72	30850.72	30722.93	30516.38	30491.14	30525.28
2025	30525.28	30682.51	30733.01									

Source: Monthly statistical Bulletin, Department of Fertilizers, Government of Indi

Correlation analysis

The correlation analysis is used here to measure the strength and direction of crude oil prices and MOP prices.

Purpose: To identify whether the fluctuating crude oil prices significantly influence the MOP (Muriate of Potash) prices in India.

	Column 1	*Column 2*
Column 1	1	
Column 2	0.211659	1

Column 1 represents the crude oil prices in India.

Column 2 represents the MOP prices in India.

The result of the correlation analysis shows a positive relationship between the prices of crude oil and MOP prices, with a correlation coefficient of about 0.216569. This implies a weak positive relationship between the two variables. This means that as the prices of crude oil rise, the prices of MOP also tend to rise, but the strength of the relationship is quite low. The relationship exists but is not strong enough to suggest a close linear relationship between the two variables.

One of the main reasons for this weak correlation is that crude oil is not a direct raw material in the production of MOP. Even though crude oil prices have an effect on transportation costs, energy costs, and global trade costs, the prices of MOP are also affected by international supply conditions, import dependence, exchange rate fluctuations, and government policies. Hence, the effect of crude oil prices is only indirect.

Regression analysis

The correlation analysis only shows the degree pf association it does not show the extend of influence, so regression analysis is used to measure how much variation in MOP prices are explained by changes in crude oil prices.

Purpose: To identify the extent to which changes in crude oil prices influence MOP prices in India.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.475708
R Square	0.226299
Adjusted R Square	0.217196
Standard Error	0.216641
Observations	87

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.166832	1.166832	24.8615	3.22E-06
Residual	85	3.989328	0.046933		
Total	86	5.15616			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.297528	0.623169	2.082145	0.040336	0.058501	2.536555	0.058501	2.536555
X Variable 1	0.833467	0.167157	4.986131	3.22E-06	0.501114	1.165821	0.501114	1.165821

The regression analysis examines the extent to which changes in crude oil prices explain variations in MOP prices. The R^2 value of approximately 0.226299 indicates that about 22.63% of the variation in MOP prices can be explained by changes in crude oil prices. This suggests that crude oil prices have some explanatory power in determining MOP prices, but they do not account for the majority of price fluctuations.

Furthermore, the regression results show that the relationship between crude oil prices and MOP prices is statistically significant (p-value 3.22E-06 < 0.05). This means that the observed relationship is unlikely to have occurred due to random chance. Hence, crude oil prices do have a measurable influence on MOP prices, even though the overall explanatory strength of the model is moderate.

One important reason for this partial explanatory power is that MOP prices are largely determined by international market dynamics and import costs. Since India depends heavily on imports for MOP, global supply conditions, shipping costs, exchange rate fluctuations, and government subsidy mechanisms play a significant role. As a result, crude oil prices explain only a portion of the variation, while other structural and policy-related factors contribute substantially to price determination.

3.3.1.b Correlation and regression analysis between crude oil prices and Ammonium sulphate prices

Ammonium sulphate is a nitrogenous fertilizer which uses ammonia and sulphur mainly as its raw materials. Since these inputs are influenced by the crude oil prices. The fluctuations in the global crude oil prices can influence the fertilizer prices.

Table 3.4-The Ammonium sulphate prices from 2018-2025(March)

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2018	12916.98	12020.4	12020.4	12020.4	11972.8	11958.33	12020.4	11922.05	12020.4	12008.39	12497.68	13213.6
2019	13208.94	13213.6	13213.6	13213.6	13213.6	1321.6	13213.75	13213.6	13186.86	13207.94	13186.2	13156.3
2020	13166.31	13154.36	13176.14	13211.63	13155.26	13155.32	13164.41	13151.99	13154.7	13155.37	13155.37	13150.29
2021	13155.95	13155.37	13603	14823.51	15295.14	15319.2	15304.51	15914.62	16213.6	16326.48	16768.55	17436.76
2022	18751	19967.7	21496.5	22000	21834.1	20714.3	20714.3	20141	20000	20000	20393.6	20536.79
2023	20086.58	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
2024	20000	20000	20000	20000	19771.36	19158.54	18825.18	18821.43	18829.27	18829.01	18825.3	18821.43
2025	18821.43	18818.18	11821.43									

Source: Monthly statistical Bulletin, Department of Fertilizers, Government of India

Correlation analysis

The correlation analysis is used here to measure the strength and direction of crude oil prices and Ammonium Sulphate prices.

Purpose: To identify whether the fluctuating crude oil prices significantly influence the Ammonium sulphate prices in India.

	Column 1	*Column 2*
Column 1	1	
Column 2	0.802526	1

Column 1 represents the crude oil prices in India.

Column 2 represents the Ammonium Sulphate prices in India.

The correlation coefficient between the prices of crude oil and Ammonium Sulphate prices is roughly 0.802526, which indicates a strong positive correlation between the two variables. This implies that as the prices of crude oil rise, the prices of Ammonium Sulphate also rise. The strong value of the correlation coefficient indicates that the two variables are related to each other in the same direction to a large extent.

The main reason for this strong correlation is that the production of Ammonium Sulphate is energy-intensive and indirectly dependent on petroleum-based products. The changes in the prices of crude oil affect the energy costs, transportation costs, and distribution costs, which

have a large impact on fertilizer prices. Hence, the changes in the prices of crude oil are more directly related to the prices of Ammonium Sulphate than to other fertilizers.

Regression analysis

Regression analysis is used to measure how much variation in Ammonium sulphate prices are explained by changes in crude oil prices.

Purpose: To identify the extent to which changes in crude oil prices influence Ammonium sulphate prices in India.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.802526
R Square	0.644047
Adjusted R Square	0.63986
Standard Error	2258.004
Observations	87

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.84E+08	7.84E+08	153.7958	9.18E-21
Residual	85	4.33E+08	5098581		
Total	86	1.22E+09			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	5438.708	894.6221	6.079336	3.32E-08	3659.96	7217.457	3659.96	7217.457
X Variable 1	1.919216	0.154757	12.40144	9.18E-21	1.611517	2.226915	1.611517	2.226915

The regression analysis evaluates how much variation in Ammonium Sulphate prices can be explained by changes in crude oil prices. The R^2 value (approximately 0.644047) indicates that about 64.40% of the variation in Ammonium Sulphate prices is explained by fluctuations in crude oil prices. This reflects a substantial explanatory power, meaning crude oil prices play a dominant role in determining the movement of Ammonium Sulphate prices during the study period.

Furthermore, the regression results show that the relationship is statistically significant (p-value 9.18E-21< 0.05), implying that the observed impact of crude oil prices on Ammonium Sulphate prices is not due to random variation. The significant regression coefficient confirms that increases in crude oil prices lead to systematic increases in Ammonium Sulphate prices, strengthening the evidence of a strong economic linkage between the two variables.

The primary reason for this high explanatory power is that Ammonium Sulphate production heavily depends on energy inputs and industrial processes that are sensitive to fuel and

petroleum costs. Since energy constitutes a major component of production and transportation expenses, fluctuations in crude oil prices directly influence overall production costs, thereby significantly affecting market prices of Ammonium Sulphate in India.

3.3.1.c Correlation and regression analysis between crude oil prices and DAP

DAP is one of the most widely used phosphatic fertilizers in India. The country depends on imports to meet its demand. Since the international prices and the energy costs influence the production and import of DAP, the fluctuations in the crude oil prices may indirectly affect the crude oil prices.

Table3.5 The DAP prices from 2018-2025(March)

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2018	21991.24	23920.92	24177.65	24297.12	24731.28	25449.68	25706.15	26069.49	26721.37	27969.45	28623.3	28844.67
2019	28910.62	28613.78	28536.37	28515.44	28542.45	28440.62	27786.74	26628.21	26487.49	25657.31	25642.21	25226.9
2020	25155.1	25152.2	25215.77	24873.82	24953.48	24957.09	24852.24	24832.17	24818.29	24813.21	2479.55	24809.13
2021	24796.05	24866.23	26235.06	27839.49	31940.22	24000	24036.06	24000	24000	24000	24000	24000
2022	24006.07	24000	24220.79	26280.4	27000	27000	27000	27000	27000	27000	27000	27000
2023	26998.82	27000	27000	27000	27000	27000	27000	27000	26999.13	26998.4	26999.78	27000
2024	26999.78	27000	27000	27000	27000	27000	27000	27000	27000	27000	27000	27000
2025	28065.88	27000	27000									

Source: Monthly statistical Bulletin, Department of Fertilizers, Government of India

Correlation analysis

The correlation analysis is used here to measure the strength and direction of crude oil prices and DAP prices.

Purpose: To identify whether the fluctuating crude oil prices significantly influence the DAP (Di-ammonium Phosphate) prices in India.

	Column 1	*Column 2*
Column 1	1	
Column 2	0.278184	1

Column 1 represents the crude oil prices in India.

Column 2 represents the DAP prices in India.

The correlation coefficient between the prices of crude oil and the price of DAP is roughly 0.278184, which indicates that there is a weak positive correlation between the two variables. This means that as the price of crude oil rises, the price of DAP also tends to rise, although the strength of the correlation is quite low. The positive sign indicates that both variables tend to move in the same direction, but the magnitude of the correlation coefficient is quite low, which indicates that the relationship is not very strong and that the changes in crude oil prices are only weakly associated with the changes in DAP prices.

The main reason for this weak positive correlation is that the production of DAP is more directly associated with the use of ammonia and phosphoric acid as inputs rather than crude oil. Although crude oil has an indirect effect on the cost of transportation, energy costs, and global market trends, the prices of DAP are also significantly influenced by global supply-demand trends, import dependence, exchange rate fluctuations, and government subsidy policies. Hence, the effect of crude oil is still quite indirect.

Regression analysis

Regression analysis is used to measure how much variation in DAP prices are explained by changes in crude oil prices.

Purpose: To identify the extent to which changes in crude oil prices influence DAP prices in India

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.278184
R Square	0.077387
Adjusted R Square	0.066532
Standard Error	2905.121
Observations	87

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	60171843	60171843	7.129593	0.009083
Residual	85	7.17E+08	8439730		
Total	86	7.78E+08			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	23049.18	1151.01	20.02517	6.23E-34	20760.66	25337.7	20760.66	25337.7
X Variable 1	0.531647	0.199109	2.67013	0.009083	0.135765	0.92753	0.135765	0.92753

The regression analysis examines the extent to which variations in crude oil prices explain changes in DAP prices. The R^2 value (approximately 0.077387) indicates that only about 7.7% of the variation in DAP prices is explained by crude oil price fluctuations. This shows that crude oil prices have very limited explanatory power in determining DAP prices, and the majority of price variation is influenced by other factors not included in the model.

However, the regression results indicate that the relationship is statistically significant (p-value $0.009083 < 0.05$), meaning that crude oil prices do have a measurable effect on DAP prices and the relationship is unlikely to be due to random chance. Even though the impact is statistically significant, the low R^2 value confirms that crude oil is not the dominant factor affecting DAP price movements during the study period.

The primary reason for this limited explanatory power is that DAP prices are largely driven by global phosphate rock markets, ammonia prices, import costs, and government subsidy mechanisms in India. Since India relies heavily on imports for DAP and its raw materials, international market conditions and policy interventions play a more substantial role than crude oil prices alone, thereby reducing the overall influence of crude oil in the regression model.

3.3.1.d Correlation and regression analysis between crude oil prices and SSP

SSP is a phosphatic fertilizer commonly used in agriculture in India. SSP id produced domestically in India. However, its raw materials like rock phosphate and sulphur are influenced by international market prices. Although it is less import- dependents like DAP and MOP it is still affected by raw material prices and energy expenses.

Table 3.6 The SSP prices from 2018-2025(March)

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2018	7735.19	7227.47	7270.69	7533.68	7379.13	7363.5	7392.25	7438.204	7477.933	7352.766	7441.69	7634.93
2019	7574.912	7525.28	7444.52	7450.01	7669.09	7650.91	7727.28	7779.04	7770.13	77760	77856.52	7872.76
2020	7855.48	7783.74	7815.85	7875.64	7906.71	8092.13	8135.62	8123.694	7999.26	8114.712	8134.98	8334.114
2021	8272.511	8247.03	8310.36	8648.28	8394.35	7776.62	7670.61	7687.77	6949.54	6887.939	6891.28	6941.06
2022	6996.18	6979.37	7040.36	8274.62	10144.1	10710.6	10788.4	10479.3	10842.44	10979.22	10925.8	10624.07
2023	10535.65	10524.79	10457.98	10432.96	10003.78	10470.58	10530.61	10491.8	10468.37	10903.2	12051.09	12103.3
2024	12051.09	11583.95	11409.69	10974.09	10695.42	10446.72	10473.9	10417.19	10241	10042.67	10134.41	10275.02
2025	100474.3	10421.29	10329.64									

Source: Monthly statistical Bulletin, Department of Fertilizers, Government of India

Correlation analysis

The correlation analysis is used here to measure the strength and direction of crude oil prices and SSP prices.

Purpose: To identify whether the fluctuating crude oil prices significantly influence the SSP (Single Super Phosphate) prices in India.

	Column 1	*Column 2*
Column 1	1	
Column 2	0.045262	1

Column 1 represents the crude oil prices in India.

Column 2 represents the SSP prices in India.

The correlation coefficient between the crude oil prices and SSP (Single Super Phosphate) prices is about 0.045262, which is a very weak positive correlation between the two variables. The value is almost close to zero, and this indicates that there is no linear relationship between the crude oil price variations and the SSP prices. However, the positive correlation indicates that the relationship is weak and has no significance, and this implies that the variations in the crude oil prices have very little to do with the SSP prices.

The main reason for this very little correlation is that the SSP production process is less energy-dependent compared to other fertilizers and is based on phosphate rock and sulphuric acid, which are not dependent on crude oil. Additionally, the country's production and government pricing policies also influence the SSP prices.

Regression analysis

Regression analysis is used to measure how much variation in SSP prices are explained by changes in crude oil prices.

Purpose: To identify the extent to which changes in crude oil prices influence SSP prices in India.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.190732
R Square	0.036379
Adjusted R Square	0.025042
Standard Error	0.193041
Observations	87

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.119581	0.119581	3.208933	0.076796
Residual	85	3.167523	0.037265		
Total	86	3.287104			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.982956	0.555285	5.371939	6.69E-07	1.878901	4.087011	1.878901	4.087011
X Variable 1	0.266818	0.148948	1.791349	0.076796	-0.02933	0.562967	-0.02933	0.562967

The regression analysis examines how much variation in SSP prices can be explained by changes in crude oil prices. The R^2 value (approximately 0.036379) indicates that only about 3.6% of the variation in SSP prices is explained by crude oil price fluctuations. This very low explanatory power suggests that crude oil prices do not significantly determine SSP price movements and that most of the variation is influenced by other factors outside the model.

Furthermore, the regression results show that the relationship is not statistically significant (p-value 0.076796 > 0.05). This means that the observed association between crude oil prices and SSP prices may have occurred due to random variation rather than a systematic economic relationship. Therefore, crude oil price changes do not have a meaningful impact on SSP prices during the study period.

The primary reason for this weak explanatory power is that SSP prices are largely influenced by domestic production conditions, raw material availability, and government support policies rather than global energy price movements. Since SSP manufacturing relies less directly on petroleum-based inputs, fluctuations in crude oil prices do not substantially affect its production cost or market price in India.

3.3.1.e Correlation and regression analysis between crude oil prices and NPK

NPK is a kind of fertilizer composed of nitrogen (N), phosphorus (P), and potassium (K). Its production uses several raw materials, including ammonia, rock phosphate, and potash. A large share of these materials is imported or affected by changes in global market prices. The cost of NPK is impacted by energy prices and the price of imported materials. Changes in crude oil prices can indirectly influence its market price. Therefore, it is important to examine whether there is a statistical link between crude oil prices and NPK prices.

Table 3.7 The NPK prices from 2018-2025(March)

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
2018	18018.49	19425	19425	19425	19425	19425	27153.42	19425	19425	19676.33	20194.9	20680
2019	20680	20680	20680	20680	20791.11	21200	21200	21200	22000	21200	21200	21200
2020	21200	21200	21200	21200	21200	21200	21200	21207.27	21207.27	21215.09	21207.84	21200
2021	21208.16	21200	21200	21200	21200	23600	23600	23607.41	23607.6	27000	27000	279200
2022	28038.46	30025	30000	30000	29412.2	29400	29400	29400	29400	29400	29400	29400
2023	29400	29400	29400	29400	29400	29400	29400	28403.39	28000	28000	29367.44	29400
2024	29367.44	29400	29400	29400	29400	29400	29400	29400	29400	29400	29400	29400
2025	29611.76	33000	33000									

Source: Monthly statistical Bulletin, Department of Fertilizers, Government of India

Correlation analysis

The correlation analysis is used here to measure the strength and direction of crude oil prices and NPK prices.

Purpose: To identify whether the fluctuating crude oil prices significantly influence the NPK prices in India.

	Column 1	*Column 2*
Column 1	1	
Column 2	0.12652	1

Column 1 represents the crude oil prices in India.

Column 2 represents the NPK prices in India.

The correlation coefficient between the prices of crude oil and NPK prices is about 0.12652, which shows a weak positive correlation between the two variables. This implies that as the prices of crude oil rise, the prices of NPK also tend to rise, but the strength of the correlation is low. The coefficient is positive but of low magnitude, which shows that the relationship between the prices of crude oil and NPK prices is not strong and that the two variables are not closely related in their movements.

The main reason why the correlation coefficient between the prices of crude oil and NPK prices is low is that the prices of NPK fertilizer are dependent on several raw materials like nitrogen, phosphorus, and potassium, most of which are affected by the international commodity market and not just the price of crude oil. Even if the price of crude oil affects the transportation and energy costs, the prices of NPK are also affected by factors like import dependence, international demand for fertilizer, exchange rate variations, and government subsidy policies. Hence, the effect of crude oil prices on NPK prices is not direct.

Regression analysis

Regression analysis is used to measure how much variation in SSP prices are explained by changes in crude oil prices.

Purpose: To identify the extent to which changes in crude oil prices influence NPK prices in India

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.433738
R Square	0.188129
Adjusted R Square	0.178577
Standard Error	0.123355
Observations	87

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.299711	0.299711	19.69642	2.71E-05
Residual	85	1.293402	0.015216		
Total	86	1.593113			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.830574	0.354832	7.977224	6.29E-12	2.125073	3.536075	2.125073	3.536075
X Variable 1	0.422411	0.095179	4.438065	2.71E-05	0.23317	0.611653	0.23317	0.611653

The regression analysis measures the extent to which variations in crude oil prices explain changes in NPK prices. The R^2 value of approximately 0.188129 indicates that about 18.8% of the variation in NPK prices is explained by fluctuations in crude oil prices. This suggests that crude oil prices have some explanatory power in determining NPK price movements, but they are not the dominant factor influencing price changes.

Furthermore, the regression results show that the relationship is statistically significant (p-value 2.71E-05< 0.05). This implies that the impact of crude oil prices on NPK prices is not due to random variation and that there exists a measurable economic relationship between the two variables. Even though the explanatory power is moderate, the statistical significance confirms that crude oil price fluctuations do have a systematic influence on NPK prices during the study period.

The primary reason for this moderate explanatory power is that NPK production and pricing involve multiple cost components, including imported raw materials and blending processes, in addition to energy costs. Since crude oil mainly affects energy and transportation expenses, it explains only part of the total variation in NPK prices, while other structural and policy-related factors contribute substantially to price determination.

3.4 Conclusion

Analysis of the data reveals that the international crude oil prices have been extremely volatile over the last fifteen years, with sudden spikes and drops due to various global economic shifts, geopolitical issues, and events such as the COVID-19 pandemic. While the overall trend

suggests a positive movement, the fluctuations suggest the unpredictability of the global oil market. The findings from the correlation and regression analysis reveals that the influence of crude oil prices on different fertilizers is not similar, and while it has a strong influence on Ammonium Sulphate fertilizer, it has a moderate influence on NPK and MOP fertilizers, and a weak or negligible influence on DAP and SSP fertilizers. This clearly reveals that the level of dependence on energy inputs, import orientation, and production structure defines the degree of sensitivity of fertilizer prices to crude oil prices. In summary, the findings clearly establish that while crude oil prices are a crucial determinant, fertilizer price fluctuations are also significantly influenced by domestic policies, subsidy arrangements, international supply trends, and raw material dependence.

CHAPTER 4

THE IMPACT OF FERTILIZER PRICE FLACTUATIONS ON COST OF CULTIVATION AND INCOME OF FARMERS OF PINDIMANA GRAMA PANCHAYATH

4.1 Introduction

This chapter provides a critical examination of the effect of fertilizer price fluctuations on the cost of cultivation and the farmer's income. The main objective of this study is to understand the effect of fertilizer price fluctuations on the overall agricultural expenditure and the economic condition of the farmers. As fertilizers are a key component of agricultural expenditure, an increase or decrease in fertilizer prices will have a direct impact on the overall cost of production and, consequently, the net income of the farmers. The analysis aims to identify the extent of this impact and to examine how farmers adjust their cultivation practices in response to price changes.

The study is conducted using primary data obtained from the farmers of Pindimana Grama Panchayath, which comprises 13 wards. Representatives from all 13 wards were chosen for the study to ensure a comprehensive and well-represented sample. The data obtained was processed using percentage analysis, graphical analysis, and weighted average ranking technique to interpret the findings of the study and determine the severity of the effect of fertilizer price variability on the farmers in the study area.

4.2The impact of fertilizer price fluctuations on the cost of cultivation and income of farmers in Pindimana Grama Panchayat

This session focusses on the impact of price fluctuations on the cost of cultivation and the income of farmers of Pindimana Grama Panchayath.it examines how the fluctuations in fertilizer prices influence the income, profitability and expenditure patterns of farmers.

4.2.1 GENERAL PROFILE OF FARMERS

The general profile of the farmers gives idea about the basic socio-economic characteristics of the farmers such as age and educational level.

Table 4.1 Age wise distribution of farmers

AGEGROUP (YEARS)	FREQUENCY	PERCENTAGE%
BELOW 30	2	5.71
31-40	4	11.43
41-50	10	28.57
ABOVE 50	19	54.29
TOTAL	35	100

Source: Primary data

The table 4.1 indicates that majority of the farming population in the study area is dominated by the older farmers, with more than half the respondents belonging to the age group above

50yrs (54.29%). There is also a significant share of middle-aged farmers. This shows lower participation among the youth in agricultural activities in the Pindimana Grama panchayath.

Table 4.2 Educational status of farmers

EDUCTIONAL LEVEL	FREQUENCY	PERCENTAGE%
PRIMARY	7	20
SECONDARY	10	31.43
HIGHER SECONDARY	16	45.71
GRADUATE AND ABOVE	2	2.86
TOTAL	35	100

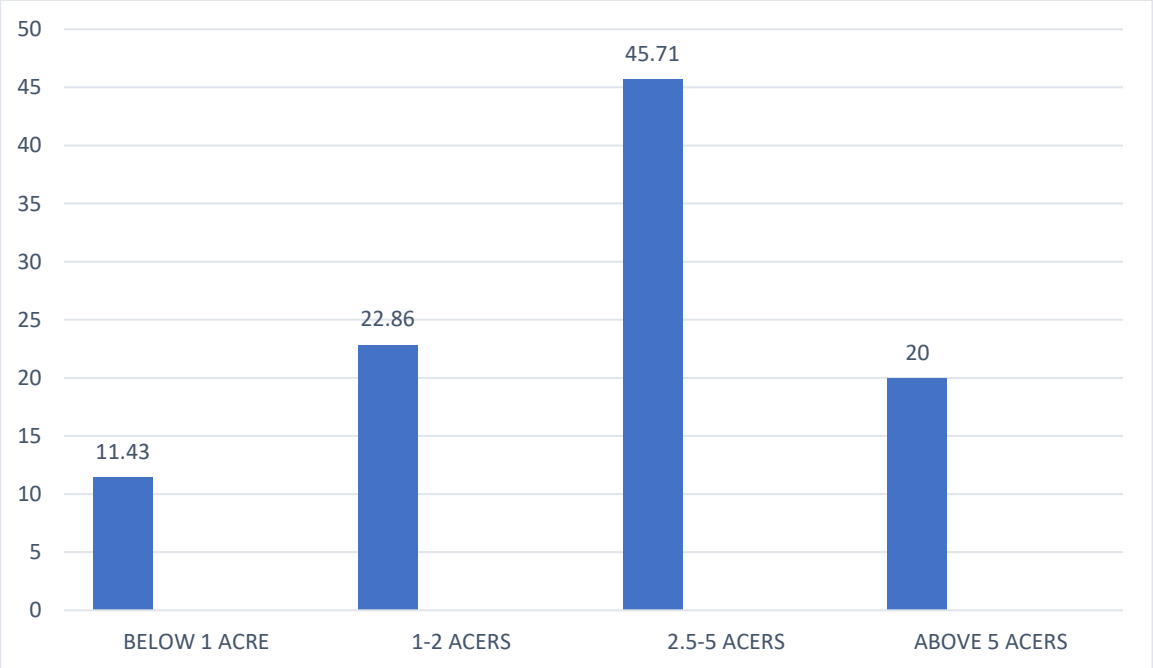
Source: Primary data

The table 4.2 shows that most of farmers (45.71%) have attained higher secondary education, followed by the farmers with secondary education. This indicates moderate educational attainment among the respondents. Only a very few farmers have attained education at the graduate level or more.

4.2.2 SIZE OF LAND HOLDINGS AND CROPPING PATTERN

The size of land holdings indicates the scale of farming activities, and the cropping Pattern indicates the types of crops cultivated by the farmers.

Figure: 4.1 Distribution of farmers by size of land holdings



Source: Primary Data

The figure 4.1 reveals that majority of farmers (45.17%) belongs to 2.5-5 acers category indicating the predominance of medium landholders in the pindimana Grama Panchayath. This is followed by small of farmers owning 1-2 acers of land. The smallest share is observed among the marginal farmers with below one acers of land. The distribution given above indicates the overall dominance of medium-scale farmers.

Table 4.3 Crops cultivated by farmers.

CROP	FREQUENCY	PERCENTAGE
PADDY	6	17.14
COCONUT	33	94.29
ARECANUT	28	80
RUBBER	20	57.14
BANANA	18	51.43
NUTMEG	15	42.86
PEPPER	19	54.29
TAPIOCA	8	22.86
COCOA	20	57.14
VEGITABLES	10	28.57
FRUITS	9	25.71

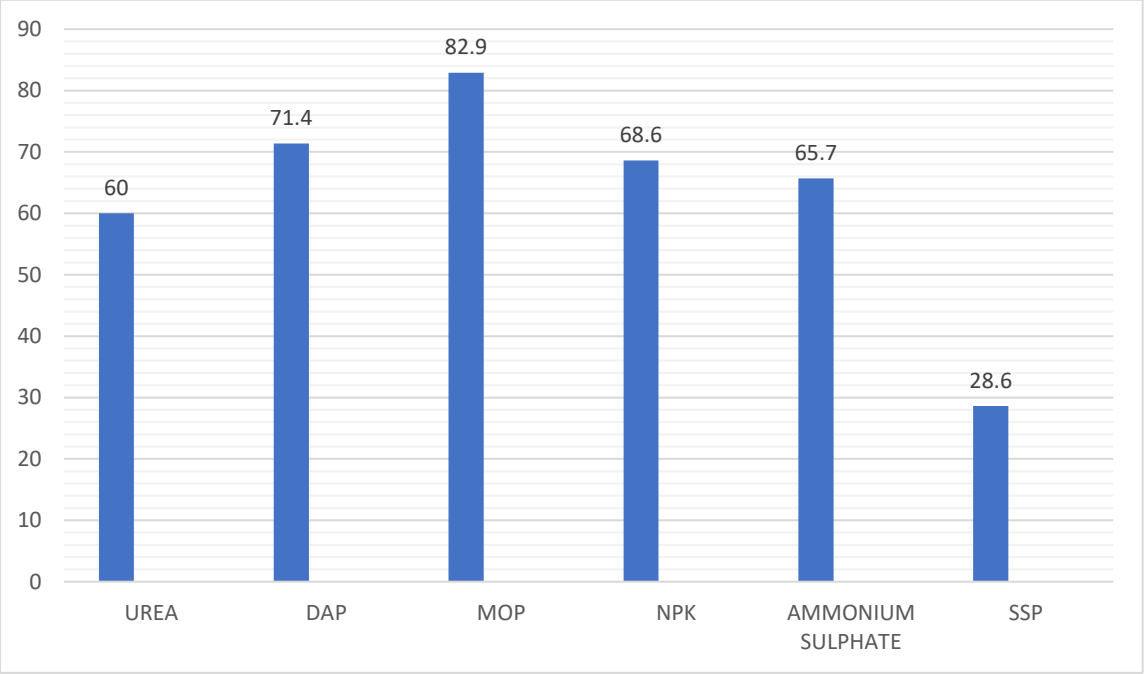
Source: Primary data

The table 4.3 shows that coconut is the most cultivated crop, which is cultivated by 94.29% of the farmers, followed by arecnut. whereas crops such as rubber, banana cocoa and pepper are cultivated by more than half of the respondent, this reflects a diversified cropping pattern in Pindimana Grama Panchayath. The paddy cultivation is very less indicating a shift from the cultivation of traditional crops.

4.2.3 FERTILIZER USAGE PATTERN

the fertilizer usage pattern includes the types of fertilizers used by the farmers of Pindimana Grama Panchayath and their share in the total cost of cultivation.

Figure 4.2 Types of fertilizers used by farmers.



Source: primary data

Among the chemical fertilizers used by the farmers of Pindimana Grama Panchayath MOP is the most widely used fertilizer followed by DAP and NPK, indicating high demand for potassium based and phosphorous based fertilizers. Ammonium sulphate and urea are also used widely whereas the SSP is the least preferred fertilizer.

Table 4.4 Share of fertilizer expenditure in total cultivation cost

SHARE OF FERTILIZER COST IN TOTAL COST OF CULTIVATION	FREQUENCY	PERCENTAAGE (%)
LESS THAN 10%	4	11.4
10-20%	10	28.6
20-30%	16	45.7
ABOVE 30%	5	14.3
TOTAL	35	100

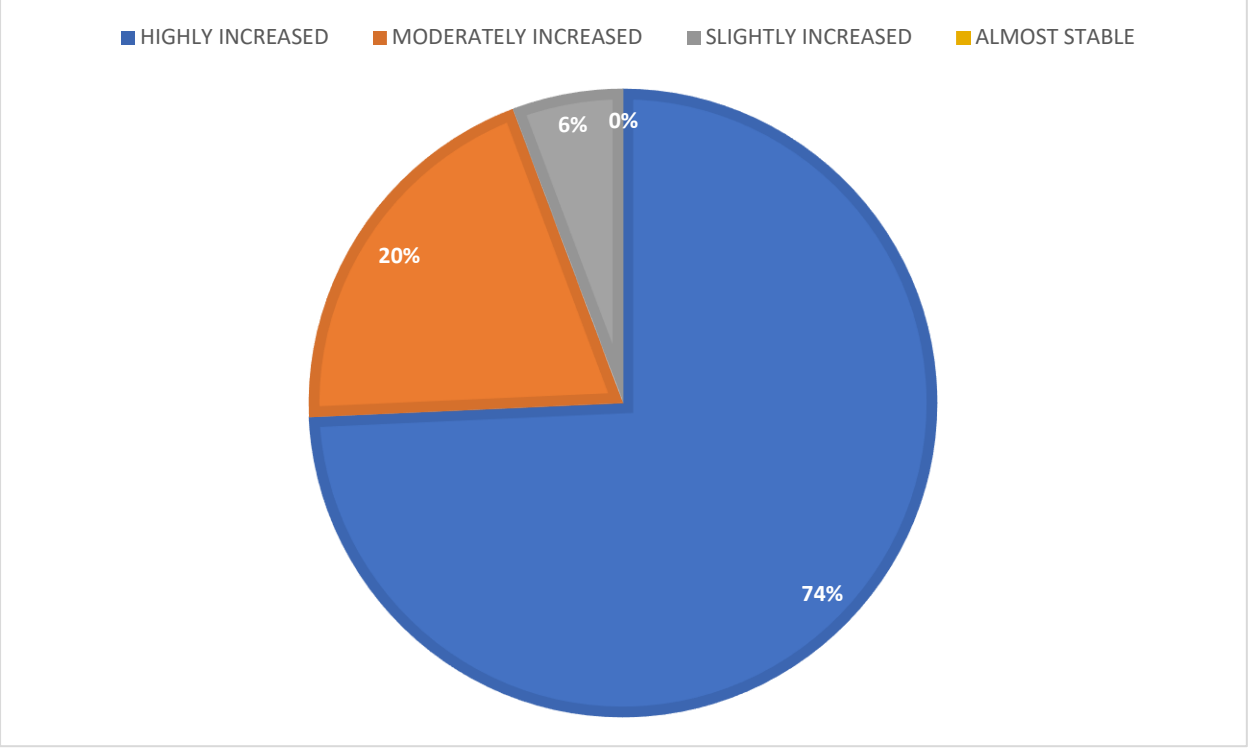
Source: Primary data

The table 4.4 shows that a major proportion of the farmers spend per cent of their cultivation cost on fertilizers, indicating that fertilizer is an important cost component in agriculture. Only a small proportion of farmers spend above 30per cent, which include mostly large-scale farmers, whereas Only a few percentages of farmers spend less than 10 per cent on fertilizers.

4.2.4 FERTILIZER PRICE FLACTUATIONS

This session analyses the farmers perception on fertilizer price changes during the last ten years and fertilizers with the highest price increase according to the farmers.

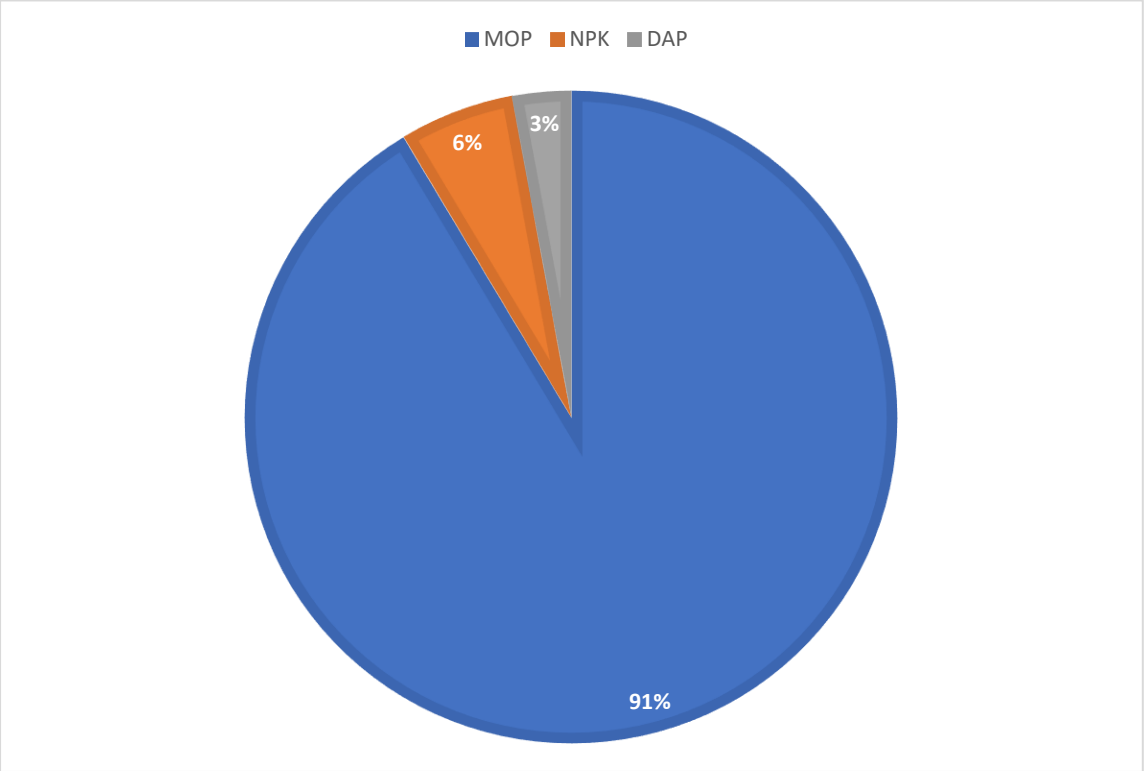
Figure 4.3 Farmers perception on fertilizer price changes during last ten years



Source: Primary data

Most of the farmers perceived that the fertilizer prices have highly increased during the past 10 years. While some of the farmers believe that fertilizer prices have moderately increased. Only few among the farmers believes that there has been only a slight increase in the fertilizer prices. No one among the farmers thinks that fertilizer prices almost remained stable. This shows that there is widespread concern over the rising fertilizer prices in the study area.

Figure 4.4 Fertilizer with highest price increase (farmers opinion)



Source: Primary data

The majority of farmers were of the opinion that MOP is the fertilizers with the highest price increase, which means that it is the fertilizer that is contributing highest to the rising cultivation costs. The NPK was reported as the second expensive fertilizer type, followed by DAP. This indicates that the potassium-based fertilizers are the ones contributing highly to the cultivation cost.

4.2.5 IMPACT OF FERTILIZE PRICE FLACTUATIONS ON THE COST OF CULTIVATION OF THE FARMERS

This section allows farmers to rank the inputs on the basis of their contribution to the increase in their cost of cultivation and changes that happened in the fertilizer application due to the rising prices.

Table 4.5 Ranking of input costs contributing to increase in the cultivation cost.

INPUT	WEIGHTED MEAN SCORE	RANK
FERTILIZER	4.69	1
LABOUR	4.26	2
IRRIGATION	3.06	3
PESTICIDES	2	4
SEEDS	1	5

Source: Primary data

The weighted ranking method is used to rank different fertilizers based on their contribution to the increasing cost of cultivation. The table 4.5 shows the results of the weighted ranking method used, which shows that majority of farmers ranked fertilizer rank one with the highest weighted mean score of 4.69, so it is the input which contributes highly to the cultivation cost. Labor is ranked second which shows its crucial role is deciding agricultural cost. Irrigation is ranked third indicating its moderate level contribution to the cultivation expenses. In contrast the pesticides and the seeds are ranked 4^{th} and 5^{th} indicating that they contribute relatively low to the agricultural expenses.

Table 4.6 Change in fertilizer application due to rising prices.

CHANGE IN APPLICATION	FREQUENCY	PERCETAGE
REDUCED QUANTITY	9	25.71
MAINTAINED SAME QUANTITY	4	11.43
INCREASES ORGANIC INPUTS	16	45.71
SHIFTED TO ALTERNATIVES	6	17.14
TOTAL	35	100

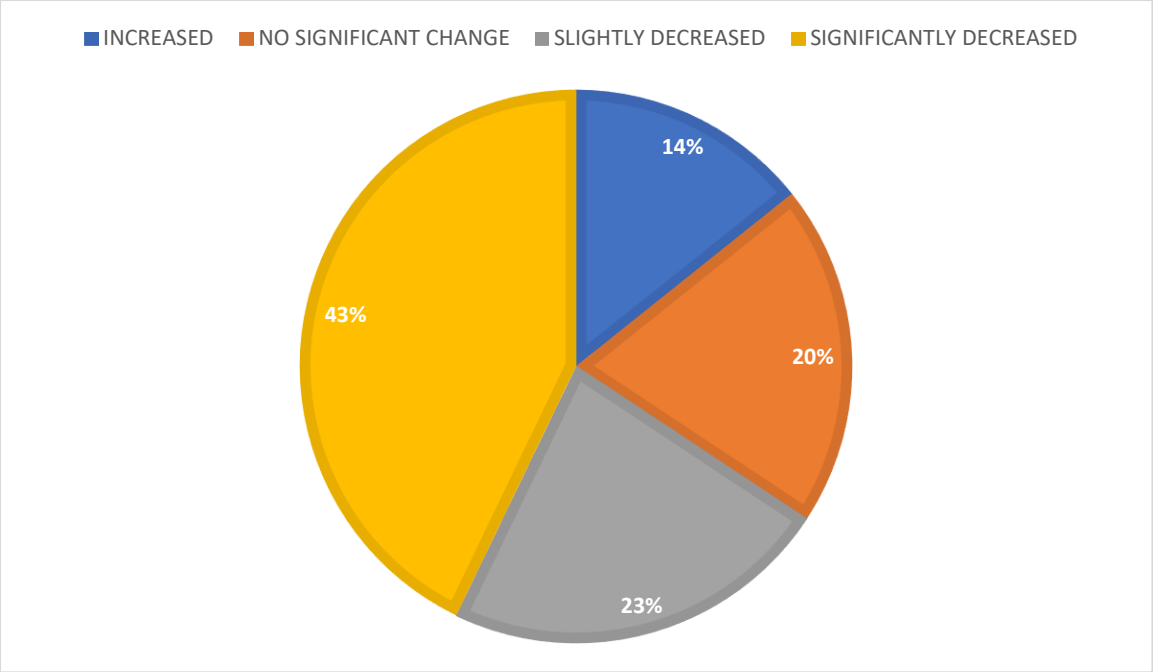
Source: Primary data

The rising fertilizer prices have caused significant changes in the fertilizer usage pattern among the farmers of Pindimana Grama Panchayath. Nearly to the half of the farmers have increased the usage of organic inputs, while many of the have reduced the quantity of fertilizer usage. This reflects various strategies adopted by the farmers to deal with the rising fertilizer cost.

4.2.6 IMPACT ON INCOME AND FARM DECISIONS

This session analyses the changes in the crop yield and the farmer profitability after the fertilizer adjustments due to the rising prices.

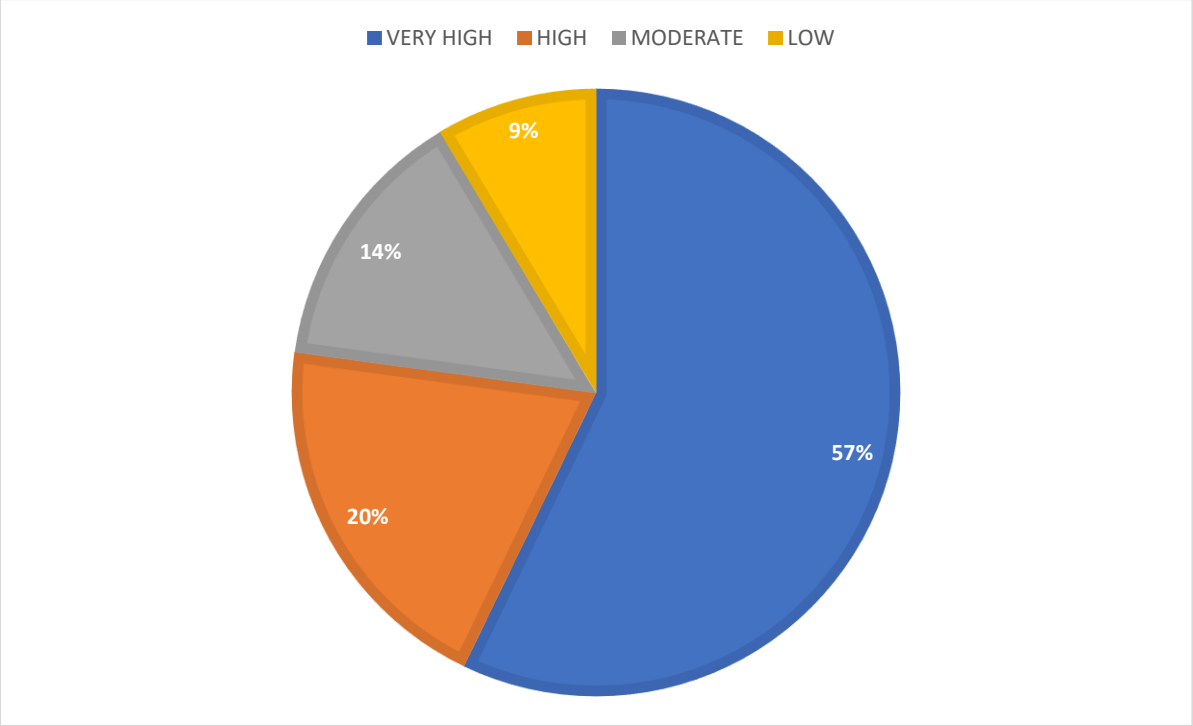
Figure 4.5- Changes in crop yield after fertilizer adjustment



Source: Primary data

The diagram 4.5 reflects that the increasing fertilizer prices which resulted in changes in the fertilizer usage pattern have negatively affected the crop yield, while only a small proportion of farmers experienced an improvement in the crop yield. This suggest that the reduced or adjusted fertilizer application have adversely affected the productivity.

Figure 4.6 – Extent to which fertilizer price increase affect Farm profitability.



Source: Primary data

The impact of fertilizer price increase on the farmer profitability is severe in the study are. A majority of the farmers reported a very high impact on profitability, while others experienced high or moderate effects. Only small proportion of the of farmers felt that the impact was low.

4.3 Conclusion

The farmers of Pindimana Grama Panchayat felt that fluctuations in fertilizer prices have significantly increased their cost of cultivation, with many reporting that a considerable share of farm expenditure is now devoted to fertilizer purchase. A large proportion of farmers perceived that fertilizer prices have risen sharply over the past decade, which has created financial pressure and compelled them to modify input use patterns. The findings also indicate that commonly used fertilizers such as MOP, DAP, and NPK continue to dominate farm practices, making farmers more vulnerable to price increases in chemical fertilizers.

The farmers further reported that rising fertilizer prices have led to adaptive responses such as reducing fertilizer usage, shifting towards organic inputs, and exploring alternative nutrient sources. However, these adjustments were often associated with concerns regarding reduced crop yield and productivity, highlighting the trade-off between cost management and output stability. Overall, the findings suggest that fertilizer price volatility has had a noticeable impact

on both cultivation costs and income levels, with a majority of farmers experiencing moderate to severe economic effects on their farming operations.

CHAPTER 5
FINDINGS, CONCLUSIONS AND RECOMENDATIONS

5.1 FINDINGS

OBJECTIVE-1- To analyse the trend and volatility of international crude oil prices over the past 15 years.

- The study analysed the brent crude oil prices for the period 2010-11 to 2024-25. The crude oil prices have shown frequent ups and downs during this period indicating highly volatile nature of the crude oil prices. These frequent fluctuations where related to several global, economic, geopolitical and supply side factors.
- The long term global brent crude oil price trend line during the last fifteen years has shown an upward sloping which indicates that despite of several downturns the global crude oil prices has shown an upward rising trend.
- The 2022-23 period shows the highest crude oil price (Rs.7,485.98/bbl.), while the lowest price was recorded during 2015-16(Rs3,022.39/bbl.).
- During the initial phase (2010-11 to 2013-14), there is a consistent increase of global crude oil prices due to several factors such rising global demand, post-global financial crisis recovery and supply disruptions caused by Arab spring.
- A huge structural break was observed during the period 2014-15 to 2015-16 during which there was a drastic decline in the crude oil prices which was caused by US shale oil bloom, excess global supply and production strategies followed by OPEC.
- Due to renewed sanctions by Iran and production freezes by major oil- producing countries the crude oil prices exhibited a moderate recovery phase during the period from 2016-17 to 2018-19.
- During the period from 2019-20 to 2021-22 the crude oil prices have again shown a drastic decline due to the COVID-19 pandemic and global lockdown.
- A strong recovery of prices occurred during the period 2021-22, with highest annual percentage increase of +77.43%, this was mainly due to the supply disruptions caused by Russia – Ukraine war.
- During the recent period the crude oil prices have shown a declining trend due to increase in production by OPEC countries and shift towards renewable sources of energy.
- The year wise percentage change analysis revealed that out of all the years considered 8 years recorded growth and 6 years recorded negative growth. Indicating unstable nature of global crude oil prices.
- The average crude oil price during the entire study period is Rs5,054.02/ bbl. Indicating that the mean price remains high despite of the instabilities.
- Volatility analysis using Standard Deviation and coefficient of variation revealed that-
    - Phase I (2010-11 to 2014-15) has shown relatively high prices with lower volatility.
    - Phase II (2015-16 to 2019-20) due to market uncertainty and supply demand imbalance shows lower standard deviation with higher volatility.

- Phase III (2020-21 to 2024-25) – shows the highest market volatility due to extreme price instabilities due to COVID-19 pandemic, energy market disruptions and geopolitical tensions.

The overall analysis reveals that the crude oil prices have remained highly volatile during the past fifteen years and had shown a fluctuating trend due to several global, economic, geopolitical and supply side factors.

OBJECTIVE -2 - To examine the relationship between crude oil prices and fertilizer prices in India.

- Effect of crude oil price fluctuations on the fertilizers-m MOP, Ammonium Sulphate, DAP, SSP and NPK.

MOP

- The crude oil price changes explain 22.6% of price variation in MOP.
- The crude oil price increase causes small but significant rise in MOP prices.

Ammonium Sulphate

- The crude oil price changes explain 64.4% of price variation in Ammonium Sulphate.
- The crude oil price changes strongly and directly affect Ammonium Sulphate prices.

DAP

- The crude oil price changes explain 7.7% of price variation in DAP.
- The crude oil price increase causes minor but significant rise in DAP prices.

SSP

- The crude oil price changes do not significantly affect the SSP prices, which means that SSP prices are independent of crude oil price fluctuations.

NPK

- The crude oil price changes explain 18.8% of price variation in NPK.
- The crude oil price increase causes limited but significant rise in NPK prices.

OBJECTIVE -3 - To assess the impact of fertilizer price fluctuations on the cost of cultivation and income of farmers in Pindimana Grama Panchayat

- The study analysed the data collected from 35 Farmers of Pindimana Grama Panchayat
- The majority of farmers (54.29%) were over 50, indicating a low level of youth involvement in farming.
- 31.43% of farmers had secondary education, while the majority (45.71%) had higher secondary education.
- Medium farmers (2.5–5 acres) made up the majority (45.17%), followed by those with 1-2 acres (22.86%).
- The most widely grown crops were coconut (94.29%) and arecanut (80%).
- The most popular fertilizer was MOP (82.9%), which was followed by DAP (71.4%) and NPK (68.7%); the least popular was SSP (28.6%).
- About 45.7% of farmers spend 20-30% of cultivation cost on fertilizers.
- Although most farmers (74%) believe that fertilizer prices have risen extremely in the past 10 years,
- The price rise of fertilizers impacted the decision of farmers as 45.71% opted for organic inputs, 25.7% cut back on fertilizers, and 17.14% shifted to alternatives.
- About 43% of the farmers indicated that there was a significant reduction in yield due to the increase in fertilizer price.
- Profits were also significantly impacted, with severe impacts observed as very high among 57%, and high among 20%.

5.2 Recommendations

Based on the analysis of fluctuations in fertilizer prices and their impact on farmers' expenses and earnings, several measures are recommended to alleviate adverse effects and enhance agricultural stability. These recommendations emphasize maintaining consistent prices, decreasing dependence on imported goods, promoting sustainable practices, and safeguarding the financial security of farmers. By putting these approaches into action, it is possible to protect farmers from market volatility while fostering long-term productivity and sustainability in agriculture.

- Enhance Domestic Fertilizer Manufacturing.
- Boost local production to reduce dependence on imports and mitigate the influence of international oil price variations.

- Reinforce Price Stabilization Frameworks.
- Develop strategies to ensure fertilizer prices remain stable during periods of significant market fluctuations. Targeted Support Programs.
- Provide financial aid specifically for small and marginal farmers to safeguard their incomes and sustain agricultural activities.

5.3 Conclusion

The crude oil prices have been highly volatile during the past 15 years i.e., there had been several ups and downs in the crude oil prices. These fluctuations where related to several global, economic, geopolitical and supply side factors. To an extent the fertilizer prices in India had been affected by this high volatility of crude oil prices. The prices of fertilizers such as MOP and Ammonium sulphate show strong and statistically significant relationship with the crude oil prices fluctuations. Whereas prices of fertilizers such as DAP and NPK show only limited impact and SSP prices almost remains unaffected. The study also reveals that the increasing fertilizer prices have created a huge burden on farmers of Pindimana Grama panchayat. The rising fertilizer prices have significantly reduced the yields and profitability. Due to this many farmers have reduced the quantity of fertilizer usage; many have shifted to alternatives, and many have increased the usage of organic inputs. So, this study reveals that the fertilizer price fluctuations directly affects both farm income and farming decisions.

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  Petroleum Planning and Analysis Cell — https://ppac.gov.in/
- U.S. Energy Information Administration — https://www.eia.gov/
- World Bank — https://www.worldbank.org/en/topic/agriculture/overview#2

QUESTIONNAIRE

Section A: General Profile of the Farmer

1. Age of the farmer (in years): ____

2.Education level:

a) Primary
b) Secondary
c) Higher Secondary
d) Graduate and above.

3.Main occupation:

a) Agriculture only
b) Agriculture + wage labour
c) Agriculture + other income

4.Size of land holding (in hectares): ____

5. Type of crops cultivated (tick and mention area):

a) Paddy
b) Coconut
c) Arecanut
d) Rubber
e) Vegetables
f) Others (specify): ____

Section B: Fertilizer Usage Pattern

6.Types of chemical fertilizers used in cultivation:

a. Urea
b. DAP
c. MOP
d. NPK

Others (specify): ____

7.Average quantity of fertilizers used per season (kg or bags):

a. Urea: ____
b. DAP: ____
c. MOP: ____
d. NPK: ____

8. Source of fertilizer purchase:

a. Krishi Bhavan
b. Cooperative society
c. Private dealer
d. Multiple sources

9.Share of fertilizer expenditure in total cultivation cost (%): ____

Section C: Fertilizer Price Fluctuations

10.Perception of fertilizer price changes over the last 5 years:

a. Highly increased
b. Moderately increased
c. Slightly increased.
d. Almost stable

11.Fertilizer that experienced the highest price increase according to the farmer:

a. Urea
b. DAP
c. MOP
d. NPK

12.Average expenditure on fertilizers per year (₹):

- Before price increase: ____
- After price increase: ____

13.Extent to which fertilizer price changes affected total cultivation cost:

a. Very high impact
b. High impact
c. Moderate impact
d. Low impact

Section D: Impact on Cost of Cultivation

14.Change in total cost of cultivation during periods of high fertilizer prices (₹/year): ____

15.Ranking of input costs contributing most to increased cultivation cost (rank 1 to 5)

a. Fertilizers
b. Labor
c. Seeds
d. Irrigation
e. Pesticides

16. Change in fertilizer application due to rising prices:

a. Reduced quantity
b. Shifted to alternative fertilizers.
c. Maintained same quantity.
d. Increased dependence on organic inputs

Section E: Impact on Income and Farm Decisions

17.Change in crop yield after changes in fertilizer usage:

a. Increased
b. No significant change
c. Slightly decreased.
d. Significantly decreased.

18.. Extent to which fertilizer price increases affect farm profitability:

a. Very high
b. High
c. Moderate
d. Low

Section F: Fertilizer Subsidy Support

19. Fertilizer-related subsidies or schemes currently availed (mention)_____

20.Approximate total value of fertilizer subsidy received during the last cultivation season (₹) _____

21. Level of satisfaction with the existing fertilizer subsidy support:

a. Highly satisfied
b. Moderately satisfied
c. Poorly satisfied

22.Quantity of fertilizers obtained under subsidized support (bags / kg) _____

23. Quantity of fertilizers purchased beyond the subsidized limit from the open market (bags / kg) _____