

**ECONOMIC ANALYSIS OF ARRIVALS AND PRICES
OF MAJOR PULSES IN KHAMMAM APMC OF
TELANGANA STATE**

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B.Sc. (Agriculture)

**MASTER OF SCIENCE
IN
AGRICULTURE
(AGRICULTURAL ECONOMICS)**



**DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF AGRICULTURE, PARBHANI
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2022

**ECONOMIC ANALYSIS OF ARRIVALS AND PRICES
OF MAJOR PULSES IN KHAMMAM APMC OF
TELANGANA STATE**

BY
SOMU POOJA
B. Sc. (Agriculture)

A thesis submitted to
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani
in partial fulfillment of the requirement for the degree of

**MASTER OF SCIENCE
IN
AGRICULTURE
(AGRICULTURAL ECONOMICS)**



**DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF AGRICULTURE, PARBHANI
VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH,
PARBHANI- 431 402 (M.S.) INDIA**

2022

DECLARATION BY THE CANDIDATE

I here by declare that the thesis entitled, "**Economic analysis of arrivals and prices of major pulses in Khammam APMC of Telangana state,**" submitted by me is based on work carried out by me under the guidance and supervision of **Sachin Sudhakarrao More** .The extent of information derived from the existing literature has been duly cited and referenced. The existing research work or its any part is not submitted any where else for the award of any diploma or degree.

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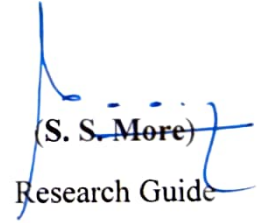
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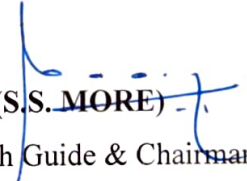
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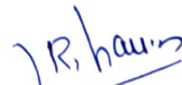
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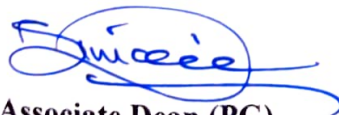

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CONTENTS

Sr. No.	Title/Particulars	Page No.
01	Declaration by the Candidate	i
02	Certificate –I	ii
03	Certificate-II	iii
04	Plagiarism Clearance Certificate	iv
05	First Page of Plagiarism Report	v
06	Acknowledgement	vi-vii
07	List of Tables	viii
08	List of Figures	ix
09	Abbreviations Used	x
10	Thesis Abstract	xi-xii
11	Chapter-I: Introduction	1-8
12	Chapter-II: Review of Literature	9-35
13	Chapter-III: Methodology	36-51
14	Chapter-IV: Results and Discussion	52-78
15	Chapter-V: Summary and Conclusions	79-84
16	Literature Cited	85-93
17	Curriculum Vitae	94

LIST OF TABLES

Table	Title	Page No.
1.1	All India Area, Production & Yield of Total Pulses.	5
3.1	Land utilization pattern of Khammam district (2019-2020)	51
3.2	Area, Yield and Production of important Crops, (Vanakalam & Yasangi) 2019-20	51
4.1	Monthly average arrivals of Red gram and Green gram in APMC Khammam. During the study period.	53
4.2	Yearly average arrivals of Red gram and Green gram of Khammam APMC during the study period.	54
4.3	Compound annual growth rates of arrivals of Red gram and Green gram in APMC, Khammam.	55
4.4	Table 4.4: Month-wise Mean, SD, and CV of Arrivals of a Green gram and Red gram	56
4.5	Coppock's Instability Index of monthly arrivals of Red gram and Green gram	57
4.6	Coppock's Instability Index of arrivals of Red gram and Green gram	58
4.7	Monthly average prices of Red gram and Green gram in APMC Khammam during study period.	58
4.8	Yearly average prices of Red gram and Green gram in APMC Khammam during the study period.	60
4.9	Compound annual growth rates of Prices of Red gram and Green gram in APMC, Khammam	61
4.10	Month-wise Mean, SD, and CV of Prices of Green gram and Red gram	62
4.11	Coppock's Instability Index of prices of Green gram and Red gram	62
4.12	Coppock's Instability Index of prices of Green gram and Red gram	63
4.13	Seasonal indices of arrivals and prices of Red gram and Green gram in APMC, Khammam	64
4.14	Unit Root test, (ADF) of Red gram price series in APMC Khammam	67
4.15	ARIMA Model parameters for Red gram price series in APMC Khammam	70
4.16	Forecasted value along with U.C.L and L.C.L of Red gram price series	72
4.17	Unit Root test, (ADF) of Green gram price series in APMC Khammam	73
4.18	ARIMA Model parameters for Green gram price series in APMC Khammam	77
4.19	Forecasted value along with U.C.L and L.C.L of Green gram price series	78

LIST OF FIGURES

Figure No.	Title	In between page no.
3.1	The Box-Jenkins methodology for optimal model selection	43
3.2	Administrative map of Khammam	51-52
3.3	Data collection at APMC Khammam	51-52
4.1	Average Arrivals of Red gram and Green gram in APMC, Khammam	53
4.2	Yearly Average Arrivals of Red gram and Green gram in APMC ,Khammam	55
4.3	CII of Monthly Arrivals of Red gram and Green gram in APMC ,Khammam	57
4.4	Average Prices of Red gram and Green gram	59
4.5	Yearly average prices of Red gram and Green gram	60
4.6	CII of average prices of Red gram and Green gram	63
4.7	Seasonal indices of arrivals of major pulses	65
4.8	Seasonal indices of prices of major pulses	66
4.9	Time sequence plot of Redgram price series in APMC Khammam	66
4.10	Auto Correlation Function of Redgram price series in APMC Khammam	68
4.11	Partial Auto Correlation Function of Redgram price series in APMC Khammam	68
4.12	Auto Correlation Function of first differenced natural lag Redgram price series in APMC Khammam	69
4.13	Partial Auto Correlation Function of first differenced natural lag Redgram price series in APMC Khammam	69
4.14	Time sequence plot after differencing data of Red gram price sereies	69
4.15	Residual ACF and Residual PACFof Red gram price sereies	71
4.16	Time sequence plot of predicted prices of selected model ARIMA (2,1,1) of Red gram price sereies	71
4.17	Time sequence plot of Greengram in APMC Khammam	72
4.18	Auto Correlation Function of Green gram price series in APMC Khammam	74
4.19	Partial Auto Correlation Function of Green gram price series in APMC Khammam	74
4.20	Auto Correlation Function of first differenced Green gram price series in APMC Khammam	75
4.21	Partial Auto Correlation Function of first differenced Green gram price series in APMC Khammam	75
4.22	Time sequence plot after differencing data of Green gram price sereies	76
4.23	Residual ACF and Residual PACF of Green gram price sereies	77
4.24	Time sequence plot of predicted prices of selected model ARIMA (2,1,2) of Green gram price sereies	78

THESIS ABSTRACT

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ABSTRACT

The edible seeds of leguminous-family plants are known as pulses. Pulses occur in a range of forms, dimensions, and hues and are grown in pods. They are grown all over the world and play a significant role in the human diet. Major nations producing pulses worldwide include Mexico, Turkey, China, India, and Brazil. Both the impoverished and vegetarians rely heavily on pulses as a source of protein. Pulses are a Smart Food because they are essential for the food basket (dal-roti, dal-chawal), a significant source of plant protein, and they aid with issues like diabetes, obesity, and other diseases. Pulses, also referred to as "Poor Man's Cal" and "Rich Man's Vegetable," are substantial suppliers of proteins, vitamins, and minerals and considerably contribute to the nation's nutritional security. Pulses have a calorific value of 343 and contain more than 20% protein, more than 1% fat, 55–60% carbohydrates, 3.2% fiber, 300–500 mg of phosphorus per 100g, 7–10 mg of iron, 10–15 mg of vitamin C, 69–75 mg of calcium, and 430–489 IU of vitamin A. Present the study is about economic analysis of major pulses in APMC Khammam of Telangana state.

The arrival and price data for selected major pulses were collected monthly from the official records of APMC, Khammam. Based on the availability of data, the latest 20 years of data from 2001-2002 to 2019-2020 were collected. The discussion regarding trends in arrivals and prices, growth rates, coefficient of variation, Coppock's instability index, seasonal indices of market arrivals and prices, and forecasting of prices were calculated.

Growth and Instability In Arrivals of Red Gram and Green Gram In APMC Khammam was objective of study, results revealed that average arrivals of Red gram were Maximum during April month (8291.40 qt) and minimum in December month (939.87 qt), respectively in the case of average arrivals of Green gram was maximum in the month of September (8729.55 qt) and was minimum in the month of June (627.64 qt). The highest arrivals was seen in the year of 2003 and lowest arrivals in the year of 2020 for the Red gram. For Green gram the highest arrivals was seen in the year 2003 and lowest observed in the year of 2014.

Growth and Instability In Prices of Red Gram and Green Gram in APMC Khammam was objective of study result obtained was the average prices of Red gram were continuously fluctuating ranging from (Rs.3258.9 to Rs.3567/qt) showing the highest during September month (Rs.3567.95/qt) and the lowest during December month (Rs.3258.9/qt). While the average prices of Green gram were uneven and fluctuating showing the highest during April (Rs.3867.5/qt) and the lowest during (Rs.3301.03/qt) September.

Maximum Seasonal indices of red gram arrivals were found in the month of October (237.64 Per cent) and minimum in month of March (43.66 Per cent). Whereas, prices indices were maximum in the month of December (101.73 Per cent). The maximum arrivals was during the October month which coincides with higher magnitude of arrivals indices (237.64 per cent), the price indices were not high during October. The highest seasonal indices of Green gram arrivals were observed during the month of May (351.12 Per cent). The Lowest seasonal indices of Green gram prices were observed during the month of September. The prices of green gram was observed maximum during the month of August (105.58 per cent) and lowest were observed in the month of March (95.66 per cent).

The average predicted price of red gram has ranged between from Rs. Rs.6318/qt to Rs.6971/qt for the months from April 2021 to March 2022. The average predicted price of green gram has ranged between Rs.6458 /qt to Rs.6784 /qt for the months from April 2021 to March 2022.

Keywords: Arrivals and Prices, APMC, Compound growth rate, Seasonal indices, Variability, Forecasting, ARIMA, Green gram, Red gram, Khammam.

CHAPTER-I
INTRODUCTION

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INTRODUCTION

India is an Agrarian nation. About 55 per cent of the total workforce is engaged in agricultural and allied sector activities according to Census 2011 and accounts for 17.8% of the country's Gross Value Added (GVA) for the year 2019-20 at current prices, (agricoop.nic.in).

In India, growth of agriculture is crucial for the economic well-being, but it also has a profound impact on our social, political, and cultural livelihood. Former Prime Minister Sri Jawaharlal Nehru stated that, agriculture has to be given top attention, without it, the government and the country would both fail to thrive. Despite the fact that other industries have experienced significant expansion, agriculture remains the principal source of income for human civilization. Only when the agricultural sector keeps expanding and generates sufficient demand for goods and services as well as a market for farm products can the growth of two non-farm sectors, such as secondary and tertiary industries, be sustained.

Agriculture marketing is essential for transfer of goods from the producer to the consumer and for keeping prices stable. The intended rise in agricultural output needs to be coordinated with shifts in the supply and demand for agricultural products, as well as with changes in marketing. In spite of the size of the farmers' marketable surplus, this can only be successful if the producer's share of the consumer's rupee rises significantly.

In the present context, long-term marketing refers to any economic efforts that apply an integrated strategy to satisfy consumers. Because of the specialization and commercialization of Indian agriculture, the study of agricultural marketing has become progressively essential. Agriculture marketing is one of the multiple areas that has a direct impact on the success of the country's producers.

As early as 1928, the Royal Commission on Agriculture remarked extensively on the shortcomings of the existing marketing system and proposed the introduction of controlled markets. According to the Royal Commission on Agriculture, "group marketing must be more efficient than individual marketing, especially in situations

such as those seen in India, because individual farmers are a small unit," (Shorote, 2021).

Due to small size holdings and illiteracy of farmers create poor negotiating position and the numerous obstacles they face while selling their produce in the market. They are also required to pay a variety of excessive and unnecessary fees. The only option for producer is to sell the produce at whatever price the customers are willing to pay. One of the essential elements for increasing agricultural productivity is an effective marketing system, which motivates farmers by paying them fairly for their output.

Most of the agricultural markets in the country are created and governed by state APMC Acts. The entire state is divided into market regions, each of which is managed by market committees formed by the separate state governments. After a certain territory is identified as a market area and comes under the supervision of a Market Committee, no individual or organization may participate in wholesale marketing operations. Due to the monopoly of government-regulated wholesale markets, the country has been unable to create a competitive marketing system. The agricultural produce marketing committee was formed by state governments in India. Farmers may sell their products and obtain a fair price since the state government has given infrastructure. The majority of APMCs include market yards where merchants and other marketing agents may acquire agricultural products from farmers. Farmers can sell their products to wholesalers or customers under the supervision of the APMC.

Farmers were allowed to freely market their produce under the 2003 Model APMC Act. The farmers had the option of selling their goods either directly to the contract sponsors or in a market that had been set up by customers, producers, or private persons. By permitting uniform registration of market intermediaries, the Model Act also promotes the market's competitiveness for agricultural products.

1.1. Pulses Scenario

The edible seeds of leguminous family plants are known as pulses. Pulses occur in a range of forms, dimensions, and hues and are grown in pods. They are grown all over the world and play a significant role in the human diet. Major nations producing pulses worldwide include Mexico, Turkey, China, India, and Brazil

(Shrote, 2021). Both the impoverished and vegetarians rely heavily on pulses as a source of protein. Pulses are a Smart Food because they are essential for the food basket (dal-roti, dal-chawal), a significant source of plant protein, and they aid with issues like diabetes, obesity, and other diseases. Additionally, they have a high water efficiency, may be grown in locations that are prone to drought, and can increase soil fertility by fixing nitrogen in the soil. The pulses are also a plentiful supply of dry and green feed for raising livestock. They are crucial to the pattern of cropping because of this.

Due to their importance as a major source of protein, pulses constitute a crucial component of the Indian diet. Due to the decreasing consumption of dairy and animal products and the rising number of vegetarians, pulses are known as "the poor man's meat" among the lowest sections of both rural and urban India. Pulse crops are utilized as green manure and help to improve the condition of the soil. By fixing nitrogen in the soil, pulses help to improve both human health and soil conservation. They are a great crop for achieving food and nutritional security, and tackling poverty and malnutrition because of their crucial role in the agricultural system and in people's diets. Pulses, also referred to as "Poor Man's Calorie" and "Rich Man's Vegetable," are substantial suppliers of proteins, vitamins, and minerals and considerably contribute to the nation's nutritional security. Pulses have a calorific value of 343 and contain more than 20% protein, more than 1% fat, 55–60% carbohydrates, 3.2% fiber, 300–500 mg of phosphorus per 100g, 7–10 mg of iron, 10-15 mg of vitamin C, 69–75 mg of calcium, and 430–489 IU of vitamin A. The amount of protein in pulses is often around twice that of whole-grain cereals like wheat, oats, barley, and rice, benefits human health in most poor nations.

In recognition of their importance, the UN General Assembly passed a resolution (A/RES/68/231) on December 20, 2013, designating 2016 as "The International Year of Pulses" (IYP). The Food and Agriculture Organization of the United Nations (FAO) organized a year-long event, which raised public awareness of the nutritional and environmental advantages of pulses as a component of sustainable food production.

Building on the success of the International Year of Pulses and realizing their potential to help accomplish the Sustainable Development Goals 1, 2, 3, 5, 8, 12, 13,

and 15 of the 2030 Agenda for Sustainable Development, Burkina Faso proposed the celebration of World Pulses Day. World Pulses Day was declared by the General Assembly in 2019 (resolution A/RES/73/251). The topic of the 2022 World Pulses Day is "Pulses to Empower Youth in Achieving Sustainable Agrifood Systems." The program of the event is therefore heavily weighted toward the testimonies and viewpoints of representatives of youth organizations. As the pulses industry is made up of a diverse group of players, it offers jobs to urban families in the industrial industry as well as to rural women and young people in farming areas. In order to create equitable and sustainable agri-food systems, pulses help to create chances for livelihood.

Pulses are primarily produced, consumed, and imported by India. To increase the domestic production of pulses and decrease reliance on imports, the government has recently implemented a variety of initiatives. Which lead to the consistently increasing in the production of pulses. The production, which ranged between 16 and 19 million metric tons (MMT) from 2010 to 2016, has dramatically climbed to 25 to 27 MMT over the past two years. The production of pulses, which was 18.24 MMT in 2010–11, increased to a record 25.46 MMT in 2020–21. The decline in imports during the past three years complements the increase in pulse output. From 2010 to 2015, the import of pulses ranged from 2 to 5 MMT, valued at between Rs. 7500 and 17,000 crores annually. In 2016–17, imports peaked at 6.66 MMT, worth Rs. 28,750 crores. The import of pulses has generally been on the decline over the past five years. In 2020–21, the amount of imports decreased to 2.46 MMT, the lowest level in the previous ten years. Not only the production of pulses has increased but the area and yields have also increased exponentially due to the systematic efforts of the government. In 2015-16, 24.91 Million Hectares (Mha) area was under pulses with an average yield of 652 kg/ha. In 2020-21, 28.78 Mha area is under pulses with an average yield of 885 kg/ha (static.pib.gov.in).

Table 1.1 All India Area, Production & Yield of Total Pulses

TOTAL PULSES			
Years	Area (million ha)	Production (million tons)	Yield (kg/ha)
2010-2011	26.28	18.24	694
2011-2012	24.78	17.21	694
2012-2013	23.47	18.34	785
2013-2014	25.21	19.25	764
2014-2015	23.55	17.15	726
2015-2016	25.26	16.47	652
2016-2017	29.46	22.95	779
2017-2018	29.36	25.42	865
2018-2019	28.28	23.4	827
2019-2020	27.99	23.02	823
2020-2021	28.78	25.75	885

(Source-static.pib.gov.in).

Since pulses are cultivated as a residual crop on marginal lands and are rain-fed, the production of pulses has been stagnating for almost forty years. Due to significant production and price risk, ineffective procurement, and other factors, farmers are not encouraged to grow pulse crops. The net per capita availability of pulses has fluctuated over the period from 1970 to 2018 due to the expanding population, diminishing pulse production, and rising pulse pricing. In India, the net availability of pulses per person has dramatically decreased, going from 51.2 grams per day in 1971 to 29.1 grams per day in 2003, and then rising to 51.3 grams per day in 2018. (Agricultural Statistics at a Glance, 2019). Presently, India produces over 23 million tons of pulses yearly, and it is anticipated that India will produce 39 million tons of pulses to achieve self-sufficiency (IIPR Vision-2050).

Present study is an economic analysis of major pulses in APMC Khammam of Telangana state. The total cultivable area under pulses of the state is 5.92 lakh ha, the production of pulses is 5.90 lakh tones and the yield of pulses of the state is 997 kg/ha (Crop-wise Area, Production and Productivity of Pulses from 2010-11 to 2020-21, DPD, GoI, Bhopal).

1.2 Importance of study

Farmers do not earn appropriate returns on their investments in practice. The variation in agricultural commodities prices has been one of the primary factors impacting the income levels of Indian farmers. The market witnessed more arrivals as agricultural production increased year after year, and prices varied. Agricultural commodity arrivals and prices often grow year after year.

The price volatility of agricultural commodities is impacted by a variety of variables, including yearly fluctuation in output, low price elasticity of demand, and seasonality of agricultural production. The knowledge regarding pricing behaviour in terms of the price level, trend, and volatility is the most essential aspect in assessing commodity competitiveness at the local and international levels, as well as in developing long-term trade strategies. Analyzing commodity price trends in the past is also beneficial in understanding the current situation and developing appropriate tactics to enhance the marketing system. This is true for a number of items in India's export basket.

The analysis of the relation among market arrivals and prices is quite beneficial. Larger output and arrivals have a negative influence on pricing, driving them to drop. However, in a mixed economy, market forces are given some direction, therefore this law may not always hold true. This market force management approach may try to regulate market supplies or consumption or both, particularly in the case of commodities where the brief reaction between sellers and purchasers and the consequence of this reaction at a specific point in time are represented in supply and price position. Thus, in a mixed economy, it is vital to investigate market arrivals and pricing as well as the variables that influence them.

Price forecasting reflects the extensive agreement among market players on the expected demand and supply of commodities at contract maturity (future pricing). As a result, price forecasting gives future prices that reflect future market supply and demand conditions. Price forecasting provide farmers with market information to assist them pick the optimal farming approach. The arrival and pricing study assists the farmer in selecting when to sell agricultural goods for the highest feasible price. As a result, it helps them decide when to sell in order to earn the greatest price.

Objectives

1. To estimate growth and instability in arrivals of major pulses in Khammam APMC of Telangana state.
2. To estimate growth and instability in prices of major pulses in Khammam APMC of Telangana State.
3. To estimate seasonal indices of arrivals and prices of major pulses in Khammam APMC of Telangana state.
4. To forecast major pulses prices in Khammam APMC of Telangana state.

Hypothesis

1. The arrivals and prices of major Pulses in Khammam APMC is increased over the period of time.
2. The arrivals and prices of major Pulses in Khammam APMC are more volatile.
3. The arrivals and prices of major Pulses in Khammam APMC are seasonally bounded.
4. Prices in the short run of major Pulses in Khammam APMC are increasing.

Scope of the Study

The agricultural sector plays a crucial role in the Indian economy. In India, agriculture is mostly rainfed which leads to the cultivation of pulses as they need less moisture as compared to cereals *viz*, rice, wheat and sugarcane. Severe fluctuations in the arrival of monsoons made agriculture gambling. This risk can be mitigated by the cultivation of crops that require less moisture and time i.e. pulses.

Seasonal price variation is observed for agricultural commodities mainly because of the nature of agricultural production. Nowadays the fluctuation in market arrivals and prices of agricultural produce is observed more. The arrivals in the postharvest period create a glut in the market resulting lowering of prices and considerable loss to growers. The research study helps the farmer to make the decision on when to sell their produce, where to sell their produce, and how to sell their produce. The study also helps the administrator with policy-making and improving the facilities available in the APMC of Khammam which is useful to farmers. Administrators and farmers can also understand the arrivals and prices of

growth and instability of pulses in APMC, that helps the both for better decision making.

Limitations of the study

The study is based on secondary data, so there is no control over the data collection process. The data may be biased and it is hard to know, if the information was collected is accurate. It is difficult to find the exact information for our study from existing work.

CHAPTER-II
REVIEW OF LITERATURE

CHAPTER-II

REVIEW OF LITERATURE

Review of literature gives the guidelines from the past researchers and provides foundation to the theoretical frame work for the present study. The review of past literature makes the researcher to get an insight in to the methods and procedure to be followed. Review of literature forms an integral part of research work.

1. Growth and instability of arrivals of major pulses

Reddy *et al.* (2006) made an effort to analyse the state-level growth, variability, and drivers of growth and instability in chickpea production. To reach the goals, compound growth rates, coefficient of variation, Coppock's Instability Index (CII), and decomposition analysis were computed using time series data for the production, area, and yield of chickpeas from 1971 to 2000. While the coefficient of variance increased from 14% to 17% over the same time period, the average chickpea output grew by 7% from 4.8 mt in 1970- 85 to 5.2 mt in 1986-2000. The majority of the states produce chickpeas in the low growth/high risk category as a result. Only three states qualify for the high growth/low risk category: Madhya Pradesh, Andhra Pradesh, and Orissa. Madhya Pradesh, Maharashtra, and Karnataka all contributed to increases in output, but Uttar Pradesh, Punjab, and Haryana did not. Yield and area both had a positive and negative impact on the growth in chickpea production between the periods. Large portions of the rise in variability in the nation's output of chickpeas were provided by Rajasthan and Madhya Pradesh as well as changes in interstate covariance. The variability in chickpea output has increased as a result of changes in area variance, area-yield covariances, and mean yields. The reduction in output variability was aided by changes in mean areas. During this time, there was a rise in state-to-state correlations between production, area, and yield; more states showed area correlations than yield correlations.

Rahman *et al.* (2009) studied the growth, instability and forecasting of Pigeon Pea, Chickpea and Field Pea Pulse production in Bangladesh. The study reveals that the pigeon pea pulse production was relatively stable (CV being 26.70%) compared to the chickpea (CV being 49.43%) and field pea (CV being 27.78%). Among the deterministic type models for pigeon pea, chickpea and field pea pulse production the cubic model is found to be the most appropriate one. The variation of

the growth rates in pigeon pea pulse production it - 28.71 % to.52%, in chickpea pulse production was -79.49% to 2.56% and in field pea pulse production it was - 19.12% to 5.83% during the study period.

Rao *et al.* (2010) estimated the growth patterns, the level of instability and evaluated the effects of the explanatory factors on the production of pulses in Andhra Pradesh. The data collected from years 1986–1987 to 2007–2008 were gathered from a number of publications of the Government of Andhra Pradesh's Bureau of Economics and Statistics. To accomplish the goals, hierarchical and K-Means clustering, compound growth rate (CGR), coppock's instability index (CII), and decomposition analysis were used. Results showed the growth performance of pulse production was strong. It was also highly unstable. Decomposition analysis showed that the area impact was still somewhat unstable.

Bera (2010) studied the present status of pulses in West Bengal. Over the years. Area and production of pulses has declined grossly in both the state as well as country level. Exponential growth rate of area, production and productivity of pulses of West Bengal were estimated to be -3.49, -2.47 and 1.02 respectively as against - 0.12, 0.37 and 0.87 respectively at the country level during period 1975-76 to 2005-06. Pulses area as a per centage of gross cropped area has come down from 12.86 in 1960-61 to 2.31 in 2004 05 in West Bengal. Due to Low productivity, low net return, pulses have been marginalized by highly remunerative competing crops.

Chaudhari and Pawar (2010) studied pigeon pea output, productivity, and relationship between market arrivals and pricing. Statistics on arrivals and pricing were compiled from 1985–1986 to 2004–2005 from four APMCs, Latur, Udgir, Osmanabad, and Paranda. Double log model and compound growth rate were used to achieve the objectives. The results indicated that pigeon pea production and area increased significantly in the Nanded and Jalna districts whereas these variables varied more widely in all other districts. Pigeon pea arrivals peaked in January in each of the selected markets. However, the correlation between arrivals and pricing in the Latur market was noticeably negative.

Kakde *et al.* (2013) studied Performance of Pulses in Akola District. The current study was conducted with the goals of examining market arrivals of specific pulses as well as seasonal, cyclic, and trend changes in arrivals and prices of specific

pulses in all APMCs of the Akola district, including Akola, Akot, Balapur, and Telhara, over a 20-year period from 1987 to 2006. The analysis in mung showed that the highest increase in arrival in Balapur market was (1205.54%), followed by Telhara (122.94%), (Akot 12.21%) and Akola (-32.78), Akola market showed decreasing trend in arrival of mung

Kumbhar *et al.* (2016) studied the growth rates in arrivals and prices of pulses in selected markets in Maharashtra state. The period of study was (1999 to 2010) monthly arrivals and prices of gram and pigeon pea, have been worked out separately for Solapur and Pune markets. The CGR of arrivals of gram was found to be 11.83 per cent in Solapur market and it was 4.53 per cent in Pune market and both were positively significant, indicating increasing trend over a period of time. The CGR of arrivals of pigeon pea in Solapur market was -1.58 per cent and it was non-significant, which indicated the decreasing trend of the arrivals of pigeon pea over period of time.

Sahoo and Singh (2017) studied trend and seasonality in prices and arrivals of Bengal gram. The study was conducted for the period of 2003-2016 by collecting secondary data from market of Bengal gram. The major APMC markets were selected purposively on the basis of high prices and arrivals in Uttar Pradesh and Madhya Pradesh which was the major Bengal gram growing states of India. There was a positive and significant growth rate was observed in the prices of selected APMC markets i.e. Bareilly and Shujalpur which was 0.78 and 0.49 respectively but there observed a positive and insignificant growth rate in the arrivals which was 0.07 and 0.02 at 5% level of significance. Both Bareilly and Shujalpur market have high seasonal indices in the month of May and June indicated the high post-harvest arrivals in the months. The low arrivals in the month of August, January, and July indicated the shortage and speculation in the pulse market. There was an inverse relationship between arrival and prices of Bengal gram in the selected markets.

Rani *et al.* (2017) Primary objective of the study is to assess the development, instability, and yearly changes of cotton in Pakistan during the previous three decades. Time series data on cotton acreage, output, and yield are collected from 1981 to 2015. The results demonstrate that private company involvement has fostered favourable growth rates in cotton production, yield, and acreage over time. The greatest and lowest yield growth rates for cotton are found in Pakistan, respectively, at 2.65 and 0.88. The results of the data analysis show that

Pakistan's cotton output is quite unstable even if the country's land is relatively steady. Cotton output varied significantly and inconsistently each year during the course of the study period, but especially between 1981 and 1990. In the years 1983–84 and 1984–85, the fluctuation was at its lowest. The variation in cotton area in the nation reached its peak in 1995–1996 and its trough in 2010–11. The years 1983–84 and 1984–85 had the lowest cotton yields, respectively.

Kurmi *et al.* (2018) the study was done on market monthly arrivals and prices for the years 2004–05 and 2014–15, which were used as the base year and current year for this study. Regarding chickpea arrivals on a monthly basis, it has been noted that in the chosen controlled market, the peak season, which is March and April, had the highest percentage of arrivals at 30.30 percent, while the midseason and lean season saw arrivals of 60.99 and 8.71 percent, respectively. Only 6.4% of the total chickpea arrivals in the chosen controlled market were discovered to have occurred in August.

Navasare *et al.* (2018) studied the behaviour in prices and arrivals of sorghum, tur, soybean, chickpea and bajra in Ahmednagar district. The 12 years (2005–06 to 2016–17) time series data from all four APMC of Ahmednagar district was collected. The analysis of compound growth rate reveals that the growth rates of arrival and prices of overall period was positive and significant. In APMC, Ahmednagar the highest per annum growth rates were noticed in the soybean (161.82%) and lowest growth rate were noticed in the bajra (32.24%). In Karjat, APMC the highest growth rates were noticed for sorghum (0.46%) and lowest growth rate were noticed in the bajra (-32.71%) per year, respectively.

Neelamma and Banakar (2018) analysed the growth trend and instability in arrivals and modal prices of the commodity. The growth rate in arrivals and prices of selected commodities in APMCs of Karnataka was calculated for the period of fifteen years. CAGR (compound annual growth rate) technique was used to calculate the growth rate of arrivals and prices of commodities. Instability was assessed with the help of Instability index technique. It can be observed that growth rate of arrivals in all most all the market was significant. In the Challakere and Ranebennur market the growth rate was non-significant and positive unlike in Vijayapur where in the growth rate was negative and non-significant. Instability index was found lesser in all the commodities. Among those Bagalkot, Gadag,

Kalburgi and Shivamogga showed comparatively high instability.

Devi *et al.* (2019) studied price and arrivals pattern and market integration of major pulse crops (gram and tur) in Gujarat state. According to the study, there was a considerable increase in the price of gram and tur in every market that was chosen throughout the study period, with positive and statistically significant compound growth rates. The inter-year pricing analysis also revealed an upward trend in yearly price indices. The intra-year pricing research showed that there was a broad pattern of seasonal fluctuations in prices, with prices increasing in the off-season and declining in the main season in the majority of the chosen markets for both crops. The arrivals trend reveals that in the chosen markets, there were higher arrivals during the off-season. The arrivals trend reveals that in the chosen markets, there were higher arrivals during the off-season. This can happen as a result of the stockiest companies releasing their stock at the start of the new season. The market integration results showed that each market pair had a positive and substantial connection, indicating that the wholesale prices of gram and tur were integrated in each of the chosen market places. The statistics above suggest that when prices rise in one market, it causes prices to rise in other markets as well.

Kamble and Tiwari (2019) studied volatility of the agricultural markets, exports, area, production, and yield of onions in Maharashtra. This was accomplished by first examining onion arrival and pricing data from 2000 to 2015 in A.P.M.C., Pune, Solapur, Pimpalgaon, Mumbai, Lasalgaon, Yeola, Malegaon, Manmad, Kolhapur, and Nagpur. For seasonal instability, the multiplicative method was used, and for area, production, yield, and export instability, the Cuddy-Della Valle index was used. All of the examined market places had rising price and arrival patterns. Prices for onions displayed substantial year-to-year and inter-year variation. It was discovered that onion prices were highest during a lean season and lowest during a time of significant arrivals. Between August and January, export instability was at higher levels.

Dhende *et al.* (2020) studied the trends in arrivals and prices of selected agricultural commodities in APMC, Sangli. The study covering the period of eleven years (2007-08 to 2017-18) of monthly arrivals and prices were collected from APMC, Sangli. Methodology used is the compound growth rate of arrivals and prices of selected agricultural commodities was worked out by using an exponential form,

the annual compound growth rates of arrivals of gram were found positive and significant during the period under the study. The arrival of gram increased by 9.82 per cent per annum and price of gram was found positive and highly significant means prices have been increased by 11.12 per cent per annum during study period.

Gholap *et al.* (2021) based on secondary data from 2009–10 to 2018–19, the current study examined the tomato arrivals and price behaviour in the Gultekdi market in Pune. It calculated changes in area, production, productivity, pricing, and arrivals as well as seasonal and cyclical variations. The findings showed that, during the research period, there was an upward trend in the area, output, and productivity of tomatoes in India. Tomato output and area in Maharashtra were on the decline, but productivity rose sharply thanks to a 2.91 percent growth rate. Immediately following harvest, the monthly seasonal indexes for arrivals were higher. When arrivals were at their highest, the price indices were lower, and vice versa. It was discovered that the CV of real prices exceeded arrivals. A long-term procurement strategy should be established to ensure price stability by announcing the MSP in order to reduce price risk and safeguard the price security of the agricultural community.

2. Growth and instability in prices of major pulses

Barua *et al.* (2000) analysed the growth, price instability, and flexibility of major crops in Bangladesh. They estimated compound growth rate of prices and instability of prices. There was a compound growth rate of the real price of selected crops during the study period 1980-81 to 1998-99 was estimated. The results revealed that, the declining rate of Boro price occupied the top position followed by Aus, Aman, jute and wheat. The real price of jute occupied the highest level of instability followed by wheat, boro, aman and aus during the study period.

Rao *et al.* (2010) investigated the growth trends and levels of instability and evaluated the impact of the explanatory variables on the production of pulses in Andhra Pradesh. Area, output and productivity data for the years 1986–1987 to 2007–2008 were gathered from a variety of publications by the Government of Andhra Pradesh. The study's goals were accomplished using hierarchical and K-Means clustering, compound growth rate (CGR), Coppock's instability index (CII) and decomposition analysis (change in average production). Although the growth performance of pulse generation was strong, it was highly unstable. Decomposition

analysis showed that the area effect on the production disparity was just slightly greater than the productivity effect. Therefore, area-attributing variables like the availability of remunerative pricing and a secure supply of agricultural inputs should be the key sources of output development.

Gajbhiye *et al.* (2010) estimated chickpea growth and instability. The Vidharbha area of Maharashtra state served as the location for the current study. The study's secondary data included the years 1980–1981 through 2007–2008. The study's findings revealed that the growth rates for chickpea output and area were noteworthy. Less variance in chickpea productivity is a result of instability. This indicates that chickpea output has been essentially steady over the years.

Bodade *et al.* (2011) analysed Vidharbha region's major crops, their growth and instability. The Vidharbha region's Buldhana district was selected for the study since it has the biggest area under chickpea production. The study's foundation was secondary data that covered the years 1990–1991 through 2008–2009. Significant growth rates for the chickpea crop were discovered. According to a study on instability done in Buldhana, there was significant volatility in chickpea output.

Saima Rani *et al.* (2012) estimated compound growth rate, instability index, and annual fluctuations in area, yield, production, and prices of major pulses (gram, masoor, mung, and mash). In the present paper time series data from 1976 to 2010 on the price, area, yield, and production of major pulses were collected. Own price flexibility and cross-price flexibility between gram, masoor (winter pulses), mash and mung (summer pulses) were analyzed to measure the impact of production on cross-prices. The growth rate of prices for all these pulses was positive throughout the study period. The price of masoor was highly unstable as compared to other pulses. High fluctuation in the area of mung was found throughout the study period. The analysis of own price flexibility revealed that gram and mung were less risky pulses.

Niaz *et al.* (2013) studied growth rate, instability and production forecasting of mung bean and grass pea pulses. Forecasts have been prepared based on the best fitted deterministic and ARIMA model, which has been fitted with deterministic and ARIMA models for predicting. By calculating the coefficient of variation (CV) and the percentage deviations from values with a three-year moving average, the amount of instability in the production of grass pea and mung bean pulses was evaluated. According to the study's findings, the production of grass pea pulses was shown to be

more steady (CV = 44.38%) than that of mung bean pulses (CV = 52.87%). During the research period, the growth rates of the production of mung bean and grass pea pulses varied from -21.55% to 20.26% and -19.51% to 14.44%, respectively. The production forecast demonstrated the grass pea and mung bean pulse's important potential in Bangladesh.

Srivastava *et al.* (2013) investigated major pulses' development patterns in eastern Uttar Pradesh. According to the study, from an area of roughly 11.98 million hectares, chickpeas produce about 10.92 million tonnes of grains to the world's food supply. The purpose of the study was to determine the acreage, production and productivity growth rates of the main pulses (chickpea and pigeonpea) in eastern Uttar Pradesh. According to a study, the primary cause of the output loss in eastern Uttar Pradesh is the decrease in the area planted with chickpea and pigeonpea. It was necessary to increase the productivity and add additional land to the production of chickpea and pigeonpea.

Ramachandra *et al.* (2013) carried out our research on local growth, production, and productivity for various crops. The required secondary data were gathered for a 26-year period, from 1982–1983 to 2007–2008. Estimates of the growth in the area, production, and productivity under various crops revealed a significantly positive development in the area under pulses, vegetables, spices, fruits, and nuts, but a significantly negative growth in the area under cereals. The area planted with jowar, bajra, ragi, and minor millets was significantly declining each year. The area planted with commercial crops and oilseeds increased negatively and little. Cereals, legumes, and fruits all saw large increases in agricultural production over time. Oilseed productivity had a marginally significant increase.

Pichad and Wagh (2014) made an effort to research the chickpea crop's performance in terms of output, area, and productivity in the Amravati district. The data covered a 20-year span, from 1990–1991 to 2009–2010. By calculating growth rates and the co-efficient of variation of area, production, and productivity of chickpea, the effectiveness of the crop was investigated. The findings showed that period II's compound growth rates for area, output, and productivity were positive and substantial. The co-efficient of variation showed that, throughout the course of the time, instability in the chickpea region showed less change than production and productivity.

Sharma (2014) predicted trends for pulse production, area, and productivity. The study used secondary data spanning the years 1950–1951 through 2012–2013. The acreage, production, and productivity trends of pulse crops in India were examined using the fitting of the linear, quadratic, and exponential functions. Due to its greater R^2 value compared to the other two functional forms, the quadratic functional form was used to match the trends. In addition to these, the co-efficient of variation (CV), instability index (II), and compound growth rate (CGR) were calculated. The impacts on area, productivity, and their interactions with rising production trends were calculated in the current study. Additional research showed that has a favourable and statistically significant impact on the entire time period of pulse generation in the nation, particularly during Phase I and Phase II. Pulse crop acreage, output, and productivity had a CV of less than 0.08%.

Sharma *et al.* (2014) studied the behavior of market arrivals and prices of pearl millet in Rajasthan's Nagaur market. It was discovered that the majority of the produce was obtained in the market was lower prices. In the Jodhpur market, there was a positive and statistically significant correlation between arrivals and prices. This positive and significant correlation coefficient may be due to the higher prices of off-season pearl millet supplies.

Kumbhar *et al.* (2016) studied the Growth rates in arrivals and prices of pulses in selected markets in Maharashtra state. Monthly arrivals and prices of gram and pigeon pea, have been worked out separately by using compound annual growth rate for Solapur and Pune markets from 1999 to 2000. The result obtained for price of gram, the CAGR was 5.24 percent and 4.51 percent while significant magnitudes in the Solapur and Pune market, respectively, which indicated that prices were increasing over a period of time. The compound growth rate of price of pigeon pea in Solapur market was positive and significant means price are increased by 7.04 per cent over a period of time.

Qammer and Baba (2016) used time series data to analyse the development, instability and factors of Indian walnut export. With an annual growth rate of 1.70 percent, the area planted with walnut has significantly increased, and this, together with rising yield levels, has increased output. India contributed 2.73 percent of the world's shelled walnut exports in 2012, according to research, and it has a negligible part in the export of walnuts

already shelled. It was noted that, the United Kingdom is the biggest importer of Indian shelled walnut, followed by Egypt, Germany, Spain, and the Netherlands. Between 1979 and 2012, the equivalent export of Indian walnuts climbed dramatically, notwithstanding minor fluctuations around 2000. With an average annual growth rate of roughly 3%, the export of shelled walnut (kernel) has greatly expanded between 1979 and 2012.

Sahoo and Singh (2017) investigated trend and seasonality in prices and arrivals of Bengal gram. For the period 2003-2016, the study was carried out through the collection of market secondary data for bengal gram. The major APMC markets were purposefully selected based on high prices and arrivals in Uttar Pradesh and Madhya Pradesh, India's two most important Bengal gram-growing states. The study found a positive and significant growth rate in the prices of selected APMC markets, namely Bareilly and Shujalpur, which were 0.78 and 0.49 respectively, but a positive and insignificant growth rate in the arrivals, which were 0.07 and 0.02 at the 5% level of significance. The high seasonal indicators of Bareilly and Shujalpur market in the months of May and June indicated high arrivals in the following months. The low arrivals in August, January, and July indicated a pulse demand shortage and speculation. There was an inverse relationship between Bengal gram arrival and prices in the selected markets, according to the study. It was suggested that infrastructure, transportation, and storage facilities be strengthened, as well as the market information network be improved. Productivity and develop market basic infrastructure such as warehousing, transportation, and processing.

Neelamma and Banakar (2018) conducted a 15-year study of the growth trend, instability, and modal prices of the chosen commodities in the Karnataka APMCs (2003-04 to 2017-18). From thirteen distinct market places in Karnataka, thirteen different commodities were chosen. The market was chosen based on a particular commodity's greatest market arrivals, and the data were analysed using a variety of statistical techniques, such as the CAGR method, coefficient of variation, and instability index. When compared to the price of the product, arrivals in the market had a varying growth rate, but it is clear that the growth rate of arrivals in virtually all market places was considerable. The coefficient of variance and kind of instability of arrivals and modal pricing were examined. It was noted that all

commodity modal prices showed strong, positive growth with little unpredictability or volatility. High levels of variety and instability were present in the arrivals, and most commodities shown notable and positive growth rates, with the exception of a handful that displayed notable and negative growth rates. Compared to when they arrive, there is a lot of pricing instability and variance.

Navasare *et al.* (2018) researched how sorghum, tur, soybean, chickpea, and bajra prices and arrivals behaved in the Ahmednagar district APMC market. Over a 12-year period, data from all four APMCs in the Ahmednagar district were collected (2005-06 to 2016-17). Arrivals and prices both grew positively and significantly throughout the course of the time, according to an analysis of the compound growth rate. The bajra had the lowest annual growth rate (32.24%) and the soybean had the highest annual growth rate (161.82%) in APMC, Ahmednagar. Sorghum, tur, soybean, chickpea, and bajra prices all climbed considerably over the research period. There was an inverse link between arrivals and prices for sorghum, tur, chickpeas, and bajra, meaning that the prices of these commodities fell as arrivals rose.

Geetha and Srivastavas (2019) analysed the development, volatility, trade direction, potential, and factors that affect maize exports from India between 1981 and 2016. The study made use of the compound annual growth rate, the Cuddy-Della Valle approach, Markov Chain analysis, the Revealed Comparative Advantage Index, and regression analysis. Prior to the WTO, the increase of export volume and value was determined to be non-significant, however the rise of unit value was negative. Export quantity, value, and unit value all increased dramatically in the post-WTO era at rates of 38.74, 42.12, and 2.43 percent annually, respectively.

Devi *et al.* (2019) Gujarat state's principal pulse crops (gramme and tur) were evaluated for pricing, arrivals pattern, and market integration. Over the past 10 years, secondary information on monthly wholesale pricing and arrivals has been collected from the regulated markets' websites listed on agmarknet.gov.in (2007 to 2016). The gathered data were analysed using a variety of statistical techniques that include time series analysis, including trend analysis, seasonal indices, compound growth rates, and integration analysis. The price of gram and tur increased significantly in all of the selected markets over the research period, with a positive and statistically significant compound growth rate, according to the findings of the

inter-year price analysis, which also shows an increasing trend in yearly price indices. In practically all of the examined markets for both crops, the intra-year price analysis revealed a general tendency of seasonal price changes, with prices rising in the off-season and falling in the main season. The market integration findings revealed that each market pair had such a strong positive connection, proving that all of the chosen markets had merged grams and tur wholesale prices. The aforementioned conclusions lead to the conclusion that as prices in one market increase, prices in other markets also increase, indicating positive market integration in terms of pricing.

Vekariya *et al.* (2020) the present study was carried out by using time series data of price from 1998 to 2018, to compare the price variation, to measure the price instability of major domestic groundnut markets of Saurashtra region of Gujarat state i.e. Rajkot, Junagadh, Amreli and Gondal. Data were collected from the registers maintained in the respective Agricultural Produce Market Committees (APMCs). The price variation had been compared by using descriptive statistics in which range and standard deviation indicated wide variation in the price level of all the markets as well as markets have positively skewed ($\gamma_1 > 0$) and mesokurtic ($\beta_2 \sim 0$) distribution. The price instability based on trend model was measured. Fitting of trend model is done by regressing the variable under consideration on chronological time period. Estimates of fitted cubic trend model for all the markets were significant. Higher instability was observed for Gondal market.

3. Seasonal indices of arrival and prices

Kumar *et al.* (2009) after China, India is the world's second-largest producer of veggies. In 2004–2005, the nation produced 101.33 million tonnes of vegetables on 67.55 million hectares, yielding productivity of 15.01 percent. The market in Bangalore served as the subject of the current study from 1999 to 2008. The Agricultural Produce Market Committee (APMC) and the Karnataka State Agricultural Marketing Board, Bangalore, provided the secondary data on monthly arrivals (Qtls) and prices (Rs/Qtls) of green pepper, onion, potato, and tomato. The Multiplicative Time Series Analysis, twelve-month centered moving average, and two-way ANOVA were used to assess the seasonality of arrivals and prices. With the exception of onion pricing, all crops exhibit seasonality in terms of arrivals and prices within a given year. The market does not modify its seasonal pattern over

time.

Asmatoddin *et al.* (2009) to establish price index changes for significant pulse crops, researchers examined arrivals and pricing behavior in the APMC market Parbhani over the years 2004–2005. Nine years of arrival and pricing information, from 1996-1997 to 2004-2005, were gathered and examined. The outcome showed that the month of March saw the highest price index recorded, while the month of October saw the largest green gram arrivals. The price index fluctuated between a low of 83% and a high of 105. When it comes to pigeon peas, the arrival index peaked in January while the price index peaked in September. The price index ranges from 93 to 107 percent.

Chaudhari *et al.* (2010) analysed the growth, instability and price analysis of pigeon pea (*Cajanuscajan L.*) in Marathwada region. To measure the seasonal variation in market arrivals and prices of pigeon pea, ratio to moving average method was used. The result was revealed that the seasonal indices of pigeon pea were higher from January to May in Latur and Udgir market, from December to March in Osmanabad market and from December to February in Paranda market. The highest market arrivals were recorded in the month of January (253.76 per cent), February (286.85 per cent), January (383.96 per cent) and December (484.84 per cent) in Latur, Udgir, Osmanabad and Paranda markets, respectively. Where as lowest market arrivals of pigeon pea recorded in the month of October in all selected markets during the study period. A bulk of produce reached to a market immediately after harvesting found seasonality in market arrivals causes higher arrivals.

Jadhav *et al.* (2011) this analysis was based on secondary data on soybean arrival and pricing during the ten-year period from 1999–2000 to 2008–2009 in A.P.M.C., Achalpur, Amravati, Morshi, and Daryapur. In all the chosen markets, a rise in arrival and price index was seen for soybeans compared to the base year. The monthly seasonal index of soybeans was discovered to be at its greatest right after harvest in all of the chosen market places. Conversely, it was shown that the price index for soybeans was lower in the months with the most arrivals.

Thombre and More (2013) research were done on the Marathwada region's pigeon pea market arrivals and pricing. The results show that, the ratio to moving average approach was used to calculate the seasonal variation in arrivals and

pricing. A simple linear regression equation and a double log models were used to evaluate the link between market arrivals and pigeon pea prices. The findings showed that pigeon pea arrivals and pricing were strongly influenced by the season. The findings supported the notion that arrivals and pricing in both of the study's marketplaces were negatively correlated.

Kakade *et al.* (2013) selective Pulses examined the seasonal fluctuation, cyclic variation, and trends in arrivals and prices in all APMC in the Akola district, including Akola, Akot, Balapur, and Telhara, for a period of 20 years (1987 to 2006). Crop price indices were lower during peak arrival months and vice versa, and the monthly seasonal indices for chosen pulse arrivals were higher shortly following harvest in all the research markets. It was discovered that cyclical variations in pricing were more pronounced than seasonal fluctuations. This demonstrated that prices fluctuated throughout the month leading up to harvest when output was at its highest. Real price fluctuation was shown to have the largest coefficient of variance.

Patel and Patel (2013) investigated the performance of the fennel and cumin marketing systems in the market at APMC, Unjha. Cumin and fennel arrival and pricing statistics for the past 10 years, ending in 2011–12, were gathered from the APMC of Unjha. For the agricultural items, cumin and fennel, a trend and cyclic trend component were discovered. Studies on both agricultural crops found a substantial correlation between arrivals and pricing. The seasonal arrival indicators showed that cumin arrived in great quantities in APMC from April to June. Fennel, on the other hand, had significant arrivals from July to September. It has been determined that market arrivals have a detrimental effect on pricing. In light of this discovery, the likelihood of price swings would be reduced if variations in market arrivals are controlled by market extension.

Mahalle *et al.* (2014) results show rising trends in chickpea prices and market arrivals in each of the studied markets from 1997 to 2011. Market arrivals and chickpea pricing were both subject to seasonal variations between market places. In markets, interpreting marketing system stability, the average seasonal price fluctuation and the intra-year price increase for chickpea ranged from 7.93% to 11.75% and 8.26% to 12.49%, respectively. Two of the four markets were co-integrated, according to the results of the Johansen market integration technique.

Error-correcting mechanisms proved that chickpea markets eventually reached price equilibrium.

More and Katkade (2014) research was done to determine how oilseed crop arrivals and prices changed over time in the Marathwada area. The oilseed industry plays a significant role in the Indian economy, but because these crops are grown in high-risk areas with unpredictable levels of production, their arrival on the market is subject to greater fluctuations, which eventually lead to price volatility. The study focused on two significant oilseed crops in the area: soybean and safflower. For a span of twenty years, from 1991–1992 to 2009–2010, monthly time series data for sixteen main markets from eight districts of the Marathwada area were gathered and examined. We calculated the mean, coefficient of variation, and seasonal indicators (using the ratio to moving average approach). They came to the conclusion that soybean and safflower arrivals and pricing in all of the Marathwada region's chosen markets were seasonal. Soybean and safflower arrival peaks were seen from October to December and March to May, respectively. The highest monthly prices for soybean and safflower were recorded in December and June, respectively, with minor coefficients of variation of 29% and 19%. The Latur market had the highest soybean arrivals and prices. Safflower arrived more often in Latur's market, although Aurangabad's market had the highest pricing.

Patil and Bhurke (2014) studied economic influence of the arrivals and costs of pulses in the Indian state of Maharashtra. According to the study, the most significant products in the Agricultural Produce Market Committees (APMC) in Akola were pulses (red, green, and black gram). With the entrance of the new crop in December, red gram arrivals in the APMC market begin to rise. The lowest arrivals (10.12) were seen in the pre-harvest month of November. Price indexes reflect a pattern from July through October of dropping and rising values, respectively. September had the most black gram arrivals, according to reports (317.45). There were several differences in the cost of black gram. Regarding pricing, there were two high points: January (143.55) and July (121.12). Maximum arrivals are seen in the month of September according to seasonal indexes of green gram (399.01). While the pre-harvest period, from March (101.77) to July (125.41), had the highest prices achieved, the post-harvest period saw the lowest prices. The study found that prices rose when arrivals rose and vice versa. Private sector and public sector

organizations must take the lead in designing profitable, win-win models of price discovery mechanisms for sustainable development in rural income levels in order to overcome this barrier.

Naidu (2014) examined the market arrivals' behavior and cotton prices in Andhra Pradesh. In contrast to prices, which were high in September and low in November, the volume of market arrivals was low in September and high in November. Arrival and price cyclical indices were closer to one, but no clear cycle could be seen. With the exception of 2010–2011, the monthly arrivals and price association was strong. The predicted maximum and lowest costs were seen in September and October, although the highest and lowest arrivals that year were in November and September.

Kumawat and Singh (2015) examined Moth bean arrival and price trends in Rajasthan. They demonstrated that the prices were at their lowest when the bulk of the product was delivered to the market. In Nagaur and Jodhpur, there was a substantial inverse relationship between moth bean prices and arrivals. Merta and Jaipur markets, however, showed a negative but insignificant link. The association between arrivals and prices in the Nokha market, however, was favorable but not statistically significant. Except for the Jodhpur market, where it was significant, the trend analysis of moth bean arrivals in the markets of Nagaur, Merta, Jodhpur, and Jaipur revealed a declining trend that was non-significant. Over time, the trend values of arrivals in the Nokha market demonstrated a positive but unremarkable tendency. Moth bean prices are low during the peak season. Government should thus increase efforts to purchase moth beans at MSP during the peak season. Farmers should also take out marketing loans to hold back their goods for a while so they can earn a fair price during the lean and mid-seasons. In order to have specialized storage facilities at the village level, credit facilities should also be made available to farmers through the Gramin Bhandaran Yojana.

More *et al.* (2015) with the goals of firstly identifying the pattern of market arrivals and prices of important pulse crops and secondly identifying seasonality in arrivals and prices, the arrival and price changes of important pulse crops in the Marathwada area of Maharashtra State were researched. In Latur and Hingoli market places, the study found a negative relation between pigeon pea and chickpea crop arrivals and prices over time. Pigeon pea arrivals at the Latur market were seasonal

(from January to May). The month of January had the highest number of arrivals, followed by February and March. The pigeon pea price index reached its peak in November, with a large coefficient of variation (176.25) suggesting that greater prices are not guaranteed throughout this month. The greatest arrival index for chickpeas was recorded in the months of March and April. The price index peaked in October, then fell in November with a smaller coefficient of variation value, suggesting that the farmer could change his or her chickpea-sale schedule in October and November for successful marketing.

Sharma (2016) conducted a study by gathering monthly wholesale wheat prices in the Rajasthani district of Sriganganagar. This study was based on secondary data on the arrival and pricing of wheat over a period of ten years in the following locations: APMC, Sriganganagar, Sadulsahar, Guarana, Apgar, Vijayanagar, Suratgarh, Gajsinghpur, Karanpur, and Raisinghnagar (2005 - 2014). In the analysis, all of the chosen markets had rising prices. The monthly variance in wheat prices is quantified by the seasonal price index. It was discovered that the price of wheat was greatest during the off-season and lowest during the harvest. Because wheat is a *rabi* crop, there were many arrivals from March to May. December through February, when arrivals were found to be minimal, then the higher seasonal price indices were identified.

Benke *et al.* (2016) studied green gram price behavior in Akola area. The data on green gram arrivals and pricing for the 20-year period (1987 to 2006) were utilized. They came to the conclusion that for APMC, Akola, the compound growth rate of production and arrival were found to be favorably linked throughout the period I of the research (1987–1966) and negatively associated during period II (1997–2006). Despite obvious seasonality in arrivals, there were differences in green gram pricing. It was discovered that price changes are more apparent during cyclical periods than during seasonal ones. This demonstrated that prices fluctuated during the month before harvest when output was at its highest. For the crop of green gram, the C.V. was the lowest. According to the study mentioned above, there were more arrivals during the post-harvest periods for the majority of agricultural commodities, which led to a glut and a consequent drop in prices. Additionally, markets detected a negative correlation between arrivals and pricing, with very few exceptions. The majority of academics have recommended treatments

including storage for a period of time and providing farmers with credit facilities. Price variations were the primary cause of decreased revenue for farmers.

Sahoo and Singh (2017) with the aim of analyzing seasonality indices in Bengal Gram using the moving average approach, researchers looked at the trend and seasonality in Prices and arrivals of Bengal Gram. Significant seasonal indices were found to indicate a large level of post-harvest arrivals at both the Bareilly and SHUJALPUR market places in the months of May and June. The low arrivals in January, August, and July indicated a lack of pulses and market speculation.

Nannajkar *et al.* (2017) the study conducted on chickpeas and pigeon peas. From 2004–2005 through 2014–2015, monthly time series data for three important market places in the Solapur area were gathered and examined. Calculations were made for the mean, coefficient of variation, and seasonal indices. Results indicated that, pigeon pea and chickpea arrivals and pricing were seasonal in all of the Solapur District's chosen marketplaces. Pigeon pea and chickpea peak arrivals were recorded in January through March and February through May, respectively. In the months of June and July, the price index for chickpeas and pigeon peas was at its highest. Pigeon pea prices and arrivals peaked at the Barshi market. Whereas Solapur market saw the highest level of chickpea arrivals.

Sonvane and Koshta (2019) this study aims to investigate chickpea arrivals, pricing behaviour, and forecasts in the Chhattisgarh plains' Krishi Upaj Mandis. According to the number of chickpea arrivals, Krishi Upaj Mandi (KUM) Bhatapara, KUM Mungeli, KUM Rajnandgaon, KUM Kabirdham, and KUM Bemetra were chosen. Using the twelve-month ratio to moving average approach, the seasonal fluctuations in pulses' pricing and arrivals as well as their seasonal indices were computed. Three peak chickpea arrivals were noted, occurring in the months of March (3594.18 qt), April (6326.90 qt), and May. (2639.87qt). However, three price peaks were seen in the seasonal indices of chickpea prices, which were in the months of August (97.04 per cent), September (186.07 per cent), and October (186.08 per cent). According to the study's findings, there is an inverse relationship between chickpea arrivals and pricing. The range of anticipated chickpea arrivals is predicted to be between a low of 1054.85 tonnes in October 2018 and a maximum of 5459.60 tonnes in March 2021. From Rs./qtl 2859.08 to Rs./qtl 3878.50 is the predicted range for chickpea prices for the months

of October 2018 to April 2020. By providing projections of arrivals and pricing for next months, this data let policymakers and planners make more informed decisions.

Balai *et al.* (2021) analyzed that the highest and lowest arrivals of gram was observed during the month of June (112.61%) and January (87.27%) in Krishi Upaj Mandi Samiti, Bikaner of Rajasthan. The highest and lowest prices of gram was reported in the month of January and June at the rate of 113.37 and 84.90 per cent, respectively.

Kachroo and Nazir (2021) the goal of the study was to determine how the arrival and pricing changes for the high-value agricultural commodities that were chosen. Secondary data was gathered for the study's 2004–2020 time frame from the CMIE (Centre for Monitoring Indian Economy) database. The key agricultural products were purposefully chosen based on market arrivals and strong price volatility. Castor seed, coriander, jeera, soybeans, and turmeric are among the products chosen for the study. The study's findings indicated a significant and positive correlation between growth rates and prices of particular commodities, with coriander having the highest growth rate overall (7.55%), followed by soybean (7.24%), and jeera having the lowest (5.69%). Jeera had the highest growth rate in arrival (9.87%), followed by turmeric (9.05%), and coriander had the lowest growth rate (5.06%). The data showed that from March to June, high seasonal indices were seen across all commodities, indicating a substantial volume of post-harvest arrivals during these months. Since there aren't enough storage facilities and the output is quite low during these months, the seasonal index for pricing for soybean and turmeric is high from April to September. This research recommended upgrading the infrastructure, storage, and post harvest practises such that the arrivals of these commodities rise and availability is year-round, hence reducing price volatility.

4. Forecasting of major pulses prices

Niaz *et al.* (2013) studied modeling and forecasting of lentil, pulse production in Bangladesh. The Box Jenkins ARIMA methodology has been used for forecasting. The diagnostic checking has shown that ARIMA (0, 1, 9) was appropriate. The forecasts from 2011-12 to 2015-16 were calculated based on the selected model. These forecasts would be helpful for the policy

makers to foresee ahead of time regarding the future requirements of grain storage import and export and adopt appropriate measures in this regard.

Vishwajith *et al.* (2014) pulses are relative affordability as sources of protein for balancing the human diet, pulses are sometimes referred to as "poor man's meat." In a populous growing nation like India, the production of pulses is essential to the nation's nutritional security. The production of pulses has been modeled and predicted using the Autoregressive Integrated Moving Average (ARIMA) approach. The majority of the time, adding production parameters to the model performed better than using only standard ARIMA modeling. Generalized Autoregressive Conditional Heteroscedastic (GARCH) models are utilized to handle conditional variances and have also been employed in this study. With its expected share of 3661 thousand tonnes out of total India's output of 14360 thousand tonnes in 2015, Madhya Pradesh must play a significant part in increasing pulses production in India, according to the forecasted value. According to the comparative investigation, neither the ARIMA model nor the GARCH could be consistently superior in simulating and predicting the production behavior of pulses in India.

Shukla and Jharkharia (2015) investigated the applicability of ARIMA models in wholesale vegetable market. Models were built, taking sales data of one perishable vegetable from Ahmedabad wholesales market in India. It was found that, these models can be applied to forecast the demand with Mean Absolute Percentage Error (MAPE) in the range of 20 per cent. This error was acceptable in fresh produce market where the demand and prices are highly unstable. The model was successfully validated using sales data of another vegetable from the same market. This model can facilitate the farmers and wholesalers in effective decision making. ARIMA model was applied due to its superior behavior over other models in the same class to forecast the demand of a fresh produce on a daily basis. The data was collected from Ahmedabad wholesales market over a period of twenty-five months (1-Jan-07 to 31-Jan-2010) to build the models. The model was identified using twenty-four months of onion sales data. The left one month data was used to forecast the sales and to calculate the accuracy of the model. It was racy of Meat observed that the model was able to forecast the demand with an accuracy of Mean Absolute Percentage Error (MAPE) of 19.39 per cent. In order to validate the model, data was collected for potato sales in the same market and the model was applied. Result shows that the

proposed model was able to forecast the daily demand with approximately with the same accuracy.

Rahman and Baten (2016) this study made an effort to provide insight into concerns like Bangladesh's black gram production and area predictions. Data on the acreage and output of black gram pulse were gathered from the Bangladesh Bureau of Statistics during a 47-year period (1967-68 to 2013-2014). To determine stationarity and identify potential autoregressive & moving average orders for the data, the autocorrelation function, partial autocorrelation function, and Phillips-Perron unit root test are calculated. The ARIMA (0,1,0) model was determined to be suitable for the production and pulse area of black gram. The model's performance was verified by comparing it to the mean absolute percent error and the percentage departure from the real data (MAPE). The projection was created for the years 2014–15 to 2018–19.

Esther and Magdaline (2017) studied to forecast pulses production in Kenya. After cereals the staple food in Kenya was pulses. The objective of the study is on forecasting the production of pulses in Kenya by using Autoregressive Integrated Moving Average (ARIMA) model. From the food and agriculture organization of the united nation (FAO) statistical book the data was collected from the period of 1961 to 2012. The findings of the study showcased that pulses production in Kenya is 25437.53 tonnes by 2020, 25342.27 tons in 2025, and 25357.44 tons in 2030. To meet the expanding population's demand for pulses and improve food security in Kenya, the government should develop and put into place effective policies to encourage pulse cultivation.

Darekar and Reddy (2017) in terms of consumption and production, pigeon peas are the second-most significant pulse crop after chickpeas. The demand for pulses was increasing. Due to uncertainty in the prices of pulses, the farmers are getting huge losses. Considering these points the study was undertaken with the objective to forecast the future prices of the pigeon pea by using the ARIMA model for a price forecast. And to test the reliability of the model MAPE, AIC, and BIC Criterion was used. To predict 2017-2018 prices the researcher analyzed monthly data from January 2006 to December 2016. The result showcased the prices of pigeon pea would be in the range of Rs. 4,300 - 7,600 per quintal from November to January 2017-18.

Divya *et al.* (2017) this study uses the univariate Auto Regressive Integrated Moving Averages (ARIMA) model to anticipate the monthly prices of Bengal gram in a few Andhra Pradesh market places. For the analysis, secondary data on monthly prices (Rs/QTLs) of Bengal gram that were gathered from April 2000 to December 2014 were used. The ARIMA (0, 1, 1) model and the ARIMA (1, 1, 1) model both provide the best fit to the data for Bengal gram in Koilakuntla market. When compared to real-time pricing, forecasts were shown to be relatively accurate.

Anjoy *et al.* (2017) both consumers and government continue to experience pain from the high cost of pulses. The primary indicator of inflation in India is the wholesale price index (WPI). The wholesale price of a sample basket of items is what the WPI gauges. As a result, exact WPI forecasting employing certain cutting-edge statistical methods is required. In the current experiment, multi-step-ahead forecasting of the monthly WPI of pulses is done using Wavelet and artificial neural network (Wavelet-ANN) hybrid models. Using the maximal overlap discrete wavelet transform (MODWT), which is based on the Haar wavelet filter, the original series is segmented into its low-frequency and high-frequency components. The deconstructed series was then fitted with an appropriate artificial neural network (ANN) model before being merged and forecasted using the inverse wavelet transform (IWT). The findings of a comparison between hybrid models and their individual counterparts show that in every scenario evaluated, the hybrid models outperform the traditional artificial neural network (ANN) model

Gupta *et al.* (2018) researcher analyzed monthly data from April 2009 to December 2017 of arrivals and prices of three major pulse crops in Chhattisgarh. The study was to forecast arrivals and prices of pulse crops by using the analytical tool i.e. seasonal ARIMA model. The objective is future forecasts for the next two years. The results arrived that the arrivals of all three pulse crops will follow the same pattern of seasonality for the next two years.

Gupta *et al.* (2019) this study aimed to meet the need of local farmers for precise and trustworthy market information on the pricing of pigeon pea in Chhattisgarh's Kawardha market. In order to predict prices for the upcoming 24 months, from July 2019 to June 2021, monthly time series data from April 2009 to June 2019 (123 months) were employed. Over the course of the research period, an

overall tendency of rising pigeon pea prices was discovered. According to seasonal indicators, the price is essentially constant throughout the year but increases somewhat from August to October. Based on the lowest values for AIC, RMSE, and MAPE as well as the greatest R^2 values, seasonal ARIMA models ARIMA (2,1,1) (1,0,1) were shown to be the best fitted model for the price of pigeon pea.

Gupta *et al.* (2019) one of the most significant oilseed crops in Madhya Pradesh is soybean. The Ujjain district in Madhya Pradesh produces the most soybeans. This study aims to anticipate soybean market prices in Ujjain. For the study, 214 months of time series data on monthly average wholesale soybean prices from January 2002 to October 2020 were gathered. For price modeling, the seasonal ARIMA model was utilized, and the optimal model was chosen based on the lowest AIC and MAPE values. The model that performed the best was ARIMA (2,1,2) (0,0,2). The sample period's fitted values were nearer to actual price values. The most accurate model was used to forecast prices over the next 12 months (November 2019 to October 2020). The price is expected to increase starting in February 2020 and then stable. The statistical program "R" was used for the analysis.

Pani *et al.* (2019) this study proposed a GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model for predicting weekly Green gram prices were collected from the AGMARK NET website from January 2004 to July 2018. It then assesses the model's performance by contrasting it with ARIMA models in terms of the MAPE criterion. According to the estimate (made using the GARCH model), green gram market prices would range between Rs. 5,350 and 5,577 per quintal from July to September 2018.

Sonvane and Koshta (2019) this study aims to investigate chickpea arrivals, pricing behavior, and forecasts in the Chhattisgarh plains' Krishi Upaj Mandis. According to the number of chickpea arrivals, Krishi Upaj Mandi (KUM) Bhatapara, KUM Mungeli, KUM Rajnandgaon, KUM Kabirdham, and KUM Bemetra were chosen. Using the twelve-month ratio to moving average approach, the seasonal fluctuations in pulses' pricing and arrivals, as well as their seasonal indices, were computed. For the purpose of predicting chickpea arrivals and pricing in a few chosen Krishi Upaj Mandis of the Chhattisgarh plains, the ARIMA model was used. The Box-Jenkins model is another name for this one. Three peak chickpea arrivals were

noted, occurring in the months of March (3594.18), April (6326.90), and May. (2639.87). However, three price peaks were seen in the seasonal indices of chickpea prices, which were in the months of August (97.04), September (186.07), and October (222.89). According to the study's findings, there is an inverse relationship between chickpea arrivals and pricing. The range of anticipated chickpea arrivals is predicted to be between a low of 1054.85 tonnes in October 2018 and a maximum of 5459.60 tonnes in March 2021. From Rs./qtl 2859.08 to Rs./qtl 3878.50 is the predicted range for chickpea prices for the months of October 2018 to April 2020.

Kumar *et al.* (2020) the goal of the current study is to predict jute prices in the Murshidabad area of West Bengal. For the period of January 2002 to December 2019, the time series data on the monthly price of jute needed for the study were obtained from the AGMARKNET website. The Box-Jenkins method was used to model pricing using the seasonal ARIMA model, and the best model was chosen based on the lowest RMSE, AIC, and MAPE values, with the best model being ARIMA (1,1,1) (1,0,0) . Both the anticipated and fitted values for the out-of-sample period were closer to the real-time price value. The most accurate model was used to forecast prices over the next 12 months (January 2020 to December 2020). The price is expected to increase starting in March 2020 and then stable. The statistical program "R" was used for the analysis.

Mahapatra and Dash (2020) a study was done on predicting black gram productivity in Odisha. Box-Jenkins for predicting Black gram yield, autoregressive integrated moving average (ARIMA) time-series methods was taken into account. On the basis of Autocorrelation Function (ACF) and Partial autocorrelation Function (PACF) at various lags, several ARIMA models are chosen. Data from 1971–1972 to 2006–2007 are used to develop several ARIMA models, and data from 2007–2008 to 2015–2016 are used to successfully cross-validate the chosen model, which is based on the Mean absolute percentage error (MAPE). ARIMA models are fitted to the initial time series data as well as the first difference data to examine stationarity. The potential ARIMA Models are found based on the significant coefficient of the autoregressive and moving average components. The best fitting ARIMA models are chosen based on low values of Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE). In cross-validation of the model, ARIMA (0,1,1) without a constant was determined to be the best-fitted model for Black gram productivity, with

absolute percentage error ranging from 19.99% to 43.29%. The model predicted that productivity will be about 221.45 kg per hectare in the years 2018–19, with lower and higher limits of 90.36 and 392.89 kg per hectare, respectively.

Kumar and Baishya (2020) to forecast the prices of potato researcher used the ARIMA model by using time series data from 2002-2019. According to the report, potato prices will rise to start in the first quarter in India, West Bengal, and Uttar Pradesh. In the fourth quarter, Madhya Pradesh and Tripura would have the highest potato prices. The third quarter will see an increase in potato prices in Punjab. According to the forecast, potato market prices in Uttar Pradesh, West Bengal, Madhya Pradesh, Gujarat, Punjab, and Tripura will be at their greatest in 2020, with respective values of 1208/qt, 1812/qt, 1345/qt, 1712/qt, 1354/qt, 2636/qt, and 1715/qt, respectively.

Divisekara *et al.* (2021) with a share of 32.8% of the global output, Canada is the world's largest producer of lentils. However, due to the effect of unpredictable elements like weather and economic crises, lentil output is prone to change. The commodity price will shift and become volatile as a result. The method of modelling and projecting future pricing using the data will offer adequate numbers to help producers and end users make decisions on the production of lentils. Consequently, the goal of this study is to use the Seasonal Autoregressive Integrated Moving Average model to predict and forecast the price of red lentils (SARIMA). From 2010 to 2019, 520 observations over eight years of weekly data were used in the analysis. In Saskatchewan, the cost of red lentils per 100 pounds was on average \$24.75, although weekly prices varied greatly over time. By computing the seasonal index and running SARIMA models against the time series, it is possible to estimate and anticipate the seasonality and volatility of red lentils. The findings show that, while predicting the price of red lentils, the SARIMA (2,1,2) (0,1,1) model performs well both in and outside of samples. As a result, both producers and end users may use this model to manage total price risk and make the best production decisions.

Kathayat *et al.* (2021) the study's goal was to anticipate wholesale paddy prices for the upcoming farming season in five important states: Punjab, Uttar Pradesh, Tamil Nadu, West Bengal, and Delhi. The prices have been predicted using the ARIMA model. Analysis of the seasonal price changes shows that northern states

have had greater price volatility than other states. According to the findings, wholesale prices for the agricultural year 2020–21 would range between Rs. 1810.23 and Rs. 2239.59 per qt-1 for Punjab, Rs. 1662.91 and Rs. 1674.98 per qt-1 for Tamil Nadu, Rs. 3010.00 and Rs. 3133.36 per qt-1 for Delhi, Rs. 1835.05 -Rs. 1902.22 per qt-1 for West Bengal, and Rs. 1080.90-Rs.1495.35 qt-1 for Uttar Pradesh. RMSE and MAPE were used to assess ARIMA models. For Punjab, Tamil Nadu, Delhi, West Bengal, and Uttar Pradesh, respectively, ARIMA(4,0,1), ARIMA(0,1,6), ARIMA (0,1,1), ARIMA (0,1,2), ARIMA (0,1,3), and ARIMA (3,1,1) were found to be the best fits for the various markets. The study's findings may be useful in assisting the stakeholders in making prompt judgments because important decisions about production, marketing, and consumption depend on particular pricing expectations.

Jamuna *et al.* (2021) researcher evaluated the applicability of historical agricultural price data for forecasting in India. They examined to forecasting potato prices in the places where these seasonal predictions showed skill. We developed a method that can forecast the price of crops on an annual as well as a monthly basis using South India as the location for dates and their price prior to seed planting. The ARIMA model uses time series analysis to examine its ability to predict potato and other crop prices. They forecast the price of the crops using this approach. To evaluate areas of effective probabilistic prediction, employed the rolling mean, standard deviation, dickey fuller test, partial auto-correlation function, and auto-correlation function. In the majority of the locations, annual yield anomalies may be predicted two months before sowing. We came to the conclusion that there is potential for using previous trend data to forecast with ARIMA models to estimate future prices of a certain crop from the sample data set of crop prices on a daily basis.

Saroha *et al.* (2021) every area of the global economy has been structurally touched by the unusual disaster that the Covid-19 outbreak has brought forth. This research makes an effort to analyze how the present outbreak has affected India's pulse industry specifically. This study concludes that Covid-19 has a markedly detrimental effect on the market for pulses. There is a supply-side constraint for pulses in India's domestic economy since the market arrival of pulses has decreased recently while market demand has grown. This study contends that the Government of India's Agriculture Department must act quickly to address the current deficit of indigenous pulses available in "mandis" (agricultural markets). In this study, market

arrival for pulses, in particular green gram (Moong whole), has been anticipated for the next months in Indian agricultural markets using forecasting approaches such as the auto-regressive integrated moving average (ARIMA) model and the artificial neural network (ANN) methodology for the pre-and post-pandemic period by using the arrival data in Indian agricultural markets from Agmarknet. There will be a sharp decline in market arrival with an average arrival of 494 quintals per day, which can be maximized up to 623 quintals per day by stimulating the modal price at the maximum possible point, according to the results of this study using ARIMA models and ANNs, which have been compared to obtain the final conclusions with higher visibility in forecasting performance. To fulfill domestic demand with domestic supply, it is imperative that farmers in various agro-climatic zones scale up their technical efficiency.

Raghav *et al.* (2022) objective of the study was to predict pulse output in Afghanistan, Bangladesh, China, India, Nepal, and Pakistan. The data series were analyzed from 1961 to 2015. NNAR was the model that fit India the best, similar to Afghanistan, was NNAR (3,2). ARIMA was the most accurate forecasting model in China and In Nepal. ETS (A, N, N) was the forecasting model that suited Pakistani conditions. The most accurate estimates indicate that the production of pulses in (Afghanistan, China, and India) would rise until 2027, with a growth rate of 15.73% from 2020 to 2027. Between the six nations, India will continue to produce the most pulses; in fact, the output is predicted to reach 1088.778 thousand tonnes in 2027. These findings may be essential for creating a production strategy for agriculture that works, whether by supplying output forecasts or assessing existing strategies.

CHAPTER-III
METHODOLOGY

CHAPTER-III

METHODOLOGY

The methodology used for the study is essential to any scientific investigation, thus it must be detailed in full to enable readers and other research workers to understand the results drawn from this specific study. In this regard, the current chapter describes in detail the research methodology used in the study. It focuses on the sources of empirical data used in the study, the types of data used, the time period selected for the study area in Khammam district, and the analytical technique used to arrive at relevant conclusions in order to meet the study objectives.

Methodology

The current study was based on the data on arrivals and prices of selected agricultural commodities in APMC, Khammam.

3.1 Selection of market

The research was based on the arrival and prices of major pulses in APMC, Khammam.

3.2 Selection of the commodities

The present study focused on two major pulses, Red gram, and Green gram, in the selected APMC.

3.3 Source of data

The present study is empirical in character based on the analytical method. The study is mainly based on secondary data which were analysed, and calculated mainly from APMC Khammam of Telangana state. Other information were collected from the thesis, journals, conferences, and websites.

3.4 Method of data collection

The arrival and price data for selected major pulses were collected monthly from the official records of APMC, Khammam. Based on the availability of data, the latest 20 years of data from 2001-2002 to 2019-2020 were collected.

3.5 Analysis of data

3.5.1 Estimation of growth rates in arrivals and prices

The time series data pertaining to monthly arrivals and prices of major pulses for a period of 20 years from (2001 to 2020) was collected from APMC, Khammam. The compound growth rates of arrivals and prices of major pulse commodities were calculated using the following exponential form of equation,

$$Y = ab^t$$

Where,

Y = Monthly arrivals/prices

a = Constant

b = Trend coefficient

t = Time period

Annual compound growth rate (CAGR) in percentage was calculated as,

$$\text{CAGR} = (\text{Antilog of } b - 1) \times 100$$

3.5.2. Instability Analysis

To measure the instability in arrivals and prices, an index of instability is used as a measure of variability.

The coefficient of variation (CV) was calculated by using the formula.

$$\text{CV (\%)} = \frac{\text{standard deviation}}{\text{Mean}} \times 100$$

The coefficient of instability is another measure of instability besides the coefficient of variation. The coefficient of variation measures the absolute variation while the coefficient of instability measures the variation around the trend.

3.5.3. Coppock's Instability Index

Coppock's instability Index were used to measure the coefficient of instability

$$\text{Delta M} = \frac{\sum[\log(x_i + 1) - \log(x_i)]}{(N - 1)}$$
$$\text{V Log} = \frac{\sum\{\log(x_i + 1) - \log(x_i)\} - m^2}{(N - 1)}$$

$$\text{Coppock's Index} = [\text{Anti Log}(\sqrt{V \text{ Log}}) - 1] \times 100$$

Where,

X_t = Arrivals or prices of crop in year 't'

N = Number of years

M = The arithmetic mean of the difference between the Log of X_1 and X_{t-1} , X_{t-2} etc

V Log = Log arithmetic variance of the series.

3.5.4 Seasonal indices in arrivals and prices

Seasonal indices are annual fluctuations in economic activity that occur on a regular basis and have their origin in the year. Because such variations repeat themselves over a twelve-month period. They may be predicted very accurately. To obtain a statistical description of a seasonal variation pattern, it was necessary to first remove the influence of trends, cycles, and irregular variations from the data. The seasonal index is calculated in index form as a measure of seasonal variance once these other components have been eliminated. Each month's seasonal index is calculated. As a result, a specific seasonal index refers to seasonal fluctuations in a particular year. The proportion of their average was used to calculate seasonal indices. Using the moving average method, the seasonal indices of arrivals and prices of selected agricultural commodities are calculated through the following steps;

- a. Express the price of each month as a percentage of the average price for the concerned year.
- b. Work out the average (over years) of the percentage for each month computed in (a)
- c. Calculate the sum of 12-month averages (s) worked out in (b) and multiply the average of each month by the correction factors ($k=1200/s$) to make a total of 1200 or an average of 100. Seasonal indices of price and arrival of green gram and red gram were worked out separately with the ratio to moving average method.

Seasonal index (Price) = Actual average price for the month/Moving average price for the month x 100

3.5.5 Price function of major pulses in APMC, Khammam

Analysis of prices, market arrivals, and the previous month's price over time serves as an important item for formulating a sound agricultural policy. Fluctuations in market arrivals largely contribute to the price instability of the produce. In order to

derive appropriate ways and means for reducing price fluctuations in agricultural policy commodities, there is a need to have a thorough understanding of price over time and space. It has been noticed that, when major portions of the product reach the market during the peak season, the prices are generally low, which depresses the farmer's morale as well as income to a greater extent. Proper planning in disposing of the products by the farmer can considerably increase their income without incurring much additional cost.

3.5.6. Forecasting the future values of major Pulses

The prices of two important pulses, pigeon pea and green gram were forecasted for the short future in the Khammam area of Telangana using univariate time series models. Agricultural price modeling differs from non-farm commodities and services price modeling due to the unique characteristics of agricultural product marketplaces. Seasonality of the production-derived nature of demand, and price-inelastic demand and supply functions are some of the unique features of agricultural crops. Agricultural product price behavior is influenced by the biological nature of crop production.

Structural and time series models are the two most used approaches to forecasting. The structural models employ consumer and producer theory first principles to identify demand and supply schedules, as well as the equilibrium prices that result from their intersection. The structural modeling techniques reveal important insight into the factors that influence commodity price movements. The computational and data demands of structural price forecasting are generally far greater than what is routinely available in developing countries. As a consequence, for their forecasting needs, researchers frequently rely on parsimonious representations of price processes. In this study, a different methodology, namely time series modeling, was used to forecast the major pulses crop prices. Time series modeling is extensively used in the contemporary parsimonious form of price forecasting. For frequent and up-to-date price forecasting, time series modeling requires less onerous data input.

The ARIMA model was used to quantify and forecast future prices for a given set of data. The model outline is shown below.

3.5.6.1 Auto-Regressive Integrated Moving Average (ARIMA) model (Box-Jenkins models)

The Box-Jenkins procedure is concerned with fitting a mixed Auto-Regressive Integrated Moving Average (ARIMA) model. The main objective of fitting an ARIMA model is to identify the time series' stochastic process and properly predict future values. These methods have also successfully been implemented in various situations involved in the development of models for discrete time series and dynamic systems. This method, however, is inefficient for long lead times or seasonal series with a large random component. Originally, Box and Jenkins investigated ARIMA models extensively, and their names have been regularly used simultaneously with the general ARIMA process used to time series analysis, forecasting, and control. However, the stochastic model for that series determines the optimum forecast of future time series values. There are two types of stochastic processes: stationary and non-stationary. The first thing to be noted is that the majority of the time series are non-stationary, whereas the ARIMA model exclusively considers stationary time series. Therefore, it is necessary to have a distinction between the original non-stationarity time series and its stationarity counterpart.

3.5.6.2 Stationarity and non-stationarity

The term "stationarity" refers to the fact that the data generation process is in equilibrium around a constant value, and that the variance around the mean remains constant throughout the time period. Along the time axis, the data must be approximately horizontal.

If the mean changes over time (with some trend cycle pattern) and the variance is not reasonably constant then the series is non-stationary in both mean and variance.

If a time series is not stationary, then it can be made more nearly stationary by taking the first difference of the series. Conversely, a stationary process may be summed or integrated to obtain a non-stationary process.

Let X_t is a random variable and X_t (where, $t=1, 2, n$) is the observations on X_t with density function $f(x_t)$. If the observations are independent, then

$$f(X_1, X_2 \dots X_n) = f_1(x_1), f_2(x_2), \dots, f_n(x_n)$$

This implies that the joint distribution is independent of historical time. The assumption of stationarity reduces the number of parameters in the joint probability density function of a random variable X_t in the series.

Since the ARIMA model refers only to a stationary time series, the first stage of Box-Jenkins model is reducing non-stationary series X_t to a stationary series Y_t by taking first differences as follows,

$$\begin{aligned}
 Y_t &= \Delta X_t \\
 &= X_t - X_{t-1} \\
 &= X_t - BX_t \\
 &= (1-B) X_t \qquad \dots\dots\dots (1)
 \end{aligned}$$

Where,

B = Backward shift operator

The backward shift operator is convenient for describing the process of differencing. To define B , such that,

$$B^i X_t = X_{t-i} \quad i = 1, 2, \dots$$

Suppose the first difference of the series doesn't become stationary then second order differencing is done as follows.

$$\begin{aligned}
 y_t &= \Delta (\Delta X_t) \qquad \dots\dots\dots (2) \\
 &= \Delta (X_t - X_{t-1}) \\
 &= (X_t - X_{t-1}) - (X_{t-1} - X_{t-2}) \\
 &= X_t - 2X_{t-1} + X_{t-2} \\
 &= X_t - 2BX_t + B^2X_t \\
 &= (1 - 2B + B^2) X_t \\
 &= (1 - B)^2 X_t
 \end{aligned}$$

In general, if it takes a d^{th} order difference to achieve stationarity, it is written as, d^{th} order difference = $(1-B)^d X_t \dots\dots\dots (3)$

The general ARIMA (o, d, o) model is

$$(1 - B)^d X_t = e_t \qquad \dots\dots\dots (4)$$

Where e_t is error term distributed normally with

$$\begin{aligned}
 E(e_t) &= 0, \quad V(e_t) = \sigma^2 \text{ and} \\
 \text{Cov}(e_i, e_j) &= 0 \text{ for all } t (i \neq j)
 \end{aligned}$$

In order to test the stationarity, auto-correlation functions (ACF) of difference series (Y_t) up to 36 lags should be computed. If the ACF for first and higher differences (after 2-3 lags) drop abruptly to zero then it indicates the series is stationary.

3.5.6.3 Stationary time series model

(a) Auto regressive process (p, 0, 0)

If the observation Y_t depends on previous observation and error term e_t is called auto regressive process (AR process)

$$\begin{aligned}
 Y_t &= \mu + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + e_t \\
 &= \phi_p(B)(Y_t - \mu) + e_t \quad \dots\dots\dots (4)
 \end{aligned}$$

Note the term μ in equation is not quite the same as the “Mean” of the Y series. Rather, the development is as follows.

$$\begin{aligned}
 (Y_t - \mu) &= \phi_1 (Y_{t-1} - \mu) + \phi_2 (Y_{t-2} - \mu) + \dots + \phi_p (Y_{t-p} - \mu) + e_t \dots\dots\dots (5) \\
 &= \phi_1 (Y_{t-1} - \phi_1 \mu) + \phi_2 (Y_{t-2} - \phi_2 \mu) + \dots + \phi_p (Y_{t-p} - \phi_p \mu) + e_t \\
 Y_t &= (\mu - \phi_1 \mu + \phi_1 \mu - \phi_2 \mu + \phi_2 \mu - \dots + \phi_p \mu) + \phi_1 Y_{t-1} + \dots + \phi_p Y_{t-p} + e_t \\
 &\quad \mu_1 + \phi_1 Y_{t-1} + \dots + \phi_p Y_{t-p} + e_t
 \end{aligned}$$

And the values of auto regressive coefficient restricted to lie between -1 and +1.

(b) Moving average process (0, 0, q)

If the observation Y_t depends on the error term e_t and also on one or more previous error terms (e_t ‘s) then we have moving average (MA) process.

$$Y_t = \mu + e_t - \theta_1 e_{(t-1)} - \theta_2 e_{(t-2)} - \dots - \theta_q e_{(t-q)} \quad \dots\dots\dots(6)$$

Where,

- $\theta_i = i^{\text{th}}$ moving average parameter
- $i = 1, 2, \dots, q$
- $q =$ Order moving average

The values of the coefficient are restricted to lie between -1 to +1.

(c) Mixtures: ARIMA process

If the non-stationarity is added to a mixed ARIMA process, then the general ARIMA (p, d, q) is implied. Here the word integrated is confusing to many and refers to the differencing of the data series.

$$(1-B)d(1-\phi_p B_p) Y_t = u = (1-\phi_q B_q) e_t \quad \dots\dots\dots(7)$$

(d) Seasonality and ARIMA models

Some time series have discernible periodic patterns, such as price and arrivals of agricultural commodities, which generally follow a seasonal pattern process. The ARIMA notation may easily be modified to handle seasonal aspects, and ARIMA is the common shorthand notation.

(non-seasonal part of the model) (Seasonal part of the model)

s = number of periods per season

The mixture of AR and MA seasonal model is

$$\phi_p(B) \Delta d \phi_p(B_s) \Delta D x_t = \theta_q(B) \cdot (H)Q(B_s) e_t \quad \dots\dots\dots (8)$$

If $Y_t = \Delta d \Delta x_t$ - the model becomes an integrated model.

Box-Jenkins method :

Box and Jenkins 1976 describe the entire model-building and forecasting process in detail. In summary, they recommend four essential steps: (i) Model identification, (ii) Model parameter estimation, (iii) Model diagnostic checking, and (iv) Model forecasting. Below are the details of the estimating and forecasting procedure.

Box-Jenkins method :

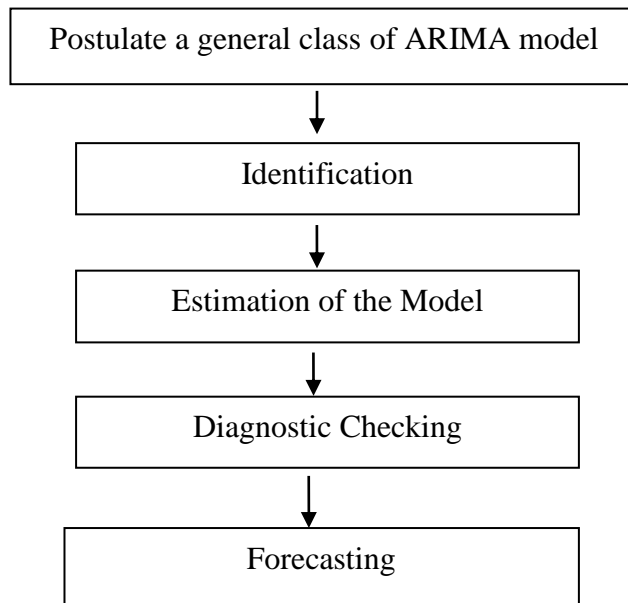


Fig: 3.1 The Box-Jenkins methodology for optimal model selection

(1) Identification of models

A graphical depiction of the data is a suitable starting point for time series analysis. It helps to identify the presence of trends.

The data are not evaluated before estimating the model parameter p and q to determine which model best describes the data. This is done by examining the sample ACF (Autocorrelation function) and PACF (Partial Autocorrelation function) of differenced series Y_t .

The sample auto correlations for k time lags can be determined as follows and denoted by r_k

$$\begin{aligned} \hat{P}_k(Y_t) &= r_k(Y_t) && \dots\dots\dots (9) \\ &= C_k(Y_t) / C_0(Y_t) \end{aligned}$$

$$\begin{aligned} C_k(Y_t) &= 1/n \sum (Y_t - \bar{Y})(Y_{t+k} - \bar{Y}) \\ k &= 0, 1, 2, \dots n \\ t &= 1, 2, \dots n-k \\ \bar{Y} &= 1/n \sum Y_t \\ n &= \text{Length of time period} \end{aligned}$$

Both ACF and PACF are used as the aid in the identification of appropriate models. There are several ways of determining the order type of process, but still there was no exact procedure for identifying the model.

(2) Estimation of parameters

After tentatively identifying the suitable model, next step is to obtain Least Square Estimates of the parameters such that the error sum of squares is minimum.

$$S(\theta, \emptyset) = \sum e_t^2(\theta, \emptyset) \dots\dots\dots (10)$$

Where,

$$t = 1, 2, 3, \dots n$$

There are fundamentally two ways of getting estimates for such parameters.

Trial and error: Examine many different values and choose set of values that minimizes the sum of squares of residuals.

Interactive method: Choose a preliminary estimate and let a computer programmed refine the estimate interactively.

The latter method is used in our analysis for estimating the parameters.

(3) Diagnostic checking

After having estimated the parameters of a tentatively identified ARIMA model, it is necessary to do diagnostic checking to verify that the model is adequate.

Examining ACF and PACF of residuals may show an adequacy or inadequacy of the model. If it reveals random residuals, then it indicates that the tentatively identified model is adequate. When an inadequacy is identified, the checks should give an indication of how the model need be modified, after which further fitting and checking takes place.

One of the procedures for diagnostic checking mentioned by Box-Jenkins is called over fitting *i.e.* applying more parameters than necessary. However, the main difficulty in making a correct identification is not getting enough hints from the ACF due to an inadequate level of differencing. When all of their ACF were within the limitations, the residuals of ACF and PACF were considered random.

$$\pm 1.96\sqrt{1/(n - 12)} \quad \dots\dots\dots (11)$$

We also used Box and Pierce ‘Q’ statistic for whether the auto correlations for these residuals are significantly different from zero. It can be computed as follows.

$$Q = n \sum_{K=1}^m rk^2 \quad \dots\dots\dots (12)$$

Where,

- m = Maximum lag considered
- n = N – D
- N = Total number of observations
- rk = ACF for lag k
- D = Differencing

And Q is distributed approximately as a Chi-square statistic with (m-p-q) degree of freedom.

The minimum Akaike Information Coefficient (AIC) criteria is used to determine both the differencing order (d, D) required to attain stationarity and the appropriate number of AR and MA parameters, it can be computed as follows.

$$AIC (p+q) = N \ln \sigma^2 + 2 (p + q) \quad \dots\dots\dots (13)$$

Where,

σ^2 = Estimated MSE

N = Number of observations

(p+q) = Number of parameters to be estimated.

This diagnostic checking helps us to identify the differences in the model, so that the model could be subjected to modification, if need be.

(4) Forecasting

After satisfying about the adequacy of the fitted model, it can be used for forecasting. Forecasts based on the model.

$$(1-\phi B) (1-\theta B) s Y_t = (1-\theta B) (1-(H)s B) e_t \quad \dots\dots\dots (14)$$

This was computed for upto 12 months (m) ahead. The above model (14) gives the forecasting equation is

$$Y_t = \phi Y_{t-1} + \theta Y_{t-12} - \phi \theta Y_{t-13} + e_t - \theta e_{t-1} - (H) e_{t-12} + \theta(H) e_{t-13} \dots\dots\dots (15)$$

Given data upto time 't' the optional forecast of Y (also called Ex-Ante forecast) model at the t is the conditional expectation of Y_{t+1} .

It follows, in particular, that

$$e_t = Y_t - Y_{t-1} \quad \dots\dots\dots (16)$$

The errors e_t in model (15) are in fact that forecast errors for unit lead time. That for an optimal forecast these 'one step ahead' forecast errors ought to form an uncorrelated series is otherwise obvious. Suppose, if these forecast errors were auto correlated, then it could be possible to forecast the next forecast error in which case it could not be optimal.

The required expectations are easily found because

$$E (Y_{t+m}) = Y_t (m), E (e_{t+m}) = 0 \quad \dots\dots\dots (17)$$

Where,

$$m = 1, 2, 3 \quad \dots\dots\dots n$$

$$E (Y_{t-m}) = Y_{t-m} E (e_{t-m}) = a_{t-m} = Y_{t-m} - Y_{t-m-1}$$

Where, $m = 0, 1, 2, \dots n \quad \dots\dots\dots (18)$

For instance, to determine the three month ahead (1-3) forecast for series Y_t (use equation 14).

$$\begin{aligned}
Y_{t+1} &= Y_{t+3} \\
&= \phi Y_{t+2} + \phi Y_{t-9} - \phi Y_{t-10} + e_{t+13} - \theta e_{t-2} - (H) e_{t-9} + \theta(H) e_{t-10}
\end{aligned}$$

taking conditional expectations at time t,

$$\begin{aligned}
Y_t(1) &= Y_t(3) \\
&= \phi Y_t(2) + \phi Y_{t-9} - \phi Y_{t-10} + 0 - \theta(0) - (H) (Y_{t-9} - Y_{t-10}) + \theta(H) (Y_{t-10} - Y_{t-11})
\end{aligned}$$

Because, $E(e_{t+1}) = 0$, $E(e_{t-1}) = Y_{t-1} - Y_{t-1} = e_{t-1}$

$$i.e. Y_t(3) = 0 Y_t(2).$$

The forecast $Y_t(2)$ can be obtained in a similar way in terms of $Y_t(1)$ from $E(Y_{t+2})$. Similarly $Y_t(1)$ can be obtained from $E(Y_{t+1})$. In practice it is very easy to compute the forecast $Y_t(1)$, $Y_t(2)$, $Y_t(3)$ etc. recursively using the forecast function (15).

$E(Y_{t+1}) = E(0Y_{t+1-1} + Q_{t+1-0} e_{t+1-1}) - \theta e_{t+1-1} - (H) e_{t+1-12} + \theta(H) e_{t+1-13}$ and using 16 and 17.

However, using these methods, Ex-post forecasts can also be calculated for comparing with the value actually realized.

3.6 Socio economic status of the study area

3.6.1 Introduction

The Telangana was part of the Hyderabad state from September 17th 1948 to November 1st 1956, until it was merged with Andhra state to form the Andhra Pradesh state. Before India became independent, it was included in the Hyderabad state, which comprised two divisions, namely, Warangal and Medak. at that time, Telangana was governed by the Nizams. Up to 2014, the erstwhile Andhra Pradesh was divided in to three prominent regions namely; Telangana, Coastal Andhra and Rayalaseema, which comprising nine and four districts. After a series of agitation and decades of long movement, Telangana state was formed by passing the AP state reorganization bill (2014) in both houses of parliament. Telangana became the 29th state of India on 2nd, June 2014 with Hyderabad as the capital city.

Telangana state is spread over 1,12,077 sq.kms and comprised of 10 districts namely Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Rangareddy, Khammam, Nalgonda, Mahabubnagar and Hyderabad with 464 mandals.as per the AP Re-organization act 2014,Telangana state has lost seven mandals namely; Kukunoor, Velairpadu, Bhurgampadu, Chitoor, Kunavaram, Vararamchandrapuram

and Bhadrachalam from Khammam district to Andhra Pradesh, in order to facilitate the Polavaram irrigation project . Among these seven mandals, five mandals are completely merged and the other two mandals *i.e.*, Bhadrachalam and Bhurgampadu have lost most of the area and finally, 459 mandals were existed, in Telangana state. The present study is about APMC in Khammam district.

The nomenclature of Khammam is said to have derived from a temple 'Narasimhadri' built on a hillock in the town. The temple was referred as 'Stamba Sikhari' and later 'Stambadhri'. It is believed that lord Narasimha emerged from a stone pillar and killed the evil king Hiranya kasyapu to save his child devotee Prahlada. This incident is said to have occurred in the Krutayuga. The vertical rock under the temple is known as 'Kamba' and the town at the foot of the hill was called Kambamettu which gradually changed to Khammam matt and finally Khammam.

3.6.2 Location

The Telangana state extends from 15⁰55' to 19⁰ 55' North latitude and 77⁰ 10' and 81⁰50' East longitude. It is triangular with the Penganga, Wardha, Pranahita and Godavari as its northern boundary, while the rivers Krishna and Tungabhadra serve as the southern boundary. Telangana is surrounded by Maharashtra and Chhattisgarh in the north, Karnataka in the west and Andhra Pradesh in the south and east direction. Most part of the Telangana region lies on the deccan plateau. The Khammam district, which is a part of Telangana region and state has between 160 - 15'-0" and 170 -47'-42" of Northern Latitude and 790 - 57'-22" and 800 -55'-0" of the Eastern Longitude.

3.6.3 Area

Khammam district has an area of 4361.33 Sq.Km which consists 3.89 percent of the state. Agriculture is the main stay in the district as majority of the population depend on agriculture and allied activities for their lively hood.

3.6.4 Boundaries

The District shares boundaries with three Districts *i.e.*, Bhadradi Kothagudem, Mahabubabad, Suryapet Districts in Telangana State and Krishna, West Godavari Districts of Andhra Pradesh State. The District headquarters is located at Khammam Town which is located on the Bank of the Munneru River one of the tributaries to the river Krishna.

3.6.5 Climate

Khammam experiences typical Indian climatic conditions. The summer season is hot and the temperatures can climb rapidly during the day. The monsoon season brings a certain amount of rainfall and the temperatures gradually reduce during this period. After the onset of the monsoon, day temperatures are much lower and as the winter approaches, they reduce further. The summer season is from March and lasts till the end of May. During this time of day temperatures are high and can reach 40 °C to 48 °C. Humidity is low as it is not located near the ocean. Conditions are generally dry during this period and the temperatures range from a minimum of 35 °C and can rise up to a maximum of 40 °C to 45 °C. Monsoon season brings much needed relief from the heat. Monsoon seasons are from the months of June to September. Temperatures average around 30 °C during this period. The place gets rain from the South West Monsoon. Some amount of rainfall can be experienced in October as well. The winter season is from December to February. January is usually the coldest part of the year. Temperatures range from 28 °C to 34 °C during this time.

- Winter: December To February
- Summer: March to June
- South West Monsoons – July to September
- North East Monsoons – October to November

3.6.6 Drainage

The Telangana state is drained by two major rivers namely, Godavari and Krishna and their tributaries before entering in to the state of Andhra Pradesh and finally to Bay of Bengal. The pattern of drainage is generally dendritic with wide valleys in western Padi plain. Munnuru is a left tributary of the Krishna River. It originates in Warangal district of Telangana, and flows in the districts of Khammam and Krishna. The river is named after Rishi Maudgalya, who is said to have created this river with his spiritual power and performed a penance ritual in Khammam. In the Khammam district, a dam known as the Kinnera Sani dam is built on the river of Kinnera Sani. Taliperu is a river in the Godavari system originating in the Bijapur district of Chhattisgarh. It is a left bank tributary of Godavari River, draining in to it through a confluence located near cherla in the Khammam district in Telangana. A dam known as the Taliperu project has been built on the river for

agricultural purpose. Palair lake is a manmade lake and a major source of freshwater in the Khammam district of Telangana located in Kusumanchi mandal. Wyra Reservoir located in Wyra mandal and Lankasagar project located in Penuballi mandal.

3.6.7 Soil

Soil is the surface layer on the earth , composing mineral particles formed by the break down of rocks, decayed organic materials,water and air.In India ,the Indian Council of Agricultural Research (ICAR) has classified the soils in to 8 groups. They are 1)Alluvial soils, 2)Black soil, 3)Red and yellow soils, 4)Laterite soils, 5)Mountains soils, 6)Desert or arid soils,9)Saline soils and 10)Peaty or organic soils.

A total seven types of soils are spread over Telangana state (as per soils of AP -1976). They are 1)Red loamy sands (dubba), 2)Red sandy loams (chalka),3) Laterite soils, 4)Shallow to medium black soils,5) Deep black soils,6)Salt affected soils and 7)Alluvial soils. Khammam district consist of red loamy sand soil (dubba soils) and some parts of Khammam district consist of laterite soils.

3.6.8 Population

According to the 2011 census, the overall population of the Telangana state is 35,003,674 people, with 17,611,633 mens and 17,392,041 womens. The sex ratio is 988 females for every 1000 males. Male literacy was 75.04 percent, and female literacy was 57.99 percent, for a total literacy rate of 66.54 per cent.

The total population of Khammam district is 14,01,639 consisting of 6,99,124 males and 7,02,515 females as per 2011 census. The sex ratio works out of 1005 females per 1000 males. The total literacy percentage was 65.95 per cent in which male literacy was 73.69 per cent and female literacy was 58.31per cent. Out of Its total population, 77.40 per cent is rural population.

3.6.8 Land utilization pattern of Khammam district

Land is a crucial input in the process of agricultural production. Its availability and proper use is an essential condition for the development of agriculture. The detail information of land use pattern in the district is shown in the following Table 3.6.1.

Table 3.6.1 Land utilization pattern of Khammam district in the year (2019-2020)

Land Utilization, 2019-2020 (Units:Area in lakh Acres)			
Sl. No.	Items	Area	Percentage
1	Total Geographical Area	10.78	100
2	Forest	1.21	11.22
3	Barren and Un-culturable Land	0.56	5.19
4	Land Put to Non- Agricultural Uses	1.18	10.95
5	Culturable Waste	0.05	0.46
6	Permanent Pastures and Other Grazing Lands	0.43	3.99
7	Land under Miscellaneous Tree Crops and Groves	0.03	0.28
8	Current Fallow Lands	0.73	6.77
9	Other Fallow Lands	0.13	1.21
10	Net Area Sown	6.46	59.93
11	Gross Area Sown	9.51	88.22
12	Gross Area Irrigated	7.6	70.5
13	Gross Area Irrigated to Gross Area Sown (%)	79.92	

(Source-Khammam Glance)

Table 3.6.2 Area, Yield and Production of important Crops, (Vanakalam & Yasangi) in the 2019-20

Sl. No	Crops	Area (Acres)	Production (MTs.)
I	Cereals and Millets		
1	Rice	430677	664572
2	Jowar	702	603
3	Maize	100384	300661
	Total	531763	965836
II	Pulses		
1	Bengal gram	25	15
2	Red gram	1661	906
3	Green gram	20791	6557
4	Black gram	457	324
5	Horse gram	0	0
6	Cow gram	161	62
7	Other Pulses	0	0
	Total	23095	7864
III	Total Foodgrains	554858	973700

(Source-Khammam Glance)

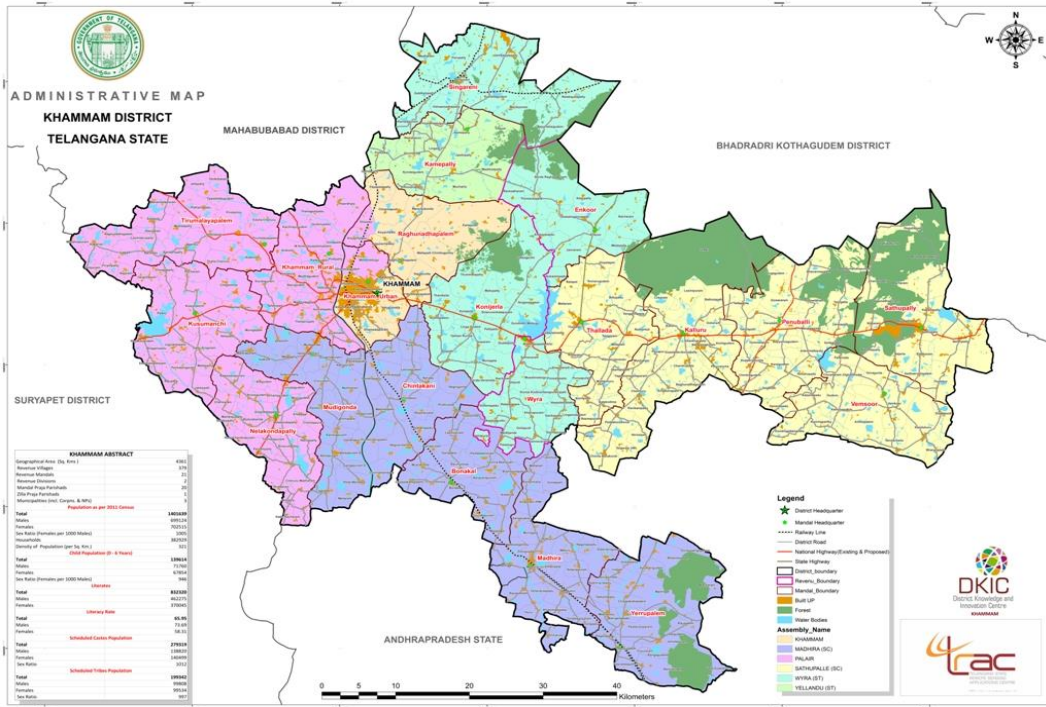


Fig 3.2: Adiministative Map of Khammam district.

(Source-Khammam.Telangana govt.in)



Fig3.3: Data collection at APMC Khammam.

CHAPTER-IV
RESULTS AND DISCUSSION

CHAPTER-IV

RESULTS AND DISCUSSION

The chapter is devoted to expressing the results obtained from the present investigation. The discussion regarding trends in arrivals and prices, growth rates, coefficient of variation, Coppock's instability index, seasonal indices of market arrivals and prices, and forecasting of prices were calculated from 2001 to 2020. The coefficient of variation of arrivals and prices of each month of the study period was calculated to know the fluctuations in arrivals and prices of Red gram and Green gram. The results were presented and discussed under following heads.

4.1 Estimate growth and instability in arrivals of major pulses in Khammam APMC of Telangana state.

4.2 Estimate growth and instability in prices of major pulses in Khammam APMC of Telangana State.

4.3 Estimate seasonal indices of arrivals and prices of major pulses in Khammam APMC of Telangana state.

4.4 Forecast major pulses prices in Khammam APMC of Telangana state.

4.1 Growth and instability in arrivals of green gram and red gram in APMC Khammam.

The present objective is to study the growth and instability in arrivals of major pulses *viz.*, red gram and green gram in APMC Khammam. To know the growth in arrivals of red gram and green gram statistical tool *i.e.* compound growth rate (CAGR) was used. To study the instability in terms of arrivals of red gram and green gram from secondary data from (2001 to 2020) the coefficient of variation (CV) and Coppock's instability index were worked out.

The results obtained for the average arrivals of red gram and green gram are depicted in table 4.1 Results revealed that, average arrivals of red gram were Maximum during month of April (8291.40 qt) and minimum in December month (939.87 qt). The average monthly arrivals of red gram shows that, from November month (977.73 qt) arrivals was upward trend till the April month (8291.40 qt). The monthly average arrivals ranging from (8291.40 qt to 939.87 qt). Average monthly arrivals of green gram was maximum in the month of September (8729.55 qt) it

follows decreasing trend during month of October (6202.65 qt) and was minimum average arrivals in the month of June (627.64 qt).

Table 4.1: Monthly average arrivals of Red gram and Green gram in APMC Khammam. During the study period.

Months	Red gram	Green gram
	Arrivals(qt)	Arrivals(/qt)
April	8291.40	1712.7
May	3751.40	926.05
June	3738.80	627.64
July	4072.05	740.09
August	2276.16	2531.59
September	1820.30	8729.55
October	1697.01	6202.65
November	977.73	3368.85
December	939.87	1855.90
January	2465.99	1686.25
February	4873.27	1231.30
March	7669.86	1365.95

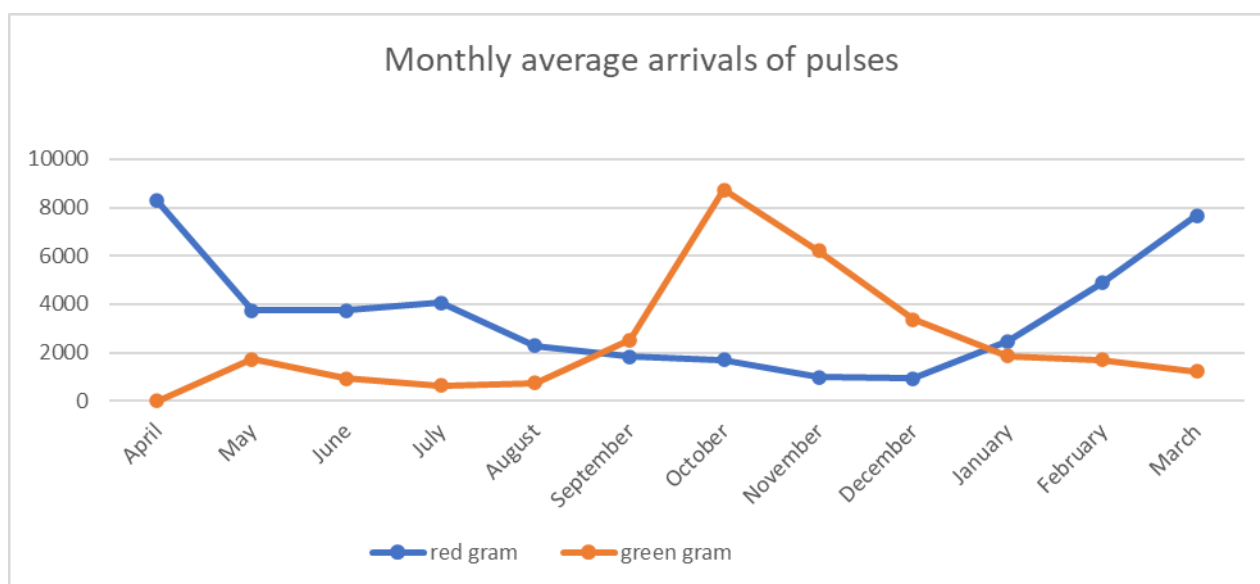


Fig: 4.1: Average Arrivals of Red gram and Green gram in APMC, Khammam
Yearly average arrivals of Red gram and Green gram in APMC Khammam during the study period.

From 2001 to 2020 the yearly average arrivals of red gram and green gram from APMC Khammam were calculated. Results obtained are, the average arrivals were ranging from (9589.25 qt) to (467.75 qt) respectively.

Table 4.2: Yearly average arrivals of Red gram and Green gram of Khammam APMC during the study period

Years	Red gram	Green gram
	Arrivals (qt)	Arrivals(qt)
2001-2002	7694.41	5249.50
2002-2003	8225.41	4749.30
2003-2004	9589.25	6760.40
2004-2005	6427.91	2936.30
2005-2006	7409.25	3889.80
2006-2007	6083.00	2473.00
2007-2008	5390.66	4423.00
2008-2009	2522.00	4110.90
2009-2010	1895.50	1271.40
2010-2011	1731.41	2503.60
2011-2012	4850.75	1595.10
2012-2013	906.25	2276.50
2013-2014	1042.16	1633.80
2014-2015	643.83	628.80
2015-2016	489.16	1549.10
2016-2017	834.83	858.80
2017-2018	1904.75	832.60
2018-2019	2057.87	2200.10
2019-2020	790.41	795.70
2020-2021	467.75	893.20

The highest arrivals (9589.25 qt) was noticed in the year of 2003, and lowest arrivals (467.75 qt) was observed in the year of 2020 for the red gram. It means average arrivals of Red gram was decreasing trend during 2020 year. Green gram yearly arrivals was maximum (6760.4 qt) in the year of 2003 and minimum (628.8 qt) in the year of 2014. It means the year 2003 have maximum arrivals of Red gram and Green gram to APMC Khammam.

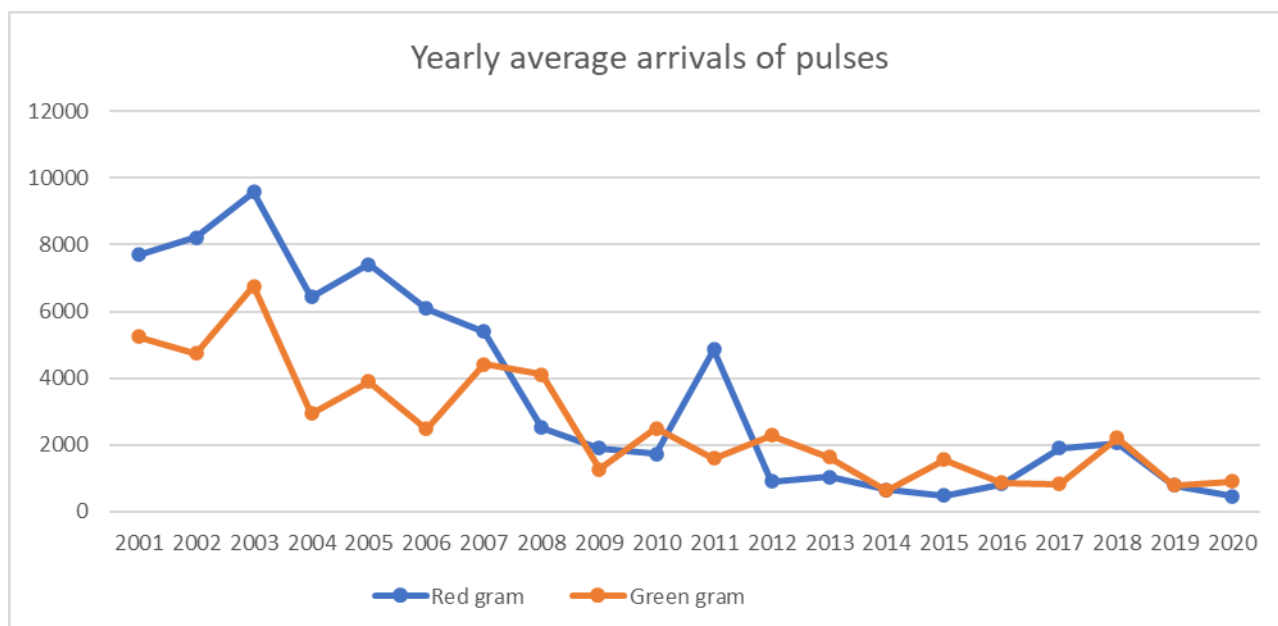


Fig: 4.2: Yearly Average Arrivals of Red gram and Green gram in APMC, Khammam.

UN General assembly passed a resolution on December 20, 2013, designated 2016 as “The International year of pulses”. The average arrivals of Red gram and Green gram during the year of 2016 was 834.83 qt and 858.8 qt . For Green gram the average arrivals was increased slightly compared to 2016 that was 893.2 qt in 2020 - 2021 study period.

4.1.1 Compound Annual Growth Rates of Arrivals of Red gram and Green gram in APMC, Khammam district.

The compound annual growth rates (CAGR) of annual arrivals of Red gram and Green gram for the entire period (2001-2020) were estimated by fitting an exponential type of equation and the results are presented in table 4.3.

Table 4.3: Compound annual growth rates of arrivals of Red gram and Green gram in APMC, Khammam.

Variables	Khammam	
	Green gram	Red gram
	Arrivals	Arrivals
A	8.69	9.30
B	0.90	0.86
T	-6.59	-7.14
R²	0.70	0.73
CAGR	-9.65	-13.90

The arrivals of green gram was negatively significant similarly arrivals of red gram was also negatively significant .The model of green gram and red gram are statistically significant. The R² were 0.70 and 0.73, respectively the “b” coefficients of both the models were significant as calculated “t” value were greater than table t value at 4.3. If shrote (2021) reported that, the arrivals of pigeon pea was negative and significant.

4.1.2. Instability of arrivals of Red gram and Green gram

To study the variability in terms of arrivals of red gram and green gram from secondary data from (2001 to 2020).The coefficient of variation (CV) and Coppock’s instability index were worked out.

The monthly mean, standard deviation, and coefficient of variation of red gram and green gram arrivals are computed in table 4.4. Results revealed that, in Khammam market highest degree of variation in green gram was observed (138.20 percent) during march month. The lowest coefficient of variation was observed in September month (61.50 per cent) and maximum average arrivals are seen in same month September (8729.55 qt). Similarly, in Khammam market highest degree of variation in red gram was in November month (117.09 per cent), and the lowest coefficient variation was observed during the month of March (86.72 per cent).

Table 4.4: Month-wise Mean, SD, and CV of Arrivals of a Green gram and Red gram

Months	ARRIVALS					
	Green gram			Red gram		
	Mean(qt)	SD	CV%	Mean(qt)	SD	CV%
April	1712.70	1696.17	99.03	8291.40	8249.11	99.48
May	926.05	1168.41	126.17	3751.39	3496.99	93.21
June	627.64	693.72	110.52	3738.84	3984.39	106.56
July	740.09	814.45	110.04	4072.05	3915.52	96.15
August	2531.59	2015.80	79.62	2276.16	2445.61	107.44
September	8729.55	5369.00	61.50	1820.33	2045.40	112.36
October	6202.65	4872.28	78.55	1697.01	1563.38	92.12
November	3368.85	3455.05	102.55	977.73	1144.91	117.09
December	1855.90	1816.30	97.86	939.87	1033.40	109.95
January	1686.25	1639.54	97.23	2465.99	2658.11	107.79
February	1231.30	1335.07	108.42	4873.27	4424.52	90.79
March	1365.95	1887.79	138.20	7669.86	6651.75	86.72

The study used another index that is Coppock's Instability Index (CII) to estimate the instability in monthly arrivals of Red gram and Green gram. The results elucidated in table 4.5.

Table 4.5 : CII of monthly arrivals of Red gram and Green gram

CII OF ARRIVALS		
Months	Red gram (per cent)	Green gram (per cent)
April	176.8	178.8
May	334.2	360.79
June	288.62	412.12
July	186.06	374.37
August	288.4	306.45
September	475.95	168.55
October	508.93	293.19
November	513.99	267.16
December	428.21	212.81
January	922.44	111.38
February	129.25	228.2
March	142.7	109.12

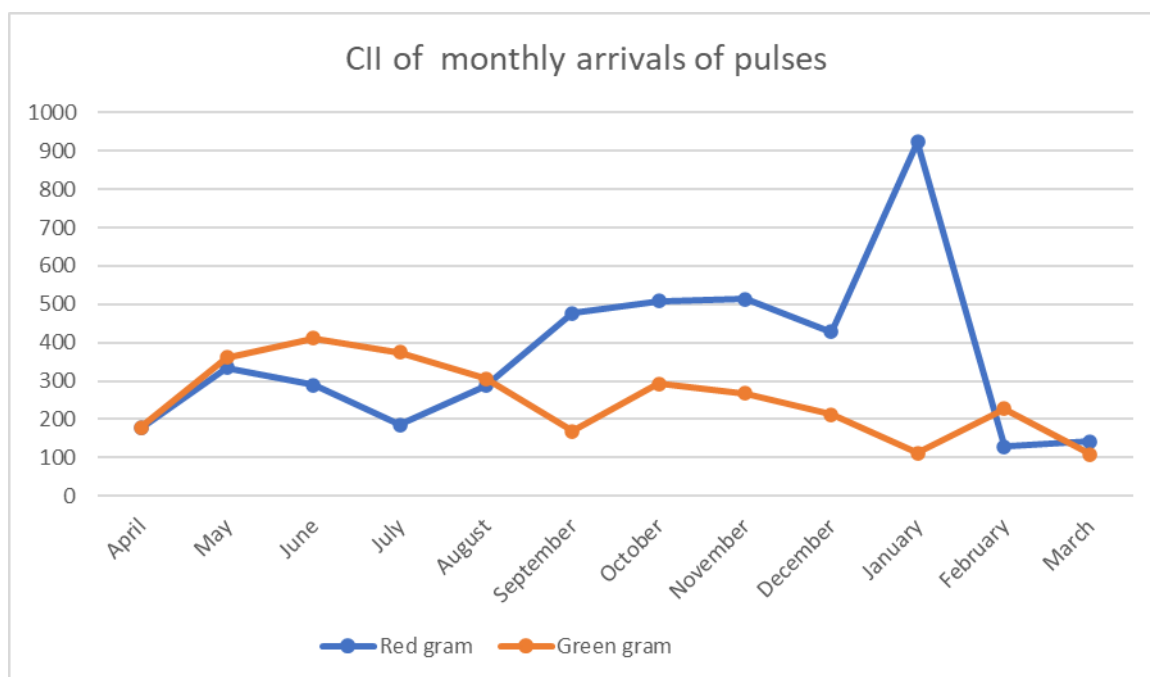


Fig: 4.3: CII of Monthly Arrivals of Red gram and Green gram in APMC, Khammam.

The result showed that, the highest variation is scrutinized during the month of January (922.44 per cent) and followed by November month (513.99 per cent) . The lowest variation observed during month of February (129.25 per

cent) for the Red gram. Similarly, the highest variation is scrutinized during the month of June (412.12 per cent) and followed by July month (374.37 per cent) . The lowest variation observed during month of March (109.12 per cent) for the Green gram.

Table 4.6 : Coppock’s Instability Index of arrivals of Red gram and Green gram

CII	
Arrivals (Per cent)	
Red gram	82.54
Green gram	88.49

The result showed that, the variation observed for arrivals of red gram was 82.54 per cent and for the green gram instability was noticed 88.49 per cent.

4.2 Growth and Instability in Prices of Red Gram and Green Gram In APMC Khammam.

The result obtained for the objective growth and instability of prices of major pulses *viz.*, red gram and green gram was deciphered below in the table 4.7. The average monthly prices of Red gram were less oscillate ranging from (Rs.3258.90-3567.00/qt) revealed, the highest during September month (Rs.3567.95/qt) and the lowest during December month (Rs.3258.90/qt). The average prices of Green gram were viewed, the highest during month of April (Rs.3867.50/qt) and the lowest during (Rs.3301.03/qt) September month. Prices are less fluctuating when compared to arrivals fluctuations. The difference between the range of fluctuations are less for average prices of green gram and red gram than average arrivals.

Table 4.7: Monthly average prices of Red gram and Green gram in APMC Khammam during study period.

Months	Red gram	Green gram
	Prices	Prices
April	3425.80	3867.50
May	3417.20	3757.97
June	3403.55	3684.74
July	3500.65	3505.75
August	3551.50	3411.54
September	3567.95	3301.03
October	3494.20	3451.00
November	3329.30	3573.65
December	3258.90	3595.04
January	3407.15	3683.52
February	3321.50	3740.45
March	3442.10	3792.65

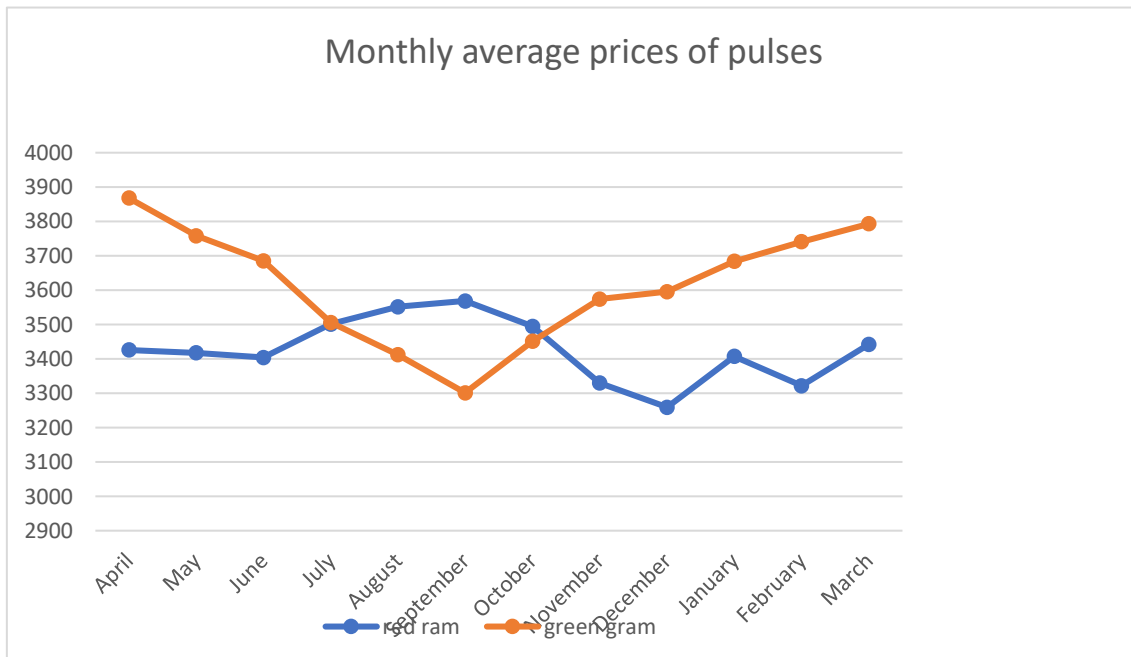


Fig:4.4 Average Prices of Red gram and Green gram

Yearly average prices of Red gram and Green gram in APMC Khammam during the study period.

From 2001 to 2020 the yearly average arrivals of Red gram and Green gram of APMC Khammam were calculated. Results obtained are the highest prices (Rs.7298.41/qt) was seen in the year of 2015, and lowest prices (Rs.1327.87/qt) was observed in the year of 2002 for the Red gram. Average prices of Green gram yearly was maximum (Rs.6817.16/qt) in the year of 2015 and minimum (Rs.1412.25 /qt) in the year of 2001.

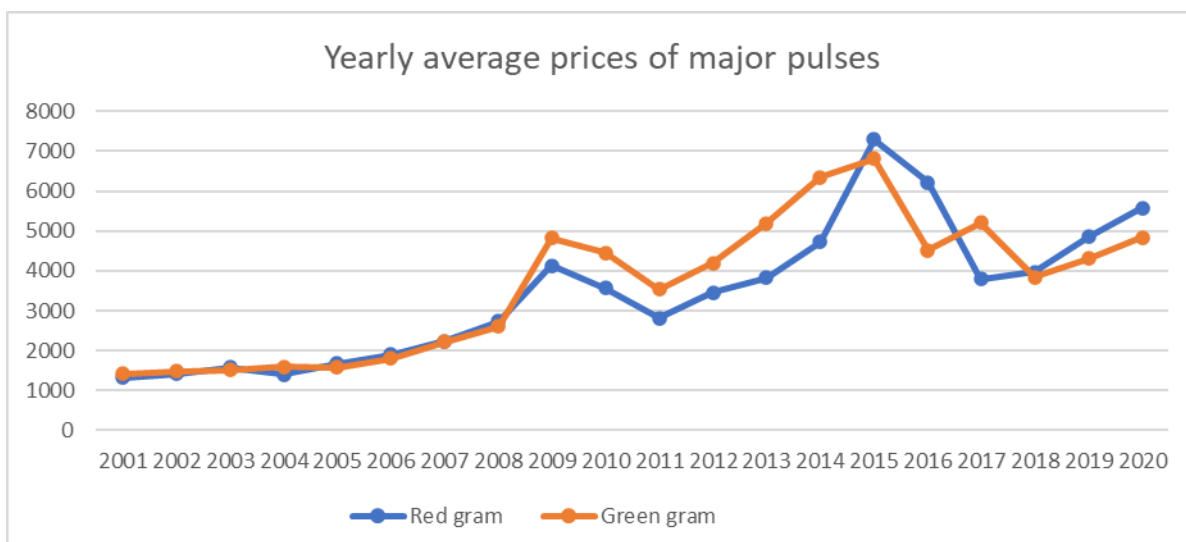


Fig:4.5: Yearly average prices of Red gram and Green gram

Table 4.8 : Yearly average prices of Red gram and Green gram in APMC Khammam during the study period.

Years	Red gram	Green gram
	Prices(Rs.)	Prices(Rs.)
2001-2002	1327.83	1412.25
2002-2003	1423.91	1479.16
2003-2004	1580.30	1509.66
2004-2005	1408.50	1587.00
2005-2006	1679.58	1574.25
2006-2007	1901.33	1802.75
2007-2008	2237.58	2220.41
2008-2009	2734.41	2611.91
2009-2010	4130.25	4819.16
2010-2011	3564.75	4448.25
2011-2012	2815.25	3535.416
2012-2013	3453.00	4188.91
2013-2014	3825.58	5198.50
2014-2015	4728.16	6342.25
2015-2016	7298.41	6817.16
2016-2017	6224.58	4522.69
2017-2018	3787.75	5205.08
2018-2019	3968.58	3846.02
2019-2020	4861.66	4311.48
2020-2021	5581.41	4842.41

4.2.1 Compound annual growth rate of prices of Red gram and Green gram in APMC, Khammam.

The compound annual growth rates (CAGR) of annual prices of Red gram and Green gram for the entire period (2001-2020) were estimated by fitting an exponential type of equation and the results are presented in table 4.9

According to the outcome data tabulated below showed the positive significant growth rate of prices of Red gram and Green gram. The prices of Green gram was positively significant similarly prices of Red gram was also positively significant. The model of Green gram and Red gram are statistically significant. The R^2 were 0.73 and 0.8, respectively the “b” coefficients of both the models were significant as calculated “t” value were greater than table t value at 4.9.

Table 4.9: Compound annual growth rates of Prices of Red gram and Green gram in APMC, Khammam

Variables	Khammam	
	Green gram	Red gram
	Prices	Prices
A	7.23	7.16
B	1.08	1.08
T	7.07	8.87
R²	0.73	0.81
CAGR	8.19	8.41

4.2.2. Instability of Prices of Red gram and Green gram

To study instability in prices of red gram and green gram was studied from secondary data from (2001 to 2020) with the help of the coefficient of variation (CV) and Coppock’s instability index.

Table 4.10: Month-wise Mean, SD, and CV of Prices of Green gram and Red gram

Months	PRICES					
	Green gram			Red gram		
	Mean(q)	SD	CV%	Mean(q)	SD	CV%
April	3867.50	1980.68	51.21	3425.80	1947.19	56.83
May	3757.97	1950.59	51.90	3417.20	1956.82	57.26
June	3684.74	1842.70	50.00	3403.55	1910.63	56.136
July	3505.75	1631.91	46.54	3500.65	1905.48	54.43
August	3411.54	1574.29	46.14	3551.50	1942.69	54.70
September	3301.0	1604.84	48.61	3567.95	1938.27	54.32
October	3451.00	1802.58	52.23	3494.20	1943.24	55.61
November	3573.65	1887.15	52.80	3329.30	1439.65	43.24
December	3595.04	1891.15	52.60	3258.90	1483.02	45.50
January	3683.52	1848.29	50.17	3407.15	1779.31	52.22
February	3740.45	1858.70	49.69	3321.50	1619.55	48.75
March	3792.65	1876.86	49.48	3442.10	1766.67	51.32

The monthly mean, standard deviation, and coefficient of variation of red gram and green gram prices are computed in table 4.10. Results revealed that, in Khammam market highest degree of variation in green gram was observed (52.80 per cent) during November month. The lowest coefficient of variation was observed in August month (46.14 per cent). Similarly, in the Khammam market highest degree of variation of Red gram was in May month (57.26 per cent), and the lowest coefficient variation was observed during the month of November (43.242 per cent).

Coppock's instability index of prices of Green gram and Red gram

The study utilized another index that is Coppock's Instability Index (CII) to estimate the instability in arrivals and prices of Green gram and Red gram.

Table 4.11 Coppock's Instability Index of prices of Green gram and Red gram

Months	CII OF PRICES	
	Red gram (Per cent)	Green gram (Per cent)
April	31.97	31.31
May	34.52	35.81
June	35.02	29.59
July	36.67	24.74
August	33.57	21.79
September	31.51	27.07
October	33.85	34.73
November	24.43	39.67
December	25.41	38.67
January	27.15	32.96
February	25.2	31.84
March	27.02	27.78

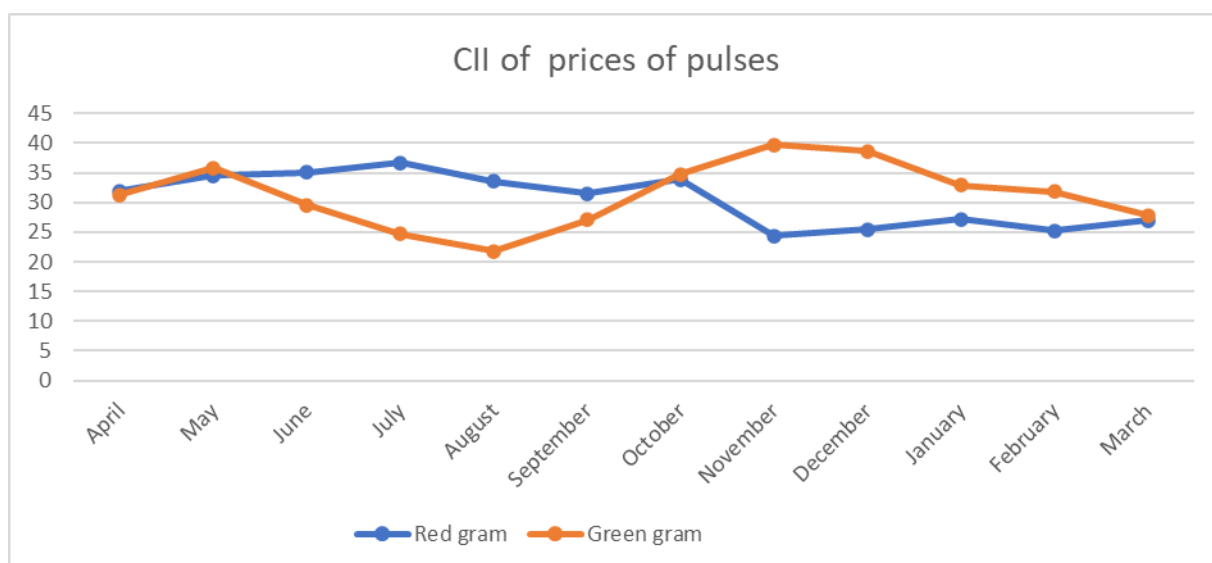


Fig:4.6: CII of average prices of Red gram and Green gram

The result showed that, the highest variation is scrutinized during the month of July (36.67 per cent) and followed by June month (35.02 per cent) . The lowest variation observed during month of November (24.43 per cent) for the red gram prices . Similarly, the highest variation is scrutinized during the month of November (39.67 per cent) and followed by December month (38.67 per cent) . The lowest variation observed during month of August (21.79 per cent) for the green gram prices.

Table 4.12 Coppock’s Instability Index of prices of Green gram and Red gram

CII	
Prices (Per cent)	
Red gram	24.33
Green gram	23.92

The results of Coppock’s Instability Index are presented in Table 4.12 . The result showed that variation observed for prices of red gram was 24.33 percent and for the green gram the instability was observed the 23.92 percent.

4.3. Seasonal indices in arrivals and prices of Red gram, and Green gram in APMC, Khammam

Seasonal indices are those periodic movements in business activity which occur regularly every year and have their origin in the year itself. Since such variations repeats during a period of twelve months that can be predicted fairly and

accurately. The estimation of seasonal indices of arrivals and prices of Red gram and Green gram in APMC, Khammam are depicted in table 4.13 respectively.

Table 4.13 Seasonal indices of arrivals and prices of Red gram and Green gram in APMC, Khammam

Months	Red gram		Green gram	
	Arrivals (per cent)	Prices (per cent)	Arrivals (per cent)	Prices (per cent)
April	81.79	101.33	245.62	95.68
May	104.17	100.61	351.12	98.26
June	117.37	99.41	192.09	100.79
July	140.29	97.96	60.78	104.29
August	193.39	97.91	43.71	105.58
September	223.23	98.56	40.57	104.97
October	237.64	100.26	68.83	102.90
November	230.31	100.93	118.07	100.88
December	123.88	101.73	189.09	99.06
January	68.90	100.83	197.92	97.10
February	53.06	100.91	207.27	96.24
March	43.66	99.69	174.08	95.66

Table 4.13 revealed that, the arrival indices of Red gram was more than 100 per cent for the months from May to December. Maximum arrivals were found in the month of October (237.64 Per cent) followed by November month (230.31 per cent) and September month (223.23 per cent). The October month has highest seasonal indice, from October the indices per cent were decreasing till March month (43.66 per cent) and increasing trend observed from April month (81.79 per cent) . The minimum arrivals indices was observed in month of March (43.66 Per cent). Whereas, prices indices variation was less ranging from (101.73 per cent to 97.91 per cent) compared to arrival indices ranging from (237.64 per cent to 43.66 per cent). Where as seasonal indices of prices of red gram was maximum during the month of December (101.73 Per cent) and fluctuated with little difference during the rests of the months and lowest indice were observed during month of August (97.91 per cent).

The maximum arrivals was during the October which coincides with higher magnitude of arrivals indices (237.64 per cent), the price indices were not high during October. Whereas, during the post-harvest period the indices of arrivals were fluctuating, and price indices were also irregular showing increasing and decreasing trend simultaneously. These results are in conformity with the results obtained by Singh *et al.* (1995), Bawaskar (2002) and Kale *et.al.* (2006).

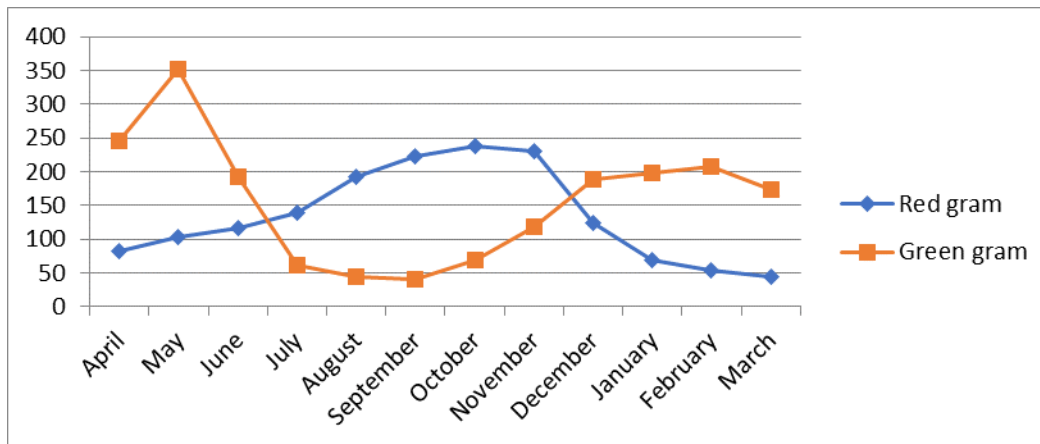


Fig 4.7: Seasonal indices of arrivals of major pulses

Table 4.13 revealed that, the arrival indices for Green gram was high compared with prices seasonal indices variation. The arrivals indices ranging from (351.12 per cent to 40.57 per cent). Maximum arrivals were found in the month of May (351.12 Per cent) followed by April month (245.62 per cent) and February month (207.27 per cent). The May month has highest sesonal indices from May the indices per cent were decreasing till September month (40.57 per cent) continuously next follow the increasing trend till May month (351.12 per cent) .This shows that cycle is continous seasonal. Where as seasonal indices of prices of Green gram was maximum during the month of August (105.58 Per cent) and fluctuated with little difference during the rests of the months and lowest indice were observed during month of March (97.91 per cent).

Results reported by Prakash and Shrivastav (1995) in their study in Uttar Pradesh also revealed that of the total volume of the market arrivals of gram about 60 per cent of total arrivals reached to the market immediately after harvest when prices were low.They have advised the urgent need to create more strong facilities; to the farmers to avoid this situation.

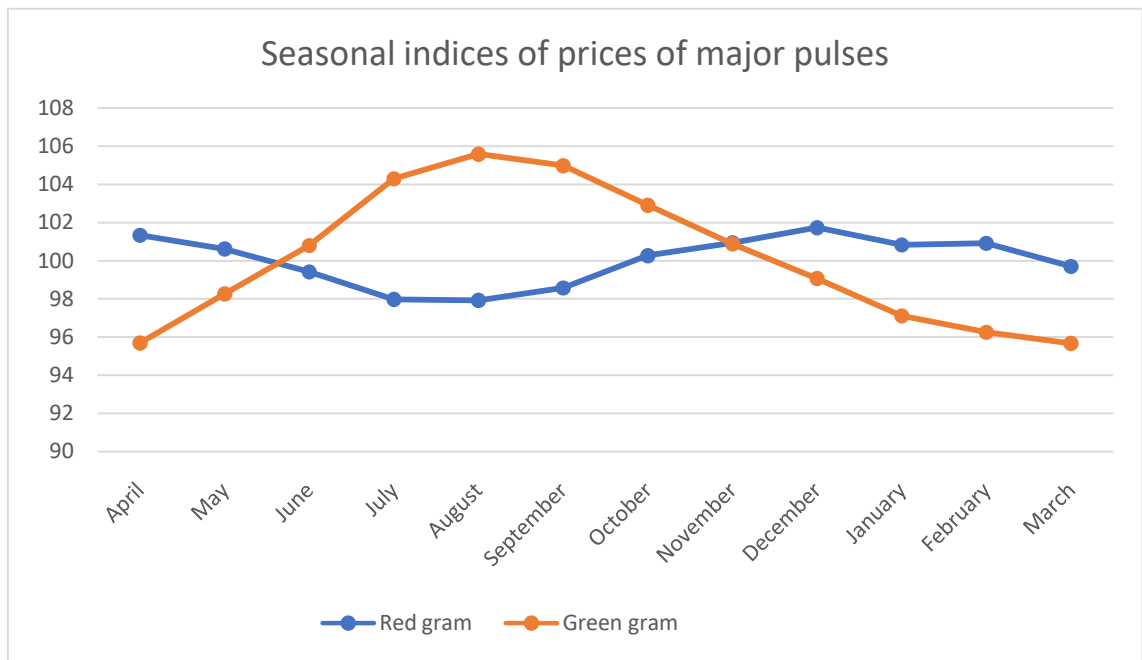


Fig 4.8 : Seasonal indices of prices of major pulses

4.4 To forecast major pulses prices in Khammam APMC of Telangana state

4.4.1 Forecasting of prices of Red gram in Khammam APMC

The detailed analysis of forecasted prices of Red gram in APMC, Khammam market has been presented. The original time sequence plot of red gram price series in APMC Khammam is presented below figure 4.9. The figure clearly shows that, over a period of time the variation in the prices is increased and price series of red gram was non-stationary.

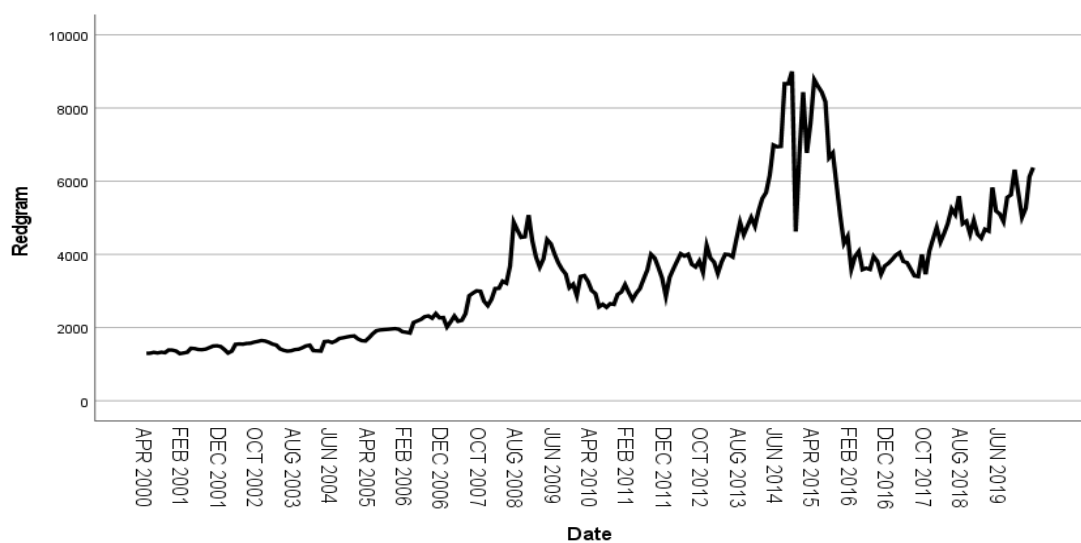


Fig: 4.9 : Time sequence plot of Redgram price series in APMC Khammam

Forecasting of prices of Red gram in APMC Khammam required four steps. In the first step includes the identification of model through coading under which p,d,q indicates non-seasonality and P,D,Q reform to seasonality. The step -II was to estimate the parameters of model. The step-III made diagnostic checking with respect to reliability of model and in last *i.e.* step-IV made forecasting of prices of Red gram, which was presented on follows.

Model identification

The first step in developing a ARIMA model is to determine if the monthly red gram price series are stationary. For this, we used the Augmented Dickey-Fuller test (ADF), which was performed to determine if the series is stationary or not. The test confirmed that the data was non stationary and results are presented in table 4.14. In this case differencing of lag is done to give significant result, so with difference of lag the data is stationary in respect to mean and variance.

This allows going further in the steps for ARIMA model development which are to find out appropriate values of (p,d,q) (P,D,Q). It was done by observing Auto Correlation Function (ACF) and Partial Auto-Correlation Function for those autoregressive terms (AR). The best fitted model identified for Red gram was ARIMA (2,1,1) and ARIMA(1,1,0) .ARIMA model was estimated after transforming the variables under study into stationary series through computation of either seasonal or non -seasonal or both, order of differencing. A careful examination of ACF and PACF up to 16 lags revealed the presence of non-seasonality in the data seen in fig.4.10, 4.11, 4.12 and 4.13.

Table 4.14 Unit Root test, (ADF) of Red gram price series in APMC Khammam

AUGUMENTED DICKEY-FULLER TEST					
Sr.No	At level	t value	5%	1%	Prob*
1	None	-0.109	-1.942	-2.57	0.64
2	Intercept	-1.769	-2.873	-3.457	0.39
3	Trend and intercept	-2.945	-3.428	-3.996	0.15

First Difference					
Sr.No	At level	t value	5%	1%	Prob*
1	None	-14.491	-1.942	-2.57	0
2	Intercept	-14.493	-2.873	-3.457	0
3	Trend and intercept	-14.464	-3.428	-3.996	0

The results of ADF test at three different level *i.e.* no intercept, with intercept and intercept with trend shows that, the price was non-stationary, but when we differenced the series, the series become stationary.

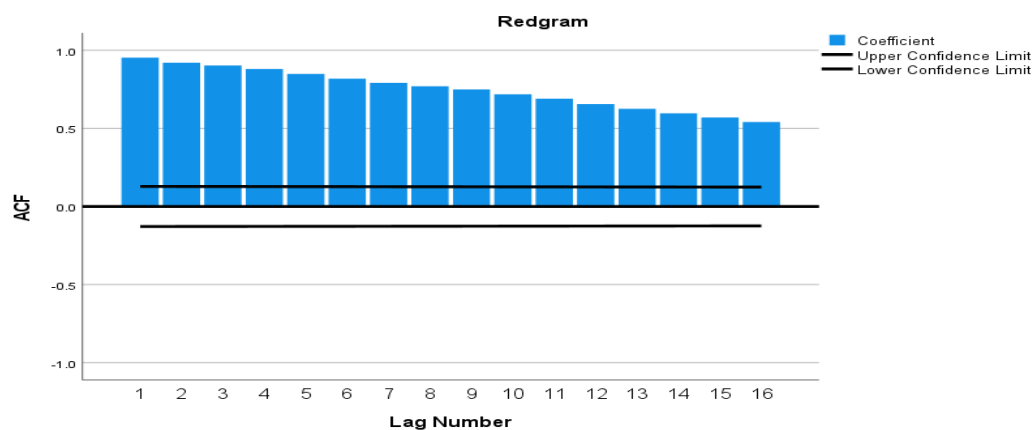


Figure : 4.10 : Auto Correlation Function of Redgram price series in APMC Khammam

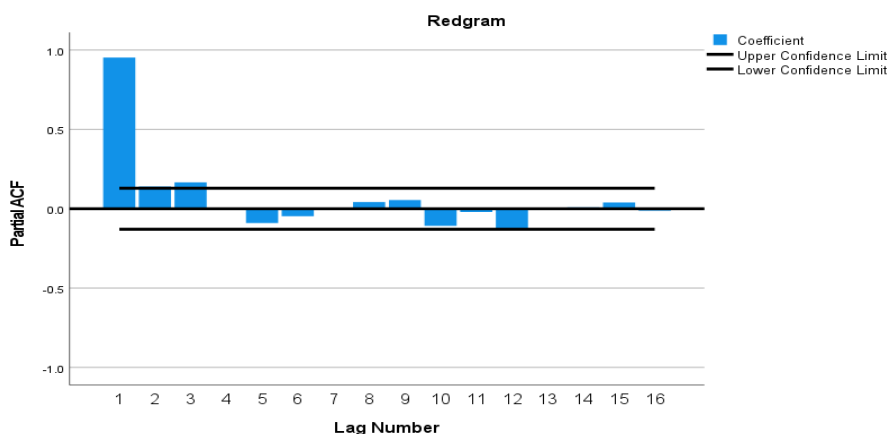


Figure :4.11 : Partial Auto Correlation Function of Redgram price series in APMC Khammam

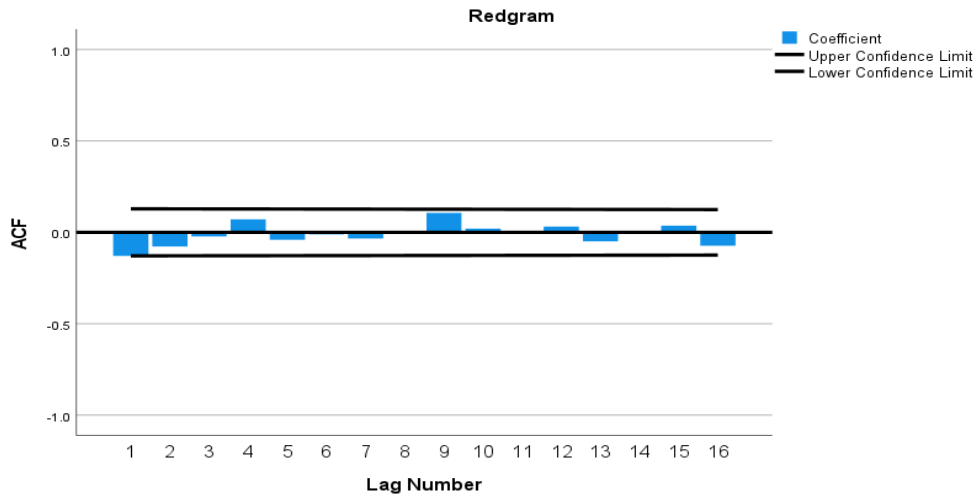


Figure: 4.12: Auto Correlation Function of first differenced natural lag Redgram price series in APMC Khammam

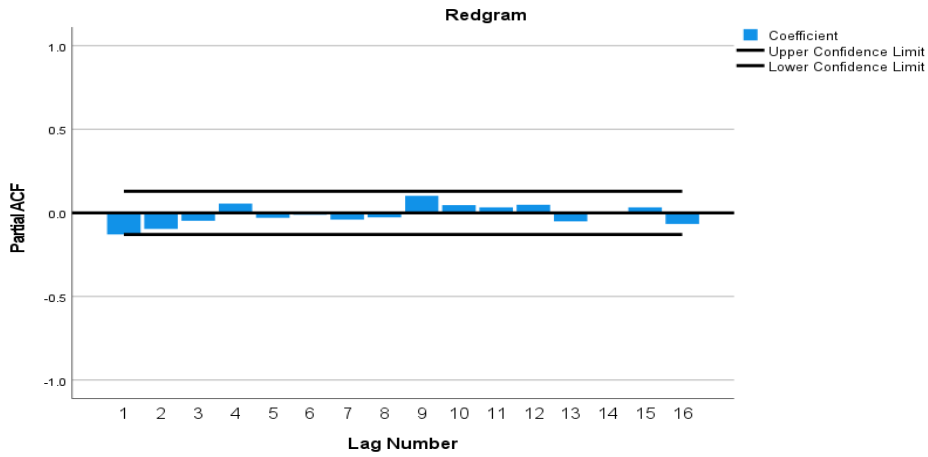


Figure: 4.13 : Partial Auto Correlation Function of first differenced natural lag Red gram price series in APMC Khammam

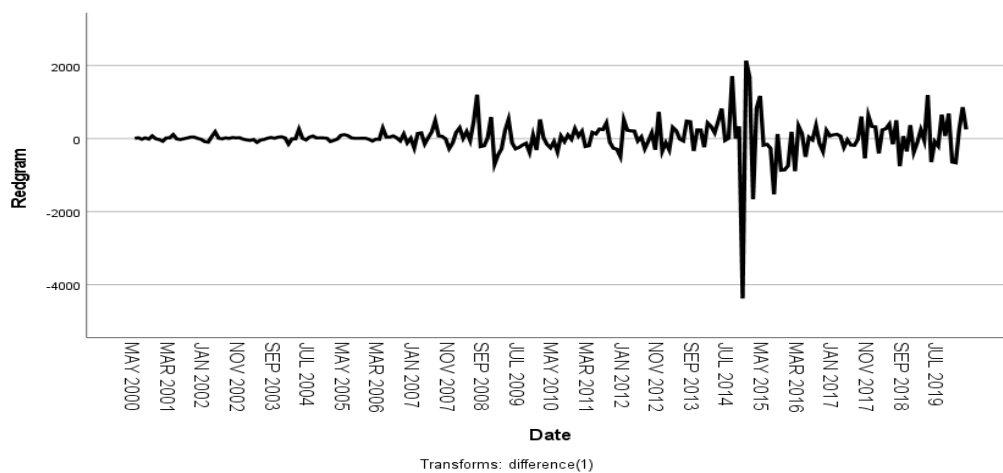


Fig: 4.14: Time sequence plot after differencing data of Red gram price series

The model verification is concerned with checking the residuals of the model to see if they contained any systematic pattern which still could be removed to improve the chosen ARIMA (Darekar and Reddy, 2017). After model validation, MAPE value found to be 6.32 and 6.37 for ARIMA (2,1,1) and ARIMA (1,1,0) respectively. The model ARIMA (2,1,1) have lowest MAPE over ARIMA (1,1,0). Hence we conclude that model ARIMA(2,1,1) was best fitted for forecasting prices of red gram in APMC Khammam. The results show that, autocorrelations of residuals were not significantly different from zero at any reasonable level. This proved that the selected ARIMA model was an appropriate model for forecasting red gram prices in Khammam APMC market. The results of Box Ljung Q statistics also confirms the same.

Table 4.15 : ARIMA Model parameters for Red gram price series in APMC Khammam

ARIMA Model Parameters ^a				Estimate	SE	
Red gram-Model_1	Red gram	Natural Logarithm	Constant	.007	.005	
			AR	Lag 1	.111	.603
				Lag 2	-.066	.114
			Difference	1		
			MA	Lag 1	.255	.603

ARIMA Model Parameters ^a						
				t	Sig.	
Red gram-Model_1	Red gram	Natural Logarithm	Constant	1.400	.163	
			AR	Lag 1	.184	.854
				Lag 2	-.582	.561
			Difference			
			MA	Lag 1	.423	.673

a. Best-Fitting Models according to Stationary R-squared (larger values indicate better fit)

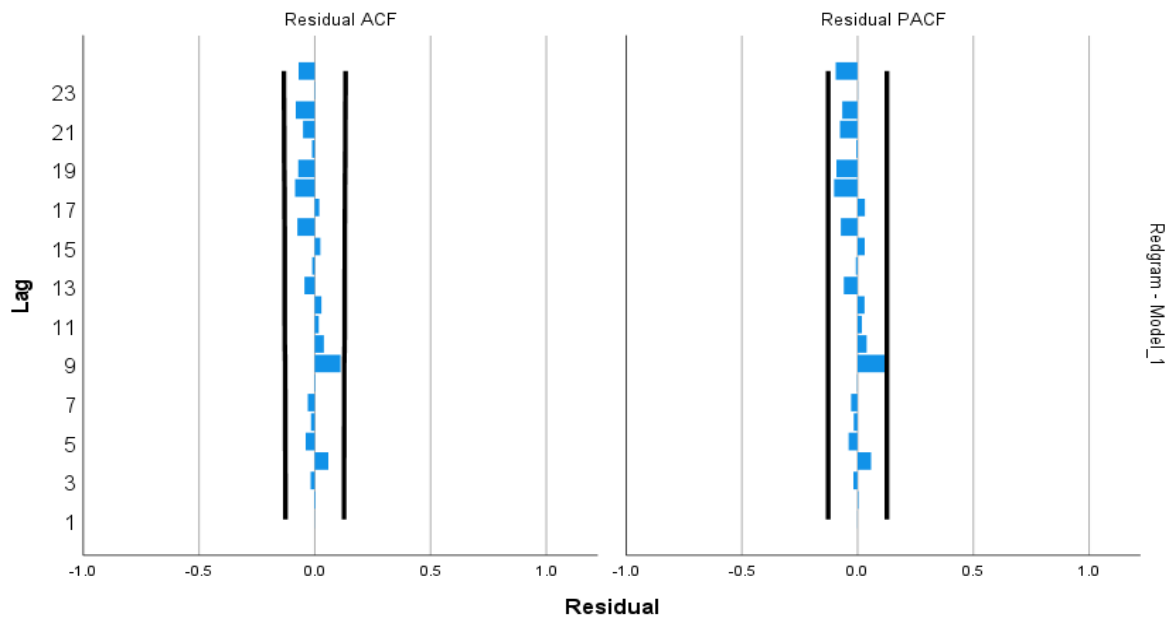


Fig: 4.15: Residual ACF and Residual PACF of Red gram price series

Forecasting using selected model ARIMA (2,1,1)

The following table and graph represents the observed values and fitted values for the red gram forecasted prices along with U.C.L and L.C.L as obtained from their best fitted ARIMA model. As can also be seen from table and graph that forecasted prices of red gram in APMC Khammam were ranging from Rs.6318/qt to Rs.6971/qt for the months from April 2021 to March 2022.

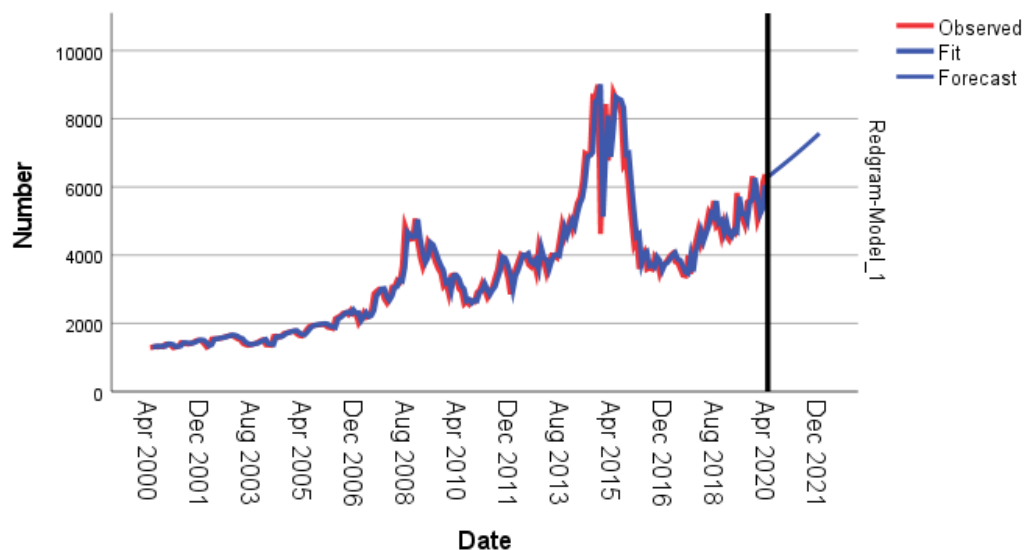


Fig: 4.16 : Time sequence plot of predicted prices of selected model ARIMA (2,1,1) of Red gram price series

Table 4.16 : Forecasted value along with U.C.L and L.C.L of Red gram price series

Month	Forecasted value	U.C. L -Upper Confident Limit	L.C.L-Lower Confidence Limit
Apr-21	6318	7553	5240
May-21	6352	8020	4956
Jun-21	6415	8397	4804
Jul-21	6477	8746	4677
Aug-21	6536	9080	4564
Sep-21	6597	9404	4465
Oct-21	6658	9719	4378
Nov-21	6719	10028	4299
Dec-21	6781	10332	4227
Jan-22	6844	10634	4162
Feb-22	6907	10933	4101
Mar-22	6971	11231	4045

4.4.2 Forecasting of prices of Green gram in APMC, Khammam market

The detailed analysis of forecasted prices of Green gram in APMC, Khammam market has been presented. The original time sequence plot of Green gram price series in APMC Khammam is presented below figure 4.18. The figure clearly shows that, over a period of time the variation in the prices is increased and price series of red gram was non-stationary.

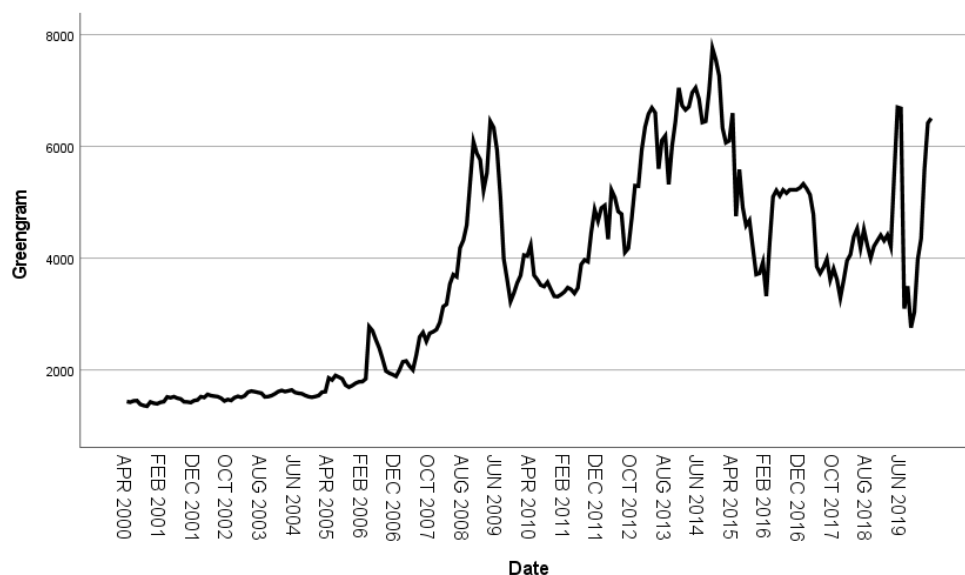


Fig 4.17: Time sequence plot of Green gram in APMC Khammam

Forecasting of prices of Green gram in APMC Khammam required four steps. In the first step includes the identification of model through coading under which

p,d,q indicates non-seasonality and P,D,Q reform to seasonality. The step -II was to estimate the parameters of model. The step-III made diagnostic checking with respect to reliability of model and in last *i.e.* step-IV made forecasting of prices of Green gram, which was presented on follows.

Model identification

The first step in developing a ARIMA model is to determine if the monthly red gram price series are stationary. For this, we used the Augmented Dickey-Fuller test (ADF), which was performed to determine if the series is stationary or not. The test confirmed that the data was nonstationary and results are presented in below table 4.17. In this case differencing of lag is done to give significant result, so with difference of lag the data is stationary in respect to mean and variance.

This allows going further in the steps for ARIMA model development which are to find out appropriate values of (p,d,q) (P,D,Q).It was done by observing Auto Correlation Function (ACF) and Partial Auto-Correlation Function for those autoregressive terms (AR). The best fitted model identified for Green gram was ARIMA (2,1,2) and ARIMA (3,1,3). ARIMA model was estimated after transforming the variables under study into stationary series through computation of either seasonal or non -seasonal or both, order of differencing. A careful examination of ACF and PACF up to 16 lags revealed the presence of non-seasonality in the data seen in the fig.4.19 ,4.20, 4.21 and 4.22.

Table 4.17 Unit Root test, (ADF) of Green gram price series in APMC Khammam

AUGUMENTED DICKEY-FULLER TEST					
Sr.no	At level	t value	5%	1%	Prob*
1	None	0.227	-1.942	-2.57	0.751
2	Intercept	-1.327	-2.873	-3.457	0.616
3	Trend and intercept	-3.587	-3.428	-3.996	0.033

First Difference					
Sr.no	At level	t value	5%	1%	Prob*
1	None	-14.11	-1.942	-2.57	0
2	Intercept	-14.11	-2.873	-3.457	0
3	Trend and intercept	-14.11	-3.428	-3.996	0

The results of ADF test at three different level *i.e.* no intercept, with intercept and intercept with trend shows that, the price was non-stationary, but when we differenced the series, the series become stationary.

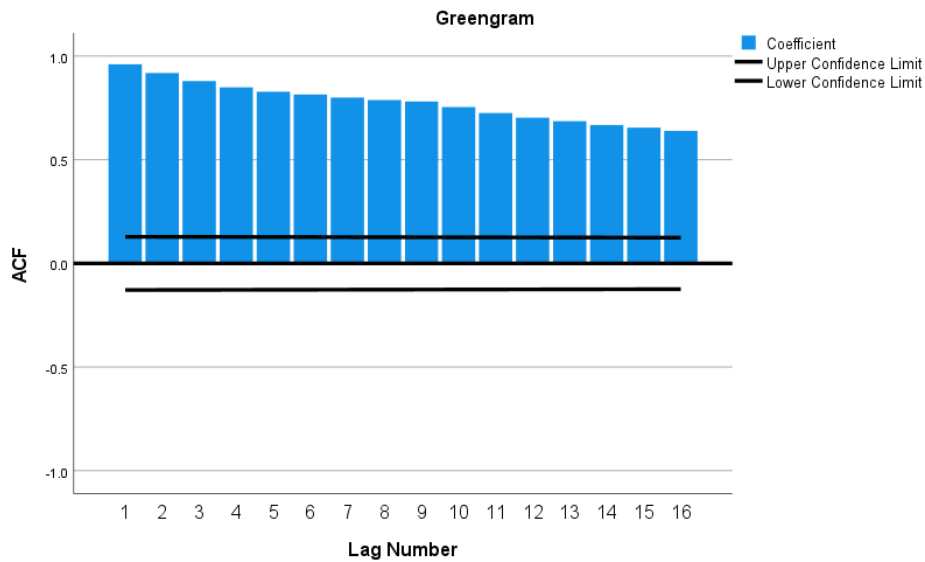


Fig 4.18 : Auto Correlation Function of Green gram price series in APMC Khammam

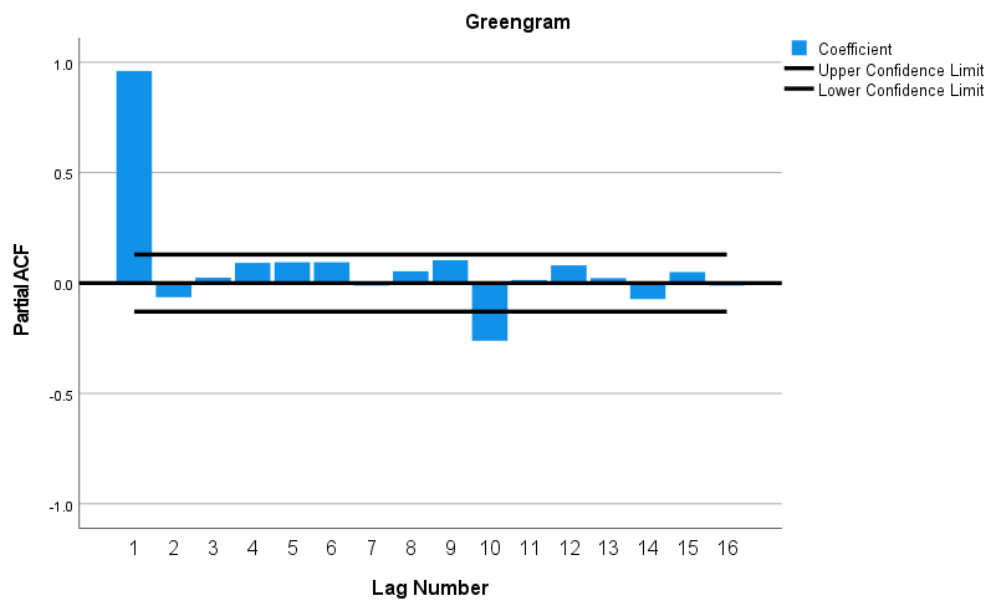


Fig 4.19: Partial Auto Correlation Function of Green gram price series in APMC Khammam

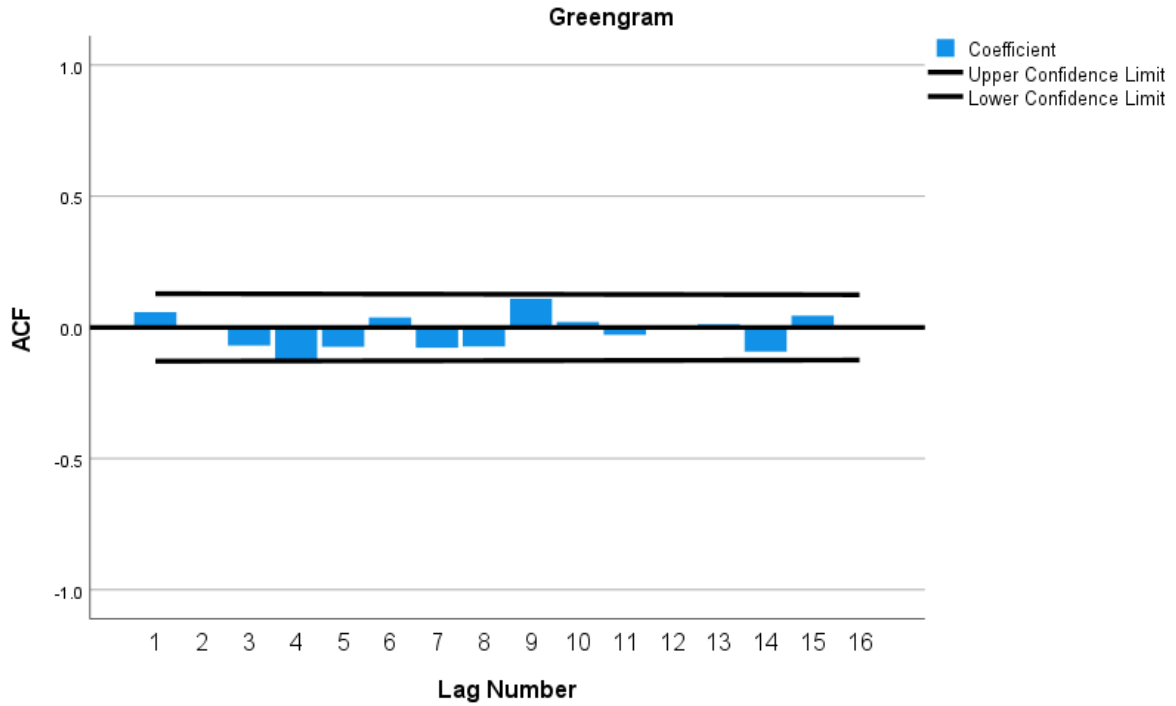


Fig 4.20 : Auto Correlation Function of first differenced Green gram price series in APMC Khammam

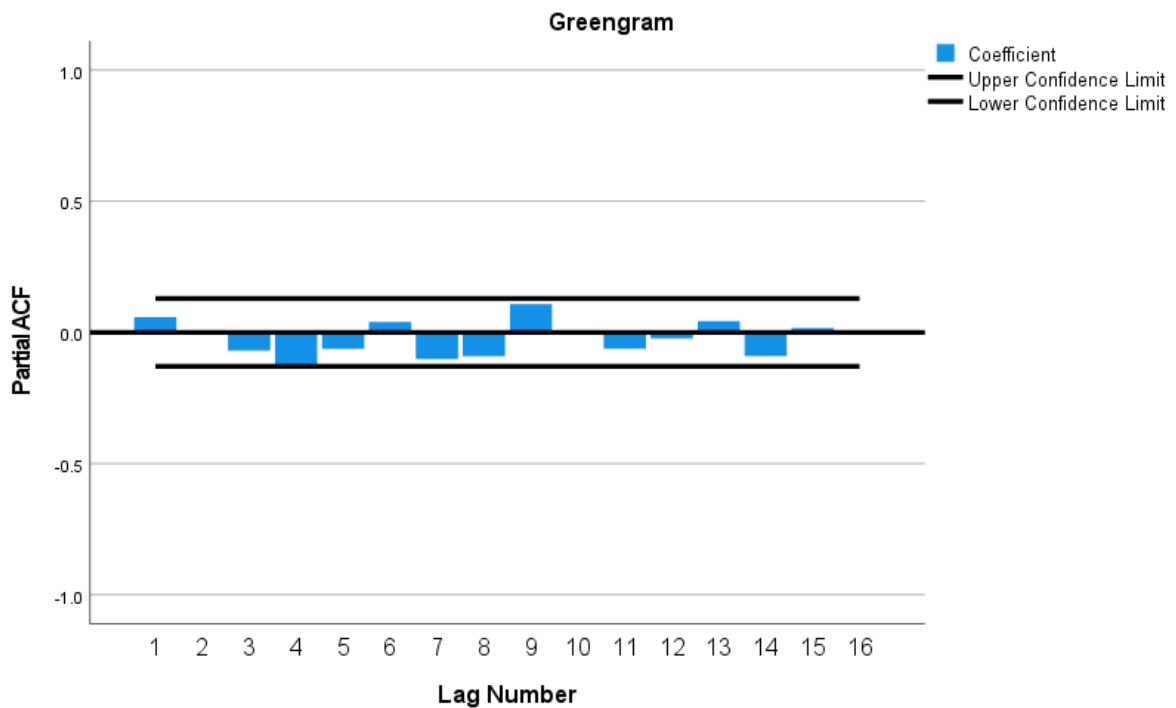


Fig 4.21 : Partial Auto Correlation Function of first differenced Green gram price series in APMC Khammam

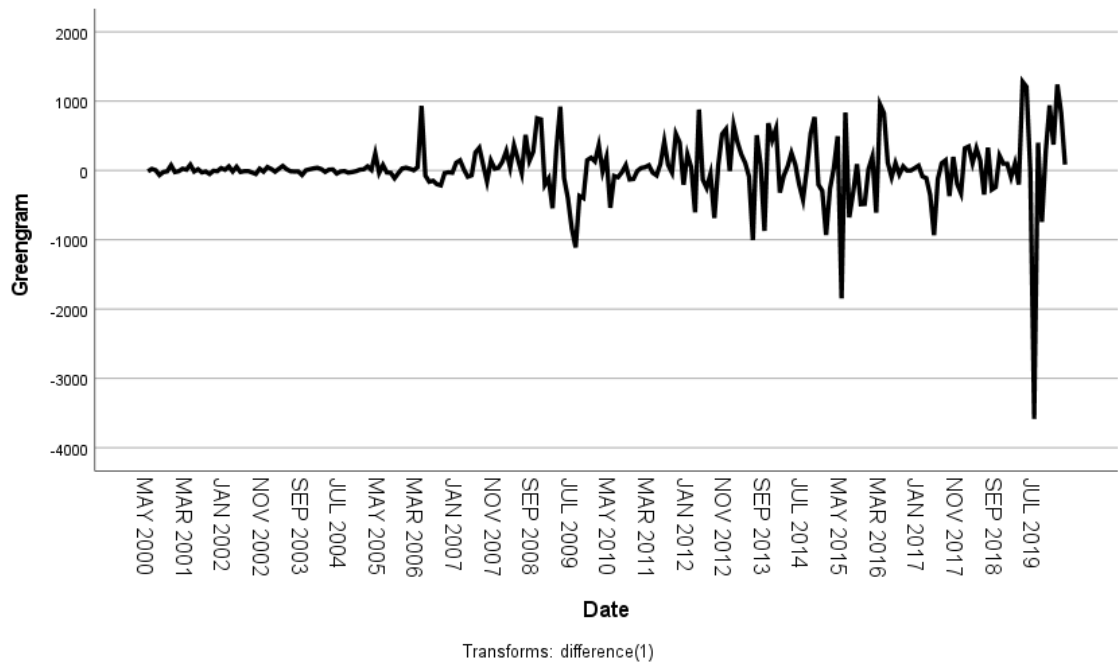


Fig: 4.22 : Time sequence plot after differencing data of Green gram price series

The model verification is concerned with checking the residuals of the model to see if they contained any systematic pattern which still could be removed to improve the chosen ARIMA (Darekar and Reddy, 2017). After model validation, MAPE value found to be 5.94 and 5.89 for ARIMA (2,1,2) and ARIMA (3,1,3) respectively. The model ARIMA (3,1,3) have lowest MAPE over ARIMA (2,1,2) but variations are more for ARIMA (3,1,3) model. Hence we conclude that model ARIMA(2,1,2) was best fitted for forecasting prices of green gram in APMC Khammam. The results show that autocorrelations of residuals were not significantly different from zero at any reasonable level. This proved that the selected ARIMA model was an appropriate model for forecasting green gram prices in Khammam APMC market. The results of Box Ljung Q statistics also confirms the same.

Table 4.18 : ARIMA Model parameters for Green gram price series in APMC Khammam

ARIMA Model Parameters ^a						
				Estimate	SE	
Greengram-Model_1	Green gram	Square Root	Constant	.176	.208	
			AR	Lag 1	.094	.028
				Lag 2	.479	.439
				Lag 3	-.615	.446
			Difference	1		
			MA	Lag 1	.029	.247
				Lag 2	.481	.519
				Lag 3	-.545	.528

ARIMA Model Parameters ^a						
				t	Sig.	
Greengram-Model_1	Green gram	Square Root	Constant	.846	.398	
			AR	Lag 1	3.411	<.001
				Lag 2	1.091	.277
				Lag 3	-1.378	.169
			Difference			
			MA	Lag 1	.117	.907
				Lag 2	.926	.356
				Lag 3	-1.033	.303

a. Best-Fitting Models according to Stationary R-squared (larger values indicate better fit).

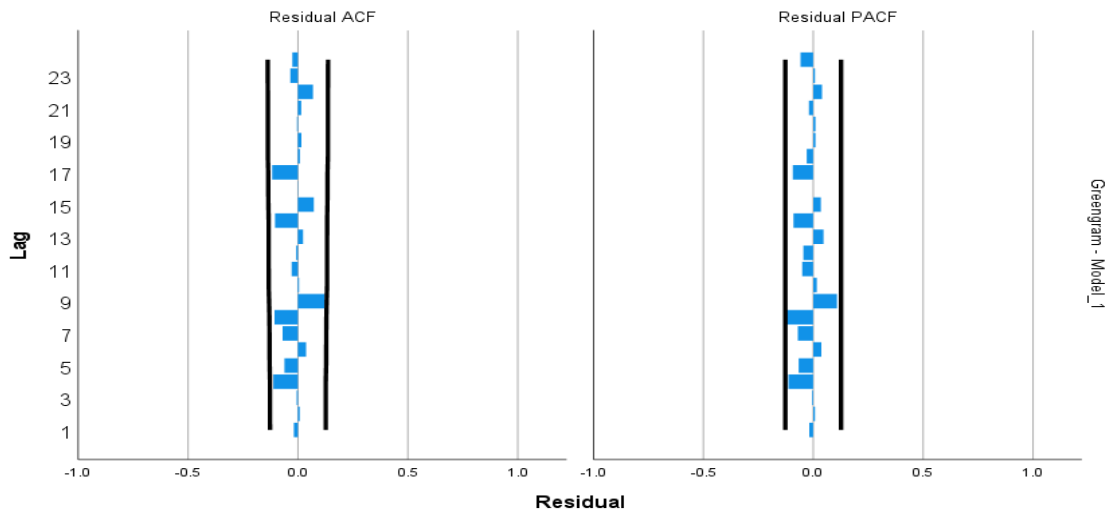


Fig: 4.23 : Residual ACF and Residual PACF of Green gram price series

Forecasting using selected model ARIMA (2,1,2) model :

The following table and graph represents the observed values and fitted values for the Green gram forecasted prices along with U.C.L and L.C.L as obtained from their best fitted ARIMA model.

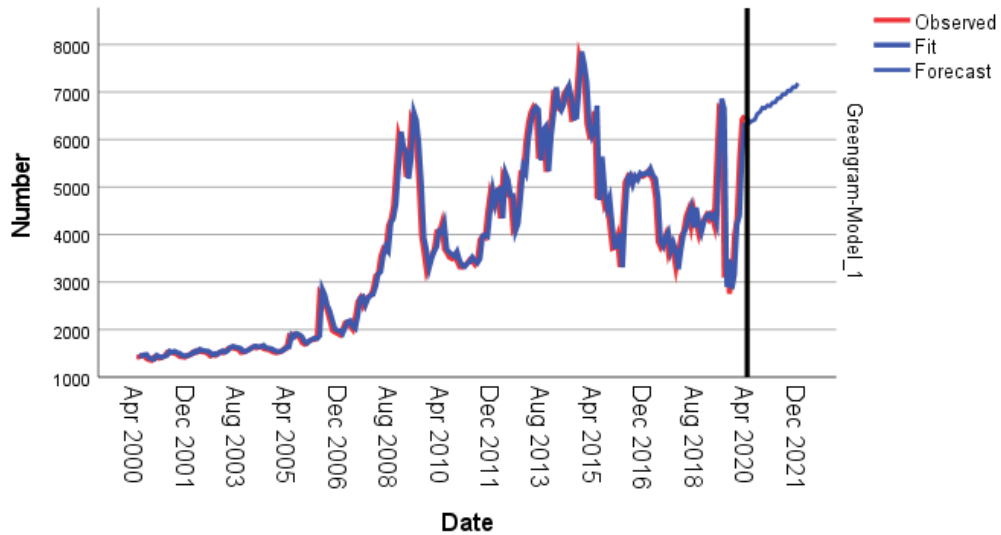


Fig: 4.24 : Time sequence plot of predicted prices of selected model ARIMA (2,1,2) of Green gram price series

As can also be seen from table 4.19 and figure 4.25 that forecasted prices of Green gram in APMC Khammam were ranging from Rs.6458 /qt to Rs.6784 /qt for the months from April 2021 to March 2022.

Table 4.19 : Forecasted value along with U.C.L and L.C.L of Green gram price series

Month	Forecasted value	U.C. L -Upper Confident Limit	L.C.L-Lower Confidence Limit
Apr-21	6458	7508	5468
May-21	6357	7897	4946
Jun-21	6396	8327	4660
Jul-21	6419	8661	4437
Aug-21	6542	9060	4342
Sep-21	6581	9331	4205
Oct-21	6670	9650	4120
Nov-21	6661	9845	3966
Dec-21	6719	10118	3868
Jan-22	6706	10297	3723
Feb-22	6779	10576	3650
Mar-22	6784	10761	3535

CHAPTER-V
SUMMARY AND CONCLUSIONS

CHAPTER-V

SUMMARY AND CONCLUSIONS

In order to evaluate market patterns, trends, and the relationship between arrivals and prices at the Khammam market, an economic analysis of arrivals and prices of Major Pulses in APMC, Khammam is conducted. The study will be helpful in developing economic policies and actions based on its findings. Additionally, it is advantageous to the government, as well as to consumers, producers, merchants, and researchers. Forecasting the prices of the two main Pulses commodities-Red gram and Green gram traded in APMC, Khammam, with the following precise goals in mind, in order to confirm trends and behavior of arrivals and price fluctuations.

1. Estimate the growth and instability in arrivals of major pulses in Khammam APMC.
2. Estimate the growth and instability in prices of major pulses in Khammam APMC.
3. Estimate seasonal indices of arrivals and prices of major pulses in Khammam APMC.
4. Forecast the major pulses prices in Khammam APMC.

The information about arrivals and prices of significant Pulses at APMC, Khammam, served as the basis for the current study. The information is for the 20-year period, or from 2001 to 2020. The secondary data on Red gram and Green gram prices and arrivals were gathered from records of the Agriculture Produce Market Committee (APMC), Khammam. The collected data were evaluated using a variety of straight forward statistical procedures, including averages, percentages, and percentage change. For analyzing the growth and instability in arrivals and prices of agricultural commodities, the compound annual growth rates of chosen agricultural commodities for arrivals and prices were calculated and for instability calculation, we used statistical tools are CV% and Coppock's instability index. We calculated seasonal indices using the moving average approach. For forecast future prices ARIMA model is used. The important findings of the present study are summarized below.

5.1 Growth and Instability in arrivals of major pulses

The Results obtained for the average arrivals of red gram and green gram are revealed that, average arrivals of red gram were Maximum during month of April (8291.40 qt) and minimum in December month (939.87qt). The average monthly arrivals of red gram shows that, from November month (977.73 qt) arrivals was upward trend till the April month (8291.4 qt). The monthly average arrivals ranging from (8291.4qt to 939.87 qt). Average monthly arrivals of green gram was maximum in the month of September (8729.55qt). It follows decreasing trend during month of October (6202.65 qt) and was minimum average arrivals in the month of June (627.64qt).The highest arrivals (9589.25qt) was seen in the year of 2003, and lowest arrivals (467.75qt) was observed in the year of 2020 for the red gram. It means Average arrivals of Red gram was decreasing trend during the year 2020 . Whereas green gram yearly was maximum (6760.4qt) in the year of 2003 and minimum (628.8qt) in the year of 2014. It means 2003 year have maximum arrivals of Red gram and Green gram to APMC Khammam.

The arrivals of green gram was negatively significant similarly arrivals of red gram was also negatively significant .The model of green gram and red gram are statistically significant. The R^2 were 0.70 and 0.73 , respectively the “b” coefficients of both the models were significant as calculated “t” value were greater than table t value.

The monthly mean, standard deviation, and coefficient of variation of red gram and green gram arrivals revealed that, in Khammam market highest degree of variation in green gram was observed (138.20 percent) during march month. The lowest coefficient of variation was observed in September month (61.50 percent) and maximum average arrivals are seen in same month September (8729.55qt). Similarly, in Khammam market highest degree of variation in red gram was in November month (117.09 percent), and the lowest coefficient variation was observed during the month of March (86.72per cent).

The CII showed that, the highest variation is scrutinized during the month of January (922.44 per cent) and followed by Noveber month (513.99 per cent). The lowest variation observed during month of February (129.25 per cent) for the red gram arrivals. Similarly, the highest variation is scrutinized during the month of June (412.12 per cent) and followed by July month (374.37 per cent). The lowest variation

observed during month of March (109.12 per cent) for the green gram arrivals.

5.2 Growth and Instability in Prices of Red Gram and Green Gram In APMC Khammam

The average monthly prices of red gram were less oscillate ranging from (Rs.3258.9-3567/qt) revealed, the highest during September month (Rs.3567.95/qt) and the lowest during December month (Rs.3258.90/qt). The average prices of Green gram were viewed, the highest during month of April (Rs.3867.50/qt) and the lowest during (Rs.3301.03/qt) September month. Prices are less fluctuating when compared to arrivals fluctuations. The difference between the range of fluctuations are less for average prices of green gram and red gram than average arrivals. From 2001 to 2020 the yearly average prices of Red gram and Green gram from APMC Khammam were calculated. Results obtained are the highest prices (Rs.7298.41/ qt) was seen in the year of 2015, and lowest prices (Rs.327.87/qt) was observed in the year of 2002 for the Red gram. Average prices of green gram yearly was maximum (Rs.6817.16/qt) in the year of 2015 and minimum (Rs.1412.25/qt) in the year of 2001.

According to the outcome data tabulated below showed the positive significant growth rate of prices of red gram and green gram. The prices of green gram was positively significant similarly prices of red gram was also positively significant .The model of green gram and red gram are statistically significant. The R^2 were 0.73 and 0.81, respectively the “b” coefficients of both the models were significant as calculated “t” value were greater than table t value.

The monthly mean, standard deviation, and coefficient of variation of red gram and green gram prices are computed. Results revealed that, in Khammam market highest degree of variation in green gram was observed (52.80 per cent) during November month. The lowest coefficient of variation was observed in August (46.14 per cent). Similarly, in the Khammam market highest degree of variation of red gram was in May (57.26 per cent), and the lowest coefficient variation was observed during the month of November (43.242 per cent).

The result showed that, the highest variation is scrutinized during the month of July (36.67 per cent) and followed by June month (35.02 per cent). The lowest variation observed during month of November (24.43 per cent) for the red gram prices . Similarly, the highest variation is scrutinized during the month of November (39.67 per cent) and followed by December month (38.67

per cent). The lowest variation observed during month of August (21.79 per cent) for the green gram prices.

5.3 Seasonal indices in arrivals and prices of major pulses

It was revealed that maximum indices of red gram arrivals were found in the month of October (237.64 Per cent) and minimum in month of March (43.66Per cent). Whereas, prices indices were maximum the month of December (101.73 Per cent) and fluctuated with some difference during the rests of the months. The maximum arrivals was during the October which coincides with higher magnitude of arrivals indices (237.64 per cent), the price indices were not high during October. Whereas, during the post-harvest period the indices of arrivals were fluctuating, and price indices were also irregular showing increasing and decreasing trend simultaneously.

The highest seasonal indices Green gram arrivals were observed during the month of May (351.12 Per cent). The lowest seasonal indices Green gram prices were observed during the month of September. The prices of green gram was observed maximum during the month of August (105.58 per cent) and lowest were observed in the month of March (95.66 per cent).

5.4 ADF test values and best fitted ARIMA models for major pulses

After model validation, MAPE value found to be 6.32 and 6.37 for ARIMA (2,1,1) and ARIMA (1,1,0) respectively. The model ARIMA (2,1,1) have lowest MAPE over ARIMA (1,1,0).Hence we conclude that model ARIMA(2,1,1) was best fitted for forecasting prices of red gram in APMC Khammam. The results show that autocorrelations of residuals were not significantly different from zero at any reasonable level. This proved that the selected ARIMA model was an appropriate model for forecasting red gram prices in Khammam APMC market .The results of Box Ljung Q statistics also confirms the same.

Forecasting using selected model ARIMA (2,1,1) for Red gram :

The observed values and fitted values for the red gram forecasted prices along with U.C.L and L.C.L as obtained from their best fitted ARIMA model. As can also be seen from table and graph that forecasted prices of red gram in APMC Khammam were ranging from Rs.6318/qt to Rs.6971/qt for the months from April 2021 to March 2022.

Best fitted ARIMA models for Green gram price forecast.

After model validation, MAPE value found to be 5.94 and 5.89 for ARIMA (2,1,2) and ARIMA (3,1,3) respectively. The model ARIMA (3,1,3) have lowest MAPE over ARIMA (2,1,2) but variations are more for ARIMA (3,1,3) model. Hence we conclude that model ARIMA (2,1,2) was best fitted for forecasting prices of green gram in APMC Khammam. The results show that autocorrelations of residuals were not significantly different from zero at any reasonable level. This proved that the selected ARIMA model was an appropriate model for forecasting green gram prices in Khammam APMC market .The results of Box Ljung Q statistics also confirms the same.

Forecasting using selected model ARIMA (2,1,2) model for Green gram :

The observed values and fitted values for the Green gram forecasted prices along with U.C.L and L.C.L as obtained from their best fitted ARIMA model. The forecasted prices of Green gram in APMC Khammam were ranging from Rs.6458 /qt to Rs.6784 /qt for the months from April 2020 to December 2021.

5.5 Conclusions

- The compound growth rate of Red gram arrivals was negative and significant and Green gram arrivals were negative and significant.
- The Coppock's Instability Index for arrivals of red gram was 82.54 percent and for the green gram, the instability was observed the 88.49 percent.
- The compound growth rate of Red gram prices was positive and significant and Green gram prices were positive and significant.
- The Coppock's Instability Index for prices of red gram was 24.33 percent and for the green gram the instability was observed the 23.92 percent
- There was slight variation observed in seasonal indices of prices but greater fluctuation in arrivals was observed in red gram and green gram.
- The average predicted price of red gram has ranged between from Rs. Rs.6318/qt to Rs.6971/qt for the months from April 2021 to March 2022.
- The average predicted price of green gram has ranged between Rs.6458 /qt to Rs.6784 /qt for the months from April 2021 to March 2022.

5.6 Implications

1. The arrivals of Green gram and Red gram decreased over the years in APMC, Khammam market. Which is very serious concern, so APMC Khammam should provide better storage facilities to the farmers, so farmers may bring their produce to APMC, Khammam for sale.
2. In short run prices of green gram and red gram is increasing, so farmers are advised to use this information in planning their marketing strategies to enhance their farm income.
3. The policy makers should encourage the farmers to bring more land under cultivation of pulses because arrivals of pulses to APMC was decreasing. Which is very serious concern.

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