Growth in Green: Analysis of Agricultural Production and Economic Growth in India

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DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation report entitled, "Growth in Green: Analysis of Agricultural Production and Economic Growth in India" is based on the results of investigations carried out by me in Economics Discipline at the Goa Business School/ Economics Dept, Goa University/ Goa Business School under the Supervision of Ms. Sumita Datta and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities/ Goa Business School will not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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This is to certify that the dissertation report "Growth in Green: Analysis of Agricultural Production and Economic Growth in India" is a bonafide work carried out by Ms. Mehek Shaikh under my supervision in partial fulfillment of the requirements for the award of the degree of Master of Arts in Economics in the Discipline of Economics at the Goa Business School/ Economics Dept, Goa University/ Goa Business School.

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PREFACE

India's farming sector has been a pillar of its economy for decades, supporting millions of people with food security, employment opportunities, and their means of livelihood.

Policymakers, economists, and scholars have long been attracted by the multifaceted connection that exists between productivity in agriculture and economic growth. Against India's changing socioeconomic landscape, this dissertation undertakes an econometric journey to explain the specifics of this relationship.

This study investigates the complex relationship between agricultural productivity and economic growth in India, using sophisticated econometric methods to analyze how it has changed over time. By reviewing actual data and using advanced analytical tools, this dissertation seeks to throw light on the hidden mechanisms by which the performance of agriculture affects broader economic outcomes, and vice versa.

The significance of the study cannot be highlighted. India is at an intersection, interacting with the requirements of achieving a sustainable agricultural future while supporting strong economic growth. Given this, understanding the complex relationships between agricultural output and economic advancement is of the utmost importance for policymakers, stakeholders, and the larger scholarly community.

This dissertation addresses a fundamental question: how does agricultural productivity affect economic growth in India? The study has major consequences for policymakers, practitioners, and others managing India's complex development landscape, beyond simply academic curiosity.

By increasing our comprehension of these interrelationships we can make better choices that encourage environmentally friendly farming methods, improve productivity, and make a contribution to India's primary goal of equitable and sustainable economic growth.

Then fascinated by this because I was interested in discovering what drives India's economic growth, and I learned that agriculture serves a significant role. However, it is not only about agriculture; it is also about how money flows and impacts everything else.

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MEHEK SHAIKH

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ABBREVIATIONS

Entity	Abbreviation
Akaike Information Criterion	AIC
Augmented Dickey-Fuller Test	ADF
Autocorrelation Function	ACF
Bayesian Information Criterion	BIC
Gross Domestic Product	GDP
Hannan-Quinn Criterion	HQC
Johansen Cointegration Test	JCT
Partial Autocorrelation Function	PACF
Vector Error Correction Model	VECM
Cost Effect	CE

ABSTRACT

Agriculture continues to be the backbone of the Indian Economy – this is hardly an extravagant statement. India is the second most populous country after China in the World. The world's largest producer of jute, pulses, and milk is India, and and ranks as the second-largest producer of wheat, rice, cotton, oilseeds, and sugarcane. In this study, the interrelationship between agricultural production and economic growth was studied in an interdependent framework for economic growth. The Econometric Model is formulated with aggregate information available over the period of 2000 to 2022, and the Augmented Dickey-Fuller Test (ADF) along with the Johansen CO-integration Test (JCT) and regression analysis were carried out to assess the performance of the set model. This study examined the agricultural production and its impact on the economic growth in India. The study revealed that decrease in agricultural output will have decrease in Economic Growth.

Keywords: Agriculture Production, Economic Growth, Augmented Dickey-Fuller tests, Johansen cointegration, Vector Error Correction Model (VECM).

CHAPTER 1

CHAPTER 1: Introduction

Agriculture remains the backbone of the Indian economy - this is hardly an extravagant statement. With a population of 1.27 billion, India is the world's second most populous country after China. Over two-thirds of the country's population is directly dependent on agriculture. More than two-thirds of the country's economy is directly dependent on agriculture, consequently, the agrarian economy's impoverished growth rate impacts the lives of over 700 thousand individuals, some of whom lacked even necessities. The contribution of agriculture to the economy's GDP fell from 49 percent in 1951 to 36 percent in 1981 to only 18 percent in 2007-08, claiming that the relatively fast growth rate of other sectors grew the income of the urban population, raised commodities and residential property prices, and indirectly took the rural population into poverty as a whole. Thus, there is a need to improve farmers' income from an area of a holding, which keeps lowering because of the divisions of owning with growing populations and rising demand for property for commercial and housing sectors because of an economic expansion of 8% or above. (Kular & Brar, 2012)

India is the world's largest producer of milk, pulses, and jute, and the second-largest producer of wheat, rice, cotton, groundnut, sugarcane, and horticultural crops. Agriculture and its associated industries are the nation's primary sources of revenue, generating 23% of GDP and employing 59% of the nation's workforce in 2016. In 2018, India placed sixth in nominal GDP and third in purchasing power parity (PPP) (Kulshrestha & Agrawal, 2019).

India was the seventh-largest agricultural exporter globally and the sixth-largest net exporter in 2013, with $38 billion worth of agricultural products shipped. Its exports of agricultural products are primarily to developing and least developed countries. More than 120 countries receive Indian agricultural, horticultural, and processed food exports, with the US, Japan, Southeast Asia, SAARC nations, and the European Union being the top destinations. At the moment, India is the second-biggest producer of various dry fruits, agriculturally based textile raw materials, pulses, fish, eggs, coconut, sugarcane, and a wide variety of vegetables. It also produces roots and tuber crops. In 2010, India was listed as one of the top five global producers of more than 80% of agricultural produce, including many cash commodities like cotton and coffee.[13] India is among the top five global livestock producers ("Agriculture in India," 2024)

Share of agriculture in India's GDP declined to 15 per cent last fiscal year from 35 per cent in 1990-91 due to rapid growth in the industrial and service sector, the government informed on Tuesday. "The share of agriculture in total Gross Value Added (GVA) of economy has declined from 35% in 1990-91 to 15% in 2022-23 ("Share of Agriculture in India's GDP Declined to 15% in FY23," 2023).

The Government is also gradually improving access to insurance through the National Insurance Scheme, although in 2009 only 18 million farmers were insured under the scheme. The scheme covers farmers who produce cereals, millets, pulses, oilseeds, sugarcane, cotton, and potatoes. In certain areas, farmers growing these crops and accessing Seasonal Agricultural Operations loans from financial institutions are required to purchase this insurance, while others can opt in voluntarily. Importantly, the scheme covers drought and other weather events as well as loss of production due to pests and disease. Premium rates are typically between 1.5 percent and 3.5 percent of the value insured, with those farming less than 2 hectares receiving a 50 percent subsidy. Recently, the Government trialed a modified insurance scheme, expanding coverage to more areas and providing premium subsidies of between 40 and 75 percent. By reducing credit risk faced by lending institutions, increased coverage of insurance should give farmers better access to credit and encourage further investment in the agricultural sector (Cagliarini & Rush, 2011).

In India, agriculture and related industries provide the majority of the country's income. Agriculture continues to be the main source of income for 70% of rural households in the country, with 82% of farmers being small-scale or marginal producers. The predicted total production of food grains in 2017–18 was 275 million tonnes (MT). India is the world's top importer (14%), user (27% of global consumption), and producer (25% of global output) of pulses. India is the world's greatest producer of milk, jute, and pulses, with an annual milk production of 165 MT (2017–18). In 2012, the country had 190 million cattle, the second-largest population of any country in the world.[153] With a 10.9% share, it is the second-largest producer of fruits and vegetables as well as rice, wheat, sugarcane, cotton, and groundnuts (*India at a Glance | FAO in India | Food and Agriculture Organization of the United Nations*, n.d.).

Growth in Indian agriculture has remained largely uneven, fluctuating across Plan periods despite the best efforts of the planners. Agriculture marketing plays a crucial role in providing remunerative prices to farmers for their produce while subjecting the same farmer entrepreneur to market risks such as price volatility, lack of demand, and marketing credit. (Swain et al., 2022). Indian agriculture has achieved significant success, particularly in irrigated areas, with food crops such as wheat and rice; however, other crops, particularly oilseeds, pulses, and coarse cereals, have not performed as well. As a result, after reaching self-sufficiency in food grains, the government is focusing on these agricultural commodities. The oilseed industry has been a key area of concern and action for Indian policymakers in the post-reform period. India became one of the largest importers of edible oils in the world, buying roughly half of local requirements in the 1990s (Sharma, n.d.).

To address the challenges faced by farmers and promote sustainable agricultural growth, the Indian government has implemented a range of agriculture schemes. These schemes encompass diverse areas such as financial support, crop insurance, irrigation, technology adoption, and market linkages. Government agriculture policies in India have played a critical role in modernizing the agricultural sector, empowering farmers, and guaranteeing national food security. These programs are intended to address a variety of issues that farmers confront, including limited access to capital, technology, irrigation infrastructure, and market linkages. Over time, these projects have expanded to include a diverse spectrum of programs, each with its own set of goals and strategies. Despite the tremendous progress made through these initiatives, obstacles remain, such as identifying the most vulnerable farmers, ensuring timely and effective implementation, and resolving environmental issues. Continuous monitoring, evaluation, and adaptive management are required to maximize the impact of these activities (Tripathi et al., 2023).

Oilseeds are planted to produce oil. Oilseeds are used for cooking, biodiesel production, and other industrial applications. India is the world's fourth largest oilseed producer, following China, the United States, and Brazil. India produces around 38 million metric tons of oilseeds annually. Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, and Andhra Pradesh are the top oilseed producing states. Many different types of oilseeds can be grown, and some are more productive than others. Farmers in the Netherlands and France have access to an extensive range of high-yielding oilseed cultivars. Farmers in India have access to high-yielding cultivars, although they are not as extensively distributed (*Agricultural Productivity in India*, n.d.).

In India, pulses are an important source of protein for vegetarians. They provide critical amino acids, vitamins, and minerals, as well as protein, to staple cereals. The world's biggest producer and consumer of pulses is India. Despite being the world's greatest producer, India imports a significant quantity of pulses to suit its expanding local demand (Gowda et al., n.d.).

The largest producers of cotton, as of 2017, are India and China, with annual production of about 18.53 million tonnes and 17.14 million tonnes, respectively; most of this production is consumed by their respective textile industries(“Cotton,” 2024). COVID-19 and the lockdown, which began in March 2020 to stop its spread, have had a significant economic impact on all industries. The agricultural sector and markets are no different. In India, the agricultural industry employs 60% of the rural population and is the primary source of income. The impact has led to both supply and demand disruptions (Deepak Varshney J. V. Meenakshi Devesh Roy, n.d.).

1.2. Background

The purpose of the study is to examine agricultural production and economic growth in India. Agriculture has always been a key component in global economies, supporting millions of people with food, jobs, and a means of survival. Understanding its function in encouraging economic growth is critical for defining development strategies and policies. Many countries regard growth in the economy as their primary development goal. Given agriculture's essential contribution to GDP, particularly in developing countries, studying its relationship with economic growth is essential for achieving broader development goals. Agriculture is essential for international trade, with agricultural products representing almost all of the global trade flows. The study of the link between agricultural production and economic growth assists governments in identifying diversifying trade opportunities, improving global market competitiveness, and utilizing agricultural exports as economic growth drivers.

1.3. Research Objectives

The specific objectives of the study are:

1. To analyze the contribution of select agricultural crops to India's Economic Growth from (2000 – 2022).
2. To fit the linear regression growth model and to analyze the link between GDP and select agricultural production variables in India.

1.4. Research Questions

1. What is the contribution of select agricultural crops to India’s Economic Growth?
2. What is the link between GDP and selected agricultural production in India?

1.5. Scope of the Study

Agriculture is naturally subject to a variety of threats, including weather-related disasters, volatile markets, and policy adjustments. Econometric models can help evaluate agricultural systems' tolerance to these dangers and create strategies for risk management that minimize the adverse effects on economic growth. Understanding risk factors and weaknesses allows governments to apply interventions such as insurance schemes, diversification techniques, and adaptive approaches to management that enhance agricultural system stability. Many countries regard growth in the economy as their primary development goal. Given agriculture's essential contribution to GDP, particularly in developing countries, studying its relationship with economic growth is essential for achieving broader development goals.

In conclusion, an econometric analysis of agricultural production and economic growth is essential for informing political choices, improving food security, reducing poverty, stimulating international trade, assuring environmental sustainability, and managing agricultural dangers. Understanding the complex relationship between agriculture and the economy allows governments to seek methods that maximize the benefits of agricultural growth while constraining its negative effects.

<u>Hypothesis</u>

We have defined two hypotheses for this study, and the following two hypotheses are formulated for each objective:

(To analyze the contribution of select crops to India’s Economic Growth)

<u>Null Hypothesis</u>: there is no contribution of select crops to India’s Economic Growth.

<u>Alternate Hypothesis</u>: there is a contribution of select crops to India’s Economic Growth.

(To fit the linear regression growth model and to analyze the link between GDP and select agricultural production variables in India.)

<u>Null Hypothesis</u>: there is no link between GDP and select agricultural production variables in India.

<u>Alternate Hypothesis</u>: there is a link between GDP and select agricultural production in India.

1.6. Limitations

The availability and quality of the data is the biggest limitation. Inconsistent or inadequate data sets might reduce the quality and dependability of the analysis, thereby leading to biases or gaps in the results. A wide range of factors influence agricultural productivity, including weather, market volatility, input costs, pest and disease outbreaks, and socioeconomic dynamics. Economic growth should be examined with macroeconomic stability indicators such as price inflation, budgetary balance, foreign debt, as well as exchange rate stability. Overlooking these elements could result in a partial comprehension of the long-term viability and resilience of economic growth. In addition to agriculture, specialized industries such as services or industry can promote growth in the economy. Focusing primarily on agriculture means overlooking other sectors' inputs to overall economic growth, as well as skipping out on possibilities for expansion and change in structure. Economic and agricultural trends shift over time, due to modifications to laws, advances in technology, fluctuations in markets, and other outside factors. The analysis might fail to adequately represent these temporal dynamics.

CHAPTER 2

Chapter 2: Literature Review

(Kulshrestha & Agrawal, 2019), this research paper has done an econometric analysis to analyze the interrelationships between agricultural production and the Economic Growth of India. The Econometric model was formed with information available for the years 1961 to 2017, and both the Augmented–Dickey-Fuller Test and Johansen Cointegration Test and regression analysis were also carried out to assess the model. Six major crops are included in the model wheat, rice, pulses, groundnut, sugarcane, and cotton (lint), and GDP growth rate is the dependent variable. The study is primarily based on the assumption that agriculture is of utmost importance in the Indian economy. The study revealed that if there is no increase in agricultural production would have negatively impacted the economic growth in India.

(Mohammad Khanssa1 & , Wafaa Nasser2 & Abbas Mourad1,2,3, n.d.), this paper uses the econometric modeling that is Vector Error Correction Model (VECM) to analyze the impact between unemployment and inflation in Lebanon throughout the period of 1993 – 2014. Cointegration, Granger causality, and VECM were used to test the relationship both in the short and in the long run. The study resulted in finding out that the Phillips curve relationship doesn't hold in Lebanon in the short run and came to the conclusion that there is a one-way causality relationship in the long run from unemployment to inflation and not in the opposite direction. The paper first introduces the theoretical background of the Phillips curve relationship and its proceeding theories then checks through previous studies whether there exists a variation in the applicability of those theories between developed and developing countries of the world. To analyze data on inflation and unemployment in Lebanon, the study uses the vector autoregression (VAR) and the vector error correction model (VECM). The presence of a co-integration relationship between two variables leads to the existence of a causal relationship between them in at least one direction. This causal relationship can be analyzed using the Granger causality test, which relies on the vector autoregression (VAR) and the vector error correction model (VECM). The study finds that no sufficient evidence was found to show that the Phillips curve relationship holds at the level of the Lebanese economy. The main aim to refer this paper was the use of VECM and its interpretation.

(Gollin, 2010), The large size of the agricultural sector does not necessarily imply that it must be a leading sector for economic growth. Agriculture in most developing countries has very low productivity relative to the rest of the economy. Expanding a low-productivity sector might not be unambiguously good for growth. Moreover, there are issues of reverse causation. Economies that experience growth in aggregate output could be the beneficiaries of good institutions or good fortune that also helps the agricultural sector. Thus, even after 50 years of research on agricultural development, there is abundant evidence for correlations between agricultural productivity increases and economic growth but little definitive evidence for a causal connection.

(Sahoo & Sethi, 2012), Agriculture and industry are regarded as the two fundamental foundations of a developing economy like India. A country cannot live without agricultural development, and no country can develop without industrialization. Agriculture and industry are both critical to a country's balanced economic development. Agriculture and industry contribute 14.6% and 28.6% of India's GDP, respectively, but their influence in the country's economic, social, and political structures extends far beyond this metric. Both sectors contribute to the general development of the economy by creating jobs, generating money, assuring self-reliance in food production and food security, providing tools and equipment to other sectors, and earning foreign earnings. The current study investigates the contribution of both agriculture and the manufacturing industry to the Indian economy while taking into consideration factors such as Gross Domestic Product (GDP), Per-capita Gross National Income (PCGNI), Gross Domestic Saving (GDS), Gross Domestic Capital Formation (GDCF), and agricultural and industrial sector production. The study uses the econometric models of the

Phillips-Pearson model, with Ordinary Least Squares, using E-views software for the period of 1950 to 2010. The findings of the simple OLS test show that agriculture and industry have a considerable positive impact on India's economic growth and development. The study concludes that agriculture is the backbone of industry as well as the economy. The study concludes by stating that both sectors should be examined because they complement rather than substitute. The issue should be addressed by considering both industry and agriculture, rather than industry versus agriculture.

(Khan et al., 2020), This study aims to assess the significance of agriculture in West Bengal's economic growth. Agriculture, being a source of livelihood and a supplier of essential commodities to many industries, supports the nation's economic growth. This research uses empirical data and a cointegration analysis to show how agriculture has contributed to West Bengal's economic success. The function of agriculture is studied in terms of four contributions product contribution (forward linkage), market contribution (backward linkage), factor contribution, and foreign exchange contribution. Time series analysis is used to examine the composition and growth of sectors, as well as their relationships with other sectors. The study's findings revealed that the agriculture sector has emerged as a major contributor to West Bengal's economic growth, despite a decline in its percentage of gross state domestic product over time. Empirical investigation indicates long-term causal links between agriculture, industry, services, and total economic growth in West Bengal.

(*Does Agriculture Matter for Economic Growth of Uttar Pradesh (India)? – Тема Научной Статьи По Сельскому Хозяйству, Лесному Хозяйству, Рыбному Хозяйству Читайте Бесплатно Текст Научно-Исследовательской Работы в Электронной Библиотеке КиберЛенинка*, n.d.), This study evaluates the impact of agriculture on the

Uttar Pradesh economy, focusing on its product, market, and factor contributions. The study investigates the long-term correlation and causality between agriculture and other economic sectors and sub-sectors. Understanding the link between agricultural and GDP growth is crucial for policymakers as it guides resource allocation for growth and development. Results indicate a rise in product, market, and factor contributions over time. According to empirical estimations, agriculture drives the unregistered manufacturing, transportation, storage, and communication sectors, as well as the entire economy. The study is based on secondary data, data has been taken from 1990 to 2015. For the analysis of the long-run association between agriculture and other sector growth, the Cointegration approach has been employed. The use of the VAR model, ADF test, and JCT is also run. The study finds that, Agriculture did not directly get benefitted from economic reforms, but it was expected to get indirect benefit due to changes in exchange and trade policy, the gradual dismantling of the industrial licensing system, and the reduction in industrial protection, which was assumed to benefit tradable agriculture by ending discrimination against it and by turning the terms of trade in its favor.

(Parikh et al., 2016), they analyzed the economic growth with technical changes in agriculture, food security, and irrigation. They investigated this using a multi-sector, inter-temporal optimal model with 20 expenditure classes (10 rural and 10 urban), each with its linear expenditure system derived from an underlying nonlinear demand system. We also evaluate the diversity of demand that is expected to emerge and its influence on poverty under various scenarios. To support GDP growth rates of more than 8%, agriculture GDP must increase by at least 4%. This requires a little optimistic agriculture TFPG growth rate of 2%, as well as a slightly optimistic development of irrigation potential to 90 million ha (net). It has 28 sectors (goods and services) of which 15 are agricultural. We use a multi-sectoral, inter-temporal programming model that has the needed structure and features for addressing these issues. Their model results indicate that strong agricultural growth may be required to support high economic growth in India. The impact of agricultural growth on GDP growth is the result of maximizing consumption rather than just economic growth in the face of three joint country-specific constraints on the total availability of agricultural output in India: limited land and water resources, combined with restrictions on food imports due to food security concerns. This means that all sectors of the economy must compete for a restricted overall supply of agricultural products to meet their ultimate or intermediate needs.

(Ravallion & Datt, 2002), the study tries to find the reason why the economic growth has been poor in some states of India. They intentionally condition out interstate differences in poverty levels via state-fixed factors. they additionally adjusted for state-specific time trends, as well as state impacts in other time-varying components, which might bias our results if left out. With this specification, they have focused on whether changes over time in aggregate farm and non-farm outputs had different impacts on poverty in different states and (if so) whether observed differences in initial conditions can account for the heterogeneity in impacts. their findings also show that the national rate of poverty reduction was affected by both the spatial composition of growth and the overall rate. However, the spatial pattern of growth in India has not been pro-poor, in the sense that the rate of increase in the non-farm economy has not been higher in states where it would have a greater influence on overall poverty.

(*Sustainability | Free Full-Text | Investigating the Linkage between Economic Growth and Environmental Sustainability in India: Do Agriculture and Trade Openness Matter?*, n.d.), This research examines the relationship between CO2 emissions and economic growth in India, accounting for energy consumption, agriculture, and trade openness. Using data from 1965 to 2019, the Bayer and Hanck cointegration and Gradual shift causality tests are used to evaluate the links between various economic variables. Furthermore, they used the wavelet coherence test. The study found strong correlations between all variables and CO2 emissions, except for trade openness. The Gradual shift causality test confirms that agriculture and energy use have a significant impact on CO_2 emissions in India. Accordingly, appropriate policy solutions are offered based on these findings. CO_2 emissions are positively correlated with agriculture, trade openness, and energy consumption, particularly in the medium to long term. Increased CO_2 emissions, agriculture, trade openness, and energy use in India may negatively impact environmental sustainability.

(Sau, 1972), This study attempts to outline the regulations of development for the Indian economy. It is so concerned with how the Indian economy operates and what factors influence the direction and momentum of its development. The paper's secondary emphasis is the prospects for development.

(Ansari et al., 2022), The study aims to assess the impact of agricultural production on economic growth in India from 1991 to 2020. A log-linear regression growth model was used, with GDP as the dependent variable and wheat, tobacco, rice, pulses, and sugarcane as the explanatory factors. E-views-10 is used to perform the regression analysis. Producing wheat, rice, and tobacco has a beneficial impact on India's GDP development. However, producing pulses and sugarcane has a large negative impact. As a result, decreasing agricultural output has contributed to lower GDP growth. This research uses secondary data from the RBI's Statistical Handbook and the Economic Survey of India from 1991 to 2020. The data is analyzed using Econometric Views 10 (E-views10). The Augmented Dickey-Fuller Test (ADF) is used to determine time-series data stationarity, Johansen Co-integration Test was also used.

(Basu & Maertens, 2007), The paper examines the Indian economy's evolution since independence and provides a cross-country review of its current position, identifying patterns in aggregate statistics. The article also examines the impact of changes in India's savings rate on growth and development, as well as the role of labor market regulation. The study finds out that, To sustain and accelerate growth, India must overcome key obstacles in its economy. Infrastructure issues (e.g., roads, freight rates, electricity supply, ports, and airports), labor and bankruptcy restrictions, and government bureaucratic corruption are major challenges.

(Abraham & Raheja, 1967), Rice and wheat are India's basic food crops, and their production is heavily influenced by the country's economy. As a result, the Indian government has implemented several steps to accelerate the production of these vital grain crops. The study used the simplest functional Linear, the Cobb-Douglas function and semi-log function was also applied. An analysis of the rise of rice and wheat crop output in India over the last 14 years (1951-1965) has been conducted with the goal of determining the contributions of the principal input, land, irrigation, and fertilizer consumption. The entire increase in rice output during the research period was predicted to be 12.6 million tonnes. Wheat crop production increased by almost 3.5 million tonnes over the period. For wheat, 17 tons of fertilizer were utilized, and for rice, 25 tons of fertilizer.

(Nath et al., 2019), A time series modeling approach was used to anticipate wheat production in India. The study used econometric tools such as ARIMA, ADF, ACF, and PACF tests to check the stationarity of the data set and also the use of ARIMA as a whole. the study used the time-series data set. The study finds that the ARIMA model forecasted an increase in production over 10 years, from 2017-18 to 2026-27. The forecast for 2026-27 is roughly 110793,000 tons. The ARIMA model, like other predictive models, has limitations in prediction accuracy. However, it is commonly used to estimate future values for time series.

(Jain, 2018), India has been concerned about achieving agricultural expansion while maintaining stability. This research examines 41 years of data (1970-71 to 2011-12) on paddy acreage, productivity, and yield to better understand the instability in rice production in India. The data demonstrates that the compound annual growth rate of area, output, and yield of rice was positive across India, but it has been gradually dropping over time. In the past decade (2000-01 to 2011-12), there has been a rise in volatility in rice area, production, and yield in India.Possible explanations for the increase in instability include a low percentage of irrigated area to total cultivated area, as well as a drop in the usage of seeds, manure, and other agricultural inputs. During the post-reform period (1990-91 to 2016-17), wholesale paddy price instability increased across states, whereas farm harvest price volatility decreased. The Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi, provided data on rice area, production, and yield, as well as cultivation costs, from 1970-71 to 2011-12. This analysis relied on secondary sources, including Agricultural Statistics at a Glance, Land Use Statistics, Agriculture Prices in India, State-wise Value of Output of Agriculture and Allied Activities by Ministry of Statistics and Program Implementation (MOSPI), and Agmark Portal maintained by the Directorate of Marketing and Inspection. Although the compound annual growth rate of rice area, production, and yield in India remains positive, it has gradually declined over time. The fall was faster after reforms. The instability index for output and yield in India declined in the 80s and 90s but grew in the last decade. During the last decade, while rice production area, total production, and paddy yield decreased, the instability index for all three variables climbed concurrently. The rise in wholesale paddy prices from 1990-91 to 2016-17 highlights the hardship of farmers.

(Miah, 2019), This project aims to identify a time series model and forecast rice production in Bangladesh. The goal is to identify preliminary Autoregressive Integrated Moving Average (ARIMA) models that accurately predict rice output in Bangladesh. Bangladesh cultivates three types of rice: Aus, Aman, and Boro. We analyzed three types of rice production from around the country. In this research, we investigate the performance of the ARIMA model. We use the time series Autoregressive Integrated Moving Average (ARIMA) model with various lag orders to analyze rice production in Bangladesh. A acceptable and efficient model for representing time series data is chosen. The optimal ARIMA(p, d, q) model for representing time series data is chosen based on minimizing AIC, BIC, RMSE, and MAPE values. The study compared the original and anticipated rice production over the next seven years, finding that the fitted model accurately predicts rice production in Bangladesh. The investigation shows that the ARIMA model produces more accurate short-term forecasts. Secondary data were obtained from the Bangladesh Agriculture Ministry's website. This website collects yearly production data (000'ton) from 1972 to 2015. The estimated model was checked to verify if it adequately represents the series. The best model was chosen based on minimum values of RMSE, MAPE, BIC, and AIC. Residuals are checked for randomness and normal distribution. Jarque-Bera test, Ljung-Box Test, were used. They used the Box-Jenkins technique to forecast rice production in Bangladesh. Our projection indicates an increase in Aman and Boro rice production, whereas Aus rice production fluctuates slightly.

(Savadatti, 2017), the study aims to investigate trends in pulse area growth, production, and productivity over time, as well as to forecast these variables' values. The initial purpose of this study is to calculate compound growth rates using the exponential growth model. For the second aim, a univariate time series analysis based on the Box-Jenkins (BJ) technique, often known as the ARIMA process, was used to forecast pulse area, production, and productivity. The current study is based on annual time series data acquired from the Centre for Monitoring Indian Economy (CMIE) from 1966-1967 to 2015-16. The growth rate analysis revealed that during the study period, there was positive and substantial growth in area, production, and productivity of pulses, but relative growth in area was lower than that in production and yield. The results were confirmed using model adequacy criteria such as residual correlograms, root mean square errors, mean absolute percentage errors, Theil's inequality coefficient, residual normality, and heteroskedasticity assumptions. Based on the selected ARIMA criteria, forecasts for the following five years beginning in 2016-17 have been made. The forecast findings show an increasing trend in pulse production and productivity, but pulse crop area grows at a near-stagnant rate during the projection period. The forecast analysis indicates a stagnation in the area under pulses, so there is a need for effective implementation of numerous government-initiated programs to increase the area under the crop so that the increasing demand for pulses due to population growth can be met through increased production.

(Gowda et al., n.d.) In India, pulses are a vital source of protein for vegetarians. They contribute essential amino acids, vitamins, and minerals, along with protein, for common cereals. They have a protein content of 22–24%, which is nearly double that of wheat and nearly three times that of rice. The study shows us how by 2030, India would require around 32 million tons of pulses to feed its estimated 1.68 billion people. Considering that India is the world's largest producer and consumer of pulses, the supply of these goods has limitations worldwide. India must therefore continue to be competitive while producing the necessary amount of pulses to safeguard domestic production. The government's recent projects and initiatives have started showing achievements, and it is expected that this enthusiasm will be sustained and increased to ensure India becomes self-sufficient in pulses.

(“An Econometric Analysis of Markets for Pulses,” 2020), Because of decreasing agricultural land for pulses and rising local demand, India imports considerable amounts of pulses each year. A time series econometric analysis was utilized to evaluate market integration, price transmission, and price volatility in the primary domestic markets for one of the imported pulses, green gram. The time-series statistics on the prices of a green gram for the major markets are sourced from 2006 to 2018 on a monthly basis. These assessments also investigated vertical integration between manufacturing and consumption markets. To remove the non-stationarity feature in the price series, the ADF test was applied, which was non-stationary at levels but became stationary at the first difference also Granger test for testing causality, Johansen Multiple Co-integration Analysis is also done. The presence of three cointegration vectors in these markets demonstrated the existence of a long-run equilibrium in green gram pricing. The Tamil Nadu market was in short-run equilibrium, while the remaining markets had long-run equilibrium as calculated by VECM. Retail pricing in Madurai have a bidirectional price influence on the Tamil Nadu market. As a result, better price discovery and timely market intelligence are indicated as vital for managing price shocks in India's green gram markets. It is safe to assume that the green gram markets were spatially integrated both vertically and horizontally. Prices for green gram were propagated throughout key markets, as evidenced by the presence of market price shocks. The markets reached a long-run equilibrium, as evidenced by the influence of price lags.

(Reddy, 2016), Cotton is the most significant commercial crop in India. Cotton, commonly known as the 'White Gold', is the most important commercial crop. The study aimed to identify trends, growth rates, and instability in cotton crop production in Kurnool District and Andhra Pradesh. It also examined the relationship between cotton output, prices, and non-price variables, as well as the impact of various factors on output. To assess cotton farming in Andhra Pradesh and Kurnool district, we suggest estimating increase and instability in area, production, and yield of cotton. The study examined cotton cultivation performance, growth, and instability, as well as production responses using a typical functional relationship. Cotton production responses were analyzed using Cagan's adopting expectation model. The approximated equation yielded final conclusions. Logistic Regression Function, Cobb-Douglas Model, tests are used to analyze. The study finds that, Cotton output in Andhra Pradesh primarily depends on area. Cotton output in Andhra Pradesh has traditionally been based on acreage and price. The remaining variables have an insignificant positive correlation with cotton production. These variables accounted for 57% of the production variation, which is considerable.

(A Study of Indian Government Policy on Production and Processing of Cotton and Its Implications - ProQuest, n.d.) India is an important player in international cotton markets, ranking second in the world in cotton production, consumption, and exports in 2009-2010. Against this backdrop, this article evaluates the competitiveness of Indian cotton growers and considers the implications for India as a global cotton market competitor. The findings show that cotton farmers' net income will drop significantly in the absence of fertilizer subsidies. The study also suggests that if the objectives of the national fiber policy are achieved, India will export more value-added cotton products like textiles and garments than raw cotton.

(*Economic Analysis of Growth, Instability and Resource Use Efficiency of Sugarcane Cultivation in India: An Econometric Approach by Nasim Ahmad, D. Sinha, Krishna M. Singh :: SSRN*, n.d.), The study aims to analyze the growth and instability of sugarcane farming in important Indian states, as well as evaluate resource efficiency and trade performance. This study uses secondary data from major sugarcane growing states in India from 2000-01 to 2015-16 to analyze sugarcane area, production, and productivity. Sugarcane production efficiency was evaluated using plot-level data from the Cost of Cultivation Scheme website of the Ministry of Agriculture and Farmers Welfare in India for 2014-15. We calculated compound growth rates, instability indices using Cuddy-Della Valle's formula, and resource use efficiency utilizing the Data Envelopment Approach. Sugarcane production and productivity increased on a national scale over the investigation period. Sugarcane crop growth rates were positive and encouraging, as well. Sugarcane areas in Uttar Pradesh, Uttarakhand, and Gujarat remained stable, while yields in Uttarakhand, Tamil Nadu, and Uttar Pradesh were nearly stable. Sugarcane production efficiency at the national level is 66%, with potential for an additional 34% increase with present technology. Allocative mean efficiencies suggest a 40% cost reduction by picking the optimal combination of inputs based on their pricing and quantity. According to cost efficiency (CE), farmers can lower sugarcane production costs by up to 60% while maintaining current output levels. India's sugar exports have significantly expanded over the inquiry period. The tools such as Compound growth rate, Estimation of instability index, Data Envelopment Analysis approach, Technical Efficiency, and Cost or Economic Efficiency.

(Gilbert & Linyong, 2013), The current analysis aims to measure the impact of agricultural exports on economic growth in Cameroon. The study uses an enhanced generalized Cobb Douglas production function model using data from food and agricultural organizations and the World Bank from 1975-2009. Since all variables were non-stationary and of order I (1), the Cointegration test was used to determine long-run equilibrium. Cointegration was established across all variables, hence the Engle and Granger approach was used to estimate the traditional vector error correction model. The study found that agricultural exports have a mixed effect on economic growth in Cameroon. Coffee and banana exports have a good and considerable impact on economic growth. Cocoa exports had a negative and small impact on economic growth. Our findings suggest that initiatives to improve cash crop yield and quality should be implemented. Cocoa and coffee beans should also be given added value before they are exported. Implementing this strategy will boost economic growth in Cameroon. The following step will introduce concerns connected to the ordinary least squares method of estimate. Unit Root and Cointegration Test and VECM was also done. The study found that agricultural export variables have varying effects on domestic growth in Cameroon. Coffee export has a positive and significant relationship with economic growth, while banana export also has a positive and significant effect. Cocoa export has a negative and insignificant effect on economic growth.

(Chandio et al., 2016), This study analyzes government spending on agriculture and economic growth in Pakistan from 1983-2011 using data from Pakistan Statistical Year Books and the Economic Survey of Pakistan. The study used ADF unit root test, Johansen Co-integration test, and Ordinary Least Squares (OLS) technique to analyze the data. The Johansen Cointegration test found a long-term correlation between government expenditure on agriculture, agricultural output, and economic growth in Pakistan. Regression research shows that agricultural output and government expenditure significantly impact Pakistan's economic growth. The agriculture sector continues to face issues such as inadequate funding, underdeveloped infrastructure, poor marketing, and limited irrigation resources. We urge that Pakistan's government invest more in agriculture to improve productivity and economic growth. This study analyzed the relationship between government spending on agriculture and economic growth in Pakistan from 1983 to 2011. The data was analyzed using the Augmented Dickey-Fuller test, Johansen Cointegration test, and the Ordinary Least Squares method. The study found a long-term correlation between agricultural output, public expenditure on agriculture, and economic growth in Pakistan using the Johansen Cointegration test. Regression research indicates a favorable correlation between agricultural output and government expenditure on the sector, resulting in economic and agricultural growth in Pakistan.

(Shyam, 2019) Water is becoming scarce in numerous parts of the country as an outcome of exploitation. In this regard, the government has effectively carried out several programs that focus on preserving and managing water from the beginning of the FYP in the nation. In addition, they help those in need in rural areas obtain an income of livelihood and safeguard and conserve the environment. The secondary data is utilized for this investigation. The data is gathered from reputable journals, books, periodicals, news articles, and research papers. India's World Trade Organization sets agricultural subsidies, emphasizing sustainable management of natural resources for intra and intergenerational equity. This helps the poor, who rely more on natural resources, achieve greater access to clean water and ecosystem services.

(Ait Sidhoum et al., 2024), This research introduces an innovative empirical method for evaluating how agri-environment systems (AES) impact farms' production. There is at present not much information accessible concerning the impact of such initiatives that equally manage economic and ecological considerations. The study utilizes a revised Malmquist-Luenberger productivity index to improve robustness, allowing us to avoid some of the original index's limitations. The data collected indicate that the advancement of farm-level green productivity is not significantly impacted by agri-environment payments.

(Federal University of Technology et al., 2014), The purpose of this study was to assess the level of how Ondo State achieved the targets laid out in the Nigerian Agricultural Insurance Scheme. A well-structured questionnaire was used to collect data from 120 insured farmers who were selected via a multi-stage sample method from two regions of local government. Descriptive statistics were used to assess the data that had been collected. According to the study, the farmers' involvement with the insurance program was purely driven by their ability to get loans. However, the farmers agreed that more investments led to greater yields. It is therefore possible to connect these increases to their ease of access to farm loans. The impact of insured farmers' participation on their farm investments, farm sizes, and farm credit accessibility was examined using descriptive statistics. The findings of this study proved that farmers' expenditures increased after they participated in the insurance program. It also indicates that the targets of the program for crop insurance have been achieved.

(Tripathi et al., 2023), Over the years, the Indian government has implemented many agriculture initiatives that promote sustainable growth, improve farm production, and improve farmers' livelihoods. This study presents a brief overview of selected government agriculture schemes in India, focusing on their objectives, implementation methods, and overall impact. The paper outlines the historical context and evolution of agricultural schemes in India, through an in-depth analysis of relevant literature and government documents. It examines how these schemes have evolved to address the diverse challenges faced by the agricultural sector, ranging from resource constraints to climate change and market fluctuations. Over time, these initiatives have spread to include an extensive range of programs, each with its own set of goals and strategies. The study finds that, in India's complex agricultural landscape, these government plans must be planned with a comprehensive and region-specific approach, taking into account the unique requirements and challenges faced by farmers across different states and agro-climatic zones.

CHAPTER 3

Chapter3: Methodology

The study intends to understand the Economic Growth of India with agricultural production of Wheat, Rice, Pulses, Oilseeds, Sugarcane, and Cotton. The analyses of the production of all these crops on the Economic Growth of India will be examined with a focus entirely on quantitative data. All of the data used in this study was gathered from secondary sources, World Bank, Statista.com, and Indiastat. The data type used in the study is time series data. Time series data is frequently used for analyzing the impact of policy changes, interventions, or external factors on a variety of outcomes throughout time.

The linear growth regression model is employed, where, GDP is a dependent variable and the explanatory variables are the major crops and factors which affect the economic growth of the country. Six major crops that are included in the model are Wheat, Rice, Pulses, Oilseeds, Sugarcane, and Cotton(lint). The data analysis is done using RStudio and Gretl Software.

(1) Model Specification: the study uses a linear growth regression model. The Gross Domestic Product (GDP) is a dependent variable and the six independent variables are the major crops such as wheat, rice, pulses, oilseeds, sugarcane, and cotton(lint).

The model of linear regression is as follows:

GDP = B0 + B1 Wheat + B2 Rice + B3 Pulses + B4 Oilseeds + B5 Sugarcane + B6 Cotton (Lint) + e

Where, GDP = is the Gross Domestic Product and B is a constant value, and B1, B2, B3, B4, B5, and B5 are parameters to be estimated. All explanatory variables: wheat, rice, pulses, oilseeds, sugarcane, and cotton (lint) are the agricultural outputs, respectively.

(2) Variables used in the Model:

(i) Dependent Variable – Gross Domestic Product: In a mixed economy, gross foreign demand for national production adds considerably to final expenditure. In this study, GDP at factor cost is used as a proxy for economic growth, which quantifies the overall output in a country's economy. It indicates the size of the country's economy and has been chosen as a significant metric in this circumstance since it includes every factor affecting the economy's performance. GDP is an estimation of total output in the period chosen at the same base year's prices.

(ii) Independent Variables: the study analyses the impact of all six explanatory variables on the Gross Domestic Product of India from 2000 – 2022.

Wheat: India is one of the largest producers of wheat in the entire world. Wheat is an essential grain in India, and its cultivation plays an important role in the nation's prosperity. Wheat production in India is impacted by a wide range of factors, including policy from the government, weather conditions, technological advances, and consumer preferences. India's elementary wheat-producing states include Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, and Bihar.

Rice: the largest exporter and the World’s second-largest producer of rice in India. India’s rice production was 53.6 million tonnes in the fiscal year 1980 and increased to an impressive 120 million tonnes i.e. 1200 lakh tonnes by the fiscal year 2020-21. The total rice production projected for the year 2022-23 is estimated at 1308.37 lakh tonnes (saubijak, 2023).

Pulses: India is the World’s largest producer of Pulses. Pulses are vital sources of protein amongst vegetarians in India, boosting the main grains in their daily diets. India is the world's largest manufacturer and biggest consumer of pulses (Gowda et al., n.d.). pulses do not require extreme irrigation techniques and can be easily produced with less use of resources, and it is cultivated mostly in rainfed areas.

Oilseeds: During the economic year 2022, India cultivated a total of 37 million tonnes of oilseeds. Soybean was the nation's most abundant oilseed, with almost 13 million metric tons grown in the country during that period (*India*, n.d.). The oilseed accounts for 13% of the Gross

Cropped Area, 3% of the Gross National Product, and 10% value of all agricultural commodities. The oilseeds include nine types of seeds, such as sesame, castor, linseed, sunflower, mustard, safflower,

Sugarcane: In the Sugar Season 2021-22, an all-time high of more than 5000 Lakh Metric Tons (LMT) of sugarcane were produced in the entire nation, of which about 3574 LMT of sugarcane was processed by sugar mills which produced about 394 LMT of sugar (glucose). During 2021-22, sugar mills obtained sugarcane costing more than 1.18 lakh crore and issued payments of nearly 1.12 lakh crore without receiving financial aid (subsidy) from the Government of India. (*India Emerges as the World's Largest Producer and Consumer of Sugar and World's 2nd Largest Exporter of Sugar*, n.d.).

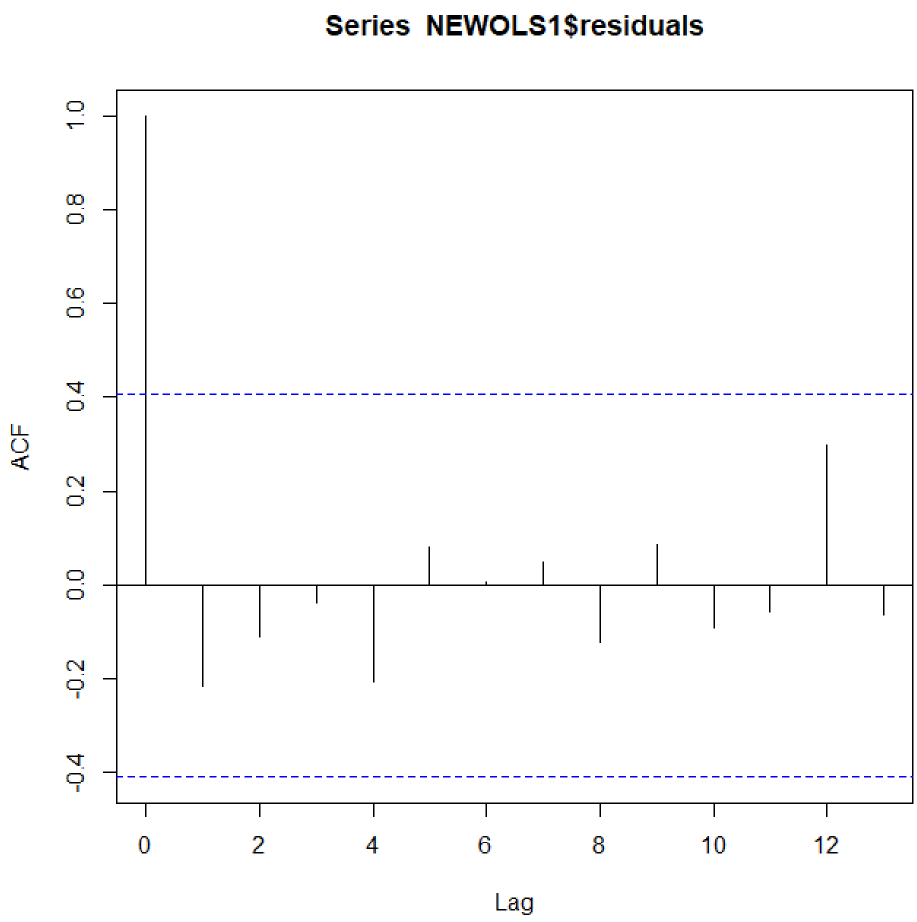
Cotton (lint): Cotton is a significant commercial crop in India, accounting for around 25% of global cotton production. Gujarat is the leading producer of cotton in the country, followed by Maharashtra, Andhra Pradesh, Punjab and Haryana. After China, India is the second largest producer of cotton in the world.

CHAPTER 4

Chapter 4: Analysis

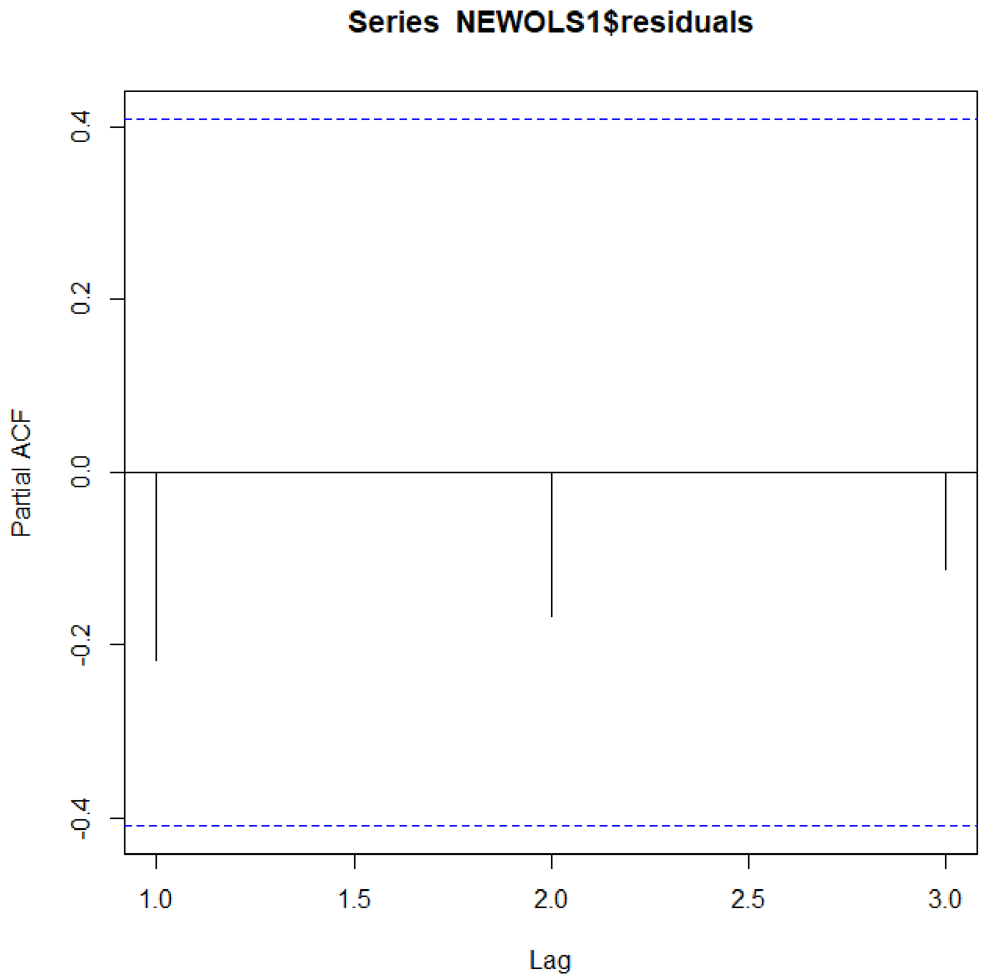
To begin the analysis of the provided data, the first step is to understand the context and variables involved. The data analysis is done using RStudio and Gretl software. The data under the study is Time-series data, therefore, first, the stationarity of the data series is tested through the Autocorrelation Test (ACF). The ACF test is done using RStudio, below is the interpretation.

Fig. 4.1: ACF Results



The data includes variables such as GDP growth rate, and agricultural production of select crops such as wheat, rice, pulses, oilseeds, sugarcane, and cotton. The ACF plot typically displays the autocorrelation coefficients at various lags. ACF is done to graphically check if the data set is having any problems with the Unit Root. The spikes crossing the significance line are absent in the above plot of ACF, this indicates that there is no strong autocorrelation in the time-series dataset. This lack of spikes and autocorrelation suggests that there is no problem with Unit Root or that any autocorrelation present is weak and not statistically significant.

Fig 4.2: PACF results



After ACF, the Partial Autocorrelation Test (PACF) was run just to again confirm if the time series dataset is having any problem of the Unit Root. Comparing the PACF with ACF can provide additional insights. If both PACF and ACF show no spikes passing through the line of significance, it suggests no presence of a unit root and stationarity in the time series dataset. While ACF and PACF can offer some indications for the presence of Unit Root, the Augmented

Dickey-Fuller (ADF) test is more commonly used to assess directly the presence of a Unit Root in time series datasets.

The data analysis is done using RStudio and Gretl software. The data under the study is Time-series data, therefore, first, the stationarity of the data series is tested through the Unit Root method using the Augmented Dickey-Fuller test (ADF). The ADF test is applied to all the variables under the study.

Null Hypothesis: H0: there is a unit root or time series that is non - stationary.

Alternate Hypothesis: H1: the time – series is stationary.

The test result reveals that the p-value is less than 0.05 level of significance, for all the variables under the study. This gives enough ground for rejecting the Null Hypothesis (H0), meaning that the data set under the study is stationary.

The summary of the unit root ADF test indicates that all the variables under the study have become stationary at the order of integration at the 1% level of significance. Therefore, from the test results, it is concluded that all the variables are stationary at the I(0) level and can be used for the time series analysis and for estimating the model. The variable under the study is stationary at I(0), therefore, it is then necessary to perform the cointegration test to establish a long-run relationship. To check whether the variables are cointegrated or not, the Johansen Cointegration Test (JCT) statistic is used.

The test hypothesis for the JCT test is as under:

Null Hypothesis: H0: there is no cointegration relationship.

Alternate Hypothesis: H1: Null Hypothesis (H0) is not true.

The series is stationary at the I(0) level without a log. Therefore, as per the JCT test requirement, the cointegration test is performed on the data without taking the log transformation of the original data.

The decision criteria for the Johansen Cointegration Test is that if the value of the trace test and max test is greater than 0.05% critical value, the null hypothesis is rejected, meaning that the series are cointegrated.

The test was conducted with 6 equations and a lag order of 1. The data used for the test is of 22 years, from 2000 – 2022. The log-likelihood value here is -1189.6, which suggests a better-fit model. The trace test and the Lmax test are conducted for different ranks. The p-values associated with these tests indicate the significance of cointegration. The Eigenvalues represent the strength of cointegration. The overall results of the analysis indicate that there are significant cointegrating relationships among the variables.

By running the Johansen Cointegration Test (JCT) with the results the cointegrated relationships between variables can be determined. By checking the Eigen Values of the variables the cointegration can be identified. The Eigenvalues greater than 1 indicate the number of cointegration relationships present in the model. Also, by checking the p-values of the Trace Test and Lmax Test, low p-values suggest rejection of the null hypothesis of no cointegration.

Based on these criteria, and provide results, we can specify cointegrated relationships among the variables. Therefore, all variables (wheat, rice, pulses, oilseeds, sugarcane, and cotton) are likely to be cointegrated with each other.

Thus, the specific cointegrated relationships among the variables are as follows:

- Wheat with other variables

- Rice with other variables
- Pulses with other variables
- Oilseeds with other variables
- Sugarcane with other variables
- Cotton with other variables

These cointegrated relationships indicate that the variables move together in the long run, despite short-term fluctuations, showing a long-term relationship among them. The Johansen Cointegration Test provides with statistical evidence to support this conclusion, and the careful analysis of the results confirms the cointegrated relationship of variables among them in the model.

Assessing the Eigenvalues suggests evidence of rejecting the Null Hypothesis (H0), which means there are cointegrated relationships present among the variables in the model. Since the variables are cointegrated with each other, we can estimate both short-run and long-run models. To estimate the long-run and short-run relationships, the GDP is set as the dependent variable, and the rest of the variables, that are select crops and their agricultural production as the explanatory variables including the error term. Since the unit root ADF test results indicate that the series under the study are stationary long-run estimates are computed using the Vector Error Correction Model (VECM).

VECM is specifically designed to model variables that are cointegrated, meaning they have long-term equilibrium relationships. VECM has an error correction system to ensure that deviations from equilibrium are steadily addressed over time. The Beta coefficients represent the long-term equilibrium relationships among the variables. Meaning, that each coefficient indicates the impact of one unit change in the corresponding variable on the cointegrated relationship. The coefficient of wheat is 1.0000, this suggests that one unit increase in wheat leads to a one-unit increase in the cointegrated relationship of variables. The coefficient for rice is -11.401, this suggests that one unit increase in rice leads to a decrease of approx. 11.401 units in the cointegrated relationship of variables. The coefficient for pulses is 13.774, this implies that one-unit increase in pulses leads to an increase of almost 13.774 units in the cointegrated relationship. The coefficient for oilseeds is 13.902, this indicates that a unit increase in oilseeds leads to an increase of approximately 3.902 units in the cointegrated combination of variables. The coefficient of sugarcane is 0.16610, this suggests that one unit increase in sugarcane leads to a slight increase of approx. 0.16610 units in the cointegrated relationship. And lastly, the coefficient for cotton is -2.5437, this indicates that one unit increase in cotton leads to a decrease of approximately 2.5437 units in the cointegrated combination. We assessed the coefficients because the coefficients represent the long-term equilibrium relationships among the variables in the dataset.

Interpreting T-Ratios and P-Values for the VECM:

The t-ratio for wheat is 0.81 and the p-value is 0.42, this simplifies that the coefficient of wheat is not statistically significant as both the values are greater than 0.05. The t-ratio for rice is 2.011 and the p-value is 0.0587, this simplifies that the coefficient of rice is marginally significant as both the p-values are almost similar to 0.05. The t-ratio for pulses is -1.104 and the p-value is 0.28, this simplifies that the coefficient of pulses is not statistically significant as the t-ratio is greater than 0.05. The t-ratio for oilseeds is 0.32 and the p-value is 0.74, this simplifies that the coefficient of oilseeds is not statistically significant as both the values are greater than 0.05. The t-ratio for sugarcane is 0.94 and the p-value is 0.35, this simplifies that the coefficient of sugarcane is not statistically significant as both the values are greater than 0.05. The t-ratio for cotton is 2.43 and the p-value is 0.025, this simplifies that the coefficient of cotton is statistically significant as the t-ratio is greater than 0.05.

The coefficient of rice appears to have marginal significance, as it has a relatively low p-value that is 0.058 and a t-ratio is 2.011, this suggests that rice may have some impact on the dependent variable. On the other hand, the coefficients of wheat, pulses, oilseeds, and sugarcane with their respective t-ratios and p-values do not appear to be statistically significant, as their p-values are greater than 0.05, showing they might not have a significant effort on the GDP growth that is the dependent variable. However, the coefficient of cotton is statistically significant, as shown by the low p-value that is 0.02 and relatively high t-ratio of 2.430, suggesting that cotton might have a significant impact on GDP Growth.

For the given VECM, the information criteria are as follows:

AIC – Akaike Information Criterion

BIC – Bayesian Information Criterion

HQC – Hannan – Quinn Criterion

The AIC value of 121.30 indicates the relative quality of a model, as the lower the AIC value better the model fit. The BIC value is 123.68 which reflects the trade-off between model fit and complexity. While, HCQ is another measure of model selection, with a value of 121.86 considering both model fit and complexity. After the cointegration test that was run, the Johansen Cointegration Test, which suggested the cointegrated variables and to make the model free from cointegration, Vector Error Correction Model (VECM) was run, which again indicates that the cointegration is solved and the model is best fit.

CHAPTER 5

CHAPTER 5: Conclusion

The study represents an attempt to examine the relationship between the Agricultural Production of select crops and the Gross Domestic Product (GDP) growth of India. The dataset used was downloaded from the World Bank, Indiasta, and Statista for the 22 years from 2000 to 2022. The software used was RStudio and Gretl to run the tests. As the data set was a time-series dataset, the first and major problem was the problem of Unit Root. To confirm the problem the Autocorrelation Function (ACF) was run, it is the graphical test to check autocorrelation present the the data. The absence of the spikes crossing the significance line in the above plot of ACF indicates that there is no strong autocorrelation in the time-series dataset. This lack of spikes and autocorrelation suggests that there is no problem with Unit Root or that any autocorrelation present is weak and not statistically significant. The Partial Autocorrelation Function (PACF) test was also done to cross-check the problem of the Unit root, hence the problem of the unit root was not detected in PACF as well.

While ACF and PACF can offer some indications for the presence of Unit Root, the Augmented Dickey-Fuller (ADF) test is more commonly used to assess directly the presence of a Unit Root in time series datasets. The ADF test was run on all the variables keeping GDP Growth as dependent and the select agricultural products (wheat, rice, pulses, oilseeds, sugarcane, and cotton) as independent variables. The test result reveals that the p-value is less than 0.05 level of significance, for all the variables under the study. This gives enough ground for rejecting the Null Hypothesis (H0), meaning that the data set under the study is stationary.

As the variables under the model were stationary with no problem of Unit Root, then it was necessary to do a test for the check of Cointegration. The Johansen Cointegration Test (JCT) was used to check the same. The results of JCT indicated that all the variables had a cointegrated relationship among them, this was concluded by the Eigenvalues, t-ratio, p-values, Trace test, and Lmax test. These cointegrated relationships indicate that the variables move together in the long run, despite short-term fluctuations, showing a long-term relationship among them. The Johansen Cointegration Test provides us with statistical evidence to support this conclusion and the careful analysis of the results that confirm the cointegrated relationship of variables among them in the model. By assessing the Eigenvalues, suggested rejecting the Null Hypothesis (H0), which means there are cointegrated relationships present among the variables in the model. As the Eigenvalues represent the strength of cointegration.

Since the unit root ADF test results indicate that the series under the study are stationary long-run estimates are computed using the Vector Error Correction Model (VECM). The coefficient of rice appears to have marginal significance, as it has a relatively low p-value that is 0.058 and a t-ratio is 2.011, this suggests that rice may have some impact on the dependent variable. On the other hand, the coefficients of wheat, pulses, oilseeds, and sugarcane with their respective t-ratios and p-values do not appear to be statistically significant, as their p-values are greater than 0.05, showing they might not have a significant effort on the GDP growth that is the dependent variable. However, the coefficient of cotton is statistically significant, as shown by the low p-value that is 0.02 and relatively high t-ratio of 2.430, suggesting that cotton might have a significant impact on GDP Growth.

The AIC value of 121.30 indicates the relative quality of a model, as the lower the AIC value better the model fit. The BIC value is 123.68 which reflects the trade-off between model fit and complexity. While, HCQ is another measure of model selection, with a value of 121.86 considering both model fit and complexity. After the cointegration test that was run, the Johansen Cointegration Test, which suggested the cointegrated variables and to make the model free from cointegration Vector Error Correction Model (VECM) was run, which again indicates that the cointegration is solved and the model is best fit.

The results for Objective 1 of the study, state that, by checking the p-values of the variables we can fail to reject the Null Hypothesis (H0) for wheat, rice, oilseeds, and sugarcane, as their coefficients are not significant or typically the p-value is greater than 0.05, so these variables have no contribution to India's Economic Growth. There is marginal evidence to reject the Null Hypothesis (H0) for rice, as its coefficient has a p-value of 0.0587 which is close to the significance level of 0.05. rejecting the Null Hypothesis for cotton of objective 1, as its coefficient has a statistically significant p-value of 0.025. Overall, this is a mixed result, we reject the Null Hypothesis for cotton but do not have sufficient evidence ro reject it for the other crops.

The results of objective 2 indicate that the p-values of the GDP growth and all the variables are more than the significant value of 0.05. based on the p-values, none of the coefficients for GDP growth in the model are statistically significant or the p-value is greater than 0.05. Therefore, we fail to reject the Null Hypothesis that there is no link between GDP growth and select agricultural production variables in India.

To prove the model to be the best fit and with no such presence of autocorrelation and heteroskedasticity, the Durbin-Watson test and the Breusch-Pagan test were run. The p-value for the autocorrelation check is 0.07 which is greater than 0.05, so we fail to reject the Null Hypothesis (H0). The p-value for the DW test is 0.624 which is again greater than 0.05, so we fail to reject the Null Hypothesis, which means there is no autocorrelation. The p-value of the BP test for all the variables is greater than 0.05, so we fail to reject the Null Hypothesis from which we can conclude that there is no Heteroskedasticity.

Hence, from the above tests, it is concluded that the model is a long-run stable model and does not suffer from Autocorrelation, and Heteroskedasticity. However, the estimating equation results are not promising as far as it relates to the explanatory power of independent variables as only two out of six variables have shown significant impact (rice and cotton). This may be because of the fact that the GDP is also affected by some other variables than the used variables in this present model.

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