

**MARKET INTEGRATION AND PRICE
VOLATILITY OF PULSES IN MAHARASHTRA**

THESIS

**Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
in partial fulfilment of the requirements
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**DOCTOR OF PHILOSOPHY
IN
AGRICULTURE
(AGRICULTURAL ECONOMICS)**

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Enrolment Number–OO/3223

2020

DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the Thesis entitled “**MARKET INTEGRATION AND PRICE VOLATILITY OF PULSES IN MAHARASHTRA**” or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or scientific organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.

Place : Akola.

(Wavdhane Vinod Pundlik)

Date : / / 2020

Enrolment No. OO/3223

CERTIFICATE

This is to certify that the thesis entitled “**MARKET INTEGRATION AND PRICE VOLATILITY OF PULSES IN MAHARASHTRA**” submitted in partial fulfilment of the requirement for the degree of “**Doctor of Philosophy in Agriculture (Agricultural Economics)**” of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Wavdhane Vinod Pundlik** under my guidance and supervision.

The subject of thesis has been approved by the Student's Advisory Committee.

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(C)**Abbreviations**

%	- Per cent
°C	- Degree centigrade (Celsius)
/	- Per
@	- At the rate
ADF	- Augmented dickey fuller
Agril.	- Agricultural
AIC	- Akaie Information Criteria
APMC	- Agricultural produce marketing committee
ARCH	- Autoregressive condition heterocedacity
ARIAM	- Auto Regressive Integrated Moving Average
Avg.	- Average
Dr. PDKV	- Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
e.g.	- Exempli gratia (For example)
et al.	- Et alia (and others)
etc.	- Et cetra
Fig.	- Figure
GARCH	- Generalized autoregressive condition heterocedacity
Ha	- Hectare
i.e.	- That is
Kg.	- Kilogram
Kh.	- Kharif
M.S.	- Maharashtra State
Mha	- Million hectare
No.	- Number (s)
q/ha	- Quintals per hectare
qtl.	- Quintal
Qty.	- Quantity
resp.	- Respectively
Rs.	- Rupees
Sr. No.	- Serial number
Viz.,	- Videlicet (namely)
w.r.t.	- With respect to

(D) Thesis Abstract

- a) Title of the thesis : **MARKET INTEGRATION AND PRICE VOLATILITY OF PULSES IN MAHARASHTRA**
- b) Full name of student : **Wavdhane Vinod Pundlik**
- c) Name and address of Major Advisor : **Dr. R. G. Deshmukh**
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ABSTRACT

The research entitled “Market Integration and Price Volatility of Pulses in Maharashtra” was carried out with objectives to study the seasonal and cyclical variations in prices and arrivals of Pulses, to assess the stationarity and volatility in prices of Pulses, to assess the co-integration and causality of price signals among selected markets of Pulses, to study the

relationship between spot and future prices of Pigeonpea (Tur) and Chickpea (Gram), to forecast the prices of Pulses for the selected markets, and to study the relationship between pulses prices and there processed product.

For study purpose the data related to monthly average prices and arrivals of selected Pulses were collected for major APMC's markets of Maharashtra for the period 2005 to 2016. Major four market are selected for each commodity i.e. Pigeon pea was Washim, Wardha, Mumbai and Latur. Green gram was Buldhana, Akola, Amravati and Latur. Black gram was Mumbai, Solapur, Washim and Akola. Chickpea was Buldhana, Washim, Latur and Amravati markets. Simple average method was used to estimate seasonal variations and Residual Method for cyclical variations. The econometric tools like ADF test, Johansen's Multiple Co-integration test, Pair-wise Granger Causality Test, ARCH-GARCH, Vector Error Correction models and ARIMA models were also used.

The prices of Pigeon pea were higher from the month of July to October. Green gram and Black gram was higher from the months of April to June and Chickpea was higher from the months of July to December in the selected markets. The higher prices of Pigeon pea recorded during the year 2005, 2006, 2009, 2015 and 2016. Green gram and Black gram was 2006, 2009, 2010, 2014, 2015 and 2016. Chickpea was 2005, 2006, 2012 and 2016 in the selected markets. The peak period of arrivals of Pigeon pea in the selected markets was January to May. Green gram and Black gram was September to December and Chickpea was February to April for every years. There was observed that inverse relation between prices and arrivals. The higher arrivals of Pigeon pea were recorded during the years 2005, 2010, 2011, 2013 and 2016. Green gram and Black gram was 2007, 2008, 2010, 2011, 2012 and 2016. Chickpea was 2006, 2007, 2010, 2011, 2012, 2013 and 2014 in the selected markets.

The price series of all selected Pulses markets was non - stationary at level with lag 1 and all markets prices series became stationary after 1storder difference. The ARCH-GARCH analysis showed that volatility shocks in the prices of Pulses were persistent in the selected markets of Pulses in Maharashtra. The selected markets having long run equilibrium

relationship for the prices of selected Pulses and there exists co-integration among them as indicated by the results of Johansen's multiple co-integration test.

The prices were bi-directional causality observed in Pigeon pea prices between Wardha and Latur, Washim and Latur, Washim and Mumbai markets respectively. The prices were bi-directional causality observed in Green gram prices between Latur and Akola, Buldhana and Amravati markets respectively. The prices were bi-directional causality observed in Black gram prices between Solapur and Akola, Solapur and Mumbai, Washim and Mumbai, Washim and Solapur markets respectively. The prices were bi-directional causality observed in Chickpea prices between Buldhana and Amravati, Washim and Amravati, Latur and Buldhana markets respectively. The estimates of Vector Error Correction Model (VECM) in Pigeon pea prices revealed that Mumbai, Wardha and Washim markets attain short run equilibrium rapidly. Green gram prices observed that Amravati and Buldhana markets attain short run equilibrium rapidly. Black gram prices recorded that only Washim market attained short run equilibrium rapidly and Chickpea prices were showed that Amravati and Latur markets attain short run equilibrium rapidly.

The Pigeon pea and Chickpea prices of spot and future markets having long run equilibrium relationship and there exists co-integration between them as indicated by the results of Johansen's Multiple Co-integration Test. The prices have no causality between Spot and Future markets of Pigeon pea. Spot market prices were not affecting the current Future market price. The prices have showed unidirectional causality between future and spot market prices of Chickpea. Future market prices were affecting the current spot market price. So, the influence of future prices plays a significant role over the spot market prices.

The forecasted prices of Pigeon pea for the month of April 2020 was predicted as 5609, 5258, 6518 and 5836 rupees per quintal and the actual minimum-maximum prices range for the months of January 2020 was rupees 4664-5139, 4700-5270, 4922-6442 and 4540-5436 rupees per quintal for the Washim, Wardha, Mumbai and Latur markets respectively. The Green gram for the

month of September 2019 was predicted as 5105, 5687, 5118 and 4818 rupees per quintal and the actual minimum–maximum prices range between for the months of September 2019 was rupees 4650-5789, 4009-5673, 3845-5607 and 4593-6240 rupees per quintal for the Buldana, Akola, Amravati and Latur markets respectively. Black gram for the month of September 2019 was predicted as 5577, 3865, 4242 and 4724 rupees per quintal and the actual minimum–maximum prices range between for the months of September 2019 was 4500-5626, 3727-5271, 4195-4652 and 3635-4850 rupees per quintal for the Mumbai, Solapur, Washim and Akola markets respectively and Chickpea for the month of April 2020 was predicted as 4272, 4301, 4317 and 4343 rupees per quintal and the actual minimum–maximum prices range between for the months of January 2020 was rupees 3408-4224, 3654-4277, 3552-4409 and 3687-4318 rupees per quintal for the Buldana, Washim, Latur and Amravati markets respectively. The forecasted price values revealed an increasing or decreasing trend in the next ensuing seasons.

There was no price causality observed between Pigeon pea and Dal prices. Pigeon pea prices were not affecting the current Dal price. There was no causality between Green gram and Dal prices. Green gram prices were not affecting the current Dal price. There was bidirectional causality observed between Black gram and Dal prices. Black gram prices were affecting the current Dal prices. There was no price causality observed between Dal and Chickpea prices. The prices of Flour and Chickpea exhibited no causality and not affecting the prices of each other.

CHAPTER I

INTRODUCTION

1.1 Background information

Agriculture plays a vital role in India's economy. Over 58 per cent of the rural households depend on agriculture as their principal means of livelihood. Agriculture, along with fisheries and forestry is one of the largest contributions to the Gross Domestic Product (GDP). Being a key sector, occupying almost 17.2 per cent share of India's Gross Domestic Product (GDP) during 2017-18, the growth of agriculture and allied sector has a significant role in the overall growth of Indian economy.

Marketing plays an important role in economic development as it stimulates production, avoids unnecessary fluctuations in output as well as prices and reduces the cost of production. However, for attaining these benefits, marketing system and marketing technology have to keep pace with the production technology and socio-economic development of the country. The experience of many countries suggests that in the absence of an efficient marketing system strategy, agricultural development cannot go very far to stimulate production (Khalon and George, 1985).

Agricultural marketing plays a significant role in the movement of a commodity from the producer to the consumer and in stabilizing the prices. The planned increase in agricultural output must be coordinated with changes in the demand and supply for agricultural commodities and marketing. This can be fruitful only when the producer's share in consumer's rupee increase considerably irrespective of the volume of the marketable surplus produced with the farmers. Therefore, marketing is rightly considered as an essential input in addition to improved seed and fertilizer in modern agriculture.

The farmers sell their produce in the regulated markets, in accordance with the Agricultural Produce Market Act of 1939 (APMC Act, 1939). The APMC's were established by the Maharashtra State Govt. for regulating the marketing of different kinds of agriculture and pisciculture produce for the same market area or any part thereof. The Maharashtra Agricultural Produce Marketing (Regulation) Act was passed in the year 1963,

with a view to regulate the marketing of agricultural and pisciculture produce in market areas. After giving due consideration to various committees' recommendations and study groups, some important changes have been made in this Act in the year 1987 and thereafter. With the introduction of regulated markets and stringent regulations, the farmers started receiving a sizeable share in the consumer's rupee for some commodities. Exorbitant market charges by the intermediaries, unauthorized deductions in weights and sale proceeds, use of defective weights and measures, drawing a large amount of produce as the sample for which no payment was made to farmers, were the malpractices widely prevalent before the introduction of APMC act. The steady growth of arrivals of commodities in the regulated markets resulted in dwindling sale of agriculture produce in the village over time. This has led to considerable improvement in the market structure, conduct and performance. The nature and supply of agricultural products generally result in the instability of prices and income within the agricultural sector as well as in other sectors of the economy. Stabilization of prices of essential agricultural commodities continues to remain as an area of major concern for policymakers. Price instability affects both producers and consumers and has macroeconomic implications as well. High growth in the prices of primary commodities spills over to other sectors of the economy leading to an increase in the overall rate of inflation.

The information about the behavior of the price in terms of the price level, trend and fluctuations is the most important factor in determining the competitiveness of the commodity in the domestic and international level and to formulate the long term strategy on trade (Chand, 2002). Analyzing the past trend in prices of commodities is also useful in understanding the present scenario and to formulate appropriate strategies to improve the marketing system. This is true in the case of several commodities in the export basket of India.

Pulses play an important and diverse role in the farming systems and in the diets of poor people around the world. They are ideal crops for simultaneously achieving three developmental goals in targeted population reducing poverty, improving human health as well as nutrition and

enhancing ecosystem resilience. A variety of pulse crops are grown in India and the world. Among the crops, the major ones are Pigeon pea, Chickpea, Green gram, Black gram, Lentil, Field peas, etc. India is the largest pulse producing country in the world with a 25 per cent share in global pulse production from 32 per cent of the global area.

Pulses refer to a group of more than sixty different grain legume crops grown around the world. The seeds of pulses are important in human nutrition. They are typically made up of 20-25 per cent protein and 40-50 per cent starch. They are also rich in dietary fiber and usually have only a small amount of oil. The protein of pulse seeds is high in amino acids, lysine and methionine, making pulse nutritionally complementary to cereals, which are deficient in these two essential amino acids.

In the world, pulses are grown by 198 countries. Beans dry was cultivated by 152 countries, which contributed about 35.93 per cent area to total world area, Chickpea by 58 contributed about 16.41 per cent, Peas dry by 98 contributed 8.14 per cent, Pigeon pea by 23 contributed 8.26 per cent, Lentil by 56 contributed by 5.31 per cent and others 25.95 per cent. The share to World production of Beans dry was 31.64 per cent followed by Chickpea 17.72 per cent, Peas dry 14.44 per cent, Pigeon pea 6.531 per cent, Lentil 6.23 per cent and others 23.66 per cent. It reveals that the India ranked first in area and production with 35 per cent and 25 per cent respectively of world area and production.

India produces about 23.40 million tonnes of Pulses annually from about 23.40 million hectares of area with average productivity of 806 kg per hectare in the year 2018-19. (DES, 2018-19). Maharashtra produces about 2.16 million tonnes of Pulses annually from about 3.51 million hectares of area with average productivity of 616 kg per hectare in the year 2018-19. (DES, 2018-19)

1.2 Pigeon pea. (*Cajanus cajan*)

Pigeon pea (*Cajanus cajan*) is an important pulse crop originated from India, grown in the tropical and subtropical regions of the world. Pigeon pea contains about 22 per cent proteins, which is almost three times that of cereals. Being rich in protein and relatively cheaper, a large section of the vegetarian population of the country consumes it as “Dal” in cooking form. Its leaves are excellent fodder for an animal, and stems are an important source of fencing fields.

In addition to being an important source of human food and animal feed, every Pigeon pea plant is in itself a mini fertilizer factory as this crop enhances the soil fertility through fixing atmospheric nitrogen. Being a drought-resistant crop, it is suitable for dry-land farming and predominantly used as an intercrop with other crops like cotton, sorghum, groundnut, black gram, etc. to increase the yield and maintain soil fertility. Pigeon pea is cultivated in a wide range of soil from black clay to sandy soil, but very sensitive to calcareous, saline, alkaline or waterlogged soils with a depth exceeding 45 cm with pH between 5 and 7 are ideal. For optimum productivity, it requires 21-25 °C temperature during the vegetative growth phase and less than 30°C temperatures with low moisture during flowering and pod formation stage.

Pigeon pea is grown throughout the tropical and subtropical countries especially in South Asia, Eastern and Southern Africa, Latin America, Central America and South America. The major countries producing the Pigeon pea are India, Myanmar, Malawi, Uganda, Kenya, Tanzania, Nepal, Dominica Republic, Congo, Bangladesh, Haiti, Panama etc. India is the leading producer of pulses as well as Pigeon pea in the world followed by Myanmar and Malawi. The major exporters of Pigeon pea are Myanmar, Dominica Republic and Malawi where as India, Trinidad, Venezuela, Nepal and Mauritius is the major importer of Pigeon pea.

1.2.1 Global Scenario of Pigeon pea

Pigeon pea is one of the important pulse crop grown in the world. India rank first in area (64%) and production (57%) at Global level. Myanmar stands second position in area (8.07%) followed by Tanzania (3.23%) respectively. Malawi occupy forth position in area (2.97%) and 3rd position in production (4.36%). In productivity, Kenya ranked first with 1612 kg/ha followed by Malawi (1506 kg/ha) and Burundi (1229 kg/ha). While, India's productivity is only 913 kg/ha (Annual report DPD, 2017-18)

1.2.2 Indian Scenario of Pigeon pea

Pigeon pea and Chick pea is the major pulse crop contributing about 50 per cent and 17 per cent of the total production of pulses in India. It produces about 3.59 million tonnes of Pigeon pea annually from about 4.78 million hectares of area with average productivity of 751 kg per hectare in the year 2018-19 (DES, 2018-19). Maharashtra rank first in Pigeon pea production. Total Pigeon pea production of the states followed by Madhya Pradesh, Karnataka, Gujarat, Andhra Pradesh and Orissa.

1.2.3 Maharastra Scenario of Pigeon pea

In Maharashtra, the production of Pigeon pea is enough to fulfill the domestic requirement of the state but not enough to fulfill the requirements of the country. Among the pulses, Pigeon pea rank first in case of area and production of pulses in the state. The area under Pigeon pea cultivation in Maharashtra is 1.21 million hectares, Production 0.68 million Tonnes and Productivity 566 kg per hectare in the year 2018-19 (DES, 2018-19).

Major Pigeon pea producer districts in the Maharashtra State are Yavatmal, Latur, Amravati, Washim, Wardha, Akola, Nagpur, Nanded and Jalna. Among these districts, Yavatmal stands first in case of the area with 9.48 per cent of total area under Pigeon pea followed by Amravati 9.15 per cent, Latur 7.32 per cent, Osmanabad 6.40 per cent and Buldana 6.02 per cent. In case of production, Latur is the largest producer district with 11.86 per

cent of total Pigeon pea production in the state followed by Amravati, Buldana, Yavatmal and Akola.

1.3 Green gram(*Vigna radiata*)

Green gram (*Vigna radiata*), or mung beans, is known in India as moong and is native to north-eastern India and Myanmar. Green gram is one of the important pulse crops in India. It has been reported that Green gram has been cultivated in India since ancient times. It is believed that Green gram is grown in India and Central Asia since prehistoric times. It is widely cultivated throughout Asia, including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos, Cambodia, Vietnam, Indonesia, Malaysia and South China. In Africa and USA, its cultivation has been initiated recently. Green gram is a protein rich staple food. It contains about 25 per cent protein, which is almost three times that of cereals. It supplies the protein requirement of the vegetarian population of the country. It is consumed in the form of a split pulse as well as the whole pulse, which is an essential supplement of cereal-based diet. Around the world, the Green gram is consumed directly and use in various dishes including curries, soups, breads, sweets, noodles and solidides. Moong dal Khichdi is recommended to the ill or aged people, as it is easily digestible and consider Green gram as complete diet. Moong dal with roti or chawal is an important ingredient in the average Indian diet. The biological value improves greatly when wheat and rice is combined with Green gram because of the complementary relationship of the essential amino acids. It is particularly rich in Leucine, Phenylalanine, Lysine, Valine, Isoleucine, *etc.*

In addition to being an important source of human food and animal feed, Green gram also plays an important role in sustaining soil fertility by improving the physical properties of soil and fixing atmospheric nitrogen. It is a drought resistant crop and suitable for dryland farming and predominantly used as an intercrop with other crops.

1.3.1 Global Scenario of Green gram

As it has been mentioned earlier, the Green gram is widely cultivated throughout Asia, including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos, Cambodia, Vietnam, Indonesia, Malaysia and South China. In

Africa and USA, it is probably recent especially in Oklahoma and has been introduced in parts of Australia. It is spreading in many other countries.

1.3.2 Indian scenario of Green gram

In India, Green gram is one of the most widely cultivated pulse crops after gram and tur. India is the world's largest producer as well as consumer of a Green gram. It produces about 20.00 lakh tonnes of Green gram annually from about 42.00 lakh hectares of area with average productivity of 840 kg per hectare in the year 2017-18 (DES, 2017-18) Green gram output accounts for about 10-12 per cent of total pulse production in the country. The major states for production of the Green gram is Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Orissa, Tamil Nadu and Uttar Pradesh.

1.3.3 Maharashtra scenario of Green gram

The area under Green gram cultivation in Maharashtra is 4.53 lakh hectares, Production 1.64lakh Tonnes and Productivity 560 kg per hectare in the year 2017-18(DES, 2017-18). Major Green gram producer districts in the Maharashtra State are Akola, Washim, Latur, Buldana, Amravati, Wardha, Yavatmal, Nagpur, Solapur and Sangli.

1.4 Black Gram (*Vigna mungo*)

Black gram (*Vigna mungo*) belongs to the Fabaceae or Leguminosae family. Black gram originated in India, where it has been in cultivation from ancient times and is one of the most highly prized pulses of India and Pakistan. The coastal Andhra region in Andhra Pradesh is famous for black gram after paddy. The Guntur District ranks first in Andhra Pradesh for the production of black gram. Black gram has also been introduced to other tropical areas mainly by Indian immigrants. Black gram is a perfect combination of all nutrients, which includes proteins 25-26 per cent, carbohydrates 60 per cent, fat 1.5 per cent, minerals, amino acids and vitamins. It stands next to soybean in its dietary protein content. It is rich in vitamin A, B1, B3 and has a small amount of thiamine, riboflavin, niacin and vitamin C in it. It contains 78-80 per cent nitrogen in the form of albumin and

globulin. The dry seeds are a good source of phosphorus. It also has very high-calorie content. 100 gm of black gram has 347 calories. Therefore, black gram is the cheapest available source of protein for the poor and vegetarians. It is consumed in the form of dal (whole or split, husked and unhusked or parched). It is the chief constituent of papad and also of spiced balls –which make a delicious curry.

1.4.1 Global Scenario of Black gram

Black gram (urad), one of the pulses, is mostly produced in Asian countries as their tropical climate and soil type suits its cultivation. India is the largest producer of this pulse followed by Myanmar and Thailand. India produces 70 per cent of world's black gram production and Black gram accounts for 10 per cent of total pulse production in India.

1.4.2 Indian scenario of Black gram

In India, the Black gram is one of the most widely cultivated pulse crops after chickpea, pigeon pea and green gram. India is the world's largest producer as well as consumer of a Black gram. It produces about 36.00 lakh tonnes of Black gram annually from about 54.00 lakh hectares of area with average productivity of 758 kg per hectare in the year 2017-18 (DES, 2017-18)

Despite being the largest producer of black gram, India is not in a comfortable situation as it is also the largest consumer of black gram. Total Indian production is not sufficient to fulfill its domestic demand. Because of this, India is also the largest importer of this pulse. Andhra Pradesh, Madhya Pradesh, Maharashtra, Uttar Pradesh, Punjab, West Bengal, Orissa, Tamil Nadu, and Karnataka are the major states producing black gram in India. While Andhra Pradesh contributes 24 per cent of total production, Maharashtra and Madhya Pradesh contribute 20 per cent and 13 per cent respectively. India is the largest producer as well as consumer of black gram. Black gram occupies a unique position in Indian agriculture. Among the pulses, it stands fourth in production and acreage.

1.4.3 Maharashtra Scenario of Black gram

The area under Blackgram cultivation in Maharashtra is 4.84 lakh hectares, Production 1.77 lakh tonnes and Productivity 538 kg per hectare in the year 2017-18(DES, 2017-18). Major Black gram producer districts in the Maharashtra State are Washim, Solapur, Latur, Buldana, Amravati, Wardha, Yavatmal, Akola, Nanded, Nagpur and Sangli.

1.5 Chickpea(*Cicer arietinum*)

The Chickpea (*Cicer arietinum*) is the second most important cool season pulse crop and ranks third among food legumes in production. Chickpea is the most important pulse crop of India and its adjoining countries which accounts for 90 per cent of total world production. Chickpea is highly palatable and nutritious. It plays an important role in a cereal-based diet because of the high protein content of about 22 to 23 per cent which is relatively cheaper than the animal protein. Among the grain legumes, Chickpea is unique because of the variety of food products that are prepared from it in different parts of the world. Besides protein, it is a good source of carbohydrates, minerals and trace elements. The straw has a good forage value and is commonly used to feed the livestock. The broken seeds and residues from dal production may be used to feed the milch cattle.

Chickpea is used in crop rotation as it greatly contributes to maintaining soil fertility by fixing atmospheric nitrogen by symbiotic association with the bacteria Rhizobium. The saponin content of Chickpea is high and its inclusion in the human diet lowers the plasma cholesterol and reduces the risk of heart diseases. Thus Chickpea is proven to be a very useful crop for the human being.

1.5.1 Global Scenario of Chickpea

Chickpea is one of the most important pulse crops in the world, especially in the Indian subcontinent. It ranks third in the world production among pulses after beans and peas. India ranks first in area and production in the world, followed by Australia, Myanmar and Pakistan. The highest

productivity of 1969 kg per hectare is observed in Ethiopia followed by Mexico, Myanmar and USA. India's productivity was 974 kg per hectare in the year 2017-18 (Annual report DPD, 2017-18).

1.5.2 Indian scenario of Chickpea

Chickpea and Pigeon pea are the major pulse crop contributing about 50 per cent and 17 per cent of the total production of pulses in India. It produces about 10.13 million tonnes of Chickpea annually from about 9.44 million hectares of area with average productivity of 1073 kg per hectare in the year 2018-19 (DES, 2018-19)

1.5.3 Maharashtra scenario of Chickpea

Maharashtra ranks fourth in acreage under Chickpea after Madhya Pradesh, Uttar Pradesh and Rajasthan. Besides Maharashtra other Chickpea growing states in India are Bihar, West Bengal, Gujarat, Punjab, Haryana, Karnataka and Andhra Pradesh. The area under Chickpea cultivation in Maharashtra is 1.29 million hectares, Production 1.07 million tonnes and Productivity 829 kg per hectare in the year 2018-19 (DES, 2018-19) Major Chickpea producer districts in the Maharashtra State are Washim, Latur, Amravati, Wardha, Akola, Yavatmal, Nagpur, Nanded and Jalna.

1.6 Importance of study

Market integration and price volatility of pulses in Maharashtra has vital use due to fluctuations in prices of Agricultural produce over a decade. Pulses play an important role in providing nutritional security and are an important and the cheapest source of quality protein, vitamin and other minerals. Although, India is the world's largest producer of pulses, there is still a huge shortage of pulses and the prices are not affordable to a large section of consumers. The findings of this study will be useful to policy makers, administrators, researchers and farmers. The analysis of arrivals and prices over time is important for formulating a sound agricultural price policy; price trade helps to understanding the month to month variation in arrivals and prices to the farmer to make decision about when to sell their produce so as to earn more profit. Higher the marketing efficiency higher is the profit earned

such a situation it is important to study analysis of price behavior which to are essential requirement for policy formulation.

1.7 Problem Focus

Pulses are widely grown and consumed pulse that has got good demand in the domestic and international market. A large group of market participants is engaged in different activities throughout the value chain of Pulses right from production to consumption. Prices show considerable volatility that could pose considerable risk to different stakeholders. Pulses are now being traded in commodity exchanges as a part of trade outside and within India. Pulses prices were quite volatile in the past few years. So there is a need to analyze the behavior of Pulses prices. This would enable to suggest appropriate measures to minimize the price volatility.

Keeping in view of the above aspects, the presents study has been taken as with following objectives.

1.8 Objectives of the Study

1. To study the seasonal and cyclical variations in prices and arrivals of pulses
2. To assess the stationarity and volatility in prices of pulses
3. To assess the co-integration and causality of price signals among selected markets of pulses
4. To study the relationship between spot and future prices of Pigeonpea (Tur) and Chickpea (Gram)
5. To forecast the prices of pulses for the selected markets
6. To study the relationship between pulses prices and there processed product

1.9 Hypothesis

The study is based on the premises of the following hypothesis,

1. Prices of pulses are volatile during last decade
2. Markets of pulses in Maharashtra are co-integrated in terms of prices

1.10 Scope of the study

Marketing is the most important aspect of the development process. This is obviously due to the fact that development basically means larger size productive activities in the economy. But we cannot have more of production unless the goods produced are actually sold out and selling depends on the proper marketing conditions. The importance of this study is to producers and to all actors in the marketing system. Knowledge of the price behavior would help government and non-governmental organizations to design appropriate intervention measures. Besides, the document also would serve as a reference for researchers to embark upon similar or related work in other parts of the country.

Agriculture is characterized by wide variations in the output of major food grains which subsequently lead to larger variation in market arrivals. The fluctuation in market arrivals leads to the price instability of major crops. The wide fluctuations affect the farmer's capacity of making sustained efforts for increasing production. This fluctuation in the prices of an agricultural commodity is the greatest obstacle in the way of agricultural development. Agricultural arrival and prices, therefore exercise a dominant influence on the agricultural economy of our country.

In order to reduce the price fluctuations of an agricultural commodity, there is a need to have a thorough understanding of the price behaviour over time. The knowledge on the interrelations between the arrival and prices of farm product is required for assessing the extent of price fluctuations over time. Price behaviour studies help in understanding the month-to-month variations in arrival and prices to the farmers to make the decision about when to sell their produce so as to earn more profit. It is observed that seasonal price fluctuation mostly follows from the poor storage facility and inadequate market information. In agriculture, the demand for food grain is stable. Thus the supply plays an active role in determining the price of goods.

It has been recognized that even when the farmer has produced efficiently with modern technology, he may be in loss due to the marketing problem. Therefore, assurance of remunerative and stable price environment

for the farmer has been considered as a basic foundation for increasing agriculture production and productivity.

1.11 Limitations of the study

The present study is based on secondary data collected from APMC's and website www.agmarknet.nic.in of major markets in Maharashtra. The findings are based on the availability as well as reliability of the data on different aspects of the study. The data sources include the future prices of Pigeon pea and Chickpea were collected from National Commodity and Derivative Exchange (NCDEX) website www.ncdex.nic.in. As the data is secondary one has to go forward by considering this data, its reliability is the only limitation of the study. Maximum efforts have been taken to minimize bias by proper crosschecks. However, the attempt is made to have an in depth analysis of the data to accomplish the objectives with meaningful conclusions.

CHAPTER II

REVIEW OF LITERATURE

The review of literature is one of the important aspects in the research process which helps researcher to get acquainted with the subject matter under study and future channelize efforts in desirable directions. It provides necessary guidelines and helps the researcher to delineate his research problem.

Systematic research study always need immense scanning of relevant literature. The knowledge of the previous research work carried out by other researchers gives an insight and becomes a guideline to plan the research work more systematically and effectively. It throws light on the manner in which the given research problem could be tackled to accomplish the objectives under study. The reviews also help to adopt appropriate methods for completing an investigation. Thus, it helps in proper understanding of the concepts, methods, analytical tools and language of interpretation of result relating to the research problem under study. The review of past literature, therefore, forms an integral part of any systematic research work.

Therefore, an attempt was made in this chapter to review the literature closely related, which has direct/indirect bearing on the present study. The detailed review of the study by objectives of the study has been put in chronological order under the following heads:

2.1 Seasonal and cyclical variations in prices and arrivals

2.2 Stationarity and Price Volatility

2.3 Market co-integration and Granger Causality

2.4 Spot and Future prices

2.5 Price Forecasting

2.6 Pulses prices and Process Products

2.1 Seasonal and cyclical variations in prices and arrivals

Gill and Johl(1970) studied Gram price structure in Punjab during 1955 to 1966 and observed that prices generally moved opposite to production trend. The prices tend to move continuously upward due to a general shortage of food-grains which showed the inflationary trend of the economy for the period under study. The violent seasonal price fluctuations affect the producers incomes as the major portion of their produce (about 70 per cent) was sold during post harvest period when the prices generally observed the lowest. This occurred due to glut situation in the market. The glut situation occurred in the market as result of distress sale or forced sale by the producers. The seasonal fluctuations in prices can be reduced if the producers avoid immediate post-harvest sales so called distress sale. They should avail the warehousing facilities and spread their sale throughout the year rationally.

Aulakh and Singh (1971) studied on marketed surplus of major food grains in Punjab. It revealed that the total arrival of wheat a 63-64, at Amritsar market was 11,74,384 quintals. Where as 69-70 it had reached the level of 6,05,553 quintals. The arrival of wheat in Amritsar market in the peak season varied from 54.13 per cent to 87.21 per cent, in mid season from 7.33 per cent to 28.98 per cent and in lean season from 5.46 per cent to 21.4 per cent of the total annual arrivals during 63-64 to 69-70. In case of Gram, arrival decreased from 30,643 quintals in 63-64 to 22,126 quintals in 69-70. The arrival of Gram in peak season varied from about 41 per cent to 65 per cent, in the mid season from 20.63 per cent to 32.07 per cent and in lean season from 6.35 per cent to 26.96 per cent of the total annual arrivals during 63-64 to 69-70 where as in case of paddy in 63-64 total arrival was 3,90,943 quintals which has significantly increased in 69-70 to 9,83,407 quintals. The arrival in peak season varied from 79.49 per cent to 96.73 per cent, in mid-season from 2.06 per cent to 15.60 per cent and in lean season from 0.27 per cent to 4.92 per cent of the total annual arrival during 63-64 and 69-70.

Chauhan *et al.* (1971) studied the price structure of wheat in Jaipur market and observed that the index of wheat arrivals started rising from

February onwards to April. After May the arrivals declined month by month till they almost dried up in February. The result of the study indicated that the price index decreased with the arrivals of new crop in the month of May when the arrivals index reached at its peak from the month of May. The price started rising again till July. The prices again started decreasing from August onwards till October.

Mandavawallla (1979) studied seasonal variations in prices of food grains with special reference to wheat and rice during 1970 -71 to 1977-78 and noted that difference between the highest or lowest normal levels of seasonally adjusted price index number was 9.6 per cent for rice and wheat and 7.7 per cent for all food grains. Whereas on the basis of unadjusted price index, the lowest level of rice price index has shifted from December to March since 1975-76; in case of wheat it was generally located in March-June. No such uniformity was noticed in respect of highest level to rice while for growth rates in area, production and productivity.

Awasthi *et al.* (1985) studied the seasonal fluctuations in the groundnut prices in Indore, Khargone and Sanwad markets, for the period of 1972-82. The study has highlighted, that there was an abrupt and sudden decline in the prices of groundnut just after the harvesting period. While the price increased moderately up to the month of February. The price after this period increased substantially till August. The high degree of positive correlation in the selected market indicated that the price of groundnut is positively correlated.

Bhatt and Shiyani (1989) studied the changes in behaviour of market arrivals and prices of groundnut in Amreli regulated market of Gujrat for the period 1970-71 to 1987 -88. They showed that the seasonal indices of arrivals varied from 25.28 per cent in August to 28.86 per cent in the month of December indicated vary wide range in flow of groundnut while those of prices were found to be in the range of 96.87 to 107.75 per cent. They further concluded that the seasonal variability in arrivals was much higher than those of prices indicated that the price was not the only factor, which determines the quality of market arrivals.

Tyagi (1990) studied the managing India's food economy regard with behaviour of prices that there have been instances when actual prices received by farmers have fallen below the floor level (minimum support prices) for some commodities in some markets.

Borah and Dutta (1991) stated that monthly seasonal indices for rapeseed and mustards were the lowest in post-harvest period *i.e.* in the month of march and the highest in pre-harvest months of October and November. The seasonal price index of mustard decreased from December to February. The seasonal indices of market prices of rape and mustard in five major markets in Assam revealed lowest in the month of March and highest in month of November.

Basavaraja (1993) conducted the study on behaviour of prices and market arrivals of major crops in Bijapur. He studied the degree of fluctuations in prices and arrivals of major crops in Bijapur market, for the period from 1971 to 1992 and noted that the prices as well as arrivals of crops showed an increasing trend. Seasonal character was more pronounced in case of arrivals than in case of prices. The higher prices were observed during the months in which market arrivals were lower and vice-versa. In the short run prices and arrivals showed inverse relationship. Seasonal pattern of market arrivals resulted in short run price instability.

Pushpavali (1993) studied the pattern of arrivals and prices of groundnut in Tiruvannamalai regulated market in Tamil nadu. The findings resulted that, the peak season for arrival in the market was October and minimum arrivals were in February. The maximum prices of groundnut prevailed in the month of July and the minimum in the month of April. The seasonal indices of arrivals varied from 34.72 per cent to 171.38 per cent while that of prices from 93.57 per cent to 107.57 per cent.

Brahmaprakash and Shrivastava (1994) studied the pattern of marketing arrivals and price of Gram in Uttar Pradesh for the period from 1987-88 to 1991-92 and observed that inter year variations in market arrivals of Gram varied between 86.6 and 120.0 per cent. There was a seasonality in pattern of quantum of arrivals of Gram varied between 57.3 and 218.9 per

cent and inter year variations in wholesale prices varied between 65.8 and 75.5 per cent and concluded that the arrivals and prices were negatively correlated.

Srivastava and Brahmaaprakash(1996) studied the trends in market arrivals and prices of Pigeon pea in Uttar Pradesh. The study was undertaken in all the 643 regulated markets of Uttar Pradesh to analyze the inter and intra-year price behaviour of Pigeon pea and studied the impact of market arrivals on it. The data on market arrivals and average wholesale prices prevailed during 1984-85 to 1991-92. The inter-year variations in market arrivals of Pigeon pea varied between 86.37 to 127.01 per cent from the average annual arrivals from 1984-85 to 1991-92. Except 1987-88 to 1989-90, the market arrivals of Pigeon pea in the state were also most stagnant and varied between 23 and 24 lakh tones. It revealed that farmers in the state sold almost same quantity of Pigeon pea through regulated markets in the state. It was clear that about half of the total arrivals reached the markets in the month of April to June when prices were low.

Raja (1997) undertaken the study on the seasonal variations in prices of Tapioca products for the period of 1983-84 to 1994-95. The variations in the prices of tapioca products were increased from the minimum of 45.16 per cent in February to the maximum of 136.53 per cent in the month of December. It is also observed that the percentage of variation in the prices of tapioca products showed a mixed trend, as the variations in the prices over these periods were not uniform. The seasonal index observed to the minimum of 97.01 per cent in the first quarter and the maximum of 102.58 per cent recorded during the third quarter. The range of differences between the two was worked out to 5.67 per cent.

Mishra andSrivastava (1998) studied the trend analysis and prices of Gram and Soybean in two mandis of Madhya Pradesh. The total arrivals of Gram was about 52 per cent occurred during harvesting season. In case of Soybean it was 74 per cent, 15 per cent, 7 per cent and 3 per cent, respectively in each season, while price in general were the lowest during the

harvesting season and increase in post harvest and pre harvest season in both the case of Gram and Soybean.

Mundinamaniet *al.* (1999) studied the trend and seasonality in market arrivals and prices of groundnut in Karnataka. The trend pattern of arrivals of groundnut in the study of markets was mixed one and that of prices was almost identical. In Bijapur and Talikoti markets, arrivals of groundnut showed mild ups and downs during the initial period and considerable increase from the year 1983 -84 onwards. In Gadag and Ranebennur markets, the arrivals pattern was almost identical whereas Raichur market showed a mild increasing trend during the study period, As far as price trend pattern was concerned, a continuous upwards movement was seen in all the markets without any exception, This was mainly caused by increase in population leading to an increase in demand for edible oils. The seasonal indices computed for groundnut arrivals and prices were presented higher indices of market. Arrivals of groundnut were noticed immediately after harvest in almost all the study markets. The low indices were found during October to January in respect of rainfed crop and April in respect of Rabi summer crop.

Vitondeet *al.* (2000) studied arrivals and prices of major commodities of A.P.M.C. Amravati in Maharashtra. They showed that, the seasonal variation were more in case of arrivals than in case of prices of selected commodities. The higher prices were observed during the months in which the market arrivals were lower and vice-versa. The cyclical fluctuations were found to be more in prices than seasonal variations. The correlation studies revealed that, the arrivals falls and vice-versa.

Bawaskar (2002) in her study on economic analysis of market arrivals and prices of selected food grains in Parbhani District analysed seasonal indices of arrivals and prices of Pigeon pea and chickpea for the period 1980-81 to 1999-2000. The study revealed that the highest indices of arrival in Pigeon pea were in the month of April-February, January and April in Parbhani, Manwat, Selu, and Jintur markets respectively while the lowest indices of arrivals were registered in the month of September in all the four

markets selected for study the monthly seasonal indices in prices of Pigeon pea were highest in the month of April, June and November, on the contrary the lowest seasonal indices in prices were observed in the month of September and November.

Kadu (2002) examined the seasonal fluctuation in arrivals and prices of major food grains. He reported that the arrivals of almost all the selected major food grains have shown variation in particular season *i.e.* the arrivals were highest in post harvest months and lowest in pre-harvest months. The seasonal fluctuation in arrivals were mainly arrived due to seasonal nature of production of forced sale by farmer. A bulk of market arrivals were arrived in peak immediate post harvest months which causes fall in prices. The seasonal fluctuation in arrivals was much higher than those of price, indicating that the price was not the only factor which determines the quantity of arrivals.

Kaur *et al.* (2005) studied seasonal indices of arrivals and prices of tomato in Punjab markets, 1989-2001 observed the lowest indices for prices were recorded during May in both the periods when there was a glut in the market with produce *i.e.* 51.32 in period I (1980-90) and 60.47 in period II (1991-01). Price increases in period II due to the increased demand by the processing units in this period.

Yogisha (2005) studied market integration for major agricultural commodities in Kolar district. As a part of research, secular trend, seasonal and cyclical fluctuations in arrivals and prices of major agricultural commodities in selected markets for the period 1994-95 to 2004-05 was assessed. Mixed trend was noticed in arrivals and prices of the all the commodities in all the markets. Majority of the markets have shown increasing trend in arrivals and prices in the later periods. Arrivals of potato were maximum during September and November in Bangalore market whereas in other markets it was during February and March. Prices of potato found highest during off season and lowest during harvest period. Arrivals of Onion, ragi and Groundnut found maximum during harvesting months.

Sable (2005) studied price behaviour of rice in four tahsils of Gadchiroli district during 2004-05 for two decades period *i.e.* from 1984-85 to 2003-04. The data revealed that highest arrival was observed in the month of January for APMC Armori (7.47 lakh qtls). The lowest arrival was recorded in August in APMC Chamorshi (0.03 lakh qtls). Price indices were found highest from April to September and lowest from November to June. Highest and Lowest indices recorded for Gadchiroli, Chamorshi, Armori and Aheri were 108.30 and 92.70, 110.87 and 92.81, 105.44 and 92.01, 104.49 and 94.18 respectively. An inverse relationship between arrival and price of rice was noticed.

Pawar and Jadhav (2007) showed that the highest mean arrival were in the month of October *i.e.* 18,887.60.qt followed by September *i.e.* 7827.20 qt. These months having overall highest arrivals in the month due to the harvest of Black gram is the month of September and the average mean prices per quintal were highest in the month October *i.e.* Rs.2087.60 followed by November *i.e.* Rs.2060. The highest indices of market arrivals were in the month of October, *i.e.* 398.96 per cent followed by September *i.e.* 372.91 per cent and the highest seasonal indices of market prices were observed in the month February *i.e.* 116.22 per cent followed by January *i.e.* 115.55 per cent. It was observed that seasonal indices of arrival and prices exhibited inverse relationship indicating that there by when arrival indices were less price indices more and vice-versa.

Singh and Rangi (2008) showed that there was significant increase in the arrivals of potato during the study period in both the markets. In Punjab market the lean period existed from April to October in arrivals. During the period of November to March, the arrival were the highest, creating glut like situation in the market consequently the prices reached at their lowest level during these month. During April the prices started recovery and reached the highest levels during the period July to September. The seasonal indices of arrivals in both the market were the highest in the month of December (190.11 and 374.80) and lowest in September (51.60 and 7.26) respectively. The price fall and was the lowest in January (83.15 and 84.85) and the highest in the month of August (118.53 and 118.88) respectively in both the

market. During the peak period of November to March the seasonal indices of potato arrival ranged between 106.30 to 190.11 per cent in the Jalandhar market while during the lean period (April to October) the seasonal indices of market arrival ranged between 51.66 to 103.15 per cent.

Benke (2008) studied arrival and price behaviour of different crops in Akola district and results indicated that compound growth rate of production and arrival were found to be positively associated in period I (1987-96) of study and negatively associated in period II (1997-2006) of study for Akola APMC. But in case of all other APMC *i.e.* Akot, Telhara and Balapur it is positively associated in both period of study. Despite pronounced seasonality in arrivals there were negligible variations in seasonal prices of almost all the crops studied. The magnitude of fluctuations in arrivals were also very high, the cyclical movement in arrivals were observed in Jowar and Tur, while cyclic price fluctuations were seen in Jowar, Wheat and Soybean in all selected market.

Mohdet *al.* (2009) studied on arrival and price behaviour of important pulse crops in Parbhani district. The study of arrivals and prices behaviour in APMC market Parbhani was carried out during the year 2004-05 to determine price index fluctuations for important pulse crops. The data on monthly arrivals and prices were for nine year (1996-97 to 2004-05) from record of APMC, Parbhani. The result revealed that greengram, the peak arrivals of greengram was in the month of October and the highest price index recorded was in the month of March. The price index touched to the lowest 83 per cent and to the peak value of 105 price index. Pigeonpea, the arrival index was the highest in the month of January whereas, the price index was highest in the month of September. The price index varies in the range of 93 to 107 per cent.

Vijaykumar (2009) revealed that highest seasonal indices of Maize prices during August month in both Karimnager (110.76) and Nijamabad (106.11) market followed by July month (110.61) and (106.10) for respective markets less arrival and more demand for the product during the above month may response for highest seasonal indices suggesting the

farming community to go for early sowing and harvesting of the crop for getting highest profit however ,the lowest seasonal indices of Maize prices during October month in both the market reflect the real fact *i.e.* sharp fall in prices during peak post-harvest handling period or immediately after harvesting of the crop. Further the result of analysis of variance indicated that the four month period from May to August was most suitable for marketing the Maize produce as the average prices during this period are higher as compared to other in this four month of July (Rs.615.32) followed by June (Rs.604.61) fetched highest average prices less arrival and more demand for the product.

Benke *et al.* (2010) studied an economic analysis of soybean arrivals and price behavior in Akola district of Maharashtra. The results indicated that the monthly seasonal indices for sorghum arrivals were higher immediately after harvest in Akola market. The price indices of sorghum were lower during peak arrival months and vice versa. Cyclical fluctuations were found to be more pronounced than seasonal fluctuations in prices.

Benke *et al.* (2011) studied an economic analysis of safflower arrivals and price behavior in Solapur market of Maharashtra. The results indicated that compound growth rate of production and arrival were found to be positively associated in period I (1987-96) of study and negatively associated in period II (1997-2006) of study for Solapur APMC. Despite pronounced seasonality in arrivals, there were negligible variations in seasonal prices of safflower. Cyclical fluctuations were found to be more pronounced than seasonal fluctuations in prices. This showed that when maximum production is there, prices decreased and increased during the pre harvest month.

Salave (2011) studied the price behaviour of selected agricultural commodities in Akola district and the study revealed that, there was inverse relation between arrival and prices of selected agricultural commodities. There were wide seasonal variations in arrival and prices of agricultural commodities. In case of Wheat peak arrival was in month of April in all APMCs. Over a period of 10 years maximum mean arrival of Wheat was

18187.92 quintals in 2004-05. Per quintal price of Wheat in Akola market steadily increased from Rs 730.17 per quintal in 2001-02 up to Rs. 1209.58 per quintal in 2008-09. Seasonal indices of arrival of all crops were observed at highest level in the month just after harvesting of Soybean, Tur, Wheat and Jowar crops with lowest price indices while it was highest during the months just before harvesting of crops showing lowest arrival in the market. The inverse relationship between arrival and prices was recorded for all crops in all selected markets.

Selvaraj (2011) explained that the price behavior of jasmine flower commodities was based on the traditional theory of supply and demand conditions. Due to seasonal behavior of agriculture, it was viewed that during peak arrivals, the prices would be low and vice versa. However the demand was spread throughout the year.

Virkar (2012) analyzed the price behaviour of wheat in selected APMC's in Nagpur district and the results indicated that in Nagpur district, over 20 years period, APMC Kalmana was found highest arrival of wheat *i.e.* 24611.33 qtls by comparing all APMCs of Nagpur district, over 20 year's period. Average price of Wheat in Nagpur district was increased from Saoner market was Rs 1161.85/qtls in 2009-10 to Kalmana market was Rs. 1399.01/qtls 2010-11. In selected APMCs in Nagpur district, highest arrival was found in month of March, April and May *i.e.* post harvesting period and lowest was in October, November and January due to lean period. The highest prices were found in the month of January, March, July and September in all APMCs of Nagpur district due to less arrival except in Kalmana market.

Changuleet *al.* (2012) studied on economic analysis of sunflower arrivals and price behaviour in Latur district of Maharashtra. Investigation was carried out during the year 2010-2011. Data were collected for the year 1991-1992 to 2010-2011 from Latur APMC. The results revealed that maximum arrival index was in the month of January 297.05 per cent and minimum arrival index in the month of September 16.02 per cent. Price index was

maximum in the month of July (104.51%) while price index was minimum in the month of October (93.58%).

Jayasreeet *al.* (2012) studied price behaviour of Cassava in Kerala: An econometric analysis. The study analyzed the price behaviour of cassava in Kerala during the period from January 1999 to June 2011. The growth in cassava prices was slow, but with high instability of 36.97%. Time series decomposition analysis was carried out to isolate the different components present in the price series. The single exponential smoothening model was found to capture the underlying trend in cassava prices with a low Mean Absolute Percentage Error (MAPE) value of 1.67. The seasonal decomposition analysis revealed that the months of March and April was typically characterized by a peak phase for cassava prices in Kerala. The period from September to November was also marked by a buoyant phase for cassava due to lean market arrival during this period. Even though no pronounced long term cycles were evident, three short cycles were identified during the study period. There were random effects in the prices but it oscillated more or less evenly around the mean value of 100, indicating that random factors were evenly occurring in cassava trading. As the shelf life of cassava tubers were too short, product development and diversification through processing and value addition was suggested to overcome the adverse seasonal and cyclical price movements.

Mishra and Kumar (2012) studied the price behaviour of major vegetables in hill region of Nepal by using time series data for 10 years from 2000-2010. The study showed that the wholesale price of all vegetables were low during post-harvest period and high during lean period which was due to seasonal and perishable nature of vegetables. Entire vegetables registered positive and increasing trend of 2-3 years in wholesale price. He suggested that important market information system was a need of efficient vegetable market in Nepal in order to involve production and marketing decisions. Government is responsible to create market infrastructure facilities like warehousing, processing, and transport for reducing variations in prices of vegetables.

Thombre and More (2013) studied on market arrivals and prices of pigeonpea in Marathwada region. The results that the seasonal variation in arrivals and prices was calculated by using ratio to moving average method. The relationship between market arrivals and prices of pigeonpea was tested with the help of simple linear regression equation and double log model. The results revealed that, arrivals and prices of pigeon pea had strong season effect. The results confirmed the negative relationship between arrivals and prices in both the markets under the study.

Anonymous (2013) studied on spatial and temporal variations in arrivals and prices of onion in Northern Karnataka – An econometric analysis. The results of the seasonal variations were revealed that the highest seasonal indices of market arrivals of onion were noticed immediately after harvest in all the study markets. And the arrivals in all the markets were found to be high during the months of October to December. Later on the arrivals were found to be tapering off during January to September. This pattern of variation in arrivals may be categorically due to seasonality in production. There was more fluctuations been observed in prices of onion which may be due to nature of arrivals to the market. The higher price seasonal indices were also observed during the month of September to January during which the arrivals were found to be low.

Patil *et al.* (2014) studied on red gram price movement across major markets of Maharashtra. The results of study showed that the prices of Red gram were higher in the months from July to October in all selected markets. The cyclical variation observed in the prices of Red gram in the selected markets. For all selected markets the price series showed the consequences of unit root and were stationary at first difference. The selected markets show long run equilibrium relationship and co-integration between them. Most of the markets showed bidirectional Causality influence on Red gram prices of each other. Akola, Latur, Jalgaon and Nagpur market, showed volatility shocks are not quite persistent in these markets.

Shukla and Raj (2014) studied on twin objectives of examining the variability pattern of market arrivals and prices of selected crops (Onion,

Garlic and Turmeric) in selected markets (Lucknow and Kanpur) of Uttar Pradesh and analysed the relationship between market arrivals and prices. The study was based on market arrivals and wholesale prices of selected crops collected from Rajya Krishi Utapadan Mandi Parishad, Lucknow (U.P.), Krishi Utapadan Mandi Samiti, Lucknow and Krishi Utapadan Mandi Samiti, Kanpur for the period 2001-2010. The study had shown that the extent of variability in market arrival of onion was lower in Lucknow market but higher in Kanpur market. Its prices variability was lower in Kanpur market and higher in Lucknow market, in case of garlic, the variability in market arrivals and prices was lower in Kanpur market but higher in Lucknow market. In case of Turmeric, the variability in market arrivals and prices was lower in Lucknow market but higher in Kanpur market. The study has confirmed the negative relationship between market arrivals prices of Onion, garlic and Turmeric over the years in all two markets.

Bondhareet *al.* (2014) studied on performance of major food grain in Wardha district. The arrivals and prices of jowar, wheat tur and gram in Wardha, Selu and Deoli markets on monthly basis were studied to see the relationship between the trend in arrivals and prices. After harvesting of particular crop there was glut in the market means arrivals were high in the market and when arrivals are low generally the prices are high.

Sharma and Singh (2014) studied an analysis of behaviour of market arrivals and prices of Pearl millet in Rajasthan. In Nagaur market, the arrivals in the peak period were maximum during last 10 years (2000-01 to 2009-10). These were in the range of about 55.91 (2003-04) to 79.92 per cent (2008-09) of the total arrivals. In Jodhpur market, the arrivals of Pearl millet followed more or less the same pattern as in Nagaur. In Jaipur market, the arrivals in peak period were maximum. The maximum arrivals were in the peak period followed by mid-period and lean period. The seasonal indices analysis of arrivals and prices revealed that when major portion of the produce was received in the market, the prices were at the lowest. Trend analysis of arrivals of Pearl millet in the selected markets of the State shows that the trend values of arrivals in Jaipur, Jodhpur and Nagaur showed an increasing trend over the years.

More *et al.* (2014) studied on arrivals and price behaviour of Soybean in major markets of Marathwada region of Maharashtra. Results revealed that, arrivals of soybean in all selected markets have seasonal effect. Arrivals of soybean in market start in the months of October and continued up to March, but peak arrivals of soybean were noticed in the month of October to December. Within all selected markets, Latur market was found to be major soybean market in terms of quantum of arrivals and better prices in the region. In contrast to general price rule, price of soybean was observed above normal during peak arrivals period of soybean *i.e.*, October to February. This may be because traders want to attract soybean stock of farmers by giving strong price signals. In all selected markets arrivals of soybean was more instable (both intra and inter year) compared to price.

Naik *et al.* (2015) studied on trends in arrivals and prices of chickpea in Western Maharashtra. The time series data on monthly arrivals and prices of chickpea were collected from the purposively selected APMC, Barshi from the years from 2001-02 to 2011-12 in order to compute the trends, growth rates and relationship between arrivals and prices. In Barshi market the variance analysis of arrivals of chickpea showed that the maximum variability was found in chickpea during the years 2006-07 and minimum in the year 2011-12. While in case of price variability of chickpea, maximum occurred during the year 2011-12 and minimum in the year 2008-09. The arrivals could not increase at the similar rate of prices during this period, which may be due to decline in production and productivity of chickpea in the study area.

Patil and Tingre (2015) studied on black gram price movement across major markets of Maharashtra. The results of study showed that the prices of black gram were higher in the months from September to November in all the selected markets. The cyclical variation was observed in the prices of black gram in the selected markets.

Patil and Tingre (2015) revealed that soybean price movement across major markets of Maharashtra. The present study aimed to study price movement of soybean *i.e.* seasonal variation among the major soybean

markets in Maharashtra. For study purpose the data related to monthly average prices and arrivals of soybean were collected from major markets in Maharashtra state viz., Akola, Washim, Latur and Nagpur for the period 2003-2013. Moving average method used to study seasonal variations. The results of the study showed that the prices of soybean were higher in the months from June to August in all selected markets. The cyclical variation observed in the prices of soybean in the selected markets.

Srikanth *et al.* (2015) studied on arrival pattern of mango in APMC and direction of trade from Srinivasapura taluka of Kolar district. Srinivasapurawas one of the biggest mango markets in south India on an average the market absorbs nearly 6 lakhs quintals of mango every year and these arrivals influenced by various factors. Quantity arrivals in the APMC in the starting seasons were very less (April). The peak season is from May 15th to June 15th, less quantity arrivals observed in the end of the season (August). Total arrivals differ from year to year indicates mango was a biannual bearing tree, one year will be higher yield and subsequent yield will be less and this was reflected in the arrivals in APMC also. The actual arrivals and prices presiding in the market are not reflected in the official records of APMC. The maximum arrivals of mango to the APMC were observed during the month of June which accounted for 180667.60 quintals. The minimum arrivals of mango to the APMC were observed during the month of April which accounted for 60 quintals.

Sharma and Burark (2015) conducted a study on seasonal price behaviour and market concentration of Maize in Rajasthan. The paper investigates the price behaviour of Maize and market concentration in Nimbahera market of Rajasthan. In view of this the present study was undertaken by collecting monthly wholesale prices of Maize in major Maize markets of Rajasthan for a period of 12 years (2002 to 2013).The seasonal price index provides a measure of the month to month variation in Maize prices. Price of maize was found to be highest during off season and lowest during harvest season. Since maize is a Kharif crop, the arrivals were high during October to January. The higher seasonal indices of prices were

observed during April to August during which the arrivals were found to be low.

Vasudev (2015) studied the price instability and price behaviour of Rice in Andhra Pradesh the present study has been undertaken with the objective of examining the price behavior of Rice in Andhra Pradesh in order to provide valuable information about the different components of the price and their interplay. Data were collected on annual and monthly average wholesale prices for a period of 20 years from 1990-91 to 2009-10. The seasonal pattern in prices was analyzed using percentage centered 12-months moving average method. The highest seasonal price indices were observed from October to December and the lowest during January. The cyclical and irregular components in the prices were worked out using moving average method. Three year price cycle was observed for Rice.

More and Katkade (2015) studied on seasonality and volatility in arrivals and prices of oilseeds in Marathwada region of Maharashtra state. Results showed that, arrivals and prices of oilseed crops i.e. soybean and safflower in all selected markets of Marathwada region of Maharashtra were seasonal. Peak arrivals of soybean and safflower were observed during October to December and March to May, respectively. The price index of soybean and safflower was highest in the month of December and June with modest coefficient of variation value of 29 per cent and 19 per cent, respectively. Maximum arrivals and price of soybean were observed in Latur market.

Benkeet *et al.* (2016) studied on economic analysis of greengram arrivals and price behavior in Akola district (Akola APMC) of Maharashtra. The results indicated that compound growth rate of production and arrival were found to be positively associated in period I (1987-96) of study and negatively associated in period II (1997-2006) of study for Akola APMC. Despite pronounced seasonality in arrivals there were negligible variations in seasonal prices of green gram. Cyclical fluctuations were found to be more pronounced than seasonal fluctuations in prices. This showed that when

maximum production was there, prices decreased and increased during the pre harvest month.

Bodade *et al.* (2016) studied on Arrival and price behaviour of Soybean in major markets of Madhya Pradesh. Soybean is the leading oilseed produced globally. Huge fluctuations in prices of farm produce were observed during past few years. The present study aimed to study price movement of Soybean i.e. seasonal variation, cyclical variation among the major Soybean markets in Madhya Pradesh. For study purpose the data related to monthly average prices and arrivals of Soybean were collected from major markets from different markets in States viz. Betul, Dewas, Dhar, and Indore for the period 2004-2015. Moving average method used to study seasonal variation. The results of study showed that the prices of Soybean were higher in the months from June to August in all selected markets. The cyclical variation observed in the prices of Soybean in the selected markets.

Kadam (2016) examined on behaviour of arrivals and prices of Soybean in Latur regulated market in Maharashtra. This paper examines the behaviour of arrivals and prices of soybean at Latur Agricultural Produce Market Committee (APMC) in Maharashtra. Latur was one of the major regulated markets for soybean in the state. It is found that both arrivals & prices of soybean have been shown continuous increasing trend during 2005-06 to 2014-15. The highest arrivals recorded in the month of October to December and prices are higher in month of June, July and August. There was no significant correlation found in arrivals and prices of soybean.

Vanatheeswari and Balamurugan. (2016) conducted research on seasonal price variation and trends of Lemon in Dindigul Market. In the analysis of lemon price, the annual average price per tonne has increased at the rate of 984.23 per annum. The indices of cyclical variation reached the maximum in 1994-95 and 1995-96 and it started declining until 2001-02 and again it started increasing and got stabilized in 2005-06. The price again started decreasing from 1998-99 onwards until 1999-2000 and then it got improved. The co – efficient of variation of irregular variation was 37.68 per cent. The irregular variation in price of Lemon may be due to sudden changes in demand, influenced by the changes in taste and buying behaviour, the

price of substitutes, change in relative income level and the like. The seasonal indices-lower price prevailed during July, August, November, December, January and February. This was due to heavy arrivals and post harvest glut in the market. The lower prices imply that growers sold their produce after storing them for some time. The highest price index during April and May was due to the seasonal shrinkage of arrivals and the pre-harvest.

Pardhiet *al.* (2017) examined the seasonality in arrivals and prices of mango in Lucknow market of Uttar Pradesh. Seasonal indices were calculated for price and arrivals of mango and trends analysis was done through the different equation forms. It was found from the study that the demand for high value commodity was always increasing and due to seasonality of the products, the prices are always fluctuating and trends of prices and arrivals estimated that prices are low during season periods with high quantities of arrivals and vice versa in case of off season.

Thakaret *al.* (2017) analyzed the economic analysis of price movement of major pulses crops of north Gujarat. It was observed that the seasonal prices of green gram were higher in the month of April, May and June in most of the selected markets. In summer season, there was a scare of vegetables and green gram was supplement to it, so the prices were higher during April to June months. Tur prices were higher in month of April to July. The seasonal arrival indices of urad were higher in the month of October, November and December in the selected market of study area.

Bodadeet *al.* (2017) studied the arrival and price behaviour of wheat in major markets of Madhya Pradesh. The present study aimed to study price movement of Wheat i.e. seasonal variation, price volatility among the major Wheat markets in Madhya Pradesh. Moving average method used to study seasonal variation. The results of study showed that the prices of Wheat were higher in the months from March to August in all selected markets. The cyclical variation observed in the prices of Wheat in the selected markets.

Dave and Tarpara (2017) study of price behavior of major pulses in Gujarat state. The prices of all the pulses with their respective markets experienced unremitting price fluctuation and indicated high degree of year to year variability in the prices. It was found that there was a lower

fluctuation in the period 2003, 2004 and 2013 while remaining years showed moderate to very high fluctuations of intra-year variability in all the markets under study period. The prices of pigeon pea and green gram revealed less degree of irregular fluctuations, while the prices of chickpea and black gram showed comparatively high and violent type of irregular fluctuations.

Sharabet *al.* (2018) studied on Price Analysis of Garlic for Major Markets of Maharashtra, India. Results indicated that the huge fluctuations in prices of farm produce were observed during past few years. For study purpose the data related to monthly average prices and arrivals of Garlic were collected for major markets of Maharashtra viz. Ahmednagar, Karad, Pune and Nagpur for the period 2005 to 2016. Moving average method was used to estimate seasonal variations and Residual Method for cyclical variations. The prices of Garlic were higher from the month of September to January in selected markets i.e. Ahmednagar, Karad, Pune and Nagpur. The higher prices recorded during the year 2006, 2007, 2011 and 2016. The peak period of arrivals of Garlic in the selected markets was February to April. The higher arrivals were recorded during the years 2008, 2009, 2012 and 2014.

2.2 Stationarity and Price Volatility

Crain and Lee (1996) explored how wheat spot and future market volatility had been impacted by government farm programme during the 1950-53 periods. They found that changing volatility in both markets was highly associated with changing farm programme at both 1950 and early 1960 were associated with low volatility while the voluntary programmes initiated in the mid 1960 seem to have induced high volatility. They examine seasonality and causality in conjunction with farm programmes.

Hudson and Coble (1999) examined the Durbin-Watson statistics resulting from the initial estimation of equation showed signs of significant auto correlation. Equation was thus corrected for autocorrelation. The model R^2 was 0.3692 which indicated that the model only explained 36.92 per cent of the variation in cotton price volatility models of this type in other commodities. It was important to note that the model was attempted to explain price variability not price level, so explanatory power was expected to be lower.

Richter and Sorenson (2000) had estimated stochastic volatility Model using panel data of Soybean futures and options on Soybean futures. He revealed that the model of commodity price dynamics was within the exponential affine class and option prices are determined using the inversions of characteristics function approach suggest by the estimation method was based on a state space formulation of the model and quasi maximum likelihood estimation results were presented based on weekly observation of Soybean future prices and option prices from Chicago board of trade in the period Oct 1984 to March 1999.

Bryant *et al.* (2004) examined price series correction as a measure of market integration of tomato, like all fresh fruits and vegetables, were perishable and cannot be stored for long periods of time. This means that price was highly dependent on the current supply and demand. Supply and demand could change in a matter of days, thus making tomato prices quite volatile. While the demand for tomatoes was increasing over time, much of the volatility in tomato prices comes from changes in supply. A bumper crop or crop disaster in a major production region could change tomato prices quickly. According to USDA's weekly report on tomato shipments dated May 4, Florida had shipped almost 7.5 million more boxes of tomatoes as of May 1 than at that same time last year (an 19 per cent increased). Mexico, on the other hand, had shipped over 3 million boxes less than one year ago at this time (an 11 per cent decrease).

Caner and Ander (2005) studied the short term fluctuations in monthly returns on composite index of 17 emerging markets affected by the financial crises in the late 1990's and 2000 were decomposed with vector autoregressive estimates. The results were compared to the behaviour of variation in returns in developed markets. Three different models were estimated for each market. Due to first order autocorrelation, lagged returns contributed significantly to return volatility in emerging markets. Decomposition of variances indicates that dividend yield and interest rate are determining factor of volatility, but a varying degrees in different emerging markets. However, the role of dividend was not as strong as it was in the

developed markets as efficient market hypothesis would imply. In some cases, exchange rates significantly influenced market volatility.

Volatility appeared to be the norm rather than exception in international trade due to its structure, climatic conditions and the rapidity with which producers responded to price changes. An interesting feature was that compared to China, India did not have a price advantage in the global market.

Sangeetha (2010) the exports had been lower during the April-December period in terms of volumes, compared with the same period last year. During 2009 period, the country exported Rs 139,000 tones of Chilli, against 146,000 tonnes shipped during April- December 2008. Exports were 5 per cent lower in volumes than the previous year. At an average price of Rs 6,473, the unit-value realization was higher at Rs 899.68 crores. In April-December 2008, the average price was Rs 5,671 and the exports earned Rs 827.98 crores during the nine-month period. As for Chilli, the country had attained 70 per cent of the export target of 200,000 tonnes and 94 per cent of the target value of Rs 960 crores for the financial year, "The off take by Malaysia dipped during the period. The Telangana protests had been delaying the arrival of the crop in the markets during December. On many days, the markets did not open. Inadequate availability of top quality Chilli from Andhra Pradesh led to lower exports," said Kannan. Higher volatility of prices also had been affecting exports, said Mehul Agrawal, research analyst of agri. commodities with SfaareKhan Commodities.

Reddy (2012) analyzed the market integration of grain legumes in India: the case of the chickpea market. The results of the study show that out of twelve markets, only three markets are co-integrated, indicating weak integration of chickpea markets in India. However, the terminal markets located in major consuming (Delhi) and export/import locations (Dohad/Gujarat) clearly played an important role in price discovery and influenced other domestic markets indicated the relevance of the import prices and large consuming centers on local market prices. Error correction terms indicate that the adjustment process from short-term disequilibrium in prices to long run price equilibrium is very slow. Overall, there was evidence of weak

co-integration in the chickpea markets in North India and imports and major consuming centres are playing an important role in price discovery in domestic chickpea markets.

Sendhilet *al.* (2013) studied on price discovery, transmission and volatility: Evidence from agricultural commodity futures. Examined the efficiency of futures trading in wheat, chickpea, maize and barley in terms of price transmission, price discovery and extent of volatility in prices. Wheat and barley have exhibited phenomenal growth coupled with high instability in futures trade quantity and value. Except for barley, futures and spot market prices have been found integrated. However, the level of integration, in terms of price transmission and long-run equilibrium, was most prominent in maize, followed by wheat and chickpea. Price discovery, one of the major benefits of futures trading, and the dominance of futures market in the process of price discovery have been clearly established. The study has indicated that futures were more efficient in price discovery of wheat and maize. Analysis of price volatility has revealed its persistence in spot prices though none of the selected commodities has exhibited an 'explosive' pattern. Further, the study has identified that farmers were not able to participate in the futures market owing to the small-scale production system prevailing in India.

Ngareet *al.* (2014) conducted the analysis of price volatility and implications for price stabilization policies in Mozambique. This paper applied the GARCH model to data from twelve months maize markets in Mozambique to estimate price seasonality and volatility. The results revealed the presence of seasonality, and high volatility. There was scope for improving price stability through the use of both market and non-market based price stabilization interventions that encourage investments in market infrastructure such as roads, warehouses and a market information system; institutions such as warehouse receipt system, credit and insurance; maintaining a strategic reserve and reduced tariffs and food-for-work programmes.

Wintanaet *al.* (2014) studied the economic analysis of spatial integration of pulse market in Ethiopia; A case of selected pulse market in Ethiopia. The results indicated that the stationarity of the price data was

tasted using Augmented Dickey-Fuller (ADF) and Phillips-Perron tests. To test the co integration level Engle and Granger test were applied. The selected markets were Addis Ababa as a central market; Adama as closest market based on distance from central market; Direedewa as remotest both for Horse beans and Chickpeas. While Desse and Gonder as main producing market of Horse beans and Chickpeas respectively. The finding indicated that all the selected markets were co integrated. However, Addis Ababa- Desse for the case of Horse beans and Addis Ababa- Gonder for Chickpeas markets have strongly integrated.

Mittal *et al.* (2018) examined the price volatility trends and price transmission for major staples in India. To examine such policies were necessary to protect domestic consumers from price fluctuations and what were their implications on international prices. To understand this, in this paper we have examined the patterns, trends and volatility in domestic and international prices of rice and wheat, and found that although both the international and domestic prices were volatile, the degree of volatility is higher in the international prices. The volatility in domestic prices is mainly due to internal production shocks and is not influenced much by the international prices.

In the present study upward and downward movement of Pulses price over the months in a year was considered as price volatility and its presence was tested statistically.

2.3 Market co-integration and Granger Causality

2.3.1 Market co-integration

Farooq (1970) studied on market and performance of rice marketing system in East Pakistan. In order to know the relationship, he computed correlation coefficients between secondary markets between terminal and secondary markets and between terminal markets and found them to be 0.90, 0.86 and 0.80, respectively. Thus, it indicated that lesser the distance higher was the correlation and greater the degree of market integration.

Blyn (1973) estimated the market integration by computing the correlation coefficients for the de-trended and de-seasoned data for eight markets in Punjab. The author pointed out that the average V was equal to V between Delhi and other markets indicating the dependence of Delhi prices on the prices of all other collecting markets. The study also showed for lower V prices were lower and vice-versa.

Singh and Arora (1975) examined the extent of market integration of groundnut prices in some important markets of Punjab for the periods 1962-63 to 1967-68 and 1962-63 to 1972-73 by calculating correlation coefficients. The authors found higher variation in groundnut prices during earlier period (1962-63 and 1967-68) than during the later period (1972-73). Their analysis yielded higher 'r' between Khanna and Malerkotta (0.872) and lower 'r' between Khanna and Sangrur and Ludhiana and Mathura markets (0.67). The study further reported that during later period *i.e.*, 1972-73, the value of 'r' was higher than the earlier two in all markets.

Johansen (1988) studied on statistical analysis of cointegration vectors. We consider a nonstationary vector autoregressive process which were integrated of order i , and generated by ii order gaussian errors. We then derive the maximum likelihood estimator of the space of cointegration vectors and the likelihood ratio test of the hypothesis that it has a given number of dimensions. Further we test linear hypothesis about the cointegration vectors.

Jayesh (2001) studied market integration for spices using correlation coefficient. The zero order correlation matrix of prices showed a strong integration among the selected markets of Kerala, Karnataka and Tamil Nadu for both pepper and cardamom.

Bessler and Kergna (2003) studied monthly millet prices in 12 markets in Bamako, Mali. They used an error correction model to consider whether the prices from these markets were integrated. They used directed acyclic graphs to study contemporaneous correlation among markets. They found that prices were discovered in the primary wholesale market, where farmers meet retailers and other middle persons. The retail markets did not serve well as points of price discovery.

Karet *al.* (2004) indicated that Chennai, Delhi and Bombay markets were well integrated indicating the existence of price dependency among various markets. It was pointed out that the values of ADF test were all significant at 10 per cent level of significance.

Dalawi (2004) analyzed the relationship between the prices in major six domestic cotton markets and also at international market (New York) using the co-integration technique. The results clearly indicated that all the price series in major four DCH cotton markets and two Jayadhar cotton markets in the state were assumed to be stationary at order of integration one. The DF test statistics obtained for all the markets including international market were found to be more than the asymptotic critical value even at 10 per cent level. Thus, the major cotton markets in the state were found to be integrated and hence quite competitive pricing behaviour.

Saran and Gangwar (2008) analyzed the spatial co integration amongst major wholesale egg markets in India through measurement of oneness in the egg markets or which, the Engle-Granger co integration test procedure was applied to egg price series for major wholesale egg markets in the country. The study indicated that the major markets were co integrated apparently due to performance of market intelligence functions by National Egg Coordination Committee (NECC) which helped in transmitting price signals across length and breadth of the country through print media on day-to-day basis. The high degree of co integration amongst various markets indicated that the markets were competitive and efficient at the wholesale levels.

Yadav (2008) in his study on Co-integration, Causality, Money and Income in India using annual data over 1950-51 to 2006-07 established that money supply and national income (both real and nominal) were found to be co-integrated which suggested the existence of long-run relationship.

Hossain and Ismail (2010) has made an attempt to examine whether the regional/divisional rice markets have become spatially integrated following the liberalization of the rice market for which they used co-integration analysis and a vector error correction model (VECM) to test the

degree of market integration in Bangladesh. The Johansen co-integration test indicated that there are at least three co-integrating vectors implying that rice markets in Bangladesh during the study period were moderately linked together and therefore the long-run equilibrium was stable. The short-run market integration as measured by the magnitude of market interdependence and the speed of price transmission between the divisional markets has been weak.

Babar *et al.* (2010) analyzed the regional market integration in many agricultural commodities in Pakistan to provide information on the dynamics of price adjustment and to know whether there exists market imperfection. This study used the monthly wholesale price data from January 1991 to December 2006 of Gram and estimated the degree of integration in Gram markets of Pakistan using co-integration analysis. The results showed that all Gram markets were highly integrated in the long run.

Line and Foyn (2010) has made an attempt to investigate price transmission for agricultural commodities between world markets and the Ugandan market to determine the impact of world market prices on the Ugandan market. The prices of Robusta coffee and sorghum were examined. The analysis focused on the spatial price relations *i.e.* the price variations between geographically separated markets in Uganda and the world markets and a dynamic vector autoregressive (VAR) model was used. The results indicated that food markets in Uganda, based on the study of sorghum price transmission, were not integrated into world markets, and it was found different for the cash crop, Robusta coffee. In the period in the 1990's with high coffee prices on the world market, prices in Uganda were strongly connected to world prices. The empirical analysis thus indicated that rising food prices (of little-traded crops) on world markets will not have a direct effect on food prices in Uganda.

Adenegan (2012) studied the spatial price analysis of Tomatoes in Nigeria. Results indicated that the maximum tomato price was recorded in Ekiti in November, 2006 while the minimum price was recorded in Kano state in August, 2006. The results also revealed that prices of tomato were not

stationary in their level form but become stationary at the first difference level. Seven tomato markets rejected their respective null hypothesis of no granger causality. None of the markets exhibited bi-directional granger causality or simultaneous feedback relationships. Seven markets exhibited uni-directional granger causality. The results also indicated that Ekiti and Katsina states occupy the leadership position in tomato price formation and transmission. We recommend there should be efficient flow of information and good access road and infrastructural development among the states to improve market performance.

Ibrahim (2013) examined the price integration of Cowpea retail markets in Niger state, Nigeria. Results from the market integration study revealed that markets in Niger State present a relatively long run integration in cowpea prices. A strong spatial price linkage exists between Kontagora vs. Sabonwuse and Bida vs. Sabonwuse markets. This was adduced to the ease, flow and use of market information, competition among market participants and the presence of arbitrage. Results from the Granger causality tests indicated both bidirectional and unidirectional causation. Recommendations from this study included the need for the provision of adequate market information on current price dissemination to market participants through government agencies.

Adesola *et al.* (2014) studied on spatial integration of Maize market in Nigeria. The study examined spatial market integration among geographically separated maize markets in Nigeria using monthly retail price data of maize grain from January 2001 – December 2010 in the selected producing and consuming states. The data were analyzed using Johansen cointegration and Vector error correction model (VECM). In the long run, the states were cointegrated and the rate at which VECM restored deviation from equilibrium was moderate. The study showed that spatial price linkages exist within maize market as products moved efficiently across market which is related to efficiency of price information flow. The study recommended that farmers should be provided with more price information in order to take advantage of spatial price differences.

Waniet *al.* (2015) analyzed the market integration and price forecasting of Apple in India. The results revealed that apple markets were perfectly integrated, and the Delhi market was the dominant one. In the short run, as a disequilibrium ranges from 2.1 to 96.9 per cent among all the varieties and grades of the selected fruits. However, the study finds no cointegration within two pairs of markets (Delhi-Srinagar and Bangalore-Kolkata) for the American Super variety and within one pair (Bangalore-Kolkata) for Moharaji Special. The Granger Causality Test revealed 39 and 18 bi-directional and uni-directional causations respectively under different market situations. Further, Vector Error Correction Model (VECM) results reveal a combination of positive and negative coefficients, though positive coefficients exceed the negative coefficients.

Ddunguet *al.* (2015) studied the marketing and market integration of cowpea in Uganda. Results from these tests showed that cowpea markets as a whole were not integrated. This was not a surprising result since it can be linked to changes in the supply of cowpeas. The results obtained will assist in subsequent cowpea variety improvement actions and decisions.

Devi *et al.* (2015) made an research on spatial integration of cotton markets in India – An application of vector error correction model. The major co on markets selected were Adoni (Andhra Pradesh), Warangal (Telangana), Hanumangarh (Rajasthan) and Gondal (Gujarat). Trace statistic and maximum Eigen value test revealed that the domestic cotton markets were found to be integrated with 3 co-integrating equations. The estimated error term coefficients indicated that in Adoni market of Andhra Pradesh and Warangal market of Telangana, 49 and 26 per cent of disequilibrium got corrected within a month by changes in its own prices. It is also evident that the long-run price movements of Andhra Pradesh, Telangana and Gujarat markets were heavily influenced by price changes in Rajasthan market.

Vasudev(2015) studied the spatial market integration of maize wholesale prices in Telangana State. The present study was conducted to assess the performance of the selected agricultural markets in the Telangana

state. Correlation analysis and co-integration analysis was carried out to determine the spatial market integration among the various agricultural markets. For co-integration analysis the time series data were tested using the Dickey-Fuller unit root test followed by Engle-Granger test to determine the market integration. Market integration analysis revealed that a moderate correlation ranging from 0.666 among Warangal – Nagarkurnool to 0.868 between Nizamabad - Siddipet for maize, and all of them were significant at 1% level of significance. DickeyFuller unit root test revealed that the market prices for all the crops were stationary in nature for a period of time. Engle-Granger (EG) test revealed that all the markets were perfectly co-integrated among each other in terms of market prices.

Ikudayisi and Rahji (2015) examined the spatial market integration among geographically separated onion markets in Nigeria. Secondary data involving monthly retail price data of onion crop in the selected producing and consuming states were used for the analysis. The study was analysed using Ravallion model, Johansen cointegration, error correction model and granger causality. The index of market concentration indicated low short run market integration of onion market ($IMC > 1$), which could be as a result of poor road network in spatially separated markets. There was long run cointegration exist among the producing and consuming states and the error correction model result indicated that the rates of price transfer were generally moderate. This may be related to efficiency of information flow. The study recommends that farmers should be provided with more price information and good road network to enable them take advantage of spatial price differences.

Gummagolmathet *al.* (2017) analyzed the spatial price integration and price transmission among major chickpea markets in India. The results of the study revealed that the short term integration of chickpea in five major markets was very much existent, indicating the short term changes in prices in markets may lead to stable long run equilibrium in the system. The speed of adjustment of prices found to be moderate in few markets and weaker in many of the markets, thus it was said that prices correct a very

small percentage of the disequilibrium in the markets with the greatest percentage by the external and internal forces.

Pawaret *al.* (2017) studied the price stability of soybean for Amravati division of Maharashtra. The present study aimed to study price movement of soybean i.e. price volatility and co-integration among major soybean markets of Amravati division viz. Amravati, Akola, Washim, Yavatmal and Buldana for the period 2003-2013. The results of study show that the all selected markets, showed that volatility shocks in Soybean prices are quite persistent in this markets. The selected markets show long run equilibrium relationship and co-integration between them.

In the present study the technique of co-integration was applied to test the integration between prices of selected markets.

2.3.2 Granger Causality

Seyoum (2010) explained granger causality in a way that if there is an integration between the two markets, the price in one market, p_1 , would commonly be found to Granger-cause the price in the other market, p_2 and/or vice versa and thus, Granger Causality gives us additional evidence whether or in which direction price-transmission is occurring between two series.

Lavanya (2011) revealed that the results of the GARCH model showed that there was no persistent volatility in prices of turmeric in the selected markets. The results of co-integration test revealed that spot and futures market of turmeric were integrated. Granger causality test confirmed that futures price influence spot prices in Erode and Nizamabad markets, while in Sangli market there was a bidirectional influence.

Saeid and Leelavathi (2013) studied the Agricultural Export and Exchange Rates in India: The granger causality approach. This paper was an attempt to investigate the causal relationships among quantity of agricultural export and real exchange rate in India by using time series data for the period between 1980 and 2010. A Granger-causality analysis has been carried out in order to assess whether there was any potential predictability power of one indicator for the other. The finding showed that there was no significant

relationship between quantity of agricultural export and real exchange rate. In Other words, both the variables do not cause each other in either direction. The result also showed that the variables were not co-integrated, so there was no the long run relationship between agricultural export and exchange rates in India.

Pala (2013) examined the structural breaks, co-integration, and causality by VECM analysis of crude oil and food price. This paper investigated form of the linkage between crude oil price index and food price index, using johansen co-integration test, and Granger Causality by VECM. Empirical results for monthly data from 1990:01 to 2011:08 indicated that evidence for breaks after 2008:08 and 2008:11. We find a clear long-run relationship between these series for the full and sub sample. Co-integration regression coefficient is negative at the 1990:01-2008:08 time periods, but adversely positive at the 2008:11-2011:08 time period. This result represents that relation between crude oil and food price changed.

In the present study Granger causality test was applied to know the direction of relationship between prices of selected markets.

2.4 Spot and Future Prices

Wang and Bingfan (2005) studied the efficiency of the Chinese wheat and soybean futures market. Formal statistical tests were conducted based on Johansen's co-integration approaches for three different cash markets and six different futures forecasting horizons ranging from 1 week to 4 months. The results suggested a long term equilibrium relationship between the futures price and cash price for soybeans and weak short term efficiency in the soybean futures market. The futures market for wheat was inefficient, which might be caused by over speculation and government intervention.

Zapata *et al.* (2005) examined the relationship between sugar futures prices traded in New York and the world cash prices for exported sugar. The co-integration between futures and cash prices suggested that the sugar futures contract was a useful vehicle for reducing overall market price risk faced by cash (spot) market participants selling at the world price (i.e., not enjoying favourable trade incentives). They also found un-directional Granger

causality from futures prices to cash prices. The futures market for sugar leads the cash market in price discovery and a shock in the futures price innovation generates a quick (one month) and positive response in futures and cash prices; but not vice versa.

Sahoo and Kumar (2008) studied impact of CTT (Commodity Transaction Tax) on commodity futures market in India and examined the efficiency through price discovery mechanism by doing Granger causality analysis between futures prices and spot prices. Since both spot and futures return series were I (0) to carried out granger causality at levels. The results revealed that in all five commodities (gold, crude, refined soya oil, chana and copper) futures prices Granger cause spot prices. Previous literature also suggested that when there was causality running from futures return series to spot return series, the market was efficient. This implies that the commodity futures market was efficient for the five commodities.

Elumalai *et al.* (2009) studied the mechanism of price discovery in India's agricultural commodity futures markets. This study attempted to assess the futures and spot price linkages for pepper, guar seed and chana released by NCDEX for a period of April 2004 to May, 2009 by using Johansen co-integration analysis and Vector Error Correction Model (VECM). On price discovery, the significant coefficient of at least one error correction term confirmed the results of presence of co integration between futures and spot prices of pepper, guar seed and chana. The results of vector error correction model revealed unidirectional lead-lag relationship existing for actively traded guar seed and thinly traded pepper and chana. The coefficient of the lagged futures price in the spot price model was positive and significant indicated information flows from futures to spot market. The results of the study broadly revealed that these three agricultural commodity futures influenced the spot prices, indicated its better hedge efficiency for producers to hedge their price risk in the futures platform of the exchange.

Singh *et al.* (2009) examined the efficiency of futures market operations in mitigating price risk in case of food, non-food and cash crops in India using spot and futures prices data pertaining to the period from

October, 2004 to May, 2007 released by MCX. The co integration test had been applied to find out whether there exists a long run relationship between spot and futures prices of various contract months for these crops assuming that in the short run there may be disequilibrium between these two. They found that short run changes in the futures price series had a positive impact on the short-run changes in the spot prices for chana, urad, masoor, refined soya oil, jeera and kapas except wheat and potato. This phenomenon of price convergence for the above crops clearly depicts that the farmers would be able to mitigate the price risk by taking opposite positions in the markets as the spot prices and futures prices effectively converge. They suggested that hedging was a good option for the farmers growing cash crops, non-food and food crops assuming that in the short-run there may be disequilibrium between these two. They found that short-run changes in the futures price series had a positive impact on the short-run changes in the spot prices for chana, urad, masoor, refined soya oil, jeera and kapas except wheat and potato.

Bharadwaj and Vasisht (2009) examined the price volatility and integration in spot and futures market of Gram. In this univariate ARCH-Type model has been used to empirically examine persistence and asymmetry in volatility of price of Gram crop. Maximum likelihood estimation resulted of the models explain the best statistical fit, lending support for hypothesis of persistence, symmetry and variability in volatility. ARCH related the error variance to the square of a previous period's error. It were employed commonly in modeling financial time series that exhibit time varying volatility clustering i.e. periods of swings, followed by periods of relative calm. An ARCH (9) model can be estimated using ordinary least squares.

Hernandez and Torero (2010) examined the dynamic relationship between spot and futures prices of agricultural commodities. Linear as well as nonlinear (nonparametric) causality tests were conducted on both spot and futures returns and their volatility. The results indicated that spot prices were generally discovered in futures markets. In particular, we found that changes in futures prices lead changes in spot prices more often than the reverse.

Sen and Paul (2010) studied the trading in India's commodity futures market and observed the steep increases in spot prices for major food items along with a granger causal link from futures to spot prices for commodities on which futures data was available. In all four commodities (wheat, soya, chana and potato) null hypothesis of no granger causality from futures prices to spot prices was rejected as indicated by low p values, but this was not true for the null hypothesis of granger causality from spot to futures prices, so it was inferred that in all these four cases futures price was causing changes in spot prices.

Agnihotri and Sharma (2011) studied on the increasing volumes in these exchanges suggest that commodity markets in India seem to be a promising game. Subsequent to liberalization of Indian economy in 1991, a series of steps were taken to liberalise the commodity forward markets. Since the introduction of modern futures trading in the commodity exchanges in India, it had reduced the volatility in the commodity market. The study explained the relationship of future and spot price of commodities Zeera, Channa, Zink, and Natural Gas and their inter relationship.

Jackline and Deo (2011) studied the lead- lag relationship between the future and spot prices. The Augmented Dickey Fuller tests and Phillips-Perron tests employed in the study proved that both the selected markets were stationary series and the Granger Causality test proved bicausality relationships among these markets. Hence, it was concluded that the profitable arbitrage does not exist in both of these markets and they are said to be in perfect equilibrium.

Inoue and Hamori (2012) examined the whether the growing Indian commodity futures market satisfies market efficiency using the multi commodity price indices released by MCX. They conducted Johansen co integration test for the spot and futures price indices from January 2006 to March 2011. The results shown that there was a co-integration and long-run equilibrium relation between them, which means a necessary condition for marketing efficiency, was satisfied. So, the commodity futures market was

more efficient only during the more recent sub sample period since July, 2009.

Chhajed and Mehta (2013) studied the market behavior and price discovery in Indian Agriculture Commodity Market. Commodity future trading was permitted in 2003. The commodity derivatives market in India has witnessed a phenomenal growth. The functioning of future market came under scrutiny during 2008–2009 due to price rise and the role of futures market in stabilizing spot prices was widely studied. The study considered average monthly spot and future prices of nine agriculture commodities viz. wheat, chana, soybean oil, jute, mentha oil, rubber, potato, crude palm oil and cardamom trading on MCX and NCDEX during 2009–2010. Granger causality test have been used to test the price discovery, i.e., the effect of future market on spot market and vice-versa. The result of the study said that the price discovery mechanism was quite different for different commodities but it suggested that causality could be used in forecasting spot and futures prices. Most of the commodities showed bi-directional causality between spot and future prices. The contango and backwardation helped in identifying the hedging opportunities in the market.

Viswanathan and Sridharan (2014) conducted the relationships between the two series by applying Pair wise Granger Causality test. Descriptive statistical analysis and JarqueBera Test were applied to study the nature of distribution of the time series data of spot and future price of Pepper. Correlogram analysis was applied to test the presence of auto correlation in the series. Granger Causality was applied to examine the relationship between spot and future price of Pepper. The test results indicated bilateral causality between the price of Pepper in the spot and futures market.

Shakeel and Purankar(2014) studied the price discovery mechanism of spot and futures market in India: A case of selected agri-commodities. In this study an attempt has been made to study the price discovery relationship for 3 of the top traded agricultural commodities on NCDEX namely Soyabean, Castorseed and Chana. The necessary daily data on spot and futures market prices are collected from the NCDEX website for

the period 1st January, 2009 to 31st March, 2014. The near month contract of the futures markets of respective commodity was considered for the study, as they are mostly heavily traded as compared to next month and far month futures contracts. Augmented Dickey Fuller test was employed to test stationary of the data series. Besides, Johansen cointegration test was employed to access the long-run relationship between the variables and Vector Error Correction Mechanism (VECM) was employed to examine the short run dynamics. The cointegration results confirm the existence of long-run relationship between spot and futures series of Castor seed, Channa and Soya bean, respectively. The vector error correction model confirms bidirectional causality between spot and futures series of Castor Seed, Channa and Soya bean, suggesting that both the spot and future markets of the selected respective agricultural commodity played the leading role through price discovery process in India and said to be informationally efficient and reacts more quickly to each other.

Bansalet *al.* (2015) studied on future and spot price relations: a case study of Caster NCDEX market. This study has analyzed the futures and spot price relations in castor and the data were collected for a period of 10 year *i.e.* July, 2004 to December, 2013. The results revealed that volume of castor traded in NCDEX has increased doting the recent times indicating the increasing information flow into the markets. Analysis of price volatility has revealed its persistence in spot and futures prices as the sum of the coefficient of ARCH (α) and GARCH (β) were estimated closer to one. The spot and future prices were found to be co-integrated assessed through Johansen Co-integration test.

Kumar (2015) analyzed the futures market of Pepper in India: An empirical study. The performance assessment methods of extent of liquidity, price volatility and basis risk have been employed as analytical variables. Using the econometrics techniques such as cointegration, VECM, Granger causality, impulse response and variance decomposition, the study seeks to generate empirical results to evaluate the level of development of pepper futures market as an efficient mechanism of risk management and price discovery. Empirical study of the pepper futures market in India

indicated that pepper has not done well as performance and efficiency were concern. Looking at the result it could be said that, hedgers find futures market useful to manage price risk and can be very useful in risk management functions. In the presence of an expected increase of price risk, findings of the study would help address the mechanisms of risk management and price discovery of futures market for pepper.

Shireesha *et al.* (2016) studied the influence of futures market on price behavior of turmeric in India. This paper emphasized on finding out the interdependence between futures and spot prices of turmeric using daily closing futures prices for the year 2014 collected from NCDEX and their respective spot prices from AGMARKNET by employing Johansen's co-integration test, examined the causality by Granger Causality test and also captured the speed of adjustment to deviations in long run equilibrium by using Vector Error Correction Model (VECM). The spot prices of Duggirala, Nizamabad and Erode attained short run equilibrium. The spot prices of all the markets were influenced by their own daily lags. Futures prices influenced the spot prices of Kadapa, Duggirala and Erode by one day lag and in turn were influenced by the spot prices of Kadapa. The causality test proved the unidirectional causality between futures and spot prices indicating that futures prices influenced the spot prices in all the selected markets but not vice-versa leading to price discovery .

Raghavendra *et al.* (2016) conducted the relationship between Spot and Futures markets of selected agricultural commodities in India: An efficiency and causation analysis. The empirical results suggested the existence of long-run equilibrium relationships between futures and spot prices for all the 5 agricultural commodities that were taken for this study. Regression model pertaining to Lead-Lag relationship between Spot and Future markets suggests that for the commodities Maize, Jeera and Turmeric, both the spot and future markets price played the leading role in the price discovery process and said to be informationally efficient and reacted more quickly to each other.

Rani *et al.* (2017) improving farmers' income by futures trading: A case study of chickpea in India. Present study was conducted to examine the relationship between spot and futures prices of chickpea. From past few years, volatility in the prices of pulses is most concerning issue in the agricultural scenario of India. Increased price volatility will results into variations in farm income. Futures trading, in this context emerged as a boom as it not only smooth the volatility and mitigate the price risks but also discovers the prices of commodity so that farmers can plan their activities in order to improve their income. Johansen cointegration test was employed to assess the long run associationship between two price series. The direction of relationship was examined by using Granger causality test. Vector Error Correction Mechanism (VECM) was employed to model the short run relationship. The cointegration results confirmed the existence of long-run relationship between the two price series. The study concluded that there was a causal relationship form futures to spot, thus futures trading fuelled the farmer to take the appropriate decisions which in turn will improve their income.

Tingreet *al.* (2018) studied the future prices and spot prices relationship of Turmeric – An econometric analysis. The time series data on future and spot monthly average price of Turmeric for the period 2005 to 2017 were collected from NCDEX and AGMARKNET websites of Government of India. Johansen's Multiple Co-integration test was employed to determine the long run relationship between the future and spot prices of Turmeric. The results of Co-integration test showed one Co-integration equation was significant at 5 per cent level of significance, indicated that the future and spot markets having long run equilibrium relationship and there existed co-integration between them.

2.5 Price Forecasting

Barathiet *al.* (2011) studied the market integration of Ramanagaram and Siddlaghatta markets and forecasting of their prices and arrivals. The present study was to determine the market integration between Ramanagaram and Siddlaghatta markets and to forecast the price and arrival of cocoon. Auto Regressive Integrated Moving Average (ARIMA) model was

used to forecast the arrival and price. Suitable model was identified based on the Autocorrelation function and Partial Autocorrelation Function. The adequacy of the model was judged based on the values of Box-Pierce Q statistics and Akaike Information Co-efficient (AIC). Market integration is found to be perfect between two markets. Forecasted values of arrival showed increasing trend in both the markets and price showed decreasing trend in Siddlaghatta market.

Pradhan (2012) conducted the study on forecasting of annual productivity of selected agricultural products. For this 34 different agricultural product was selected on annual data from 1950-1957 to 2010. In this for turmeric ARIMA (2, 1, 2,) model with adjusted R^2 being equal to 0.26 are most suitable. The forecasted value for turmeric in 2011 was 867.49, in 2012 was 940.17, in 2013 was 968.54, in 2014 was 947.47 and in 2015 was 910.68.

Chaudhari and Tingre (2013) studied the forecasting of milk production in India, an application of ARIMA model. They studied the milk production data for the period from 1979-80 to 2010-11. The aim of the study was to forecast milk production, various forecasting techniques were considered for use. ARIMA model, introduced by Box and Jenkins (1970) was frequently used for discovering the pattern and predicting the future values of the time series data. Based on the fitted model, milk production in the country was forecasted for the period from 2011-12 to 2020-21. The results showed that the forecasted milk production for the period from 2011-12 to 2020-21 were 126.43, 130.54, 134.29, 137.81, 141.15, 144.38, 147.54, 150.64, 153.71 and 156.75 million tons, respectively. It means milk production in India will increased from 126.43 to 156.75 million tones.

Patel and Patel (2013) a comparative study of arrivals and prices of agricultural commodities at APMC using time series analysis. The Regression Analysis was done for forecasting future values of arrival and their relationship on prices in the agricultural commodities cumin and fennel at APMC. Box-Jenkins model is used to the multiplicative time series model for forecasting. The series was found to be stationary, while the co-efficient dropped to zero after the first and second lag. Each individual coefficient of

ACF and PACF are tested for their significance using 't' test. Further, the absence of peak at first values clearly indicate suitability of the choice of non-seasonal difference $d=1$, to accomplish stationarity series. Hence, based on ACF and PACF many models were tried, finally model (1,1,1) (2,1,1) was tentatively identified for arrivals and price times of maize in selected markets.

Chaudhari and Tingre (2014) conducted the study on forecasting the Green gram prices for Maharashtra. For this they have used the time series data of monthly average prices for the period from January 2001 to September 2012 of Akola market. In the present study the best fitted model was ARIMA (0, 1, 0). The forecasted values of Green gram prices increasing from Rs 4646 pr quintal during October 2012 to Rs 4729 per quintal during February 2013.

Chaudhari *et al.* (2014) examined the Cotton production in India by using the time series data for the period from 1950-1951 to 2010-2011. They have observed that the value of normalized BIC was lowest and worked out 254 for the ARIMA (0, 1, 0) it indicates that the ARIMA (0, 1, 0) was suitable. It is showed that the Cotton production will increase from 33.93 million bales during 2011-2012 to 37.98 million bales during 2019-2020.

Amin *et al.* (2014) studied time series modeling for forecasting Wheat production in Pakistan. Wheat is the main agriculture crop of Pakistan. For country planning, forecasting was the main tool for predicting the production of wheat to determine the situation what would be the value of production coming year. In this research, we developed time series models and best model was identified for the objective to forecast the wheat production of Pakistan. In this research large time periods *i.e.* 1902-2005 data was used. Various time series models are fitted on this data using two software's JMP and Statgraphics. We have found that the best model is ARIMA (1, 2, 2). On the basis of this selected model, we have found that wheat production of Pakistan would become 26623.5 thousand tons in 2020 and would become double in 2060 as compared in 2010.

Prabakaran and Sivapragasam (2014) analyzed the forecasting areas and production of Rice in India using ARIMA model. Data on Rice area

and production for the period 1950-51 to 2011-12 were analyzed by time series method. Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) were calculated for the data. Appropriate Box-Jenkins Auto Regressive Integrated Moving Average (ARIMA) model was fitted. Validity of the model was tested using standard statistical techniques. ARIMA (1, 1, 1) and ARIMA (1, 1, 1) model were used to forecast area and production in India for four leading years. The results also showed area forecast for the year 2015 to be about 44.75 thousand hectare with upper and lower limits 47.53 and 41.97 thousand hectares respectively. The model also showed Rice production forecast for the year 2015 to be about 104.37 thousand tonnes with upper and lower limits 115.26 and 93.48 thousand tonnes respectively.

Vishwajith *et al.* (2014) studied the time series modeling and forecasting of pulses production in India. In this paper attempt has been made to analyse and forecast the production scenario of pulses in major pulses growing states of India. Autoregressive Integrated Moving Average (ARIMA) methodology has been used to model and forecasted the behaviour of pulses production with and without inclusion of the above factors of production. In most of the cases, inclusion of the factors of production in the model outperformed the simple ARIMA modelling. To take care of conditional variances, uses of Generalised Autoregressive Conditional Heteroscedastic (GARCH) models were found in literature; the method has also been used in this study. From the forecasted value it was clear that among the Indian states, Madhya Pradesh has to played a major role in augmenting pulses production in India with its estimated share of 3661 thousand tons out of all India production of 14360 thousand tons in 2015. Comparative analysis revealed that uniform superiority of neither the ARIMA model nor the GARCH could be established in modeling and forecasting the production behavior of pulses in India.

Rao *et al.* (2014) studied Seasonal variations and forecasting in wholesale prices of Rice (Paddy) in Guntur district of Andhra Pradesh. The analysis of trends, seasonal variations and in market prices of Rice in Guntur district and Andhra Pradesh and forecast the same for the period 1990-91 to 2009-10 collected from various published statistical bulletins. The seasonal

variations in market prices and 12 months moving average method was used to construct the seasonal indices and Box-Jenkins model was used to forecast the future prices. The annual average wholesale price trends of Rice from 1990-91 to 2009-10 has shown a significant increase over the years in both Andhra Pradesh and Guntur market. The annual increase in wholesale prices of Rice in Andhra Pradesh was Rs. 44.53 per quintal where as in Guntur market it was Rs. 49.38 per quintal. The month wise seasonal index was lowest on the month of April, May and highest in the month of September, October in Andhra Pradesh and Guntur district respectively. Thus, the farmers could receive the better price by postponing the sale of produce during the month of January to June to later months of the year.

Darekaret *et al.* (2015) studied on forecast the prices of onion in Lasalgaon and Pimpalgaon market of Western Maharashtra. The results showed the ex-ante and ex-post forecast of monthly prices of onion in selected market from 2004 to 2013. In these markets, it was observed that there was sudden increase or decrease in the prices during 2011, 2012 and 2013. The year-wise alternate decrease in production and adequate storage facilities might be the reasons for the sudden increase in the price. The forecasted price values revealed an increasing or decreasing trend in the next ensuing years. Hence, farmers need to plan the production process in such a way that a good price for the produce would be expected.

Saqib *et al.* (2015) examined the trend analysis and forecasting of Wheat and Rice prices in Pakistan. Results that the different models have been applied to get the best fit linear trend model, quadratic trend model, exponential growth model and S-curve model. The minimum values of Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD) have been acquired and then the forecasting was made for the best fitted model with minimum error. Five year average prices for the individual crop(s) were also calculated to observe the past trend. The study demonstrates that for wheat and rice (Basmati and IRRI); S-Curve model was recommended for forecasting price.

Bhardwaj *et al.* (2015) analyzed the price forecast an instrument for improvement in agricultural production and marketing in Rajasthan-A case study of rape & mustard seeds. This study was undertaken to forecast prices of Mustard seeds. The two types of methodological approaches such as Univariate and Mul variate techniques were adopted for analysis. In case of Univariate approach ARIMA and GARCH methods were applied whereas for mulvariate Vector Autoregressive (VAR) model was used. For forecasting Mustard prices, ARIMA (0, 1, 1) model was used which gives reasonable and acceptable forecasts; but it does not perform very well when there was volatility in the data series. In this study, GARCH (1, 1) has also been an emptied to forecast price but not found suitable because there was no persistent volatility in the data series. In VAR model, the lag quantity arrival and lag prices in the market influence the forecasts of Mustard prices to some extent. From absolute accuracy in forecast performance measures, VAR was the most suitable forecast model for Mustard crop.

Esther and Magdaline (2017) studied the ARIMA modeling to forecast Pulses production in Kenya. This study focuses on forecasting production of pulses in Kenya using Autoregressive Integrated Moving Average (ARIMA) model. Time series data on production collected from Food and Agriculture Organization of the United Nations (FAO) statistical yearbooks for the period 1961 to 2012 was used to model. The study found that ARIMA (1, 1, & 2) was the appropriate model to forecast pulses production in Kenya. Based on this model the point forecasts showed that 25437.53 tons of pulses would be produced in 2020, 25342.27 tons in 2025 and 25357.44 tons in 2030 holding all things constant.

Darekar and Reddy (2017) studied the forecasting of Common Paddy Prices in India. ARIMA (Box-Jenkins) model was employed to predict the future prices of paddy. Model parameters were estimated using the R programming software. The performance of fitted model was examined by computing various measures of goodness of fit viz., AIC, BIC and MAPE. The ARIMA model was the most representative model for the price forecast of paddy in overall India. In *kharif* season the paddy was harvested during September – November. The forecast showed that market prices of paddy,

would be ruling in the range of Rs. 1,600 – 2,200 per quintal in *kharif* harvesting season, 2017-18.

Divyaet *al.* (2018) studied on forecasting the prices of green gram in selected markets of Andhra Pradesh. The main purpose of this paper is to identify the Auto-Regressive Integrated Moving Average (ARIMA) model by Box Jenkin's method that could be used to forecast the prices of greengram in Suryapeta and Thandur markets. The results showed that the best selected ARIMA model for forecasting the greengram prices in Suryapeta was ARIMA (0,1,1), and, for Thandur market it was ARIMA (1,0,1). This paper makes a comparison between the original and forecasted prices which was relatively closer to the real values in both Suryapeta and Thandur markets.

2.6 Pulse Prices and there Process Products

GrangerCausality

Reddy (2012) studied the market integration of grain legumes in India: the case of the chickpea market. The results of the study show that out of twelve markets, only three markets were co-integrated, indicating weak integration of chickpea markets in India. The causality relationship had been studied by Engle and Granger and also through Granger causality tests, which showed that price changes in Matihari are influenced by five other markets, namely Sriganaganagar, Hapur, Jhansi, Kanpur and Kalpi, whereas the Dohad, Rohtak and Delhi markets were exogenous and not influenced by any other markets and are thus important sources of price formation. The Dohad price influences prices in many other markets and acts as a major source of price discovery. About 118 price relationships were exogenous among a total of 132 relationships, which showed that the chickpea markets were weakly integrated.

Bhagwat and Shelke (2012) examined the value addition by agro-processing industries in various pulse crops of dal mills in Marathwada region of Maharashtra state. The result revealed that, the average break-even point was 0.071 quintal, consisting of 0.078 quintal for small medium (Group I) sized of dal mills and 0.064 quintal for large (Group II) sized dal mills. And on overall basis the value addition was Rs. 320.98 lakhs,

consisting of Rs. 250.11 lakhs for Group I and Rs. 391.85 lakhs for Group II dal mills.

Ibrahim (2013) studied the price integration of Cowpea retail markets in Niger state, Nigeria. Data was sourced secondarily. Multistage stratified random sampling was employed to select markets, a total of six (6) markets comprising Kontagora and Salka markets (from production strata); Minna and Bida markets (from consumption strata) and Sabon wuse and Mokwa markets (from transitory strata) were selected for the market integration study. Data was analysed variously through the use of Granger causality tests. Results from the Granger causality tests indicated both bidirectional and unidirectional causation. Recommendations from this study included the need for the provision of adequate market information on current price dissemination to market participants through government agencies.

Patil *et al.* (2014) evaluated the red gram price movement across major markets of Maharashtra. The present study aimed to study price movement of Red gram. For study purpose the data related to monthly average prices of Red gram were collected from major markets of Maharashtra State viz. Akola, Latur, Jalgaon and Nagpur for the period 2003-2013. The econometric tools like Granger Causality Test and ARCH-GARCH model were used to arrive at conclusion. The results of study showed that the most of the markets showed bidirectional Causality influence on Red gram prices of each other. Akola, Latur, Jalgaon and Nagpur market, showed volatility shocks were not quite persistent in these markets.

Patil and Tingre(2015) studied the black gram price movement across major markets of Maharashtra. For study purpose the data related to monthly average prices of black gram were collected from major markets of Maharashtra state viz., Akola, Latur, Amravati and Jalgaon for the period 2003-2013. The econometric tools like Granger causality test and ARCH-GARCH model were used to study price volatility and co-integration among different markets. The results of study showed that the selected markets showed long run equilibrium relationship and co-integration between them. Most of the markets showed bidirectional causality influenced on black gram prices of each other. Akola, Latur, Amravati and Jalgaon markets showed

that volatility shocks were not quite persistent in these markets.

Patil and Tingre (2015) examined the soybean price movement across major markets of Maharashtra. For study purpose the data related to monthly average prices and arrivals of soybean were collected from major markets in Maharashtra state viz., Akola, Washim, Latur and Nagpur for the period 2003-2013. The econometric tools like Granger causality test. The casual relationship between the price series of selected soybean markets where approached through Granger causality technique. The results of the study showed that the Washim and Akola market exhibited unidirectional causality and prices of Akola market affected Washim market. Similarly Akola market also unidirectionally affecting the prices of Latur and Nagpur market. Latur and Washim market exhibited unidirectional causality and prices of Washim market affected Latur market. Nagpur and Latur market showed bidirectional causality. So the influence of Akola prices played a significant role over the other market prices and the influence is so strong that F-stat. values happened to be significant at 1 per cent level.

Waniet *al.* (2015) examined the market integration and price forecasting of Apple in India. The results of the Granger-Casualty Test reveal a number of 5 bi-directional causations among different markets in Delicious Special, 6 each in American Special, American Super, Delicious Super and 8 in both the varieties of Moharaji Special and Super. Further, the numbers of uni-directional causations were in the order of 2 each in American Super; Moharaji Special and Super; 4 each in American Special and Delicious Super and 5 in Delicious Special across the selected markets. The results have revealed disequilibrium of 2.1 to 96.9 per cent among all the varieties and grades of the fruits selected, which could be removed in each period in the identified markets. It further implies that following a shock to the market resulting in disequilibrium, the economic forces would take a few weeks to restore equilibrium.

Ddunguet *al.* (2015) analyzed the marketing and market integration of cowpea in Uganda. Data was obtained on prices of grains of cowpeas on a weekly basis from FIT Uganda between 2008 to 2011 in

Soroti, Lira and Kampala. Results indicate no causality implying independent causation between markets at Kampala and Lira. These markets do not depend on each other, meaning that prices in one market do not react to any deviation or changes of price in the other market from its equilibrium path. It is concluded that there is no leading market whose price changes influences all other markets as presented in the Granger-Causality results. The result revealed that price changes of cowpea in the markets studied are organized around more than one market.

Gummagolmathet *al.* (2017) examined the spatial price integration and price transmission among major chickpea markets in India. The results of the Granger causality tests which indicate the strength of causality in each market with reference to every other markets, based on the significance level of F (causality) statistics. The results show that null hypothesis of chickpea market of Delhi does not granger cause the markets of Amritsar, Kanpur, Kolkata, Mathura, Patna and Sainthia is rejected, signifying that Delhi market influences the prices in the above mentioned markets at 1 % significance level.

CHAPTER III

METHODOLOGY

The present study “Market Integration and Price Volatility of Pulses in Maharashtra” was carried out at the Department of Agricultural Economics and Statistics, Dr. PDKV, Akola during the years 2016-17 to 2018-19. In the present study, an attempt has been made to analyze the market prices of Pulses critically so that the conclusion of study will be useful to the farmers, consumers, traders and policy makers to take more informed marketing decisions. This chapter explains the methodological framework used in the study. More specifically, this chapter deals with the methods of data collection and the analytical tools used.

Source of Data

The study was based on secondary data. Hence, a reliable source of data is very important to get the real picture. Secondary data consisting of monthly prices and arrivals of selected Pulses were collected from Agriculture Produce Market Committees (APMC)'s and the website www.agmarknet.nic.in was also used for the purpose. The future prices of Pigeon pea and Chickpea were collected from the website www.ncdex.nic.in. The data thus collected were tabulated, analyzed and subjected to statistical and econometric analysis to study the price behaviour and integration of markets.

Selection of Crop

For the present study, four major pulses namely Pigeon pea, Green gram, Black gram and Chickpea were selected, as it is the important pulse crops grown in Maharashtra which holds economic importance in the life of farmers of the Maharashtra.

Selection of Markets

The study has been confined to the Maharashtra state. Major four APMC's markets are selected on the basis of last three years arrival for each commodity.

Table 3.1 Commodity wise major markets selected.

Sr. No	Commodity	Major markets
1	Pigeon pea	Washim, Wardha, Mumbai and Latur
2	Green gram	Buldana, Akola, Amravati and Latur
3	Black gram	Mumbai, Solapur, Washim and Akola
4	Chickpea	Buldana, Washim, Latur and Amravati

For pigeon pea namely Washim, Wardha, Mumbai and Latur Markets were selected for the study. In respect of Green gram Buldana, Akola, Amravati and Latur markets were selected. In case of Black gram Mumbai, Solapur, Washim and Akola markets were selected and the Chickpea Buldana, Washim, Latur and Amravati markets were selected.

Period of the Study

For the study, monthly time series data on the prices and arrivals of Pulses were used for the period from January 2005 to December 2016.

Tools of Analysis

The choice of the statistical and econometric tools of analysis was decided with reference to the objectives of the study and the nature of data collected. The analytical techniques used in the study are presented below.

3.1 Seasonal and cyclical variations in prices and arrivals of selected pulses

3.1.1 Estimation of seasonal indices of monthly data

Most widely used method of measuring seasonal fluctuations i.e. method of simple average was used to calculate seasonal indices. To measure the seasonal variations in prices and arrivals, seasonal indices were calculated by employing twelve months ratio to moving average method. The seasonal indices were calculated by adopting the following steps.

1. Generate a series of 12 months moving average totals.
2. Generate a series of 12 months moving averages: A series of 12 months moving averages is generated by dividing 12 months moving totals by 12.

3. Generate a series of centered 12 months moving averages. This step involves taking averages of pairs of two subsequent 12 months moving averages and entering between each pair. There are no corresponding moving averages for the first six and last six months.
4. Express each original value as a percentage of corresponding centered moving average. The percentage of moving average represents indices of seasonal and irregular components combined.
5. The next step involves removing the irregular component.
6. Arrange the percentages of moving averages in the form of monthly arrays.
7. Next, the average index for each month is calculated.
8. These averages are to be adjusted in such a way that their sum becomes 1200. This can be done by working out of correction factor and multiplying the average for each month by this correction factor. The correction factor (K) is worked out as follows:

$$K = \frac{1200}{S}$$

Where, K is correction factor and S is sum of averages indices for 12 months, multiply K with the percentage of moving average for each month to obtain the seasonal indices.

3.1.2 Estimation of cyclical indices

The residual method of estimating cyclical movement in time series was used for estimating cyclical indices, after eliminating the seasonal variation and trend components. This is accomplished by dividing (Y_t) by corresponding (S) for time 't' symbolically. These deseasonalized data contain cyclical and irregular components.

3.2 Stationarity and Price Volatility in prices of selected pulses

3.2.1 Testing of stationarity in price series of selected pulses

Before analysing any time series data testing for stationarity is per-requisite. The stationarity of time series data on Pulses prices was tested

by applying the Augmented Dickey-Fuller test (ADF). The (ADF) test is the test for the unit root in a time series sample. A stationary series is one whose parameters are independent of time, exhibiting constant mean and variance and having autocorrelations that are invariant through time. If the series is found to be non-stationary, the first order differences of the series are tested for stationarity. The number of times (d) a series is differenced to make it stationary is referred to as the order of integration, I(d).

ADF unit root test are based on the following three regression forms:

Without constant and trend $\Delta Y_t = \delta Y_{t-1} + u_t$

With constant $\Delta Y_t = \alpha + \beta T + \Delta Y_{t-1} + u_t$

With constant and trend

The hypothesis is: $H_0: \delta = 0$ (Unit root)

$H_1: \delta \neq 0$

If $t^* >$ ADF critical value then accept the null hypothesis, i.e. unit root exists and

If $t^* <$ ADF critical value then reject the null hypothesis, i.e. unit root does not exists.

3.2.2 Price volatility in prices of selected pulses

To access the presence of price volatility in selected Pulses crop the ARCH-GARCH analysis was carried out. Auto Regressive Conditional Heteroscedasticity (ARCH) models are specifically designed to forecast conditional variances. ARCH model introduced by Engel (1982) and generalized as GARCH by Bollerslev (1986). These models are widely used in various branches of econometrics, especially in financial time series analysis. The ARCH model has two distinct specifications one for the conditional variance and the standard GARCH (1, 1) specification is presented below:

$$Y_t = \gamma_0 + \gamma_1 X_{1t} + \dots + \gamma_k X_{kt} + e \dots \dots \dots 1$$

$$\sigma^2_t = \omega + \alpha e^2_{t-1} + \beta \sigma^2_{t-1} \dots \dots \dots 2$$

Equation (1) is the mean equation and equation (2) is the conditional variance equation. The ARCH component (α) indicate the lag of

the squared residual from the mean equation and the GARCH term (β) the last period's forecast variance and the resultant sum of these co-efficient ($\alpha + \beta$) are presented. The sum of co-efficient very close to 1 would indicate that the volatility shocks are quite persistent in the prices data series.

3.3 Market Co-integration and Causality in prices of selected pulses

3.3.1 Market Co-integration in prices of selected pulses

Johansen's Multiple Co-integration test was employed to determine the long run relationship between the price series of selected markets. The test shows whether the selected pulses markets are integrated or not. Johansen (1988) has developed a multivariate system of equation approach, which allows for simultaneous adjustment of both or even more than two variables. The multivariate system of equation approach is more efficient than single equation approach since it allows to estimating the co-integration vector with smaller variance. The second advantage of the multivariate approach is that in the simultaneous estimation it is not necessary to presuppose ergogeneity of either of the variables.

3.3.2 Causality of price signals between selected pulses markets

The Granger causality test was applied to study the price interaction and to know the direction of causation between the selected markets. It is named after the first causality tests performed by Clive Granger (1969). It analyses the extent to which the past variations of one variable explain (or precede) subsequent variations of the other. When a co-integration relationship is present for two variables, a Granger Causality Test can be used to analyze the direction of this co-movement relationship. Granger causality tests come in pairs, testing whether variable x_t Granger-causes variable y_t and vice versa. All permutations are possible:

Univariate Granger causality from x_t to y_t or from y_t to x_t ,

Bivariate causality or absence of causality.

Formally, the Granger causality test analyses whether the unrestricted equation:

$$y_t = \alpha_0 + \sum_{i=1}^T \alpha_{1i} y_{t-i} + \sum_{j=1}^T \alpha_{2j} x_{t-j} + \varepsilon_t \text{ with } 0 \leq i, j \leq T$$

Yield better results than the restricted equation:

$y_t = \beta_0 + \sum_{i=1}^T \beta_{1i} y_{t-i} + \varepsilon_t$ with $\sum_{j=1}^T \alpha_{2j} x_{t-j} = 0$ (The null hypothesis)
i.e. if H_0 , in which $\alpha_{21} = \alpha_{22} = \dots = \alpha_{2T} = 0$, is rejected then one can state
“variable x_t Granger causes variable y_t ”

Theoretically, a variable is said to Granger-cause another variable, if the current value is conditional on the past value.

3.3.3 Short-run and Long-run behaviour of Pulses market prices

Vector Error Correction Model (VECM) was used to test the short run and long run behaviour of pulses markets prices. Even if one demonstrates market integration through co-integration, there should be disequilibrium in the short run i.e. price adjustment across markets may not happen instantaneously. It may take some time for the spatial price adjustments. Error correction model can incorporate such short-run and long-run changes in price movement. A generalized VECM formulation to understand both the short-run and long-run behaviour of prices can be considered by first taking the autoregressive distributed lag (ADL). The generalized form of this equation for k lags and an intercept term is as follows.

$$\Delta Y_t = a_{00} + \sum a_{i1} \Delta X_{t-1} + m_0 [m_1 X_{t-k} - Y_{t-k}] + \varepsilon_t$$

$$\text{Where } m_0 = (1 - \sum a_{i2})$$

The parameter m_0 measures the rate of adjustment of the short-run deviations towards the long run equilibrium. Theoretically, this parameter lies between 0 and 1 the value 0 denotes no adjustment and 1 indicate an instantaneous adjustment. A value between 0 and 1 indicate that any deviations will have gradual adjustment to the long-run equilibrium values.

3.4 Relationship between spot and future price of selected pulses

3.4.1 Market Co-integration

Johansen's Multiple Co-integration test was employed to determine the long run relationship between the spot and future prices of pulses. The test shows whether the selected spot and future pulses market are integrated or not in terms of prices.

3.4.2 Causality of price signals between spot and future markets

The Granger causality test was applied to study the price interaction and to know the direction of causation between the prices of spot and future markets.

3.5 price forecasting of selected pulses

In order to forecast the prices of pulses for the next season, univariate time series model such as ARIMA (Autoregressive Integrated Moving Average models) were used. Among the class of ARIMA models the best fit model was selected on the basis of lowest AIC (Akaike Information Criteria) values and the residuals were in confidence limit. (Box and Jenkins 1970)

3.6 Relationship between Pulses price and there processed products

The Granger causality test was applied to study the price interaction and to know the direction of causation between the Pulses prices and there process products. The Process products of Pigeon pea, Green gram and Black gram are Dal and Chickpea are Dal & Flour.

CHAPTER IV

SOCIO-ECONOMIC STATUS OF MAHARASHTRA

Maharashtra occupies the western and central part of the country and has a long coastline stretching nearly 720 km along the Arabian Sea. The Sahyadri mountain ranges provide a physical backbone to the State on the west, while the Satpuda hills along the north and Bhamragad-Gadchiroli-Gaikhuri ranges on the east serve as its natural borders. The State is surrounded by Gujarat to the North West, Madhya Pradesh to the north, Chhattisgarh to the east, Andhra Pradesh to the south east, Karnataka to the south and Goa to the south west.

The State enjoys tropical monsoon climate. The hot scorching summer from March onwards is followed by monsoon in early June. The rich green cover of the monsoon season persists during the mild winter that follows through an unpleasant October transition. The seasonal rains from the western sea-clouds are very heavy and the rainfall is over 400 cm on the Sahyadrian crests. The Konkan on the windward side is endowed with heavy rainfall, declining northwards. East of the Sahyadri, the rainfall diminishes to a meager 70 cm in the western plateau districts, with Solapur and Ahmednagar lying in the heart of the dry zone. The rains slightly increase eastwards in the Marathwada and Vidarbha regions. Maharashtra is the second largest state in India in terms of population and has geographical area about 3.08 lakh sq. km. It has a population of 11.24 corers (Census 2011) which is 9.3 per cent of the total population of India and is highly urbanized with 45.2 per cent people residing in urban areas. The State has 36 districts which are divided into six revenue divisions viz. Konkan, Pune, Nashik, Aurangabad, Amravati and Nagpur for administrative purposes, with effective machinery for planning at the district level.

Geographic Profile and Physical Divisions Maharashtra State

The state is located between 16° N and 22° N latitudes and 72° E and 80° E longitudes and falls in the western part of India, along the Arabian Sea. The state of Gujarat and the Union Territories of Daman, Dadra and

Nagar Haveli are to the North-West; Madhya Pradesh is to the North; Chhattisgarh to the East; Andhra Pradesh to the South-East and Karnataka and Goa lie to the South of Maharashtra. A 720 km long coastline stretches from Daman in the North to Goa in the South, which falls in the resource development zone called the Western Plateau and Hill Regions of India. Physical divisions of the State comprise of three parts based on its physical features, viz, Maharashtra Plateau, the Sahyadri Range and the Konkan Coastal Strip as explained below.

Maharashtra Plateau: The major physical characteristics of the state include many small plateau and river valleys. In the north the plateau is flanked by Satpuda ranges, which run in the East-West direction in Maharashtra. The river Narmada flows along the north boundary of Maharashtra, and other major rivers like Krishna, Godavari, Bhima, Penganga-Wardha, and Tapi-Purna have carved the plateau in alternating broad river valleys and intervening highlands.

The Sahyadri Range: The Western Ghats of Maharashtra known as the 'Sahyadri' mountain ranges have an average elevation of 1000-1200 m above the MSL. The Sahyadri hills run parallel to the seacoast, with many offshoots branching eastwards from the main ranges (Satmala, Ajanta, Harishchandra, Balaghat and Mahadeo). The special features are the hills of Trimbakeshwar, Matheran and the Mahabaleshwar plateau. Its highest peak is Kalsubai at an altitude of 1650 m. Most of the rivers in Maharashtra originate in the Sahyadri and then divide to join the eastward and westward flowing rivers. These ranges are also characterized by a number of ghats, the important ones being Thal, Bor, Kumbharli, Amba, Phonda and Amboli.

The Konkan Coastal Strip: The narrow strip of coastal land between the Sahyadri and the Arabian Sea is called the Konkan coastal strip. It is barely 50 km in width; it is wider in the north and narrows down in the south. River creeks and branches of the Sahyadri, which reach right up to the coast, dissect this coastline. The important creeks in Konkan are Terekhol, Vijaydurg, Rajapuri, Raigad, Dabhol, Daramthar, Thane and Vasai. The rivers

of Konkan rise from the cliffs of Sahyadri and have a short swift flow into the Arabian Sea. Some important rivers are Ulhas, Savitri, Vashishthi and Shastri.

Administrative Divisions Maharashtra has been divided into six divisions for administrative purposes viz. Amravati, Aurangabad, Konkan, Nagpur, Nashik, Pune different modes of administration in Maharashtra. The state consists of 35 districts, 33 Zilla Parishads, 353 Tehsils, 27,946 Gram Panchayats, 349 Panchayat Samitis, 222 Municipal Councils, 22 Municipal Corporations, 3 Nagar Panchayats, 7 Cantonment Boards, 41,095 inhabited villages, 2616 un-inhabited villages and 378 towns. Further, on socio-cultural basis, the State is divided into five regions, namely, Greater Mumbai, Marathwada (Aurangabad division), Konkan, Vidarbha (Amravati and Nagpur divisions) and Western Maharashtra (Pune and Nashik divisions) (Census, 2011).

The Gross State Domestic Product of Maharashtra for 2018-19 (at current prices) is estimated to be Rs 27,96,086. This is 12% higher than the revised estimate for 2017-18. Agriculture contributes 11.9% to the GSDP, industry and services contribute 33.6% and 54.5% respectively. The GSDP is estimated to grow at 7.3% in 2017-18, lower than the 10% growth in 2016-17. The real growth of the agriculture sector is expected to register negative growth at -8.3% in 2017-18 as compared to 22.5% in 2016-17. Industry and services are expected to grow at 6.5% and 9.7% in 2017-18 as compared to 6.9% and 9.6% respectively in 2016-17. Maharashtra per capita income (2016-17) at Rs 1,65,491, exceeds the national per capita income at Rs 1,03,870. (Maharashtra Budget Analysis 2018-19)

The State has 231 lakh ha of land under cultivation and area under forest is 52.1 lakh ha. Many irrigation projects are being implemented to improve irrigation. A watershed development programme is being implemented to ensure that soil and water conservation measures are implemented speedily in the unirrigated area. Animal husbandry is an important agriculture related activity. The State's share in livestock and poultry population in India is about 6.3 per cent and 11 per cent respectively. Maharashtra is one of the highly industrialized states. It is pioneer in Small

Scale Industries and continues to attract industrial investments from both, domestic as well as foreign institutions. It is a major IT growth centre.

The State has given importance to primary education, which has resulted in consistent improvement in literacy rate. The literacy rate of the State is 82.3 per cent against 73 per cent at national level as per Census 2011. Free education up to XIIth class is provided to girls. Excellent higher educational institutions in the fields of engineering, medical and management are located here. As per India Human Development Report 2011, India's Human Development Index is 0.467 whereas it is 0.572 for the State. The State has well spread road network of 2.64 lakh km (maintained by Public Works Department and Zilla Parishads). All weather roads and fair weather roads connect more than 99 per cent villages. The surface transport facilities and connectivity with sea ports and airports have resulted in good transport system. The State is well known for its administrative acumen and innovative ideas. It is first to implement Women Policy and engendering the budget by establishing separate 'Women and Child Development' department. It is pioneer in implementing its 'Employment Guarantee Scheme' which is replicated by the Government of India. Maharashtra is not just a geographical expression but an entity built on collective efforts of its people. Natural as well as cultural diversities have helped in the development of a unique Marathi culture. It has its own spiritual dimensions and known as Land of Saints. The State has played a significant role in the social and political scenario of the nation. Monuments such as Ajanta, Ellora and Elephanta caves, Gateway of India and architectural structures like Viharas and Chaityas attract tourists from all over the world. It has produced many important personalities covering almost every aspect of human development. The State has sizable contribution in sports, arts, literature and social services. The world famous film industry, popularly known as "Bollywood" is located in the State. All the above make Maharashtra a great place to live in.

Agricultural credit is an important input for improving agricultural production and productivity and reducing farmer distress. Crop insurance schemes are also implemented as a part of risk management and risk mitigation in agriculture. Estimated monthly per capita consumption of cereals

and pulses based on 68th round (2011-12) of National Sample Survey (NSS) are 9.08 kg and 0.97 kg respectively. The annual requirement of cereals and pulses for household consumption based on mid-year projected population for 2017-18 in the State is estimated to be about 131 lakh MT and 14 lakh MT respectively.

The land utilization statistics for 2017-18 depicts that out of the total 307.58 lakh ha geographical area of the State, the gross cropped area was 231.16 lakh ha while the net area sown was 173.44 lakh ha (56.4 per cent). The area under forest was 52.07 lakh ha (16.9 per cent), land not available for cultivation was 31.78 lakh ha (10.3 per cent), other uncultivated land was 24.12 lakh ha (7.9 per cent) and fallow land was 26.18 lakh ha (8.5 per cent). During the period of last five years, land put to non-agricultural uses has increased by 1.6 per cent. Agricultural Census 2010-11 depicts that there were 1.37 corer total operational holdings in the State, of which 78.6 per cent operational holdings belonged to marginal and small farmers with land holding less than or equal to two ha. The proportion of operational holdings of SC and ST was 7.5 per cent and 6.3 per cent and their area of operational holdings was 6.6 per cent and 7.9 per cent respectively. The average size of land holding of SC and ST was 1.27 ha and 1.80 ha respectively. In all 4,726 Water Users Associations (WUA) for command area of 18.83 lakh ha has been formed up to the end of December, 2016. Due to implementation of fundamental reforms in irrigation sector, the expenditure incurred on establishment and repairs and maintenance of projects is met through the recovery of water charges for last 10 years. A committee has been appointed to finalize provisions for ongoing projects by giving priority to projects nearing completion and creating irrigation potential as well as water storage. The water charges levied during 2017-18 were Rs. 607.04 corer as against recovery of Rs. 514.77 corer and outstanding recovery at the end of 2017-18 was Rs. 1,359.73 corer.

The above picture depicts the resource imbalance in allocation, utilisation and distribution in Maharashtra State. The need and scope proclaims to study the genuine condition of resources and its imbalances concern to agriculture.

References:

Economic Survey of Maharashtra (2017-18). Human Development Report of Maharashtra (2011).

The study on the rainfall behaviour always play an important role in formulation of cropping pattern as the farmers planning during the month of March and April are always based on normal rainfall , while it may change during June as monsoon delays, hence this rainfall distribution pattern that is normal, actual and rainy days play an important role in cropping pattern changes adopted by the farmers. The district wise rainfalls of Maharashtra State are as given in Table 4.1.

District wise Rainfall of Maharashtra State present in Table 4.1.the normal rainfall, actual rainfall and rainy days for the study period normal rainfall, actual rainfall and rainy days were highest in Ratnagiri and Sindhudurg districts. The Vidarbha picture shows that the Gadchiroli district ranked first in normal rainfall, actual rainfall and rainy days. The average normal rainfall, was lowest in Buldana district, however, during 2016-17, Yeotmal district ranked least in Vidarbha region for actual rainfall and rainy days.

From table 4.2 land utilization pattern plays an important role in agricultural farming as it gives the information on the area under cultivation and its distribution with reference to the cropped area. The most important aspects or the part brought to the notice is about the forest area and area sown more than once. The region wise land utilization pattern of the State are as given below.

Table 4.1: District wise Rainfall of Maharashtra
(Figures in mm, 2016-17)

Sr. No.	District	Total rain for Year		
		Normal Rain	Actual Rain	Rainy Days
1	Thane	2558.6	2546.9	83
2	Raigadh	3201.2	2264.1	89
3	Ratnagiri	3591.4	3135.0	115
4	Sindhudurg	3596.1	2915.0	118
5	Palghar	2575.2	2263.9	74
6	Nasik	1134.5	668.9	62
7	Dhule	612.4	606.8	43
8	Nandurbar	907.7	604.2	50
9	Jalgaon	755.6	714.1	47
10	Ahamadnagar	572.0	453.3	44
11	Pune	914.5	843.2	73
12	Solapur	641.8	490.0	51
13	Satara	1033.4	1094.6	82
14	Sangli	623.9	642.8	67
15	Kolhapur	2057.1	1355.9	94
16	Aurangabad	734.1	527.3	51
17	Jalna	750.4	426.7	36
18	Beed	743.4	423.4	34
29	Latur	871.8	496.0	39
20	Osmanabad	807.2	505.2	46
21	Nanded	1017.5	436.5	38
22	Parabhani	830.3	448.3	34
23	Hingoli	956.3	549.1	42
24	Buldana	785.9	551.1	37
25	Akola	808.9	585.5	37
26	Washim	924.3	607.2	43
27	Amravati	942.3	780.0	39
28	Yavatmal	1051.6	500.3	35
29	Wardha	1056.9	735.5	45
30	Nagpur	1139.4	797.3	50
31	Bhandara	1439.8	799.9	48
32	Gondia	1517.4	1055.1	57
33	Chandrapur	1276.8	666.9	42
34	Gadchiroli	1502.3	1168.4	60
	State Avg.	1278.30	1009.20	96

(Source: www.mahaagri.gov.in)

Table 4.2 : Region wise Land utilization pattern of Maharashtra - 2016-17
(Area in 00 ha.)

Sr. No.	Particular	Vidarbha	Marathwada	Western Maharashtra	Konkan
1	Total geographical area	97233 (100)	64434 (100)	116126 (100)	29790 (100)
2	Forest	26894 (27.66)	2256 (3.50)	17095 (14.72)	5864 (19.68)
3	Barren and uncultivable land	2308 (2.37)	1140 (1.77)	8578 (7.39)	5254 (17.64)
4	Land under non-agricultural use	6215 (6.39)	2446 (3.80)	3693 (3.18)	2171 (7.29)
5	Cultivable waste land	2073 (2.13)	2178 (3.38)	2232 (1.92)	2709 (9.09)
6	Permanent pastures and grazing land	5040 (5.18)	2214 (3.44)	4078 (3.51)	1106 (3.71)
7	Land under miscellaneous tree crops and grooves	616 (0.63)	491 (0.76)	596 (0.51)	801 (2.69)
8	Current fallows	2743 (2.82)	5326 (8.27)	5054 (4.35)	660 (2.22)
9	Other fallows	1509 (1.55)	3125 (4.87)	4236 (3.65)	3046 (10.22)
10	Net area sown	49835 (51.25)	45278 (70.27)	70564 (60.77)	8179 (28.46)
11	Area sown more than once	14654 (15.07)	24748 (38.41)	17175 (14.79)	627 (2.10)
12	Total cropped area	64489 (66.32)	70026 (108.68)	87739 (75.55)	8806 (29.56)

(Source: www.mahaagri.gov.in) (Figures in parenthesis are percentage to the total)

The table present that the region wise land utilization pattern for the study period the net area shown was highest in Marathwada region 70.27 percent fallowed by Western Maharashtra (60.77%), Vidarbha (51.25%) and Konkan (28.46%) respectively. Land under miscellaneous tree crops and grooves were highest in Konkan region (2.69%) fallowed by Marathwada (0.76%), Vidarbha (0.63%) and Western Maharashtra (0.51%) respectively.

Total geographical area shown in highest in Western Maharashtra (116126) followed by Vidarbha region (97233), Marathwada region (64434) and Konkan region (29790) respectively. Percentage of forest area was observed highest in Vidarbha region (27.66%) followed by Konkan region (19.68%), Western Maharashtra (14.72%) and Marathwada region (3.50%). Percentage of barren and uncultivable land area was observed highest in Konkan region (17.64%) followed by Western Maharashtra (7.39%), Vidarbha (2.37%) and Marathwada (1.77%) respectively. Percentage of land under non-agricultural use area was observed highest in Konkan region (7.29%) followed by Vidarbha (6.39%), Marathwada (3.80%) and Western Maharashtra (3.18%) respectively. Percentage of cultivable waste land area was observed highest in Konkan region (9.03%) followed by Marathwada (3.38%), Vidarbha (2.13%) and Western Maharashtra (1.92%) respectively. Percentage of permanent pastures and grazing land area was observed highest in Vidarbha (5.18%) followed by Konkan region (3.71%), Western Maharashtra (3.51%) and Marathwada (3.44%) respectively. Percentage of current fallows land area was observed highest in Marathwada region (8.27%), followed by Western Maharashtra (4.35%), Vidarbha (2.82%) and Konkan region (2.22%) respectively. Percentage of other fallows land area was observed highest in Konkan region (10.22%), followed by Marathwada region (4.87%), Western Maharashtra (3.65%) and Vidarbha (1.55%) respectively. Percentage of area shown more than once land area was observed highest in Marathwada region (38.41%), followed by Vidarbha (15.07%), Western Maharashtra (14.79%) and Konkan region (2.10%) respectively.

The cropping pattern presents the contribution of the crops grown by the farmers in the region predominantly. The crops grown gives the farming status of the region, hence the Vidarbha region cropping pattern has impact of soybean, cotton and tur, Marathwada cropping pattern cotton, rabi jowar and tur, Western Maharashtra rabi jowar and sugarcane, while Konkan region paddy. It is depicted in the cropping pattern presented in the table 4.3.

This table 4.3 shows that the region wise cropping pattern of Maharashtra for the study period. Total gross cropped area was observed highest in Western Maharashtra (87739 ha.), followed by Marathwada region (70026 ha.), Vidarbha (64489 ha.), and Konkan region (8806 ha.)

respectively. Percentage of kh.Rice area was observed highest in Konkan region (43.83%) followed by Vidarbha (11.51%), Western Maharashtra (4.10%) and Marathwada region (0.29%) respectively.

Table 4.3 : Region wise cropping pattern of Maharashtra- 2016-17.

(Area in 00 ha)

Sr. No.	Name of Crops	Vidrabha	Marathwada	Western. Maharashtra.	Konkan
1	Kh. Rice	7420 (11.51)	204 (0.29)	3599 (4.10)	3860 (43.83)
2	Kh. Jowar	1237 (1.92)	3664 (5.23)	1900 (2.17)	-
3	Tur	5833 (9.04)	5362 (7.66)	861 (0.98)	46 (0.52)
4	Mung	768 (1.19)	1576 (2.25)	803 (0.98)	5 (0.06)
5	Udid	423 (0.66)	1516 (2.16)	775 (0.88)	51 (0.58)
6	Soybean	20740 (32.16)	12229 (17.46)	3453 (3.94)	-
7	Sugarcane	243 (0.38)	2194 (3.13)	7859 (8.96)	-
8	Cotton	14059 (21.80)	18337 (26.19)	9503 (10.83)	-
9	Rabi Jowar	263 (0.41)	8281 (11.83)	17535 (19.99)	-
10	Wheat	3596 (5.58)	2790 (3.98)	4287 (4.89)	-
11	Gram	5197 (8.06)	4871 (6.96)	4158 (4.74)	46 (0.52)
12	Others	4710 (7.30)	9002 (12.86)	33006 (37.62)	4798 (54.49)
	Gross cropped area	64489 (100)	70026 (100)	87739 (100)	8806 (100)

(Source: www.mahaagri.gov.in) (Figures in parenthesis are percentage to the total)

Percentage of kh. Jowar area was observed highest in Marathwada region (5.23%) followed by Western Maharashtra (2.17%), Vidarbha (1.92%) respectively. Percentage of Tur area was observed highest in Vidarbha (9.04%) followed by Marathwada region (7.66%), Western Maharashtra (0.98%) and Konkan region (0.52%) respectively. Percentage of Mung area was observed highest in Marathwada region (2.25%) followed by

Vidarbha (1.19%), Western Maharashtra (0.98%) and Konkan region (0.06%) respectively. Percentage of Udid area was observed highest in Marathwada region (2.16%) followed by Western Maharashtra (0.88%), Vidarbha (0.69%) and Konkan region (0.58%) respectively. Percentage of Sugercane area was observed highest in Western Maharashtra (8.96%), followed by Marathwada region (3.13%), Vidarbha (0.38%) respectively. Percentage of Cotton area was observed highest in Marathwada region (26.19%), followed by Vidarbha (21.80%) and Western Maharashtra (10.83%) respectively. Percentage of Rabi Jowar area was observed highest in Western Maharashtra (19.99%), followed by Marathwada region (11.83%) and Vidarbha (0.41%) respectively. Percentage of Wheat area was observed highest in Vidarbha (5.58%) followed by Western Maharashtra (4.89%) and Marathwada region (3.98%) respectively. Percentage of Gram area was observed highest in Vidarbha (8.06%) followed by Marathwada region (6.96%), Western Maharashtra (4.74%) and Konkan region (0.52%) respectively. Percentage of Other area was observed highest in Konkan region (54.49%) followed by Western Maharashtra (37.62%), Marathwada region (12.86%) and Vidarbha (7.30%) respectively.

Status of Agricultural Marketing in India

Agricultural marketing is mainly the buying and selling of agricultural products. In earlier days when the village economy was more or less self-sufficient the marketing of agricultural products presented no difficulty as the farmer sold his produce to the consumer on a cash or barter basis. Agricultural marketing in India is to sell the surplus produce through mandis located in various small and large towns. There are nearly 2477 mandis which are spread all over the country. As these mandis are located in a distant place, thus the farmers will have to carry their produce to the mandi and sell those produce to the wholesalers with the help of brokers or 'dalals'. These wholesalers or mahajans again sell those farm produce to the mills and factories and to the retailers who in turn sell these goods to the consumers directly in the retail markets.

Today's agricultural marketing has to undergo a series of exchanges or transfers from one person to another before it reaches the consumer. There are three marketing functions involved in this, i.e., assembling, preparation for consumption and distribution. Selling of any agricultural produce depends on some couple of factors like the demand of the product at that time, availability of storage etc. The products may be sold directly in the market or it may be stored locally for the time being. Moreover, it may be sold as it is gathered from the field or it may be cleaned, graded and processed by the farmer or the merchant of the village. Sometimes processing is done because consumers want it, or sometimes to conserve the quality of that product. The task of distribution system is to match the supply with the existing demand by whole selling and retailing in various points of different markets like primary, secondary or terminal markets.

Most of the agricultural products in India are sold by farmers in the private sector to moneylenders (to whom the farmer may be indebted) or to village traders. Products are sold in various ways. For example, it might be sold at a weekly village market in the farmer's village or in a neighboring village. If these outlets are not available, then produce might be sold at irregularly held markets in a nearby village or town, or in the mandi.

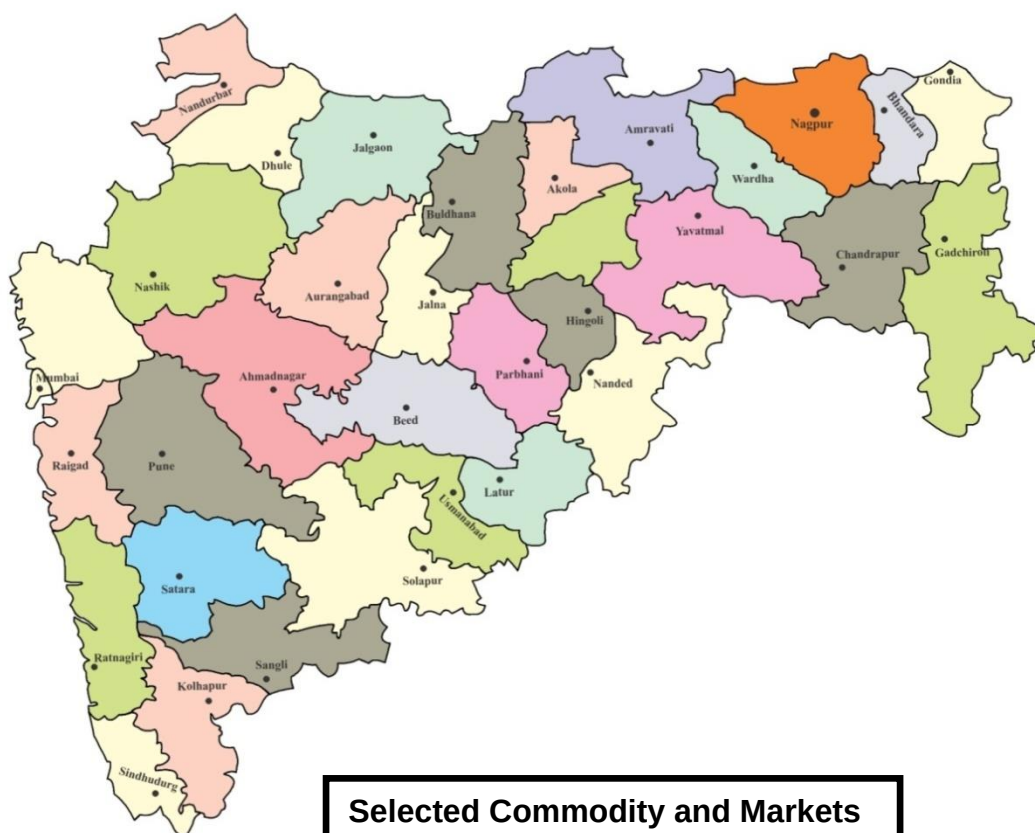
In India, there are several central government organisations, who are involved in agricultural marketing like, Commission of Agricultural Costs and Prices, Agriculture marketing information system (AGMARKNET), National Commodity and Derivatives Exchange (NCDEX) Market etc.

Presently, markets in agricultural products are regulated under the Agricultural Produce Market Committee (APMC) Act enacted by State Governments. There are about 2477 principal regulated markets based on geography (the APMCs) and 4843 sub-market yards regulated by the respective APMCs in India. The Maharashtra State Agricultural Marketing Board (MSAMB) runs 295 APMCs in Maharashtra, under the APMC Act enacted by the Government of India.

Maharashtra State is the second largest producer of pulses with 3.5 million hectare area under cultivation. There is a huge yield gap across pulse growing districts in Maharashtra are Latur, Akola, Amravati, Washim, Wardha, Nagpur, Buldana, Solapur, Parbhani and Nanded. Certain districts including Akola, Mumbai and Jalgaon are the major processing and trading hubs.



Location of Maharashtra state in India



Selected Commodity and Markets

Pigeon pea	Green gram	Black gram	Chickpea
Washim	Buldana	Mumbai	Buldana
Wardha	Akola	Solapur	Washim
Mumbai	Amravati	Washim	Latur
Latur	Latur	Akola	Amravati

Fig. 1. Map of Maharashtra

CHAPTER V

RESULTS AND DISCUSSION

The data collected were analyzed in relation to each of the specific objective of the study and results have been tabulated. In this chapter, the results of the analysis are presented and discussed in the following sections.

5.1 Seasonal and cyclical variations in prices and arrivals of selected pulses

5.2 Stationarity and price volatility in prices of selected pulses

5.3 Market co-integration and granger causality in prices of selected pulses

5.4 Short-run and long-run behaviour of pulses market prices

5.5 Relationship between spot and future prices of selected pulses

5.6 Price forecasting of selected pulses

5.7 Relationship between pulses prices and there process products

5.1 Seasonal and cyclical variations in prices and arrivals of selected pulses

5.1.1 Seasonal indices for pulses prices

The seasonal indices of monthly average prices of Pigeon pea in Washim, Wardha, Mumbai and Latur market, Green gram in Buldana, Akola, Amravati and Latur market, Black gram in Mumbai, Solapur, Washim and Akola market and Chickpea in Buldana, Washim, Latur and Amravati market have been analyzed using the method of seasonal indices for measuring seasonal variations and are presented below.

5.1.1.1 Seasonal indices for Pigeon pea prices

From table 5.1 it was observed that in selected markets the prices of Pigeon pea were higher from July to October. In the selected markets lower prices were noticed during the month from November to April. During these months the arrivals starts which lowered down the prices. Due to the poor holding capacity of the farmers. The traders are benefited confirming the inverse relationship between prices and arrivals. Similar results were

found by Patil *et al.* (2014) the prices of Pigeon pea were higher in the months from July to October in all selected markets. MohdAsmatoddinet *al.* (2009) the Pigeon pea prices indices were highest during June to November of every year and lowest during December to May.

Table 5.1 Seasonal indices of Pigeon pea prices for selected markets

Month	Washim	Wardha	Mumbai	Latur
Jan	94.66	90.95	94.96	96.18
Feb	94.60	87.65	95.28	95.96
Mar	94.34	97.83	93.02	88.91
Apr	99.66	102.46	98.14	101.55
May	100.96	104.02	98.35	92.13
Jun	101.01	94.99	99.66	93.12
Jul	106.63	109.41	101.86	105.49
Aug	108.11	109.11	103.13	106.35
Sep	106.75	110.12	103.54	107.80
Oct	103.62	101.74	108.97	110.71
Nov	92.72	96.94	102.40	97.72
Dec	96.95	94.78	100.69	104.09

5.1.1.2 Seasonal indices for Green gram prices

The seasonal indices of monthly average prices of Green gram in Buldana, Akola, Amravati and Latur markets were worked out, which are presented in table 5.2.

From table 5.2 it was observed that in selected markets the prices of Green gram were higher the months of December to June. All the markets recorded lower prices during the month from July to November. During these months the arrivals starts which lowered down the prices. Similar results were obtained by Dave and Tarpara (2016) the higher prices of Green gram were noticed during March to May months in selected markets of study. Benkeet *al.* (2016) the highest prices of Green gram were observed during March to June.

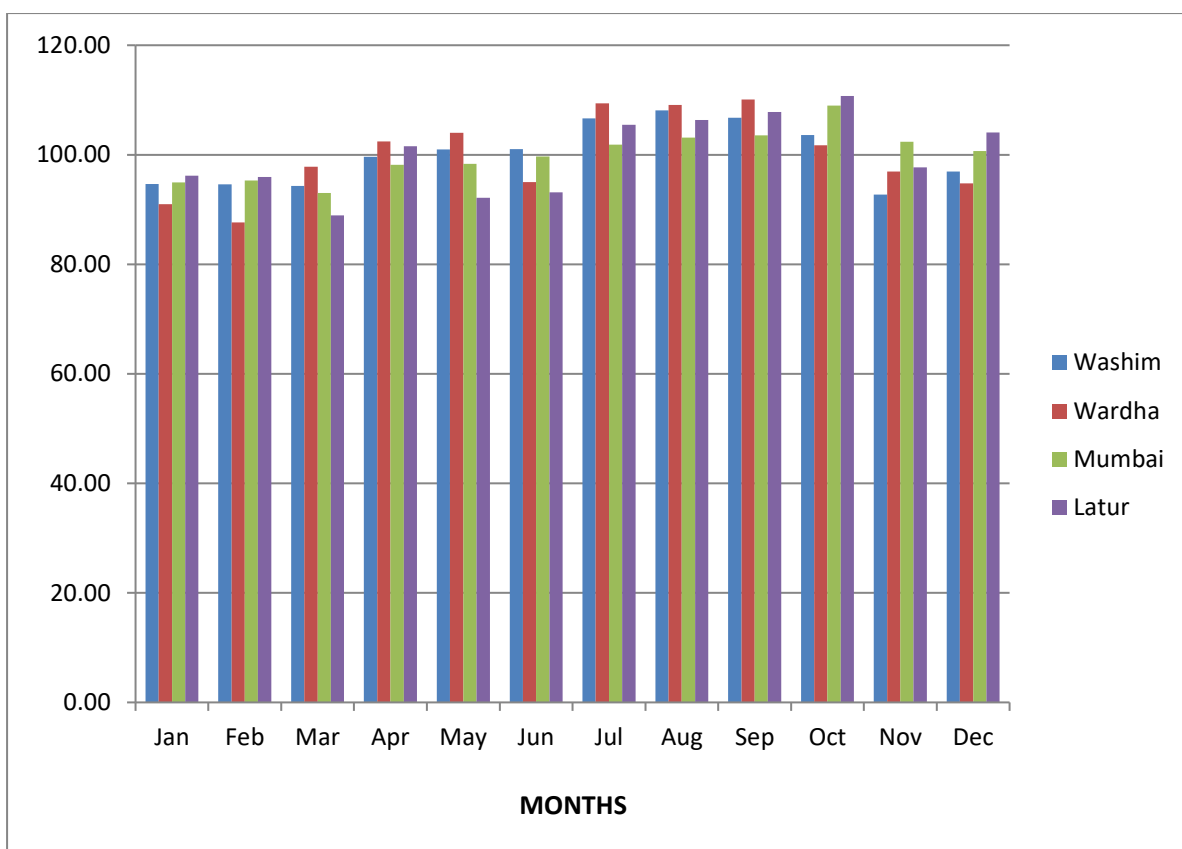


Fig. 2. Seasonal indices of Pigeon pea prices for selected markets

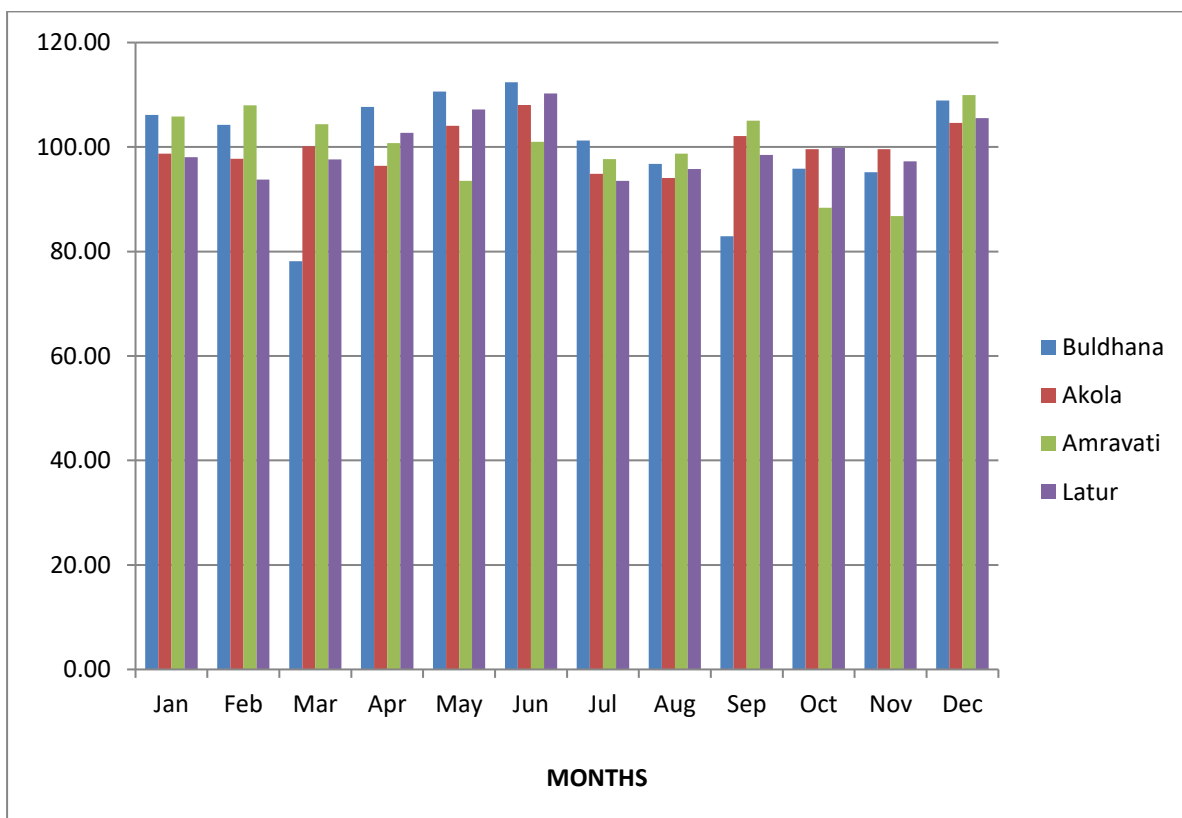


Fig. 3. Seasonal indices of Green gram prices for selected markets

Table 5.2 Seasonal indices of Green gram prices for selected markets

Month	Buldana	Akola	Amravati	Latur
Jan	106.16	98.73	105.86	98.04
Feb	104.24	97.74	107.99	93.76
Mar	78.12	100.11	104.38	97.64
Apr	107.68	96.43	100.75	102.71
May	110.60	104.06	93.52	107.16
Jun	112.40	108.04	100.97	110.24
Jul	101.22	94.88	97.67	93.55
Aug	96.78	94.06	98.72	95.77
Sep	82.94	102.12	105.06	98.50
Oct	95.82	99.59	88.37	99.85
Nov	95.15	99.60	86.76	97.26
Dec	108.88	104.64	109.96	105.53

5.1.1.3 Seasonal indices for Black gram prices

The seasonal indices of monthly average prices of Black gram in Mumbai, Solapur, Washim and Akola markets were worked out, which are presented in table 5.3.

From table 5.3 it was revealed that in selected markets the prices were higher from April to June. Also highest prices were observed during November and December in selected markets. The lower prices were recorded during July to October.

Table 5.3 Seasonal indices of Black gram prices for selected markets

Month	Mumbai	Solapur	Washim	Akola
Jan	92.46	92.81	95.12	93.83
Feb	91.24	86.58	91.37	90.50
Mar	90.76	86.35	92.50	91.09
Apr	107.92	107.22	103.85	100.86
May	108.88	113.43	114.05	108.74
Jun	107.31	114.66	106.98	108.18
Jul	95.31	99.30	99.96	101.82
Aug	99.04	96.63	96.64	100.16
Sep	96.60	92.27	96.17	95.31
Oct	101.39	97.43	98.38	100.60
Nov	103.80	102.63	102.09	102.98
Dec	105.30	110.70	102.89	105.95

Thakaret *al.* (2017) observed that the seasonal indices of Black gram prices were higher in the month of September to November and lower prices are observed during June to August in selected markets of their study.

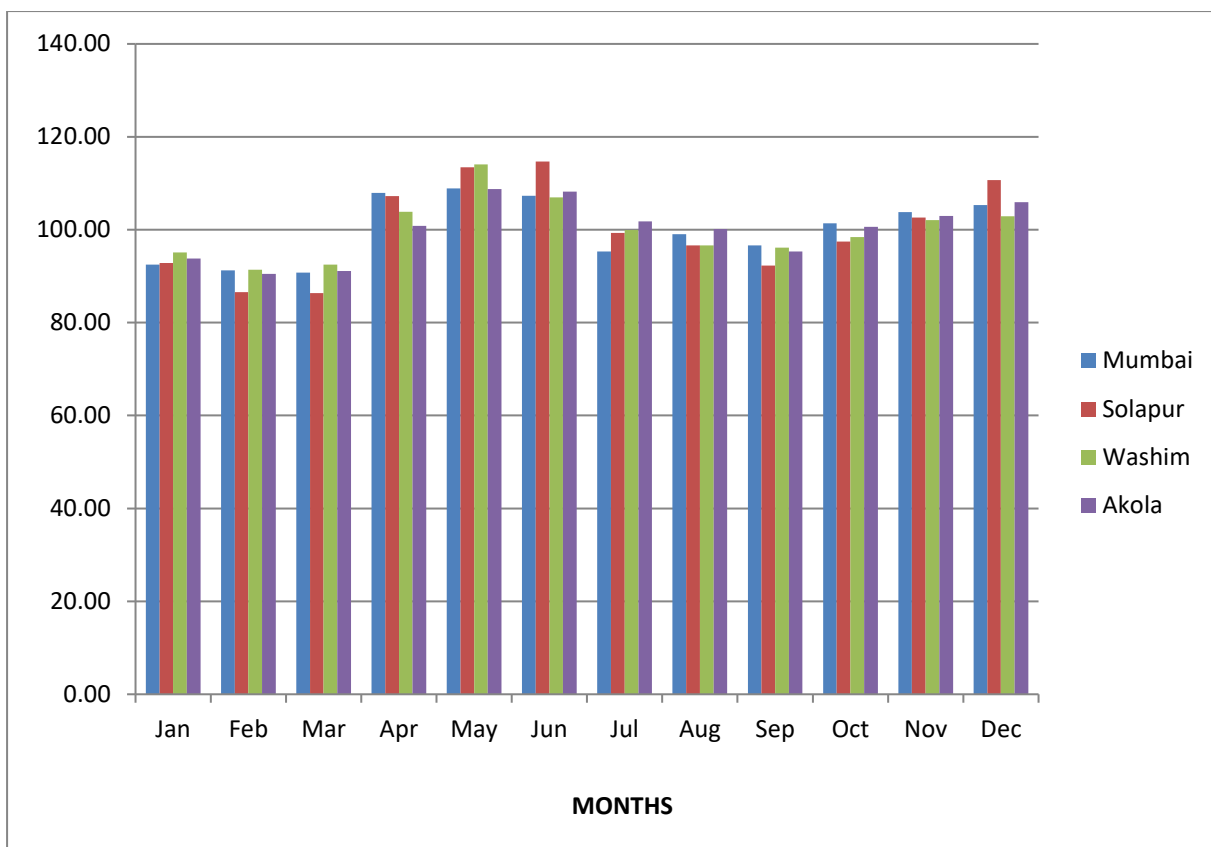


Fig. 4. Seasonal indices of Black gram prices for selected markets

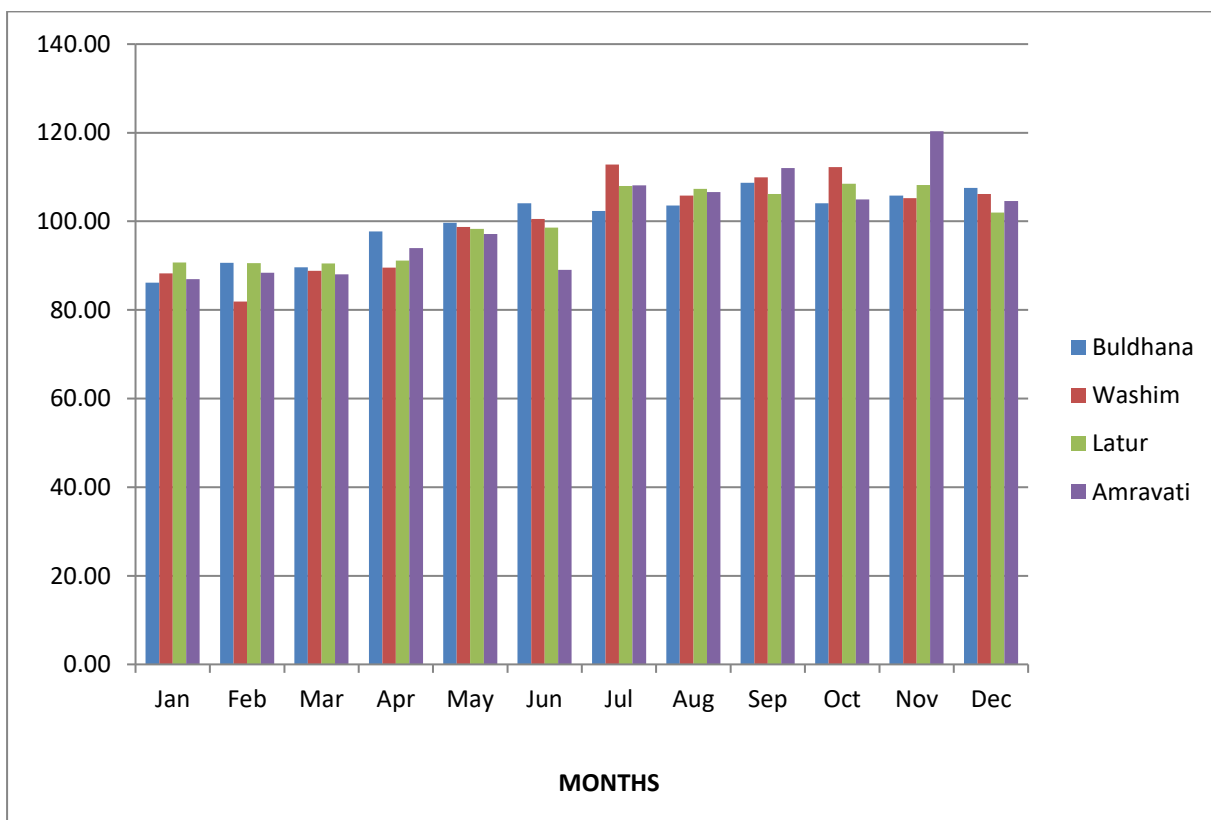


Fig. 5. Seasonal indices of Chickpea prices for selected markets

5.1.1.4 Seasonal indices for Chickpea prices

The seasonal indices of monthly average prices of Chickpea in Buldana, Washim, Latur and Amravati markets were worked out, which are presented in table 5.4.

From table 5.4 it was noticed that in selected markets the prices of Chickpea were higher during the month of July to December. All the selected markets recorded lower prices in the months from January to June. Due to heavy arrivals during these months the prices are lower down. Supporting results were obtained by Sahoo and Singh (2017) observed that the high value of seasonal indices noticed in the month of May to July and October to December month.

Table 5.4 Seasonal indices of Chickpea prices for selected markets

Month	Buldana	Washim	Latur	Amravati
Jan	86.13	88.24	90.73	86.92
Feb	90.67	81.87	90.55	88.38
Mar	89.65	88.82	90.48	88.04
Apr	97.73	89.58	91.15	93.97
May	99.69	98.76	98.31	97.13
Jun	104.05	100.53	98.59	89.05
Jul	102.37	112.82	108.01	108.14
Aug	103.56	105.77	107.33	106.58
Sep	108.73	109.93	106.19	112.00
Oct	104.07	112.27	108.48	104.92
Nov	105.79	105.26	108.18	120.33
Dec	107.56	106.14	102.01	104.55

5.1.2 Cyclical indices for Pulses prices

The cyclical variations in prices were analyzed in order to know the variations in prices over the years. The cyclical indices for Pulses prices were work out for the period of 2005 to 2016. The market have been analyzed using the residual method of estimating cyclical indices and the results are presented below.

5.1.2.1 Cyclical indices for Pigeon pea prices

From table 5.5 it was observed that the cyclical variations were observed in the prices of Pigeon pea in selected markets. The higher prices were noticed in the year 2005, 2006, 2009, 2015 and 2016 for all the markets. Lower prices were observed in the year 2008, 2011, 2012, 2013 and 2014. The rise in prices might be attributed to less production due to bad weather

and stock in the hand of middleman. Patil *et al.* (2014) observed that the higher cyclical indices of Pigeon pea prices were noticed for the year 2003, 2004, 2009 and 2010 for all the selected markets of study and lower prices were noticed in the year 2007, 2008, 2011, 2012 and 2013.

Table 5.5 Cyclical indices of Pigeon pea prices for selected markets

Year	Washim	Wardha	Mumbai	Latur
2005	128.39	127.40	145.41	142.35
2006	95.48	102.42	114.29	102.16
2007	97.90	95.92	101.73	103.01
2008	94.97	93.39	96.36	90.26
2009	130.97	134.72	118.26	134.19
2010	102.79	104.01	93.15	73.97
2011	77.56	77.11	75.29	80.40
2012	79.98	83.85	67.23	82.74
2013	79.58	68.77	69.31	79.29
2014	80.64	68.19	77.47	74.75
2015	117.10	127.99	126.40	125.98
2016	114.65	116.22	115.10	110.91

5.1.2.2 Cyclical indices for Green gram prices

From table 5.6 it was seen that the cyclical variations were observed in the prices of Green gram in selected markets. Higher prices were noticed in the year 2006, 2009, 2010, 2014 and 2015 for all the markets. The rise in prices might be attributed to less production due to bad weather condition. Lower prices were observed in the year 2005, 2007, 2008, 2011, 2012 and 2016.

Table 5.6 Cyclical indices of Green gram prices for selected markets

Year	Buldana	Akola	Amravati	Latur
2005	90.56	102.14	108.10	104.99
2006	109.67	117.75	126.37	120.51
2007	91.43	84.54	91.49	89.73
2008	84.11	76.57	58.06	78.45
2009	107.39	114.59	122.99	114.14
2010	121.66	121.54	126.31	109.64
2011	90.90	90.23	85.54	85.52
2012	93.74	88.74	83.32	87.82
2013	104.76	92.54	73.15	94.05
2014	118.22	104.87	103.44	109.07
2015	106.89	115.77	126.22	116.20
2016	80.67	90.72	95.00	89.88

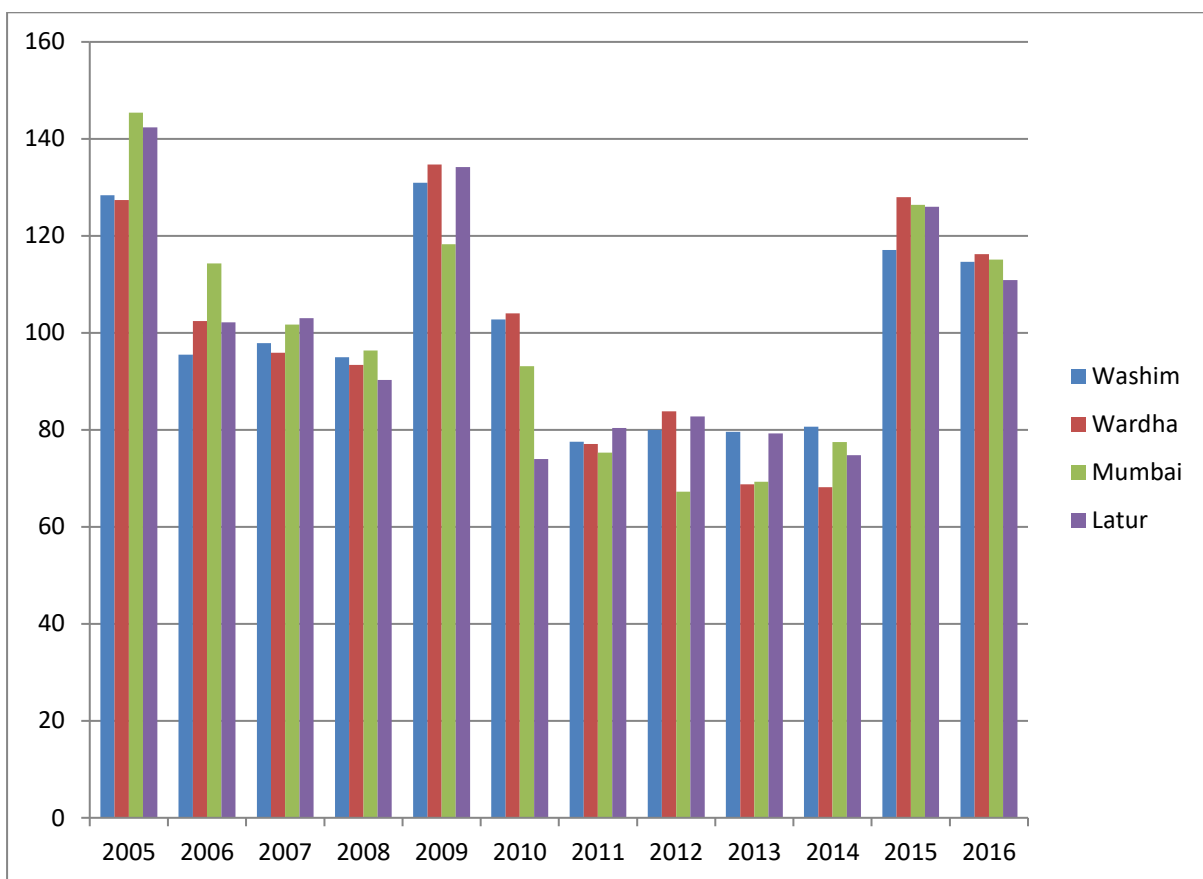


Fig. 6.Cyclical indices of Pigeon pea prices for selected markets

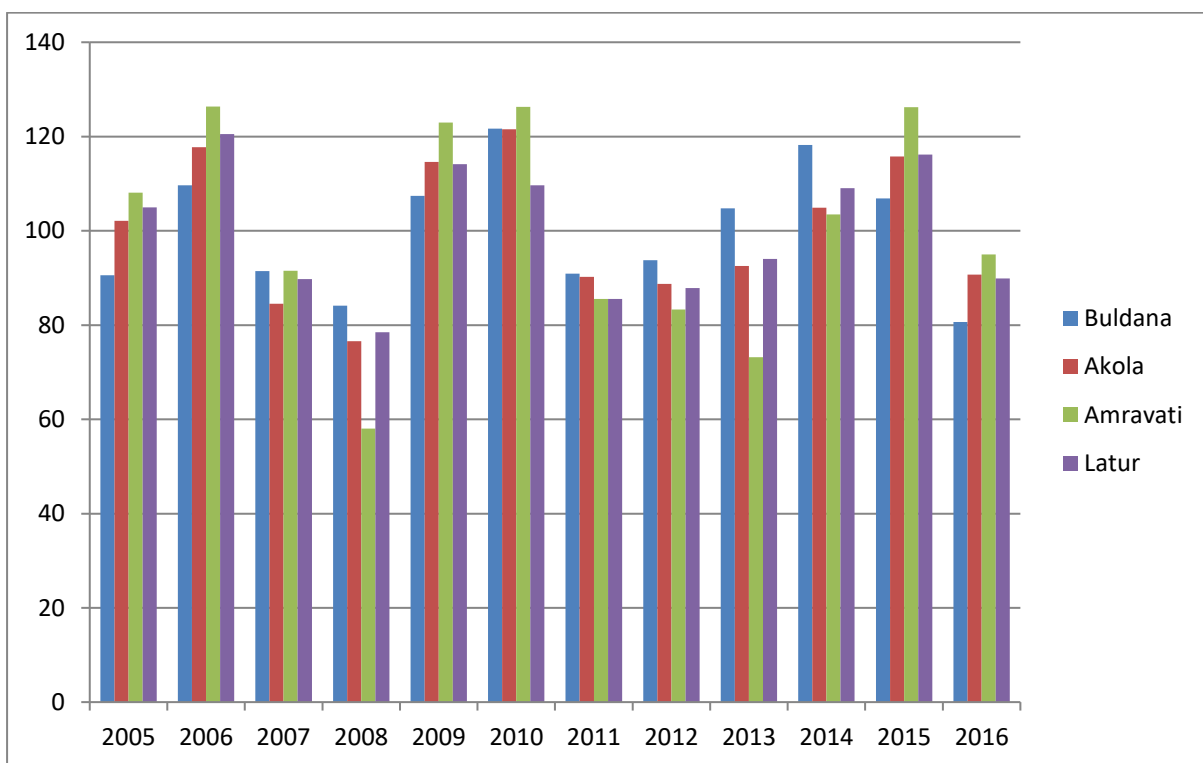


Fig. 7.Cyclical indices of Green gram prices for selected markets

Benkeet *et al.* (2016) revealed that the higher prices in Green gram were observed in the year 1997, 1998, 1999, 2000 and 2001 and lower prices were noticed in the year 2001 to 2005 for the selected markets.

5.1.2.3 Cyclical indices for Black gram prices

From table 5.7 it was revealed that the cyclical variations were observed in the prices of Black gram in selected markets. The higher prices were seen for the year 2005, 2006, 2010, 2015 and 2016. Lower prices were observed in the year 2008, 2009, 2011, 2012, 2013 and 2014 for all the markets. Patil and Tingre (2015) noted that the higher prices were observed in the year 2006, 2009 and 2010 for all selected markets of study and the lower prices were noted for the year 2003, 2005, 2008, 2011, 2012 and 2013.

Table 5.7 Cyclical indices of Black gram prices for selected markets

Year	Mumbai	Solapur	Washim	Akola
2005	131.41	107.83	145.29	117.92
2006	157.06	147.67	145.91	156.52
2007	97.26	122.88	103.96	96.04
2008	75.99	79.79	68.93	76.82
2009	96.97	95.37	102.95	100.04
2010	100.66	101.02	104.18	115.64
2011	75.62	79.21	77.91	77.98
2012	69.69	73.60	68.23	70.17
2013	74.49	64.68	66.11	65.07
2014	82.75	77.39	74.71	72.63
2015	118.85	128.09	116.84	125.47
2016	119.25	122.49	124.99	125.70

5.1.2.4 Cyclical indices for Chickpea prices

From table 5.8 it was observed that the cyclical variations were observed in the prices of Chickpea in selected markets. Higher prices were observed in the year 2006, 2007, 2012 and 2016 for all the selected markets. In the Washim, Latur and Amravati market relatively higher prices was also noticed in the year 2005. Lower prices were observed in the year 2008, 2009, 2010, 2013 and 2014 for all markets. In the Washim, Latur and Amravati market relatively lower prices was also observed in the year 2011.

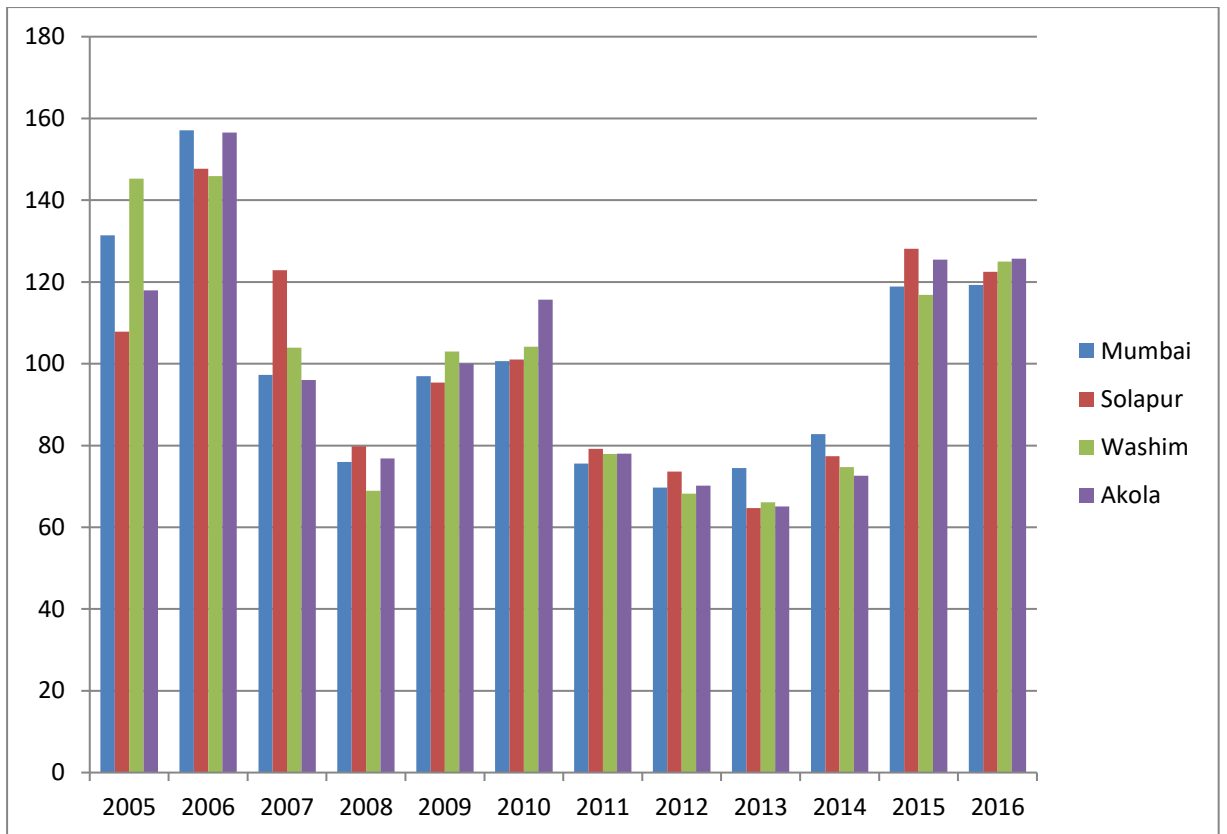


Fig. 8.Cyclical indices of Black gram prices for selected markets

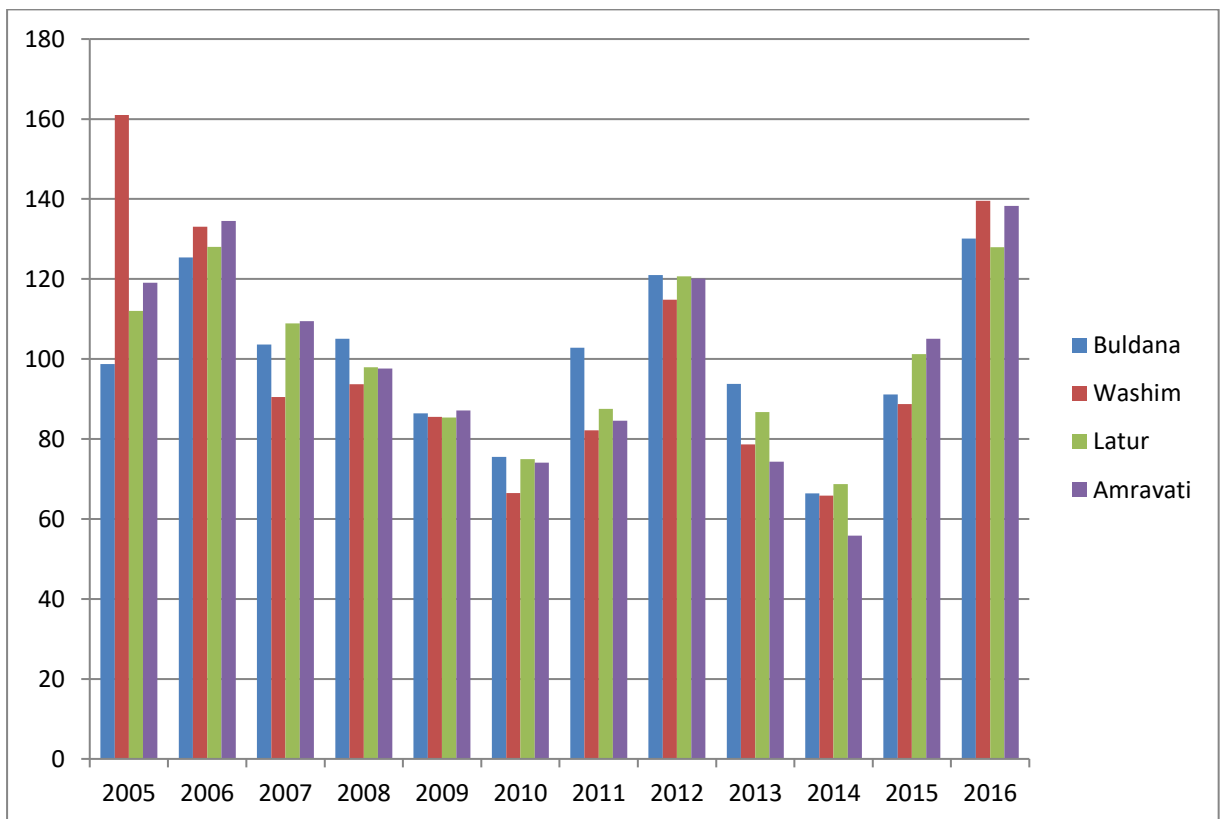


Fig. 9.Cyclical indices of Chickpea prices for selected markets

Table 5.8 Cyclical indices of Chickpea prices for selected markets

Year	Buldana	Washim	Latur	Amravati
2005	98.73	161.00	111.99	119.05
2006	125.42	133.09	128.02	134.55
2007	103.61	90.47	108.90	109.45
2008	105.02	93.69	97.97	97.59
2009	86.40	85.50	85.40	87.10
2010	75.53	66.51	74.96	74.10
2011	102.83	82.17	87.53	84.58
2012	121.02	114.85	120.70	120.09
2013	93.74	78.61	86.70	74.33
2014	66.42	65.80	68.73	55.86
2015	91.16	88.75	101.20	105.02
2016	130.14	139.56	127.91	138.27

5.1.3 Seasonal indices for pulses arrivals

The seasonal indices of monthly arrivals of Pigeon pea in Washim, Wardha, Mumbai and Latur market, Green gram in Buldana, Akola, Amravati and Latur market, Black gram in Mumbai, Solapur, Washim and Akola market and Chickpea in Buldana, Washim, Latur and Amravati market have been analyzed using the method of seasonal indices for measuring seasonal variations and are presented below.

5.1.3.1 Seasonal indices for Pigeon pea arrivals

The seasonal indices of monthly arrivals of Pigeon pea in Washim, Wardha, Mumbai and Latur markets were worked out, which are presented in table 5. 9.

Table 5.9 Seasonal indices of Pigeon pea arrival for selected markets

Month	Washim	Wardha	Mumbai	Latur
Jan	292.55	184.13	229.16	265.83
Feb	213.09	295.04	201.50	235.91
Mar	125.91	203.67	120.78	135.60
Apr	110.05	143.84	105.41	104.28
May	131.11	96.50	132.18	100.64
Jun	88.75	76.27	95.00	89.04
Jul	62.62	42.36	64.17	65.55
Aug	42.64	35.99	47.04	47.27
Sep	32.52	50.91	22.07	31.02
Oct	22.23	27.11	48.94	22.54
Nov	12.37	20.55	72.85	19.28
Dec	66.17	23.64	60.91	83.02

The arrivals of Pigeon pea start hitting in market from the month of January and continue for next four to five months. The peak period of arrivals is January to May as the higher values of seasonal indices were observed during these months. Due to large arrivals during this period the prices are declined. The lower values of indices of arrivals were during the period of June to December indicated lean period in Pigeon pea arrivals in all markets. Similar results were found by Thombre and More (2013) the bulk of commodity comes to market immediately after harvesting of crops during January to May results in price are declined.

5.1.3.2 Seasonal indices for Green gram arrivals

The seasonal indices of monthly arrivals of Green gram in Buldana, Akola, Amravati and Latur markets were worked out, which are presented in table 5.10.

The arrivals of Green gram start hitting in market from the month of September and continue for next three months. The peak period of arrivals is September to November as the higher values of seasonal indices were observed. In the month of September Amravati market production and arrival are higher as compared to other market months. The lower values of indices of arrivals were observed during the period of January to August indicated lean period in Green gram arrivals in all markets.

Table 5.10 Seasonal indices of Green gram arrival for selected markets

Month	Buldana	Akola	Amravati	Latur
Jan	76.55	41.01	35.88	65.26
Feb	41.52	75.38	27.40	27.28
Mar	20.62	9.77	30.74	24.91
Apr	8.36	7.90	56.95	55.36
May	14.27	10.20	7.47	70.82
Jun	18.20	12.41	11.83	62.56
Jul	21.73	12.47	8.70	49.03
Aug	76.25	65.80	51.57	61.64
Sep	345.12	311.64	603.25	278.17
Oct	377.37	306.81	234.17	309.44
Nov	123.65	215.04	83.12	133.52
Dec	76.34	131.58	48.92	62.00

Similar results were reported by Benkeet *al.* (2016) concluded that the bulk of commodity comes for market immediately after harvesting of

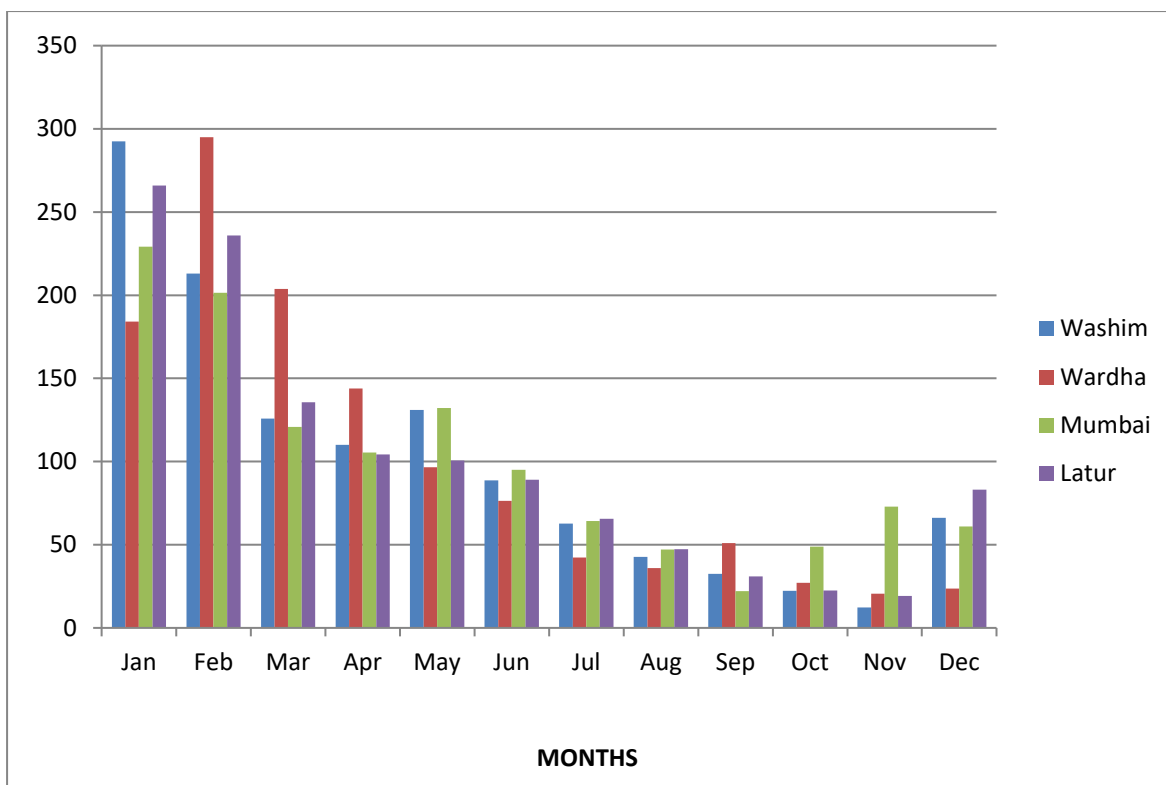


Fig. 10. Seasonal indices of Pigeon pea arrivals for selected markets

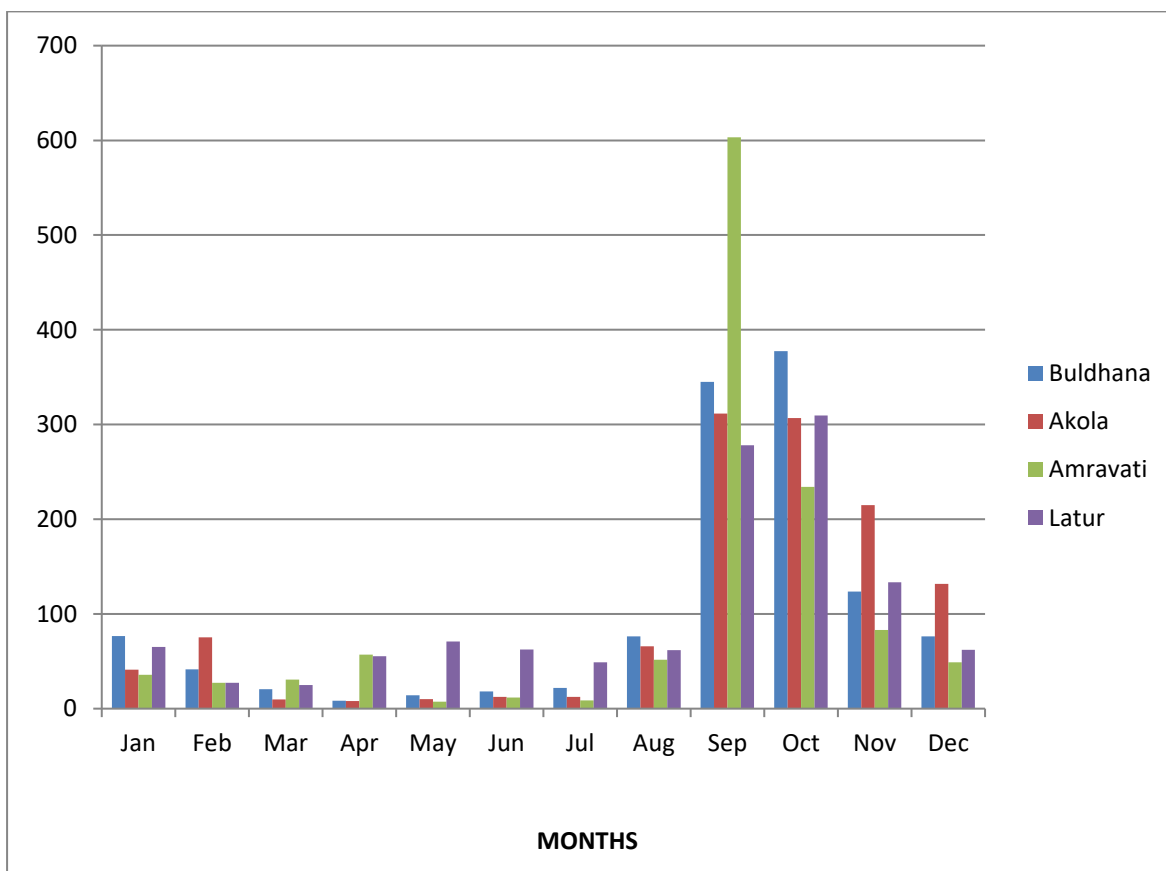


Fig. 11. Seasonal indices of Green gram arrivals for selected markets

crops during September to November results in prices are declined. Thakaret *al.* (2017) the seasonal indices for green gram arrival were higher in the month of September to November in the Palanpur and Patna market of study area.

5.1.3.3 Seasonal indices for Black gram arrivals

The seasonal indices of monthly arrivals of Black gram in Mumbai, Solapur, Washim and Akola markets were worked out, which are presented in table 5.11. The arrivals of Black gram start hitting in market from the month of September and continue for next four to five months. The peak period of arrivals is September to January. Due to large arrivals during this period of October and November for the selected market production are higher as compared to other months. The lower value of indices of arrivals was during the period of February to August indicated lean period in Black gram arrivals in all markets. Similar results were found by Thakaret *al.* (2017) observed that the bulk of commodity comes for market immediately after harvesting of crops during October to December results in prices are declined.

Table 5.11 Seasonal indices of Black gram arrival for selected markets

Month	Mumbai	Solapur	Washim	Akola
Jan	129.75	30.08	90.34	130.18
Feb	90.19	12.77	29.08	67.63
Mar	50.06	7.75	13.00	39.20
Apr	37.60	5.94	13.11	41.68
May	18.59	3.72	18.54	49.69
Jun	32.52	7.14	24.14	42.14
Jul	21.90	6.22	13.83	33.30
Aug	13.97	39.14	15.48	30.72
Sep	119.04	239.33	218.19	144.80
Oct	303.37	289.21	455.50	337.90
Nov	202.46	476.46	191.77	163.79
Dec	180.55	82.24	117.02	118.97

5.1.3.4 Seasonal indices for Chickpea arrivals

The seasonal indices of monthly arrivals of Chickpea in Buldana, Washim, Latur and Amravati markets were worked out, which are presented in table 5.12. The arrivals of Chickpea start hitting in market from the month of February and continue for next two to three months. The peak period of arrivals is February to April as the values of seasonal indices were

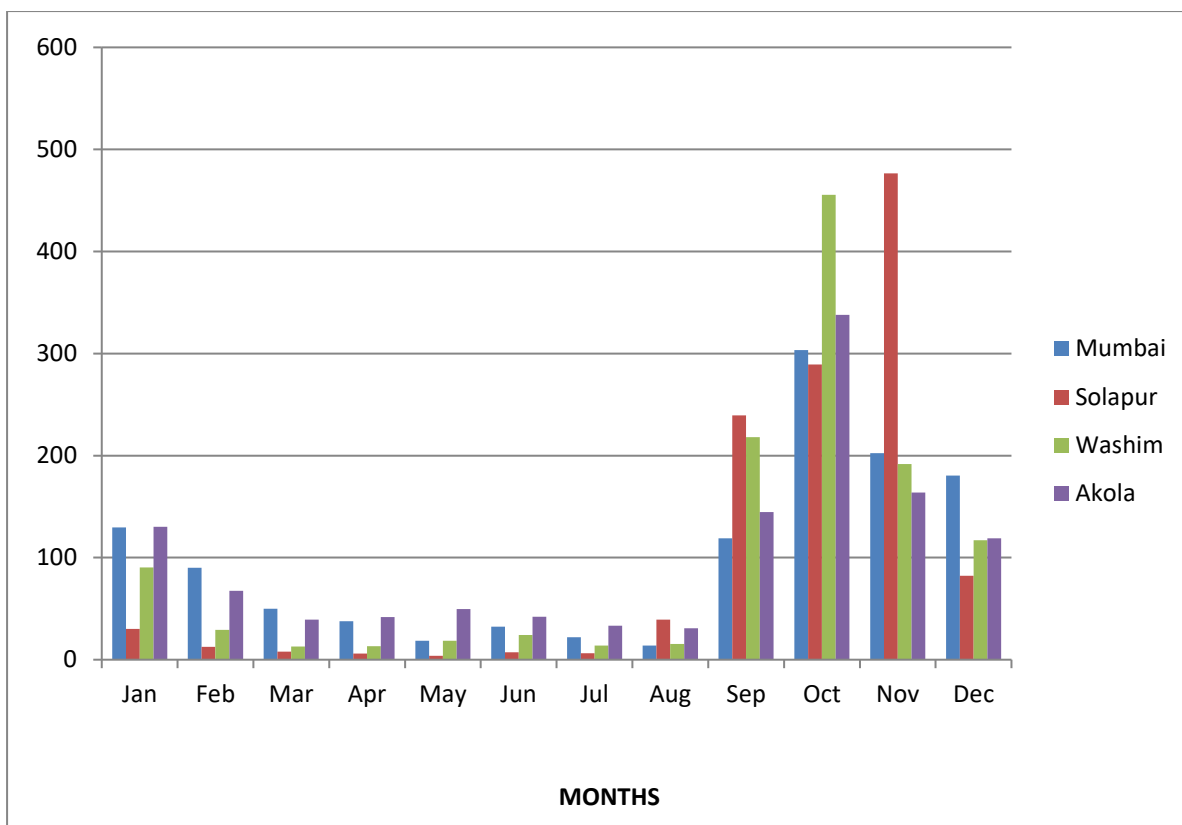


Fig. 12. Seasonal indices of Black gram arrivals for selected markets

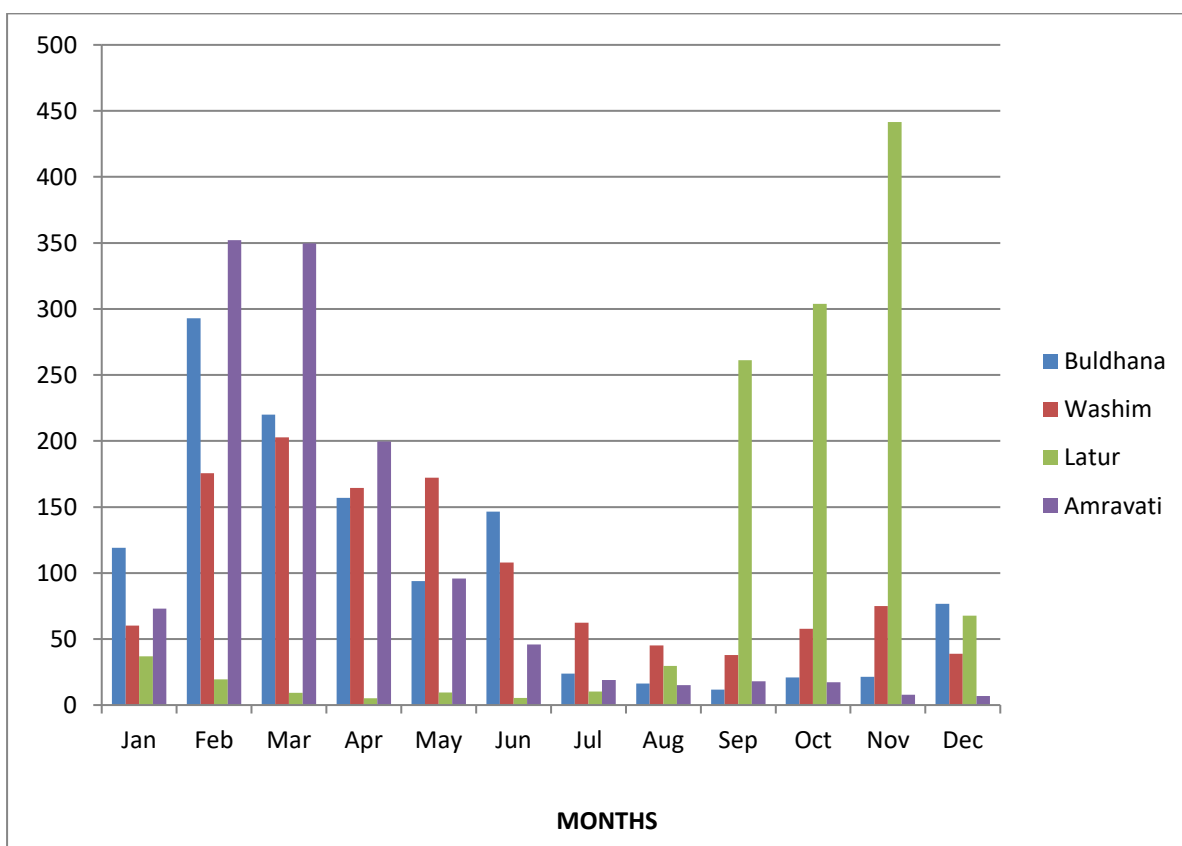


Fig. 13. Seasonal indices of Chickpea arrivals for selected markets

higher during these months. Due to large arrivals during this period the prices are declined. The lower values of indices of arrivals are during the period of July to December indicated lean period in Chickpea arrivals in all markets. Similar results were noted by Sahoo and Singh (2017) the seasonality in arrivals of Chickpea in selected markets have high seasonal indices in the month of May and June indicated the high post-harvest arrivals in the months. Naik *et al.* (2015) reported that the Chickpea arrival indices were highest during February to May of every year and lowest during June to January.

Table 5.12 Seasonal indices of Chickpea arrival for selected markets

Month	Buldana	Washim	Latur	Amravati
Jan	119.03	60.07	36.93	73.01
Feb	292.84	175.65	261.08	352.20
Mar	219.87	202.79	303.93	349.72
Apr	157.03	164.38	441.53	199.58
May	93.92	172.16	9.48	95.78
Jun	146.39	108.06	5.41	45.86
Jul	23.79	62.35	10.23	18.93
Aug	16.27	45.12	29.63	15.01
Sep	11.80	37.89	19.50	18.05
Oct	20.97	57.84	9.26	17.30
Nov	21.47	74.92	5.26	7.78
Dec	76.60	38.77	67.76	6.78

5.1.4 Cyclical indices for pulses arrivals

The cyclical variations in arrivals were analyzed in order to know the variations in arrivals over the years. The cyclical indices for Pulses arrivals were work out for the period of 2005 to 2016. The markets have been analyzed using the residual method of cyclical indices. The results of cyclical variations in arrivals of pulses are presented below.

5.1.4.1 Cyclical indices for Pigeon pea arrivals

From table 5.13 it was observed that the cyclical variations were observed in the arrivals of Pigeon pea in selected markets. The higher arrivals were noted in the year 2005, 2010, 2011, 2012, 2013 and 2016 for all the markets. In the Wardha market relatively higher arrival was also observed in the year 2013. In the year of 2005 and 2013 in Washim and Wardha market production and arrival are higher as compared to other market years. Lower arrivals were noted in the years 2007, 2008, 2009 and 2014 for all the

markets. In Wardha markets relatively lower arrival was also observed in the year 2015.

Table 5.13 Cyclical indices of Pigeon pea arrival for selected markets

Year	Washim	Wardha	Mumbai	Latur
2005	261.19	135.36	159.27	109.11
2006	48.36	105.66	38.54	96.10
2007	50.72	62.83	82.45	72.40
2008	41.03	38.20	73.88	113.85
2009	59.10	92.51	129.31	69.67
2010	147.06	119.64	148.42	101.83
2011	107.51	129.30	90.35	170.51
2012	91.22	103.38	112.34	103.28
2013	102.81	235.59	55.75	125.53
2014	58.50	20.72	91.91	62.86
2015	104.67	2.96	100.86	74.74
2016	127.83	153.85	116.92	100.12

5.1.4.2 Cyclical indices for Green gram arrivals

From table 5.14 it was showed that the cyclical variations were observed in the arrivals of Green gram in selected markets. The higher arrivals were observed in the year 2007, 2010, 2011, 2012 and 2016 for all the markets. In the Amravati market relatively higher arrival was also observed in the year 2006 and 2009. Lower arrivals were noted in the year 2005, 2014 and 2015 for all the markets. In Amravati market relatively lower arrival was also observed in the year 2008 and 2013. Benkeet *et al.* (2016) studied the arrival of green gram in Akola district, the higher arrival were observed during the years 1998, 2000, 2001, 2002, 2003 and 2004.

Table 5.14. Cyclical indices of Green gram arrival for selected markets

Year	Buldana	Akola	Amravati	Latur
2005	41.52	45.85	32.32	130.85
2006	89.23	81.63	158.78	75.95
2007	165.38	172.15	94.04	48.10
2008	150.56	83.59	16.64	169.39
2009	79.52	152.56	153.27	69.62
2010	217.77	128.38	189.16	38.01
2011	58.48	66.21	221.46	143.74
2012	109.97	144.07	103.04	59.15
2013	53.75	65.74	40.25	219.41
2014	26.14	14.57	70.54	87.08
2015	57.84	66.96	5.32	97.00
2016	149.84	178.28	115.18	61.68

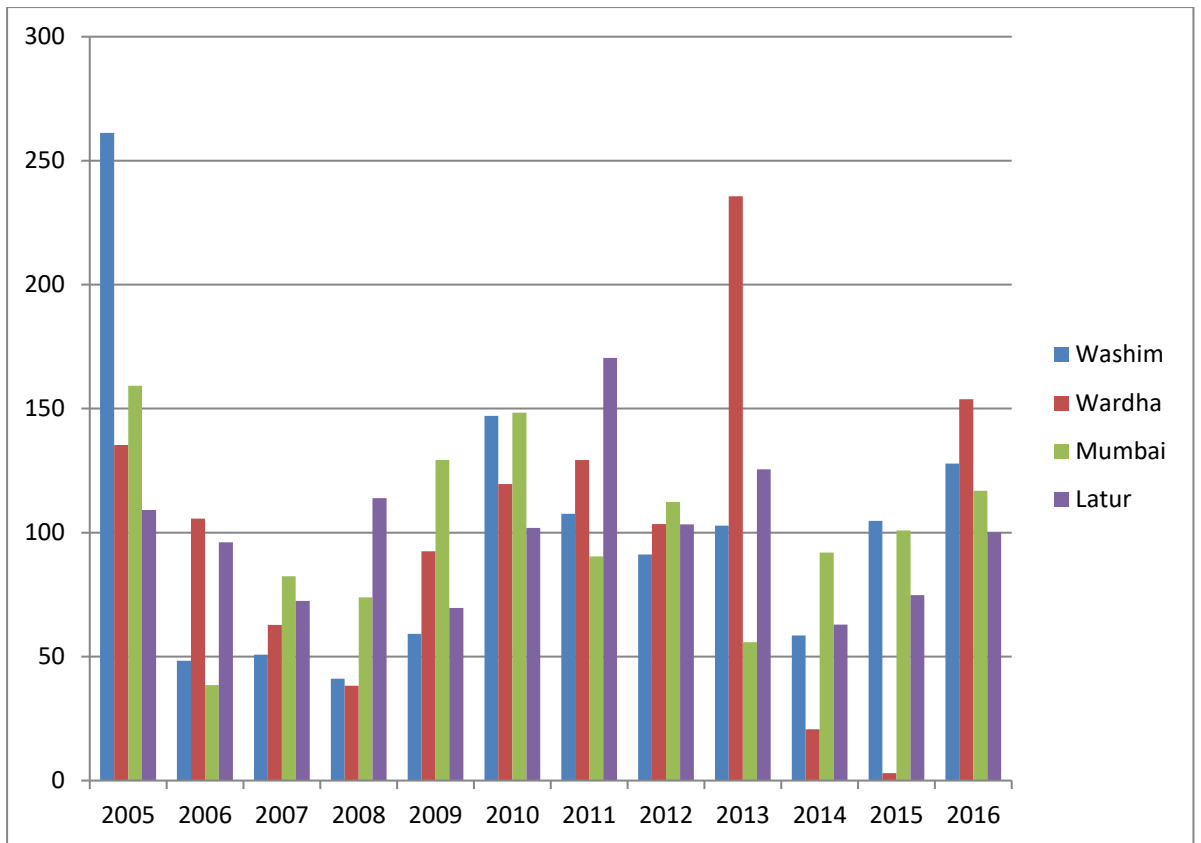


Fig. 14.Cyclical indices of Pigeon pea arrivals for selected markets

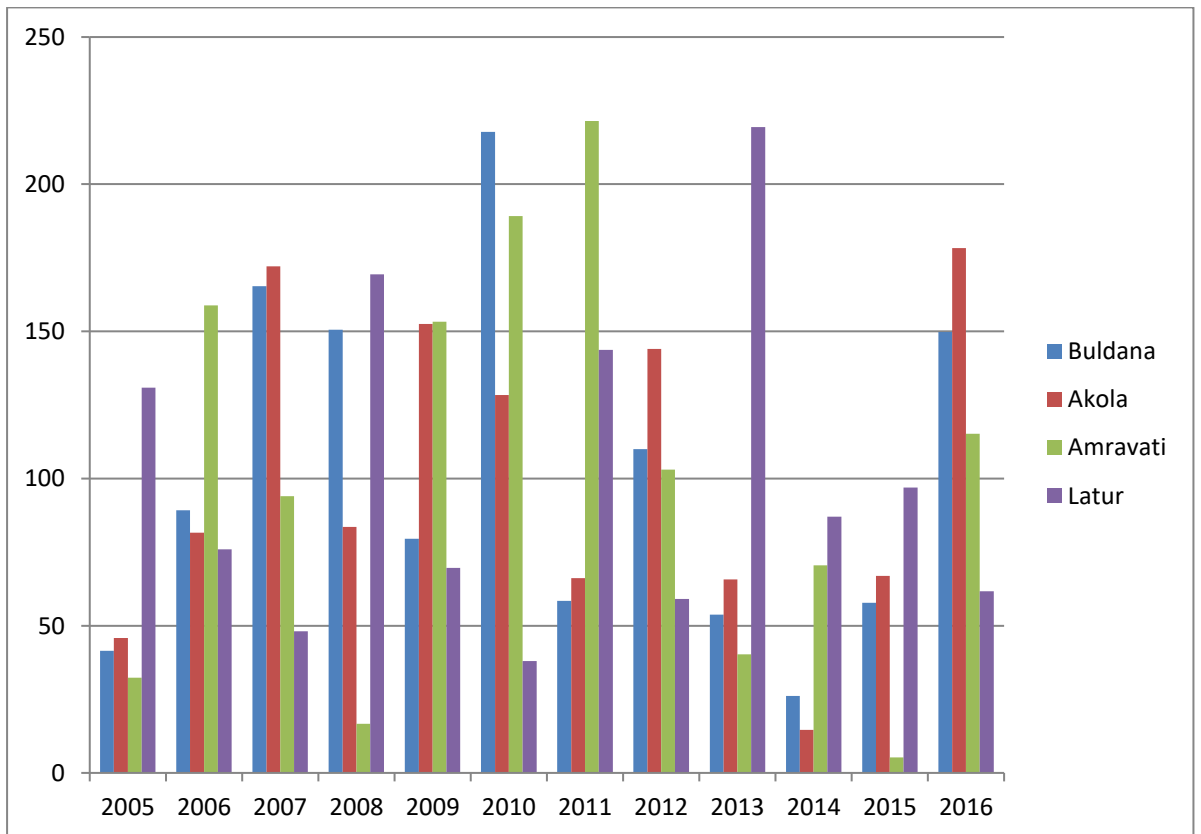


Fig. 15.Cyclical indices of Green gram arrivals for selected markets

5.1.4.3 Cyclical indices for Black gram arrivals

From table 5.15 it was observed that the cyclical variations were observed in the arrivals of Blackgram in selected markets. The higher arrivals were observed during the years 2007, 2010, 2011 and 2012 for all the markets. In the Solapur and Washim market relatively higher arrival was also observed in the year 2016. The lower arrivals were noted in the years 2005, 2006, 2009, 2013, 2014 and 2015 for all the markets.

Table 5.15. Cyclical indices of Black gram arrival for selected markets

Year	Mumbai	Solapur	Washim	Akola
2005	62.01	23.82	86.73	58.65
2006	41.75	44.77	96.68	75.07
2007	163.07	387.15	147.36	150.81
2008	126.16	34.91	71.23	112.79
2009	42.67	28.31	56.77	66.77
2010	154.93	104.78	149.78	118.42
2011	198.91	94.68	122.73	233.77
2012	119.47	116.01	152.11	155.10
2013	85.70	35.01	60.88	98.53
2014	62.24	36.34	19.99	50.19
2015	55.36	20.20	46.58	55.98
2016	87.72	274.04	189.16	23.93

5.1.4.4 Cyclical indices for Chickpea arrivals

From table 5.16 it was revealed that the cyclical variations were observed in the arrivals of Chickpea in selected markets. The higher arrivals were also observed during the year 2006, 2007, 2008, 2010, 2012 and 2013 for some markets.

Table 5.16. Cyclical indices of Chickpea arrival for selected markets

Year	Buldana	Washim	Latur	Amravati
2005	17.53	81.58	44.47	55.94
2006	139.08	111.89	32.12	130.48
2007	87.91	102.42	337.27	64.85
2008	166.03	84.15	52.60	75.04
2009	73.61	129.21	31.45	117.01
2010	102.34	109.22	109.08	97.93
2011	139.31	51.60	65.61	115.49
2012	118.29	85.07	153.24	108.48
2013	85.12	124.03	124.04	296.35
2014	96.63	140.63	99.78	57.36
2015	86.43	104.07	93.67	1.48
2016	87.71	76.14	56.66	79.58

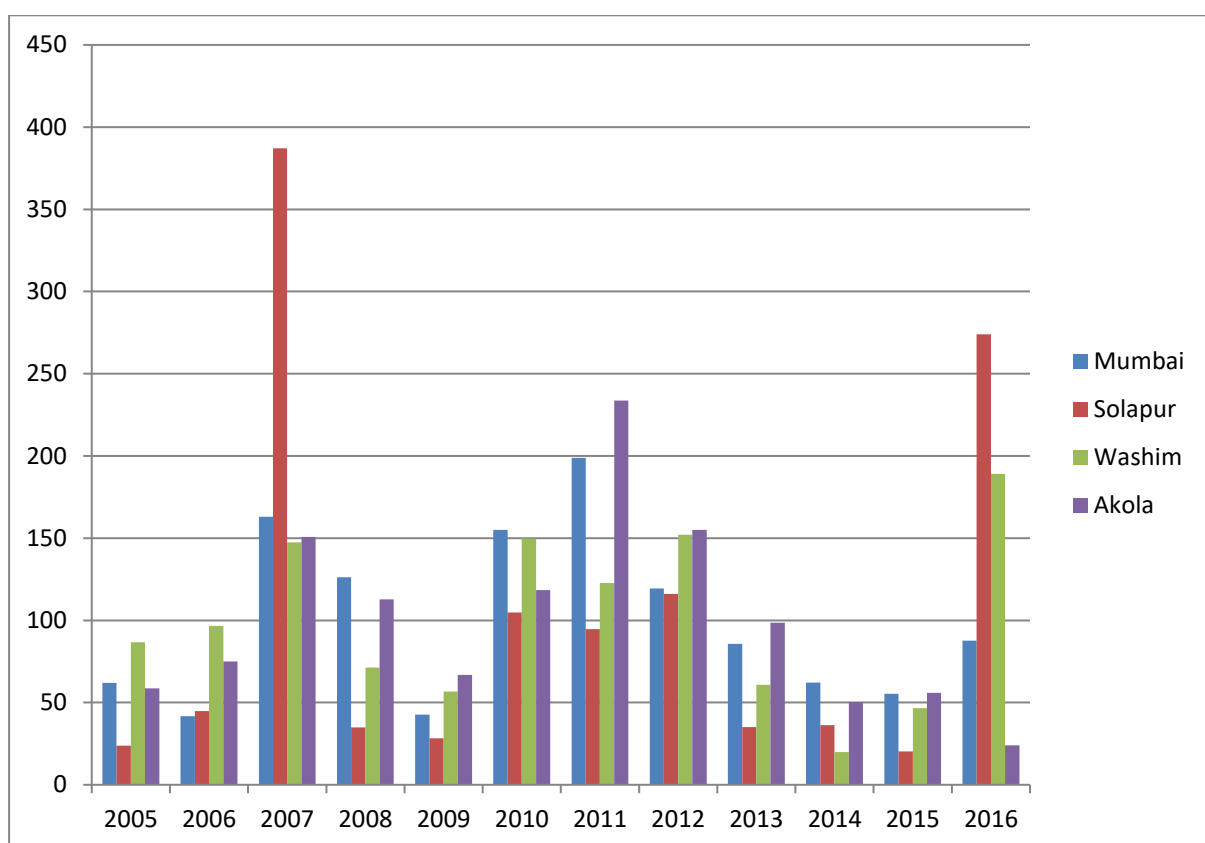


Fig. 16.Cyclical indices of Black gram arrivals for selected markets

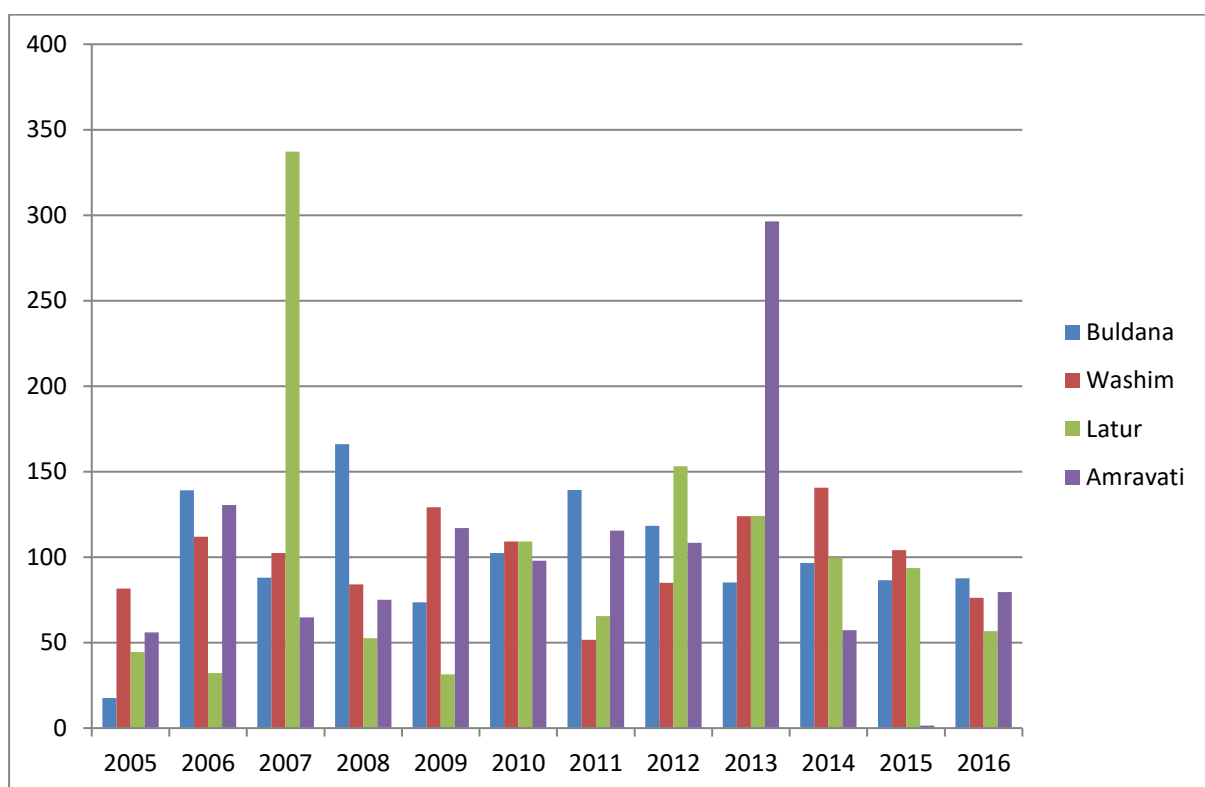


Fig. 17.Cyclical indices of Chickpea arrivals for selected markets

In the Washim market relatively higher arrival was also observed in the year 2014. Lower arrivals were noted in the years 2005, 2008, 2015 and 2016 for some markets.

5.2 Stationarity and Price Volatility in prices of selected pulses

5.2.1 Testing of stationarity in price series

The Augmented Dickey fuller (ADF) test based on unit root test procedure was carried out to check whether prices of pulses are stationary in the selected markets of pulses and the results are presented below.

5.2.1.1 Testing of stationarity in Pigeon pea price series

The Augmented Dick-Fuller (ADF) test is applied for prices data of selected markets of Pigeon pea i.e. Washim, Wardha, Mumbai and Latur market and the results are presented in table 5.17.

From the table 5.17 it was observed that at level with lag 1, the ADF values were more than critical values at 1 per cent level of significance indicating the existence of unit root implied that the prices series in all markets were non-stationary. The table further showed that in 1st order difference with lag 1, the ADF values were lower than the critical values at 1 per cent level of significance indicated that the price series were free from the consequences of unit root. This implied that the prices series were stationary at 1st order difference. Similar results were found by Patil *et al.* (2014), that the price series showed the consequences of unit root and were stationary at first order difference.

Table 5.17. ADF test results of Pigeon pea prices for selected markets

Market	Level (ADF)	First Difference(ADF)	Critical Value (1%)
Washim	-1.490	-5.589	-3.476
Wardha	-1.697	-13.846	
Mumbai	-1.767	-14.368	
Latur	-1.826	-17.790	

5.2.1.2 Testing of stationarity in Green gram price series

The Augmented Dick-Fuller (ADF) test is applied for prices data of selected markets of Green gram i.e. Buldana, Akola, Amravati and Latur markets of Green gram and the results are presented in table 5.18.

From table 5.18 it was revealed that at level with lag 1, the ADF values were higher than critical value at 1 per cent level of significance indicating the existence of unit root this implied that the prices series in all markets were non-stationary. The table further showed that in 1st order difference with lag 1, the ADF values were lower than the critical value at 1 per cent level of significance indicated that the price series were free from the consequences of unit root, implied that the prices series were stationary at 1st order difference level. Similar results were obtained by Patil and Tingre (2015), that the price series showed the consequences of unit root and were stationary at first difference.

Table 5.18. ADF test results of Green gram prices for selected markets

Market	Level (ADF)	First Difference (ADF)	Critical Value (1%)
Buldana	-3.385	-19.907	-3.476
Akola	-2.004	-12.003	
Amravati	-3.244	-9.463	
Latur	-1.388	-9.304	

5.2.1.3 Testing of stationarity in Black gram price series

The Augmented Dick-Fuller (ADF) test is applied for prices data of selected markets of Black gram i.e. Mumbai, Solapur, Washim and Akola markets of Black gram and the results are presented in table 5.19.

From Table 5.19 it was observed that at level with lag 1, the ADF values were higher than critical value at 1 per cent level of significance indicating the existence of unit root, implied that the prices series in all markets were non-stationary. The table further showed that in 1st order difference with lag 1, the ADF values were lower than the critical value at 1 per cent level of significance indicated that the price series were free from the consequences of unit root. This indicated that the prices series were stationary at 1st order difference level. Similar results were found by Patil and

Tingre (2015), that the price series showed the consequences of unit root and were stationary at first order difference.

Table 5.19. ADF test results of Black gram prices for selected markets

Market	Level (ADF)	First Difference	Critical Value (1%)
Mumbai	-1.645	-9.966	-3.476
Solapur	-1.614	-9.822	
Washim	-1.678	-12.424	
Akola	-1.642	-12.324	

5.2.1.4 Testing of stationarity in Chickpea price series

The Augmented Dick-Fuller (ADF) test is applied for prices data of selected markets of Chickpea i.e. Buldana, Washim, Latur and Amravati markets of Chickpea and the results are presented in table 5.20.

From Table 5.20 it was revealed that at level with lag 1, the ADF values were higher than the critical value at 1 per cent level of significance indicating the existence of unit root, indicated that the prices series in all markets were non-stationary. The table further showed that in 1st order difference with lag 1, the ADF values were lower than the critical value at 1 per cent level of significance indicated that the price series were free from the consequences of unit root. This implied that the prices series were stationary at 1st order difference level. Similar results were reported by Patil and Tingre (2015), that the price series showed the consequences of unit root and were stationary at first order difference.

Table 5.20. ADF test results of Chickpea prices for selected markets

Market	Level (ADF)	First Difference (ADF)	Critical Value (1%)
Buldana	-0.667	-16.476	-3.476
Washim	1.495	-11.643	
Latur	-0.111	-13.517	
Amravati	-1.204	-11.884	

5.2.2 Price volatility in prices of selected pulses

To assess the presence of price fluctuations in the prices of selected pulses markets, ARCH-GARCH analysis was carried out and the results are presented in the following tables.

5.2.2.1 Price volatility in Pigeon pea prices

To assess the presence of price volatility in the prices of Pigeon pea in Washim, Wardha, Mumbai and Latur markets, ARCH-GARCH analysis was carried out and the results are presented in table 5.21.

The sum of Alpha and Beta ($\alpha + \beta$), indicated ARCH and GARCH effect for the given market. It was observed that among the selected markets, the sum of Alpha and Beta is nearer to 1 i.e. 1.021, 1.013, 0.999 and 1.016 for Washim, Wardha, Mumbai and Latur markets respectively, indicated that the volatility shocks in the prices of Pigeon pea are quite persistent for a long time in these markets. Hence the hypothesis proposed regarding the selected markets of Pigeon pea are volatile during last decade is accepted. Similar results were found by Ngare and Mashigual (2014) studied analysis of price volatility in Mozambique and revealed the presence of seasonality, and high volatility by using GARCH model.

Table 5.21. Results of ARCH-GARCH Analysis for Pigeon pea prices of selected markets

Parameter	Washim	Wardha	Mumbai	Latur
Alpha (α)	0.761	0.398	0.740	0.428
Beta (β)	0.260	0.615	0.260	0.588
Sum of α & β	1.021	1.013	0.999	1.016

5.2.2.2 Price volatility in Green gram prices

To assess the presence of price volatility in the prices of Green gram in Buldana, Akola, Amravati and Latur markets, ARCH-GARCH analysis was carried out and the results are presented in Table 5.22.

The sum of Alpha and Beta ($\alpha + \beta$), indicated ARCH and GARCH effect for the given market. It was observed that among the selected markets, the sum of Alpha and Beta is nearer to 1 i.e. 0.995, 1.006, 0.971 and 1.015 for Buldana, Akola, Amravati and Latur markets respectively, indicated that the volatility shocks in the prices of Green gram are quite persistent for a long

time in these markets. Hence the hypothesis proposed regarding the selected markets of Green gram are volatile during last decade is accepted. Sharabet *al.* (2018) reported that the sum of Alpha and Beta is nearer to 1 for selected markets of Garlic and indicated that the volatility shocks in the prices of Garlic are quite persistent for a long time in selected markets of study.

Table 5.22. Results of ARCH-GARCH Analysis for Green gram prices of selected markets

Parameter	Buldana	Akola	Amravati	Latur
Alpha (α)	0.320	0.924	0.428	0.924
Beta (β)	0.676	0.082	0.543	0.091
Sum of α & β	0.995	1.006	0.971	1.015

5.2.2.3 Price volatility in Black gram prices

To assess the presence of price volatility in the prices of Black gram in Mumbai, Solapur, Washim and Akola markets, ARCH-GARCH analysis was carried out and the results are presented in Table 5.23.

The sum of Alpha and Beta ($\alpha + \beta$), indicated ARCH and GARCH effect for the given market. It was observed that among the selected markets, the sum of Alpha and Beta is nearer to 1 i.e. 1.031, 1.000, 1.007 and 1.012 for Mumbai, Solapur, Washim and Akola markets respectively, indicated that the volatility shocks in the prices of Black gram are quite persistent for a long time in these markets. Hence the hypothesis proposed regarding the selected markets of Black gram are volatile during last decade is accepted.

Table 5.23. Results of ARCH-GARCH Analysis for Black gram prices of selected markets

Parameter	Mumbai	Solapur	Washim	Akola
Alpha (α)	1.065	1.036	1.084	0.793
Beta (β)	-0.034	-0.036	-0.077	0.219
Sum of α & β	1.031	1.000	1.007	1.012

5.2.2.4 Price volatility in Chickpea prices

To confirm the presence of price variability in the prices of Chickpea in Buldana, Washim, Latur and Amravati markets, ARCH-GARCH analysis was carried out and the results are presented in Table 5.24.

The sum of Alpha and Beta ($\alpha + \beta$), indicated ARCH and GARCH effect for the given market. It was observed that among the selected markets, the sum of Alpha and Beta is nearer to 1 i.e. 1.008, 0.977, 1.021 and 1.051 for Buldana, Washim, Latur and Amravati markets respectively, indicated that the volatility shocks in the prices of Chickpea are quite persistent for a long time in these markets. Hence the hypothesis proposed regarding the selected markets of Chickpea are volatile during last decade is accepted. Similar results were observed by Ngare Lucy, Jaqueline Massingue (2014) studied analysis of price volatility in Mozambique and revealed the presence of seasonality, and high volatility by using GARCH model.

Table 5.24. Results of ARCH-GARCH Analysis for Chickpea prices of selected markets

Parameter	Buldana	Washim	Latur	Amravati
Alpha (α)	0.700	0.417	0.990	0.566
Beta (β)	0.308	0.561	0.031	0.485
Sum of α & β	1.008	0.977	1.021	1.051

5.3 Market Co-integration and Granger Causality in prices of selected pulses

5.3.1 Market Co-integration in prices of selected pulses

Johansen multiple co-integration trace test was applied for indicating the long-run relationship between the price series of selected pulses markets. Co-integration is used instead of regular regression method because of its capacity in dealing with non-stationary series. The most popular co-integration method, developed by Johansen (1988) is applied. The test shows whether the selected pulses markets are integrated or not. The results of the test are presented below.

5.3.1.1 Market Co-integration between Pigeon pea prices of selected markets

From table 5.25 it was observed that the presence of three co-integration equations significant at 5 per cent level of significance confirms that there exists long-run equilibrium relationship between the selected markets in terms of Pigeon pea prices. The results of Co-integration test showed three co-integration equations were significant at 5 per cent level of

significance which indicated that there existed co-integration among the markets. Hence the hypothesis proposed regarding the selected markets of Pigeon pea in Maharashtra are co-integrated is accepted. Pawaret *al.* (2017) found that the selected soybean markets having long run equilibrium relationship and there exist co-integration between them.

Table 5.25. Results of multiple co-integration analysis of Pigeon pea prices for the selected markets

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Critical Value 5%	Prob.**	Number of Co-integrating Equation CE(s)
None *	0.240	88.303	47.856	0	Three
At most 1 *	0.167	49.657	29.797	0	
At most 2 *	0.144	23.868	15.495	0.002	
At most 3	0.014	1.926	3.841	0.165	

Note:-Trace test indicates 3 co-integrating equations significant at the 5 percent level of significance.

5.3.1.2 Market Co-integration between Green gram prices of selected markets

From table 5.26 it was revealed that the presence of three co-integration equations at 5 per cent level of significance confirms that there exists long-run equilibrium relationship between the selected markets in terms of Green gram prices. The results of Co-integration test showed three co-integration equations were significant at 5 per cent level of significance which showed that there existed co-integration among the markets.

Table 5.26. Results of multiple co-integration analysis of Green gram prices for the selected markets

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Critical Value 5%	Prob.**	Number of Co-integrating Equation CE(s)
None *	0.264	100.518	47.856	0	Three
At most 1 *	0.229	57.242	29.797	0	
At most 2 *	0.116	20.527	15.495	0.008	
At most 3	0.022	3.171	3.841	0.075	

Note:-Trace test indicates 3 co-integrating equations significant at the 5 percent level of significance.

Hence the hypothesis proposed regarding the selected markets of Green gram in Maharashtra are co-integrated is accepted.

5.3.1.3 Market Co-integration between Black gram prices

From the table 5.27 it was observed that the presence of two co-integration equations significant at 5 per cent level of significance confirms that there exists long run equilibrium relationship between the markets in terms of Black gram prices. The results of Co-integration test showed two co-integration equations were significant at 5per cent level of significance which indicatedthat there existed co-integration among the markets. Hence the hypothesis proposed regarding the selected markets of Black gram in Maharashtra are co-integrated is accepted.

Table 5.27. Results of multiple co-integration analysis of Black gram prices for the selected markets

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Critical Value 5%	Prob.**	Number of Co-integrating Equation CE(s)
None *	0.168	62.422	47.856	0.001	Two
At most 1 *	0.146	36.414	29.797	0.008	
At most 2	0.084	14.149	15.495	0.079	
At most 3	0.013	1.781	3.841	0.182	

Note:-Trace test indicates 2 co-integrating equations significant at the 5 percent level of significance.

5.3.1.4 Market Co-integration between Chickpea prices of selected markets

From table 5.28 it was seen that the presence of three co-integration equations significant at 5 per cent level of significance confirms that there exists long run equilibrium relationship between the markets in terms of Chickpea prices. The results of Co-integration test showed three co-integration equations were significant at 5per cent level of significance which confirmed that there existed co-integration among the markets. Hence the hypothesis proposed regarding the selected markets of Chickpea in Maharashtra are co-integrated is accepted.

Table 5.28. Results of multiple co-integration analysis of Chickpea prices for the selected markets

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Critical Value 5%	Prob.**	Number of Co-integrating Equation CE(s)
None *	0.268	86.319	47.856	0	Three
At most 1 *	0.166	42.324	29.797	0.001	
At most 2	0.112	16.794	15.495	0.032	
At most 3	0.001	0.096	3.841	0.757	

Note:-Trace test indicates 3 co-integrating equations significant at the 5 percent level of significance.

5.3.2 Causality of price signals between selected pulses markets

Granger Causality Test is a statistical tool which used F-test to know the cause and effect relationship between the two time series and this technique is employed to know the relationship between the prices of selected Pulses markets. When a co-integration relationship is present for two price series, a Granger Causality Test (Granger, 1969) is used to analyse the direction of this co-movement relationship. The results of the test showing the relationship between selected Pulses markets were presented below.

5.3.2.1 Causality of price signals between selected Pigeon pea markets

The results of the Granger Causality test showing the relationship of prices between selected Pigeon pea markets and are presented in table 5.29. It was observed that there is bidirectional causality in Pigeon pea prices between Wardha and Latur, Washim and Latur, Washim and Mumbai respectively. The prices of Mumbai market exhibited unidirectional causality and affects the prices of Latur market. The prices of Mumbai market exhibited unidirectional causality and affects prices of Wardha market. The prices of Washim market exhibited unidirectional causality and affects prices of Wardha. So the influence of Washim market prices played a significant role over the other selected markets. From the, above discussion it can be concluded that Washim and Mumbai markets can be considered as a Lead market of Pigeon pea and influencing the prices of the remaining markets. Thus a strong market integration of the four markets Washim, Wardha, Mumbai, and Latur are established through the results of the analysis.

Table 5.29. Results of Pair wise Granger Causality Test for Pigeon pea prices

Null Hypothesis:	Obs.	F-Statistic	Prob.
Mumbai does not Granger Cause Latur	142	8.317*	0.0004
Latur does not Granger Cause Mumbai		2.509	0.085
Wardha does not Granger Cause Latur	142	4.775*	0.0099
Latur does not Granger Cause Wardha		10.477*	6.00E-05
Washim does not Granger Cause Latur	142	7.136*	0.0011
Latur does not Granger Cause Washim		4.719*	0.0104
Wardha does not Granger Cause Mumbai	142	0.168	0.8453
Mumbai does not Granger Cause Wardha		18.221*	1.00E-07
Washim does not Granger Cause Mumbai	142	5.809*	0.0038
Mumbai does not Granger Cause Washim		6.255*	0.0025
Washim does not Granger Cause Wardha	142	21.261*	9.00E-09
Wardha does not Granger Cause Washim		2.895	0.0587

Note: - * denotes significant at 1 % level of significance.

5.3.2.2 Causality of price signals between selected Green gram markets

The results of the Granger Causality test showing the relationship of prices between selected Green gram markets are presented in table 5.30. It was revealed that there is bidirectional causality in Green gram prices between Latur and Akola, Buldana and Amravati markets respectively. The prices of Akola market exhibited unidirectional causality and affects the prices of Amravati and Buldana market. The prices of latur market exhibited unidirectional causality and affects prices of Amravati and Buldana. So the influence of Akola and Latur market prices played a significant role over the other selected markets. From the, above discussion it can be concluded that Akola and Latur market can be considered as a lead market of Green gram and influencing the prices of the remaining markets. Thus a strong market integration of the four markets Akola, Buldana, Latur and Amravati are established through the results of the analysis.

Table 5.30. Results of Pair wise Granger Causality Test for Green gram prices

Null Hypothesis:	Obs.	F-Statistic	Prob.
Amravati does not Granger Cause Akola	142	2.151	0.1202
Akola does not Granger Cause Amravati		24.132*	1.00E-09
Buldana does not Granger Cause Akola	142	0.777	0.462
Akola does not Granger Cause Buldana		12.358*	1.00E-05
Latur does not Granger Cause Akola	142	8.398*	0.0004
Akola does not Granger Cause Latur		4.236*	0.0164
Buldanadoes not Granger Cause Amravati	142	6.218*	0.0026
Amravatidoes not Granger Cause Buldana		3.309*	0.0395
Laturdoes not Granger Cause Amravati	142	16.500*	4.00E-07
Amravatidoes not Granger Cause Latur		0.817	0.4441
Laturdoes not Granger Cause Buldana	142	12.012*	2.00E-05
Buldanadoes not Granger Cause Latur		1.315	0.2718

Note: - * denotes significant at 1 % level of significance.

5.3.2.3 Causality of price signals between selected Black gram markets

The results of the Granger Causality test showing the relationship of prices between selected Black gram markets were presented in table 5.31. It was observed that there is bidirectional causality in Black gram prices between Solapur and Akola, Solapur and Mumbai, Washim and Mumbai, Washim and Solapur respectively. The prices of Mumbai market exhibited unidirectional causality and affects the prices of Akola market. The prices of Akola market exhibited unidirectional causality and affects the prices of Washim market. So the influence of Solapur and Mumbai market prices plays a significant role over the other selected markets. From the, above discussion it can be concluded that Solapur and Mumbai market can be considered as a Lead market of Black gram and influencing the prices of the remaining markets. Thus a strong market integration of the four markets Solapur, Washim, Akola and Mumbai are established through the results of the analysis. Similar results were recorded by Patil and Tingre (2015) that the most of the markets of Black gram showed bidirectional causality and influenced on Black gram prices of each other.

Table 5.31. Results of Pair wise Granger Causality Test for Black gram prices

Null Hypothesis:	Obs.	F-Statistic	Prob.
Mumbai does not Granger Cause Akola	142	6.879*	0.0014
Akola does not Granger Cause Mumbai		2.542	0.0824
Solapur does not Granger Cause Akola	142	4.730*	0.0103
Akola does not Granger Cause Solapur		4.661*	0.011
Washim does not Granger Cause Akola	142	2.729	0.0689
Akola does not Granger Cause Washim		5.297*	0.0061
Solapurdoes not Granger Cause Mumbai	142	3.599*	0.03
Mumbaidoes not Granger Cause Solapur		6.789*	0.0015
Washimdoes not Granger Cause Mumbai	142	6.241*	0.0025
Mumbaidoes not Granger Cause Washim		15.507*	8.00E-07
Washimdoes not Granger Cause Solapur	142	3.527*	0.0321
Solapurdoes not Granger Cause Washim		3.862*	0.0234

Note: - * denotes significant at 1 % level of significance.

5.3.2.4 Causality of price signals between selected Chickpea markets

The results of the Granger Causality test showing the relationship of prices between selected Chickpea markets were presented in table 5.32. It was revealed that there is bidirectional causality in Chickpea prices between Buldana and Amravati, Washim and Amravati, Latur and Buldana market respectively. The prices of Latur market exhibited unidirectional causality and affects the prices of Amravati and Washim market. The prices of Buldana market exhibited unidirectional causality and affects prices of Washim market. So the influence of Buldana and Latur market prices played a significant role over the other selected markets. From the above discussion it can be concluded that Buldana and Latur market can be considered as a Lead market of Chickpea and influencing the prices of the remaining markets. Thus a strong market integration of the four markets Buldana, Washim, Latur and Amravati are established through the results of the analysis.

Table 5.32. Results of Pair wise Granger Causality Test for Chickpea prices

Null Hypothesis:	Obs.	F-Statistic	Prob.
Buldana does not Granger Cause Amravati	142	12.336*	1.00E-05
Amravati does not Granger Cause Buldana		4.267*	0.0159
Latur does not Granger Cause Amravati	142	28.363*	5.00E-11
Amravati does not Granger Cause Latur		1.099	0.3361
Washim does not Granger Cause Amravati	142	16.492*	4.00E-07
Amravati does not Granger Cause Washim		8.908*	0.0002
Latur does not Granger Cause Buldana	142	18.155*	1.00E-07
Buldanadoes not Granger Cause Latur		11.727*	2.00E-05
Washim does not Granger Cause Buldana	142	2.571	0.0801
Buldanadoes not Granger Cause Washim		12.866*	8.00E-06
Washim does not Granger Cause Latur	142	0.685	0.5059
Latur does not Granger Cause Washim		11.363*	3.00E-05

Note: - * denotes significant at 1 % level of significance.

5.4 Short-run and long-run behaviour of pulses market prices

Since the Johansen's multiple co-integration test results showed that the selected pulses markets having long-run equilibrium relationship and there exists co-integration between them, hence the vector error correction model (VECM) are employed to know the speed of adjustments for the prices of Pulses among selected markets for short run and long run equilibrium of prices the results of VECM presented below.

5.4.1 Short-run and long-run behaviour of selected Pigeon pea markets

The Vector Error Correction Model fitted to the time series prices data of selected Pigeon pea markets the results are presented in table 5.33. The estimates of vector error correction model results showed that Mumbai, Wardha and Washim markets attained short run equilibrium of prices rapidly. It means when ever fluctuations in the prices of Pigeon pea quickly the prices arrived at equilibrium position in this markets.

Table 5.33. Vector Error Correction Model results for Pigeon pea prices of selected markets of Maharashtra

Error Correction:	D(Latur)	D(Mumbai)	D(Wardha)	D(Washim)
CointEq1	0.000623	0.002819	0.009186	-0.002464
	-0.0019	-0.00121	-0.0021	-0.00128
	[0.32774]	[2.32799]	[4.37863]	[-1.91790]
D(Latur(-1))	-0.525819	0.05632	0.064213	-0.032463
	-0.09343	-0.0595	-0.10308	-0.06314
	[-5.62814]	[0.94658]	[0.62295]	[-0.51417]
D(Latur(-2))	-0.171624	0.086287	0.088337	0.020496
	-0.09368	-0.05966	-0.10336	-0.06331
	[-1.83194]	[1.44625]	[0.85462]	[0.32374]
D(Mumbai(-1))	0.16075	-0.335342	0.300455	-0.006277
	-0.16385	-0.10435	-0.18078	-0.11073
	[0.98108]	[-3.21371]	[1.66200]	[-0.05669]
D(Mumbai(-2))	0.103696	-0.145713	0.297119	0.123236
	-0.16453	-0.10478	-0.18153	-0.11119
	[0.63025]	[-1.39062]	[1.63672]	[1.10834]
D(Wardha(-1))	0.092218	0.137992	-0.235092	-0.114841
	-0.11417	-0.07271	-0.12596	-0.07715
	[0.80774]	[1.89789]	[-1.86633]	[-1.48847]
D(Wardha(-2))	0.064988	0.060458	-0.223418	-0.046079
	-0.08899	-0.05667	-0.09819	-0.06014
	[0.73027]	[1.06675]	[-2.27543]	[-0.76620]
D(Washim(-1))	0.115496	0.00662	-0.244593	-0.082377
	-0.17474	-0.11128	-0.1928	-0.11809
	[0.66095]	[0.05949]	[-1.26866]	[-0.69760]
D(Washim(-2))	0.068409	-0.049801	-0.194202	-0.20928
	-0.15712	-0.10006	-0.17335	-0.10618
	[0.43540]	[-0.49771]	[-1.12026]	[-1.97100]
C	23.35759	29.43298	28.23085	31.96055
	-73.0752	-46.5379	-80.6255	-49.3831
	[0.31964]	[0.63245]	[0.35015]	[0.64720]

Latur market one and two month lag price was affecting current prices of same market. Mumbai market one month lag price was affecting current price of Wardha and same market. Mumbai market two month lag price was affecting current price of only Wardha market. Wardha market one month lag price was affecting current price of Mumbai and same market. Wardha two month lag price is affecting current price of same market. Washimtwo month lag price was affecting current price of same market.

Results were noted by Patil *et al.* (2014), that the Red gram price estimates of Vector Error Correction Model revealed that Akola and Jalgaon markets attain short run equilibrium rapidly. Bhavani Devi *et al.* (2015) revealed that long-run price movements of Andhra Pradesh, Telangana and Gujarat markets were heavily influenced by price changes in Rajasthan market.

5.4.2 Short-run and long-run behaviour of selected Green gram markets

Table 5.34. Vector Error Correction Model results for Green gram prices of selected markets of Maharashtra

Error Correction:	D(Akola)	D(Amravati)	D(Buldana)	D(Latur)
CointEq1	-0.025707	0.717646	1.0123	0.030486
	-0.07863	-0.18228	-0.21439	-0.07423
	[-0.32692]	[3.93708]	[4.72187]	[0.41071]
D(Akola(-1))	-0.173742	-0.047082	-0.291827	0.210394
	-0.1338	-0.31016	-0.36479	-0.1263
	[-1.29851]	[-0.15180]	[-0.79999]	[1.66579]
D(Akola(-2))	-0.390969	0.440109	-0.355584	-0.27742
	-0.12659	-0.29344	-0.34512	-0.11949
	[-3.08851]	[1.49985]	[-1.03031]	[-2.32162]
D(Amravati(-1))	0.030807	-0.13481	0.392488	0.077601
	-0.04638	-0.10751	-0.12644	-0.04378
	[0.66426]	[-1.25399]	[3.10412]	[1.77258]
D(Amravati(-2))	-0.018073	-0.076799	0.293677	0.05589
	-0.03781	-0.08765	-0.10309	-0.03569
	[-0.47798]	[-0.87621]	[2.84883]	[1.56587]
D(Buldana(-1))	-0.003906	0.183163	-0.323129	0.002097
	-0.03597	-0.08338	-0.09806	-0.03395
	[-0.10858]	[2.19681]	[-3.29512]	[0.06176]
D(Buldana(-2))	0.045002	0.060807	-0.059109	0.060049
	-0.03128	-0.0725	-0.08527	-0.02952
	[1.43886]	[0.83873]	[-0.69321]	[2.03397]
D(Latur(-1))	0.281163	0.061255	-0.066944	-0.220906
	-0.12342	-0.28609	-0.33648	-0.1165
	[2.27815]	[0.21411]	[-0.19895]	[-1.89617]
D(Latur(-2))	0.321273	-0.552058	0.180539	0.162517
	-0.1212	-0.28094	-0.33043	-0.11441
	[2.65080]	[-1.96501]	[0.54638]	[1.42052]
C	25.94749	20.2333	26.6192	32.60705
	-40.2034	-93.193	-109.608	-37.9504
	[0.64541]	[0.21711]	[0.24286]	[0.85920]

The Vector Error Correction Model fitted to the time series prices data of selected Green gram markets and the results are presented in table

5.34. The estimates of vector error correction model showed that the Amravati and Buldana markets attained short run equilibrium rapidly.

Akola market one month lag price was affecting current price of Latur market. The Akola market two month lag price was affecting current prices of the same market and Latur market. Amravati market one and two months lag price was affecting current prices of Buldana and Latur market. Buldana market one month lag prices was affecting the current prices of Amravati and the same market. Buldanatwo month lag price was affecting current price of the Latur market. The Latur market one month lag price was affecting current price of the Akola and the same market. Latur two month lag price was affecting current price of the Akola and Amravati market. Results noted by Patil and Tingre (2015) showed that the estimates of Vector error correction model revealed that Latur and Nagpur market attained short run equilibrium rapidly.

5.4.3 Short-run and long-run behaviour of selected Black gram markets

The Vector Error Correction Model fitted to the time series prices data of selected Black gram markets and the results are presented in table 5.35. The estimates of vector error correction model showed that only Washim market attained short run equilibrium rapidly.

Akola market one month lag price was affecting current price of the same market. The Akola market two month lag price was affecting current price of the Solapur, Washim and same market. Mumbai one month lag price was affecting current price of Akola, Solapur and Washim markets respectively. Mumbai two month lag price was affecting current price of same market. The Solapur market one month lag price was affecting current price of Akola and Mumbai markets. Solapur two month lag price was affecting current price of same market and Washim market. Washim one month lag price was affecting current price of Akola market. Washim two month lag price was affecting current price of Akola and Mumbai market.

Patil and Tingre (2015) noted that the Black gram Jalgaon market attained short run equilibrium rapidly. Latur markets one and two months lagged price was affecting current prices of that market.

Table 5.35. Vector Error Correction Model results for Black gram prices of selected markets of Maharashtra

Error Correction:	D(Akola)	D(Mumbai)	D(Solapur)	D(Washim)
CointEq1	0.008365	-0.007014	-0.013279	0.034879
	-0.01101	-0.012	-0.01059	-0.01091
	[0.75947]	[-0.58444]	[-1.25341]	[3.19780]
D(Akola (-1))	-0.52964	-0.020718	-0.034705	-0.025824
	-0.12621	-0.13752	-0.12139	-0.12498
	[-4.19641]	[-0.15066]	[-0.28589]	[-0.20663]
D(Akola (-2))	-0.432042	-0.05947	-0.284642	-0.27727
	-0.12605	-0.13734	-0.12123	-0.12482
	[-3.42761]	[-0.43303]	[-2.34788]	[-2.22143]
D(Mumbai (-1))	0.315212	0.087499	0.294975	0.204365
	-0.106	-0.11549	-0.10195	-0.10497
	[2.97366]	[0.75761]	[2.89324]	[1.94697]
D(Mumbai (-2))	-0.007003	-0.283604	0.080221	0.148269
	-0.1055	-0.11494	-0.10147	-0.10447
	[-0.06638]	[-2.46732]	[0.79061]	[1.41931]
D(Solapur (-1))	0.192744	0.191422	0.125896	0.104194
	-0.10858	-0.1183	-0.10443	-0.10752
	[1.77513]	[1.61805]	[1.20551]	[0.96906]
D(Solapur (-2))	-0.089477	-0.14642	-0.219655	-0.266753
	-0.10589	-0.11537	-0.10185	-0.10486
	[-0.84499]	[-1.26908]	[-2.15670]	[-2.54396]
D(Washim (-1))	0.266551	0.037841	0.018325	-0.048563
	-0.13307	-0.14498	-0.12798	-0.13177
	[2.00315]	[0.26100]	[0.14318]	[-0.36855]
D(Washim (-2))	0.290576	0.299513	0.089383	0.09875
	-0.11685	-0.12731	-0.11239	-0.11571
	[2.48673]	[2.35254]	[0.79531]	[0.85344]
C	35.74728	32.82272	30.10195	33.77919
	-44.0443	-47.9886	-42.3622	-43.6141
	[0.81162]	[0.68397]	[0.71058]	[0.77450]

5.4.4 Short-run and long-run behaviour of selected Chickpea markets

The Vector Error Correction Model fitted to the time series prices data of selected Chickpea markets and the results are presented in table 5.36. The estimates of vector error correction model showed that Amravati and Latur markets attained short run equilibrium rapidly.

Amravati market one month lag price was affecting current price of Latur market. Buldana market one month lag price was affecting current prices of all markets i.e. Amravati, Latur, Washim and the same market.

Buldana market two month lag price was affecting current prices of same market. Latur one month lag price was affecting current prices of Buldana, Washim and the same market. Latur two month lag price was affecting current prices of only Washim market. Washim one month lag price was affecting current prices of Amravati and the same market. Washimtwo month lag price was affecting current prices of same market.

Table 5.36. Vector Error Correction Model results for Chickpea prices of selected markets of Maharashtra

Error Correction:	D(Amravati)	D(Buldana)	D(Latur)	D(Washim)
CointEq1	-0.9773	0.012548	-0.084139	0.151723
	-0.14814	-0.08253	-0.05596	-0.12264
	[-6.59729]	[0.15205]	[-1.50351]	[1.23715]
D(Amravati (-1))	0.073265	-0.016289	0.08124	-0.019242
	-0.12569	-0.07002	-0.04748	-0.10406
	[0.58288]	[-0.23262]	[1.71091]	[-0.18491]
D(Amravati (-2))	0.061712	0.048385	0.036226	-0.003509
	-0.09412	-0.05243	-0.03555	-0.07792
	[0.65569]	[0.92281]	[1.01888]	[-0.04503]
D(Buldana(-1))	0.236389	-0.440778	0.223011	0.27058
	-0.15635	-0.0871	-0.05906	-0.12944
	[1.51195]	[-5.06062]	[3.77581]	[2.09043]
D(Buldana(-2))	-0.073502	-0.286311	0.046969	0.074743
	-0.15977	-0.08901	-0.06036	-0.13227
	[-0.46004]	[-3.21665]	[0.77817]	[0.56506]
D(Latur (-1))	0.086592	0.626469	-0.23785	0.369947
	-0.28206	-0.15713	-0.10656	-0.23352
	[0.30699]	[3.98682]	[-2.23218]	[1.58425]
D(Latur (-2))	-0.030488	0.217383	0.052773	0.455278
	-0.26078	-0.14528	-0.09851	-0.21589
	[-0.11691]	[1.49635]	[0.53570]	[2.10883]
D(Washim (-1))	-0.252309	-0.062495	-0.019505	-0.437219
	-0.11224	-0.06253	-0.0424	-0.09292
	[-2.24787]	[-0.99944]	[-0.46000]	[-4.70508]
D(Washim (-2))	-0.113904	-0.032809	-0.005792	-0.260286
	-0.10658	-0.05937	-0.04026	-0.08823
	[-1.06876]	[-0.55260]	[-0.14386]	[-2.94999]
C	53.722	35.86858	28.05721	55.20995
	-64.6001	-35.9881	-24.4039	-53.4813
	[0.83161]	[0.99668]	[1.14970]	[1.03232]

5.5 Relationship between spot and future prices of selected pulses

5.5.1 Market Co-integration

5.5.1.1 Market Co-integration between Pigeon pea spot and future prices

Johansen's multiple co-integration test was employed to determine the long run relationship among the spot and future market prices series of Pigeon pea and the results are presented in table 5.37. It was revealed that the presence of at least one co-integration equation at 5 per cent level of significance confirms that there exists long run equilibrium relationship between spot and future market prices of Pigeon pea. The results of Co-integration test showed one co-integration equation was significant at 5 per cent level of significance which implied that there existed co-integration between spot and future market prices of Pigeon pea. Tingreet *al.* (2018) found that the selected turmeric spot and future markets having long run equilibrium relationship and there exist co-integration between them.

Table 5.37. Multiple co-integration analysis for spot and future prices of Pigeon pea

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Critical Value 5%	Prob.**	Number of Co-integrating Equation CE(s)
None *	0.999	53.048	15.495	0.000	One
At most 1 *	0.231	1.842	3.841	0.175	

Note:-Trace test indicates 1 co-integrating equations significant at the 5 percent level of significance.

5.5.1.2 Market Co-integration between Chickpea spot and future prices

Johansen's multiple co-integration test was employed to determine the long run relationship among the spot and future market prices series of Chickpea and the results are presented in table 5.38. It was observed that the presence of at least no co-integration equations at 5 per cent level of significance confirms that there exists no long run equilibrium relationship between spot and future market prices of Chickpea. The results of Co-integration test showed no co-integration equation was significant at 5 per

cent level of significance which implied that there existed no co-integration between spot and future market prices of Chickpea.

Table 5.38. Multiple co-integration analysis for spot and future prices of Chickpea

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Critical Value 5%	Prob.**	Number of Co- integrating Equation CE(s)
None *	0.099	14.765	15.495	0.064	No
At most 1 *	0.012	1.481	3.841	0.224	

Note:-Trace test indicates No co-integrating equations significant at the 5 percent level of significance.

5.5.2 Causality of price signals between spot and future markets

5.5.2.1 Causality of price signals between spot and future prices of Pigeon pea

From table 5.39 it was observed that there is no causality in spot and future prices of Pigeon pea. Spot market prices were not affecting the current future market price as well as future market prices also not affecting the current spot market prices.

Table 5.39. Results of Pair wise Granger Causality test for spot and future prices of Pigeon pea

Null Hypothesis:	F-Statistic	Prob.
Spot does not Granger Cause Future	0.154	0.867
Future does not Granger Cause Spot	1.193	0.456

5.5.2.2 Causality of price signals between spot and future Prices of Chickpea

From table 5.40 it was revealed that there is the unidirectional causality in future and spot price of Chickpea. Future market prices were affecting the current spot market price. Thus, a market integration between future and spot price of Chickpea was established through the results of the analysis.

Table 5.40. Results of Pair wise Granger Causality test for spot and future prices of Chickpea

Null Hypothesis:	F-Statistic	Prob.
Spot does not Granger Cause Future	1.732	0.181
Future does not Granger Cause Spot	19.673*	0.000

Note: - * denotes significant at 1 % level of significance.

5.6 Price forecasting of selected pulses

In order to forecast the prices of Pulses for the next season of selected markets ARIMA models were fitted. Among the class of ARIMA models the best fit model was selected on the basis of lowest AIC (Akaike Information Criteria) values and the residuals should be in confidence limit.

In the present study various ARIMA models were fitted on Pulses price data of selected markets of Maharashtra. The objective of fitting multiple models on data is to obtain reliable forecasts on the basis of statistical measures. Different ARIMA models are fitted and results are presented for Pigeon pea, Green gram, Black gram and Chickpea prices respectively in the following tables.

5.6.1 Price Forecasting for Pigeon pea

The AIC (Akaike Information Criteria) values of different fitted models for Pigeon pea prices data of selected markets are presented in table 5.41. It was revealed that the model selection for Pigeon pea prices on the basis of AIC values found that ARIMA (0, 1, 1) has lowest AIC amongst all other models and used this model for forecasting the prices of Pigeon pea for Washim, Wardha and Mumbai markets respectively. The ARIMA (1, 1, 0) has lowest AIC value for Latur market price data and used for price forecasting. Divya *et al.* (2018), selected ARIMA model for forecasting the green gram prices in Suryapeta was ARIMA (0,1,1), and for Thandur market it was ARIMA (1,0,1).

Table 5.41 AIC values of different fitted models for the Pigeon pea price data of selected markets

Sr. No	Fitted Model (p,d,q)	Washim	Wardha	Mumbai	Latur
1	AR (1,0,0)	2684.88	2910.58	2338.43	2823.78
2	ARI (1,1,0)	2664.98	2879.58	2314.8	2787.31
3	ARIMA (1,1,1)	2661.91	2865.70	2314.39	2788.54
4	I (0,1,0)	2669.11	2904.45	2321.00	2811.41
5	MA (0,0,1)	2921.57	3012.93	2574.47	2999.44
6	ARMA (1,0,1)	2679.53	2881.14	2331.84	2806.10
7	IMA (0,1,1)	2661.32	2863.71	2311.53	2788.54

The forecasted and actual prices of Pigeon pea based on selected ARIMA models for each market are presented in Table 5.42.

Generally, the arrival of Pigeon pea started in the month of January and continued for next three to four months. The forecasted prices reported for the month of January 2020 were predicted as 5543, 5195, 6435 and 5769 rupees per quintal. The actual minimum-maximum prices ranges between for the months of January 2020 was 4664-5139, 4700-5270, 4922-6442 and 4540-5436 rupees per quintal for the Washim, Wardha, Mumbai and Latur market respectively. The prices reported for the month of April 2020 was 5609, 5258, 6518 and 5836 rupees per quintal and the actual minimum-maximum prices range between for the months of April 2020 was 5087-5412, 4690-5500, 4803-6605 and 4630-5610 rupees per quintal for the Washim, Wardha, Mumbai and Latur market respectively.

Table 5.42 Forecasted and actual prices of Pigeon pea for selected markets

Markets →	Washim Prices (Rs/qrtl)		Wardha Prices (Rs/qrtl)		Mumbai Prices (Rs/qrtl)		Latur Prices (Rs/qrtl)	
Months↓	Forecast	Actual Min-Max	Forecast	Actual Min-Max	Forecast	Actual Min-Max	Forecast	Actual Min-Max
Jan-2020	5543	4664-5139	5195	4700-5270	6435	4922-6442	5769	4540-5436
Feb-2020	5565	4653-5094	5216	4661-5990	6463	4507-6537	5791	4471-5448
Mar-2020	5587	4634-5051	5237	4677-5525	6491	4788-6570	5814	4518-5552
April-2020	5609	5087-5412	5258	4690-5500	6518	4803-6605	5836	4630-5610
AIC	2661.32	-	2865.70	-	2312.53	-	2787.31	-
Best fitted Models	IMA (0,1,1) (p,d,q)	-	IMA (0,1,1) (p,d,q)	-	IMA (0,1,1) (p,d,q)	-	ARI (1,1,0) (p,d,q)	-

The forecasted price values revealed an increasing trend in the next ensuing seasons. Hence, farmers need to plan the production process in such a way that a remunerative price for the produce would be expected. Barathiet *al.* (2011) Cocoon forecasted values of arrival showed increasing trend in the selected markets and price showed decreasing trend in Siddlaghatta market.

5.6.2 Price Forecasting for Green gram

The AIC (Akaike Information Criteria) values of different fitted models for Green gram prices data of selected markets are presented in table 5.43. It was observed that the model selection for Green gram prices on the basis of AIC values found that Model ARIMA (1, 1, 1) has lowest AIC value among all other models and hence used this model for forecasting the prices of Green gram for Buldana, Amravati and Latur markets respectively. The ARIMA (0, 1, 0) has lowest AIC value for Akola market price data. Chaudhari *et al.* (2014), observed that the value of normalized BIC was lowest and worked out to 254 for the ARIMA (0, 1, 0) it indicates that the ARIMA (0, 1, 0) was suitable for forecasting the prices of Green gram.

Table 5.43 AIC values of different fitted models for the Green gram price data of selected markets

Sr. No	Fitted Model (p,d,q)	Buldana	Akola	Amravati	Latur
1	AR (1,0,0)	2975.02	2622.63	2922.69	2592.17
2	ARI (1,1,0)	2951.53	2608.19	2905.36	2535.31
3	ARIMA (1,1,1)	2935.38	2606.65	2889.28	2528.72
4	I (0,1,0)	2993.52	2606.46	2923.57	2535.94
5	MA (0,0,1)	3010.40	2856.99	2992.62	2841.67
6	ARMA (1,0,1)	2954.13	2624.60	2906.42	2591.83
7	IMA (0,1,1)	2938.61	2608.11	2890.83	2535.58

The forecasted and actual prices of Green gram based on selected ARIMA models for each market are presented in Table 5.44. Generally, the arrival of Green gram started in the month of September and continued for next three to four months. The forecasted prices reported for the month of September 2019 were predicted as 5105, 5687, 5118 and 4818 rupees per quintal. The actual minimum–maximum prices range

between for the months of September 2019 was rupees 4650-5789, 4009-5673, 3845-5607 and 4593-6240 rupees per quintal for the Buldana, Akola, Amravati and Latur markets respectively. The prices for the month of December 2019 were predicted as 5158, 5753, 5174 and 4925 rupees per quintal and the actual minimum–maximum prices range between for the months of December 2019 was 4986-6169, 4779-6388, 5053-5991 and 4908-6223 rupees per quintal for the Buldana, Akola, Amravati and Latur markets respectively. Chaudhari and Tingre (2014) the forecasted values of Green gram prices increasing from Rs 4646 per quintal during October 2012 to Rs 4729 per quintal during Feb 2013.

Table 5.44 Forecasted and actual prices of Green gram for selected markets

Markets →	Buldana Prices (Rs/qrtl)		Akola Prices (Rs/qrtl)		Amravati Prices (Rs/qrtl)		Latur Prices (Rs/qrtl)	
Months↓	Forecast	Actual Min-Max	Forecast	Actual Min-Max	Forecast	Actual Min-Max	Forecast	Actual Min-Max
Sep-2019	5105	4650-5789	5687	4009-5673	5118	3845-5607	4818	4593-6240
Oct-2019	5122	4965-5976	5709	4160-6297	5137	3836-5486	4902	4739-6283
Nov-2019	5140	5059-6404	5731	4862-6458	5155	4964-5936	4854	4787-6535
Dec-2019	5158	4986-6169	5753	4779-6388	5174	5053-5991	4925	4908-6223
AIC	2935.38	-	2606.46	-	2889.28	-	2528.72	-
Best fitted Models	ARIMA (1,1,1) (p,d,q)	-	I (0,1,0) (p,d,q)	-	ARIMA (1,1,1) (p,d,q)	-	ARIMA (1,1,1) (p,d,q)	-

5.6.3 Prices Forecasting for Black gram

The AIC (Akaie Information Criteria) values of different fitted models for Black gram prices data of selected markets are presented in table 5.45.

Table 5.45 AIC values of different fitted models for the Black gram price data of selected markets

Sr. No	Fitted Model (p,d,q)	Mumbai	Solapur	Washim	Akola
1	AR (1,0,0)	2387.40	2705.98	2682.93	2667.29
2	ARI (1,1,0)	2349.33	2673.10	2668.74	2652.98
3	ARIMA (1,1,1)	2348.97	2669.23	2669.17	2653.83
4	I (0,1,0)	2348.07	2671.11	2666.99	2651.07
5	MA (0,0,1)	2616.79	2927.39	2935.56	2920.47
6	ARMA (1,0,1)	2385.03	2707.95	2684.88	2669.29

7	IMA (0,1,1)	2348.72	2673.10	2668.66	2652.94
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It was revealed that the model selection for Black gram prices on the basis of AIC values found that Model ARIMA (0, 1, 0) has lowest AIC amongst all other models and used this model for forecasting the prices of Black gram for Mumbai, Washim and Akola markets respectively. The ARIMA (1, 1, 1) has lowest AIC value for Solapur market.

The forecasted prices of Black gram based on selected ARIMA models are presented in Table 5.46.

Generally, the arrival of Black gram started in the month of September and continued for next three to four months. The forecasted prices observed for the month of September 2019 were predicted as 5577, 3865, 4242 and 4724 rupees per quintal. The actual minimum–maximum prices range between for the months of September 2019 was 4500-5626, 3727-5271, 4195-4652 and 3635-4850 rupees per quintal for the Mumbai, Solapur, Washim and Akola markets respectively. The prices for the month of December 2019 were predicted as 5703, 4245, 4288 and 4779 rupees per quintal and the actual minimum–maximum prices range between for the months of December 2019 was 5247-6035, 4000-4500, 4120-5280 and 3875-5540 rupees per quintal for the Mumbai, Solapur, Washim and Akola markets respectively.

Table 5.46 Forecasted and actual prices of Black gram for selected markets

Markets →	Mumbai Prices (Rs/qrtl)		Solapur Prices (Rs/qrtl)		Washim Prices (Rs/qrtl)		Akola Prices (Rs/qrtl)	
Months ↓	Forecast	Actual Min- Max	Forecast	Actual Min- Max	Forecast	Actual Min- Max	Forecast	Actual Min- Max
Sep-2019	5577	4500-5626	3865	3727-5271	4242	4195-4652	4724	3635-4850
Oct-2019	5619	4523-5551	4001	3913-5185	4257	4167-5118	4742	3442-5571
Nov-2019	5661	4750-5711	4127	4055-4744	4273	4235-5220	4761	4088-6008
Dec-2019	5703	5247-6035	4245	4000-4500	4288	4120-5280	4779	3875-5540
AIC	2348.07	-	2669.23	-	2666.99	-	2651.07	-
Best fitted Models	I (0,1,0) (p,d,q)	-	ARIMA (1,1,1) (p,d,q)	-	I (0,1,0) (p,d,q)	-	I (0,1,0) (p,d,q)	-

5.6.4 Price Forecasting for Chickpea

The AIC (Akaike Information Criteria) values of different fitted models for Chickpea prices data of selected markets are presented in table 5.47. It was observed that the model selection for Chickpea prices on the basis of lowest AIC value found that Model ARIMA (0, 1, 1) has lowest AIC value among all other models and used this model for forecasting the prices of Chickpea for Buldana, Washim and Amravati markets respectively. The ARIMA (1, 1, 1) has lowest AIC value for Latur market price data.

Table 5.47 AIC values of different fitted models for the Chickpea price data of selected markets

Sr. No	Fitted Model (p,d,q)	Buldana	Washim	Latur	Amravati
1	AR (1,0,0)	2613.27	2763.84	2507.74	2843.43
2	ARI (1,1,0)	2590.21	2747.39	2491.14	2821.46
3	ARIMA (1,1,1)	2589.81	2744.56	2485.46	2814.56
4	I (0,1,0)	2600.00	2753.00	2490.96	2838.70
5	MA (0,0,1)	2807.99	2919.58	2809.91	2947.96
6	ARMA (1,0,1)	2604.60	2759.10	2508.70	2829.35
7	IMA (0,1,1)	2587.89	2744.08	2491.36	2814.38

The forecasted prices of Chickpea based on selected ARIMA models for each market are presented in Table 5.48.

Generally, the arrival of Chickpea started in the month of January and continued for next three to four months. The forecasted price reported for the month of January 2020 was predicted as 4227, 4255, 4376 and 4297 rupees per quintal. The actual minimum–maximum prices range between for the months of January 2020 was 3408-4224, 3654-4277, 3552-4409 and 3687-4318 rupees per quintal for the Buldana, Washim, Latur and Amravati markets respectively. The prices for the month of April 2020 was predicted as 4272, 4301, 4317 and 4343 rupees per quintal and the actual minimum–maximum prices range between for the months of April 2020 was 3360-4320, 3650-4380, 3620-4435 and 3950-4475 rupees per quintal for the Buldana, Washim, Latur and Amravati markets respectively.

Table 5.48 Forecasted and actual prices of Chickpea for selected markets

Markets →	Buldana Prices (Rs/qrtl)		Washim Prices (Rs/qrtl)		Latur Prices (Rs/qrtl)		Amravati Prices (Rs/qrtl)	
Months ↓	Forecast	Actual Min-Max	Forecast	Actual Min-Max	Forecast	Actual Min-Max	Forecast	Actual Min-Max
Jan-2020	4227	3408-4224	4255	3654-4277	4376	3552-4409	4297	3687-4318
Feb-2020	4242	3237-4247	4271	3512-4233	4284	3557-4385	4313	3617-4402
Mar-2020	4257	3276-4234	4286	3400-4308	4406	3547-4470	4328	3442-4411
April-2020	4272	3360-4320	4301	3650-4380	4317	3620-4435	4343	3950-4475
AIC	2587.89	-	2744.08	-	2485.46	-	2814.38	-
Best fitted Models	IMA (0,1,1) (p,d,q)	-	IMA (0,1,1) (p,d,q)	-	ARIMA (1,1,1) (p,d,q)	-	IMA (0,1,1) (p,d,q)	-

5.7 Relationship between pulses prices and there process product

5.7.1 Causality of price signals between Pigeon pea prices and there Process Product

From table 5.49 it was observed that there was no price causality between Pigeon pea and Dal prices. Pigeon pea prices were not affecting the current Dal prices. Thus, no market integration between Pigeon pea and Dal prices were established through the results of the analysis.

Table 5.49. Pair wise Granger causality test for Pigeon pea prices and there Process Product

Null Hypothesis:	F-Statistic	Prob.
Pigeon pea does not Granger Cause Dal	1.412	0.274
Dal does not Granger Cause Pigeon pea	1.307	0.300

5.7.2 Causality of price signals between Green gram prices and there Process Products

From table 5.50 it was revealed that there was no price causality between Green gram and Dal prices. Green gram prices were not affecting the current Dal price. Thus, no market integration between Green gram and Dal prices were established through the results of the analysis.

Table 5.50. Pair wise Granger causality test for Green gram prices and there Process Products

Null Hypothesis:	F-Statistic	Prob.
Green gram does not Granger Cause Dal	0.329	0.7245
Dal does not Granger Cause Green gram	0.665	0.5286

5.7.3 Causality of price signals between Black gram prices and there Process Products

From table 5.51 it was showedthat there is the bidirectional causality existed in Blackgram and its Dal prices. Both are affecting prices of each others. Thus,a market integration between Blackgram and its Dal priceswere established through the results of the analysis.

Table 5.51. Pair wise Granger causality test for Black gram prices and there Process Products

Null Hypothesis:	F-Statistic	Prob.
Black gram does not Granger Cause Dal	7.013*	0.007
Dal does not Granger Cause Black gram	3.440*	0.059

Note: - * denotes significant at 1 % level of significance.

5.7.4 Causality of price signals between Chickpea prices and there Process Products

From table 5.52 it was observed that there is no price causality between Dal and Chickpea prices. The prices of flour and Chickpea also exhibited no causality and not affecting each others. The unidirectional causality in flour and Dal pricesof Chickpea was observed. Thus, a market integration between flour and Dal prices of Chickpea established through the results of the analysis.

Table 5.52. Pair wise Granger causality test for Chickpea prices and their Process Products

Null Hypothesis:	F-Statistic	Prob.
Dal does not Granger Cause Chickpea	1.046	0.376
Chickpea does not Granger Cause Dal	1.322	0.296
Flour does not Granger Cause Chickpea	1.809	0.198
Chickpea does not Granger Cause Flour	2.170	0.149
Flour does not Granger Cause Dal	3.598*	0.053
Dal does not Granger Cause Flour	2.362	0.128

Note: - * denotes significant at 1 % level of significance.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Pulses play an important and diverse role in the farming systems and in the diets of poor people around the world. They are ideal crops for simultaneously achieving three developmental goals in targeted population reducing poverty, improving human health as well as nutrition and enhancing ecosystem resilience. A variety of pulse crops are grown in India and the world. Among the crops, the major ones are Pigeon pea, Chickpea, Green gram, Black gram, Lentil, Field peas, etc. India is the largest pulses producing country in the world with a 25 per cent share in global pulse production from 32 per cent of the global area. Pulses refer to a group of more than sixty different grain legume crops grown around the world. The seeds of pulses are important in human nutrition. They are typically made up of 20-25 per cent protein and 40-50 per cent starch. They are also rich in dietary fiber and usually have only a small amount of oil. The protein of pulse seeds is high in amino acids, lysine and methionine, making pulse nutritionally complementary to cereals, which are deficient in these two essential amino acids.

In the world, pulses are grown by 198 countries. Beans dry was cultivated by 152 countries, which contributed about 35.93 per cent area to total world area, Chickpea by 58 contributed about 16.41 per cent, Peas dry by 98 contributed 8.14 per cent, Pigeon pea by 23 contributed 8.26 per cent, Lentil by 56 contributed by 5.31 per cent and others 25.95 per cent. The share to World production of Beans dry was 31.64 per cent followed by Chickpea 17.72 per cent, Peas dry 14.44 per cent, Pigeon pea 6.531 per cent, Lentil 6.23 per cent and others 23.66 per cent. It reveals that the India ranked first in area and production with 35 per cent and 25 per cent respectively of world area and production.

India produces about 23.40 million tonnes of Pulses annually from about 23.40 million hectares of area with average productivity of 806 kg per hectare in the year 2018-19. (DES, 2018-19). Maharashtra produces about 2.16 million tonnes of Pulses annually from about 3.51 million hectares

of area with average productivity of 616 kg per hectare in the year 2018-19. (DES, 2018-19)

The important Pulses grown in Maharashtra state are Pigeon pea, Chickpea, Green gram, Black gram, Lentil and Field peas, etc. There is a good amount of marketable surplus in this state. This piece of market integration study of selected Pulses viz. Pigeon pea, Green gram, Black gram and Chickpea in Maharashtra state will help policy makers to formulate policies for the whole country. This will also result in improved market integration thereby providing a reasonable price to farmers for their produce and improved infrastructures for the markets.

The present study aimed to study the Market integration and price volatility of pulses in Maharashtra was under taken with the specific objectives as follows:

1. To study the seasonal and cyclical variations in prices and arrivals of pulses
2. To assess the stationarity and volatility in prices of pulses
3. To assess the co-integration and causality of price signals among selected markets of pulses
4. To study the relationship between spot and future prices of Pigeonpea (Tur) and Chickpea (Gram)
5. To forecast the prices of pulses for the selected markets
6. To study the relationship between pulses prices and there processed product

For the present study, four major pulses namely Pigeon pea, Green gram, Black gram and Chickpea were selected. For pigeon pea market namely Washim, Wardha, Mumbai and Latur were selected for the study. In respect of Green gram Buldana, Akola, Amravati and Latur markets were selected. In case of Black gram Mumbai, Solapur, Washim and Akola markets were selected and the Chickpea Buldana, Washim, Latur and Amravati markets were selected.

The time series secondary data on monthly average prices and arrivals of pulses for the period from January 2005 to December 2016 was collected from APMC's Markets, AGMARKNET website and future prices data from NCDEX website for respective markets and used for the present study. The moving average method was used to estimate seasonal variations and Residual Method for cyclical variations. The econometric tools like ADF test, Johansen's Multiple Co-integration test, Pair-wise Granger Causality Test, ARCH-GARCH model, Vector Error Correction model and ARIMA model were also used.

6.1 Seasonal and Cyclical variations in prices and arrivals in selected pulses

6.1.1 Seasonal indices for pulse prices

It was observed that in selected markets the prices of Pigeon pea were higher during July to October month. All the markets showed lower prices in the month from November to April month. During these month the arrivals starts which lowered down the prices. The seasonal indices of Green gram showed that in the selected markets the prices were higher from December to June. All the markets recorded lower prices in the month from July to November. The seasonal indices of Black gram were revealed that in selected markets the prices were higher from April to June. Highest prices were also observed during November and December in selected markets. The lower prices were recorded during July to October. The seasonal indices of Chickpea showed that in selected markets the prices were higher from July to December. All the selected markets recorded lower prices in the month from January to June. During these month the arrivals starts which lowered down the prices. The peak periods of chickpea arrival are during February to April at that time prices are declined. During peak season there is high arrivals so prices are low but in off season the prices are high due to shortage and lack of storage facilities.

6.1.2 Cyclical indices for pulses prices

The cyclical variations were observed in the prices of Pigeon pea in selected markets. The higher prices were noted in the year 2005, 2006, 2009, 2015 and 2016 for all the markets. Lower prices were noted in the

year 2008, 2011, 2012, 2013 and 2014. The rise in prices might be attributed to less production due to bad weather and stock in the hand of middleman. The Green gram higher prices were noted during the year 2006, 2009, 2010, 2014 and 2015 in the selected markets. Lower prices were observed in the year 2005, 2007, 2008, 2011, 2012 and 2016 for all the markets. The Black gram prices were revealed that the higher prices were recorded during the year 2005, 2006, 2010, 2015 and 2016 for all the markets. Lower prices were observed in the years 2008, 2009, 2011, 2012, 2013 and 2014 for all the markets. The cyclical variations in Chickpea prices were observed and the higher prices were observed during the year 2006, 2007, 2012 and 2016 for all the selected markets, and lower prices were observed in the year 2008, 2009, 2010, 2013 and 2014 for all markets.

6.1.3 Seasonal indices for pulses arrivals

The arrivals of Pigeon pea start hitting in market from the month of January and continued for next four months. The peak period of arrivals is January to May. Due to large arrivals during this period the prices are declined. The lower values of indices of arrivals were seen during the period of June to December indicated lean period in Pigeon pea arrivals in all markets. The peak period of Green gram arrivals is September to December. Due to large arrivals during this period the prices are declined. The lower values of indices of arrivals were during the period of January to August indicated lean period in Green gram arrivals in all markets. The arrivals of Black gram start hitting in market from the month of September and continue for next four months. The lower value of indices of arrivals was during the period of February to August indicated lean period in Black gram arrivals in all markets. The arrivals of Chickpea start hitting in market from the month of February and continued for next two months. The peak period of arrivals is February to April. The lower value of indices of arrivals was observed during the period of July to December indicated lean period in Chickpea arrivals in all markets.

6.1.4 Cyclical indices for pulses arrivals

The cyclical variations were observed in the arrivals of Pigeon pea in selected markets. The higher arrivals were noted in the year 2005, 2010, 2011, 2012, 2013 and 2016 for all the markets. Lower arrivals were noted in the years 2007, 2008, 2009 and 2014 for all the markets. The higher arrivals of Green gram were observed in the year 2007, 2010, 2011, 2012 and 2016 for all the markets. In the Amravati market relatively higher arrival was also observed in the year 2006 and 2009. Lower arrivals were noted in the year 2005, 2014 and 2015 for all the markets. The higher arrivals of Black gram were observed during the year 2007, 2010, 2011 and 2012 for all the markets. Lower arrivals were noted in the year 2005, 2006, 2009, 2013, 2014 and 2015 for all the markets. The cyclical variations were observed in the arrivals of Chickpea in selected markets. The higher arrivals were observed during the year 2006, 2007, 2008, 2010, 2012 and 2013 for all the markets. Lower arrivals were noted in the year 2005, 2008, 2015 and 2016 for all markets.

6.2 Stationarity and Price Volatility in prices of selected pulses

6.2.1 Testing of stationarity in price series of selected pulses

The Augmented Dick-Fuller (ADF) test is applied for the price data of all selected pulses market. It was observed that at level with lag 1, the ADF values were more than critical values at 1 per cent level of significance indicating the existence of unit root implied that the prices series in all markets were non-stationary. The results further showed that in first order difference with lag 1, the ADF values were lower than the critical value at 1 per cent level of significance and indicated that the price series were free from the consequences of unit root. This implied that the prices series were stationary at 1st difference level.

6.2.2 Price volatility in selected pulses prices

To assess the presence of price fluctuations in the prices of selected pulses ARCH-GARCH analysis was carried out and the results are the sum of Alpha and Beta ($\alpha + \beta$) value indicated ARCH and GARCH effect for

the given market. It was observed that for the selected markets of pulses, the sum of Alpha and Beta is nearer to 1 indicated that the volatility shocks in the prices of selected pulses are quite persistent for a long time in these markets. Hence the hypothesis proposed regarding the selected markets of pulses are volatile during the last decade is accepted.

6.3 Market Co-integration and Granger Causality in prices of selected pulses

6.3.1 Market Co-integration in prices of selected pulses

Johansen multiple co-integration trace test was applied for indicating the long-run relationship between the price series of selected pulses markets. The results of the co-integration test showed that the presence of at least three co-integration equations at 5 per cent level of significance confirms that there exists a long-run equilibrium relation in the Pigeon pea markets. Hence the hypothesis proposed regarding the selected markets of Pulses in Maharashtra are co-integrated is accepted. It is concluded that the selected markets having a long-run equilibrium relationship for the prices of selected pulses and there exists co-integration among them as indicated by the results of Johansen's multiple co-integration tests.

6.3.2 Causality of price signals between selected Pulse markets

Granger Causality Test is a statistical tool which used F-test to know the cause and effect relationship between the two time series and this technique is employed to know the relationship between the prices of selected Pulses markets. The results of the test showing the relationship between selected Pigeon pea markets showed that there is bidirectional causality in Pigeon pea prices between Wardha and Latur, Washim and Latur, Washim and Mumbai respectively. The prices of Mumbai market exhibited unidirectional causality and affects the prices of Latur market. The results of the test showing the relationship between selected Green gram markets showed that there is bidirectional causality in Green gram prices between Latur and Akola, Buldana and Amravati respectively. The prices of Akola market exhibited unidirectional causality and affects the prices of Amravati market. The relationship between selected Black gram markets revealed that

there is bidirectional causality in Black gram prices between Solapur and Akola, Solapur and Mumbai, Washim and Mumbai, Washim and Solapur respectively. The prices of Mumbai market exhibited unidirectional causality and affects the prices of Akola market. The results of the test showing the relationship between selected Chickpea markets showed that there is bidirectional causality in Chickpea prices between Buldana and Amravati, Washim and Amravati, Latur and Buldana respectively. The prices of Latur market exhibited unidirectional causality and affects the prices of Amravati and Washim market.

6.3.3 Short-run and Long-run behaviour of pulses market prices

The Johansen's multiple co-integration test results showed that the selected pulses markets having long-run equilibrium relationship and there exists co-integration between them, hence the vector error correction model (VECM) are employed to know the speed of adjustments for the prices of pulses of selected markets for short run and long run equilibrium of prices. For the pigeon pea prices the vector error correction model revealed that Mumbai, Wardha and Washim markets attain short-run equilibrium rapidly. Latur market one and two month lag price affecting the current prices of the same market. Mumbai market one month lag price was affecting the current price of Wardha and same market. Mumbai market two month lag price was affecting the current price of Wardha market. For Green gram prices the estimates of Vector Error Correction Model revealed that the Amravati and Buldana markets attain short-run equilibrium rapidly. Akola market one month lag price was affecting the current price of Latur market. In Akola market two month lag price was affecting current prices of the same market and Latur market. Amravati market one month and two month lag price was affecting prices of Buldana and Latur market. The results of vector error correction model for Black gram prices showed that only Washim market attain short-run equilibrium rapidly. Akola market one month lag price is affecting the current price of the same market. Akola two month lag price is affecting the current price of the Solapur, Washim and same market. Mumbai one month lag price is affecting the current price of Akola, Solapur and Washim market. Mumbai two month lag price is affecting the current price of the same market.

The results of vector error correction model for Chickpea prices showed that Amravati and Latur markets attain short-run equilibrium rapidly. Amravati market one month lag price is affecting the current price of Latur market. Buldana market one month lag price was affecting current prices of all markets i.e. Amravati, Latur, Washim and the same market. Buldana market two month lag price was affecting current prices of the same market.

6.4 Relationship between spot and future prices of selected pulses

6.4.1 Market Co-integration

Johansen multiple co-integration trace test was revealed that the presence of at least one co-integration equations at 5 per cent level of significance confirms that there exists long run equilibrium relationship between spot and future market prices of Pigeon pea. The results of Co-integration test showed one co-integration equation was significant at 5 per cent level of significance which implied that there existed co-integration between spot and future market prices of Pigeon pea. The Chickpea spot and future market prices showed the presence of no co-integration equation significant at 5 per cent level of significance confirms that there was no long run equilibrium relationship existed between spot and future market prices of Chickpea.

6.4.2 Causality of price signals between spot and future markets

The results of the test showing the relationship between spot and future Pigeon pea market prices revealed that there is the no causality in spot and future prices of Pigeon pea. Spot market prices were not affecting the current future market price and viceversa. Thus, no market integration existed between spot and future price of Pigeon pea established through the results of the analysis. The Chickpea spot and future market prices showed that there is the unidirectional causality in future and spot market prices. Future market prices were affecting the current spot market prices.

6.5 Price forecasting of selected pulses

In order to forecast the prices of Pulses for the next season of selected markets ARIMA models was used. Among the class of ARIMA

models, the best-fit model was selected on the basis of lowest AIC (Akaie Information Criteria) values and the residuals should be in confidence limit. It was revealed that the model selection for Pigeon pea prices on the basis of lowest AIC values showed that ARIMA (0, 1, 1) has lowest AIC amongst all other models and used this model for forecasting the prices of Washim, Wardha and Mumbai markets respectively. The ARIMA (1, 1, 0) has lowest AIC value for Latur markets price. The arrival of Pigeon pea is started in the month of January and continued for the next three to four months. The forecasted prices for the month of January 2020 was predicted as 5543, 5195, 6435 and 5769 rupees per quintal and the actual minimum-maximum prices range between for the months of January 2020 was rupees 4664-5139, 4700-5270, 4922-6442 and 4540-5436 rupees per quintal for the Washim, Wardha, Mumbai and Latur markets respectively. The model selected for Green gram prices on the basis of lowest AIC value showed that the ARIMA (1, 1, 1) was the best fit model and fitted this model for forecasting the prices of Buldana, Amravati and Latur markets respectively. The ARIMA (0, 1, 0) has lowest AIC value for Akola market and was used for forecasting.

The arrival of Green gram is started in the month of September and continued for the next three to four months. The forecasted prices for the month of September 2019 was predicted as 5105, 5687, 5118 and 4818 rupees per quintal and the actual minimum-maximum prices range between for the months of September 2019 was 4650-5789, 4009-5673, 3845-5607 and 4593-6240 rupees per quintal for the Buldana, Akola, Amravati and Latur markets respectively. The model selected for prediction of Black gram prices on the basis of lowest AIC values was showed that ARIMA (0, 1, 0) was the best fit model and used for forecasting the prices of Mumbai, Washim and Akola market respectively. The ARIMA (1, 1, 1) has the lowest AIC value for Solapur market price data. Generally, the arrival of Black gram is started in the month of September and continued for the next three to four months. The forecasted prices for the month of September 2019 was predicted as 5577, 3865, 4242 and 4724 rupees per quintal and the actual minimum-maximum prices range between for the months of September 2019 was 4500-5626, 3727-5271, 4195-4652 and 3635-4850 rupees per quintal for the Mumbai,

Solapur, Washim and Akola markets respectively. The model selection for Chickpea prices on the basis of lowest AIC value showed that Model ARIMA (0, 1, 1) was the best fit model for forecasting the prices of Buldana, Washim and Amravati markets respectively. The ARIMA (1, 1, 1) has the lowest AIC value for Latur market price data. The arrival of Chickpea is started in the month of January and continued for the next three to four months. The forecasted prices for the month of January 2020 was predicted as 4227, 4255, 4376 and 4297 rupees per quintal and the actual minimum–maximum prices range between for the months of January 2020 was 3408-4224, 3654-4277, 3552-4409 and 3687-4318 rupees per quintal for the Buldana, Washim, Latur and Amravati markets respectively.

6.6 Relationship between Pulses prices and their process products

6.6.1 Causality of price signals between Pulses prices and their process products

It was observed that there is no causality in Pigeon pea and Dal prices. Pigeon pea prices were not affecting the current Dal price. Thus, no market integration between Pigeon pea and Dal prices are established through the results of the analysis. The Green gram prices and their Dal prices were revealed that there was no causality in Green gram and Dal prices. Green gram prices were not affecting the current Dal prices. Thus, no market integration between Green gram and Dal price are established through the results of the analysis. The Black gram prices were showed that there was bidirectional causality in Blackgram and Dal prices. Blackgram prices were affecting the current Dal prices. Thus, a market integration between Blackgram and Dal prices are established through the results of the analysis. The Chickpea and their process products prices were showed that there is no causality in Dal and Chickpea prices. The prices of Flour and Chickpea exhibited no causality and not affecting Chickpea prices. The unidirectional causality observed between flour and Dal prices of Chickpea. Thus, a market integration between flour and Dal prices of Chickpea established through the results of the analysis.

Conclusions

The Major findings of the study have been summed up as follows:

- 1) The price of Pigeon pea was higher during the month of July to October. Green gram and Black gram were higher from the month of April to June and Chickpea was higher from the month of July to December in the selected markets of pulses.
- 2) The cyclical variation was observed in the prices of Pigeon pea in selected markets. The higher prices were observed during the years 2005, 2006, 2009, 2015 and 2016. Green gram and Black gram higher prices were noted during the years 2006, 2009, 2010, 2014, 2015 and 2016. The Chickpea higher prices were observed during the years 2005, 2006, 2012 and 2016 in the selected markets.
- 3) The peak period of arrivals of Pigeon pea in the selected markets was January to May. Green gram and Black gram was September to December and Chickpea was February to April for every year.
- 4) The cyclical variation was observed in the arrivals of Pigeon pea in the selected markets. The higher arrivals were noted during the years 2005, 2010, 2011, 2013 and 2016. Green gram and Black gram were 2007, 2008, 2010, 2011, 2012 and 2016. Chickpea was 2006, 2007, 2010, 2011, 2012, 2013 and 2014 in the selected markets.
- 5) The price series of all selected pulses markets were non - stationary at level with lag 1 and all markets prices series became stationary after 1st order difference.
- 6) The results of ARCH-GARCH analysis showed that volatility shocks in the prices of pulses were persistent in the selected markets of pulses in Maharashtra.
- 7) The selected markets having long-run equilibrium relationship for the prices of selected pulses and there existed co-integration.
- 8) Bi-directional causality observed in the prices of Pigeon pea between Wardha and Latur, Washim and Latur, Washim and Mumbai markets respectively. The Pigeon pea prices of Mumbai market exhibited unidirectional causality and affects the prices of Latur market. So the

influence of Washim market prices played a significant role over the other selected markets.

- 9) Bi-directional causality revealed in the prices of Green gram between Latur and Akola, Buldana and Amravati markets respectively. The prices of Akola market exhibited unidirectional causality and affects the prices of Amravati and Buldana market. So the influence of Akola and Latur market prices played a significant role over the other selected markets.
- 10) Bi-directional causality showed in the prices of Black gram between Solapur and Akola, Solapur and Mumbai, Washim and Mumbai, Washim and Solapur respectively. The prices of Mumbai market exhibited unidirectional causality and affects the prices of Akola market. So the influence of Solapur and Mumbai market prices played a significant role over the other selected markets.
- 11) Bi-directional causality observed in the prices of Chickpea between Buldana and Amravati, Washim and Amravati, Latur and Buldana respectively. The prices of Latur market exhibited unidirectional causality and affects the prices of Amravati and Washim market. So the influence of Buldana and Latur market prices played a significant role over the other selected markets.
- 12) The estimates of Vector Error Correction Model (VECM) in Pigeon pea prices revealed that Mumbai, Wardha and Washim market attained short-run equilibrium rapidly.
- 13) The estimates of Vector Error Correction Model (VECM) in Green gram prices showed that Amravati and Buldana market attained short-run equilibrium rapidly.
- 14) The estimates of Vector Error Correction Model (VECM) in Black gram prices revealed that only Washim market attained short-run equilibrium rapidly.
- 15) The estimates of Vector Error Correction Model (VECM) in Chickpea prices were showed that Amravati and Latur market attained short-run equilibrium rapidly.
- 16) The Pigeon pea and Chickpea prices of spot and future markets having long-run equilibrium relationship and there existed co-integration between them.

- 17) The prices have no causality between spot and future market of Pigeon pea.
- 18) The prices have showed unidirectional causality between future and spot market prices of Chickpea. Future market prices were affecting the current spot market price. So, the influence of future prices played a significant role over the spot market prices.
- 19) The forecasted prices of Pigeon pea for the month of April 2020 was predicted as 5609, 5258, 6518 and 5836 rupees per quintal and the actual minimum-maximum prices range for the months of January 2020 was rupees 4664-5139, 4700-5270, 4922-6442 and 4540-5436 rupees per quintal for the Washim, Wardha, Mumbai and Latur markets respectively. The forecasted price values revealed an increasing trend in the next ensuing season.
- 20) The forecasted prices of Green gram for the month of September 2019 was predicted as 5105, 5687, 5118 and 4818 rupees per quintal and the actual minimum-maximum prices range between for the months of September 2019 was rupees 4650-5789, 4009-5673, 3845-5607 and 4593-6240 rupees per quintal for the Buldana, Akola, Amravati and Latur markets respectively.
- 21) The forecasted prices of Black gram for the month of September 2019 was predicted as 5577, 3865, 4242 and 4724 rupees per quintal and the actual minimum-maximum prices range between for the months of September 2019 was 4500-5626, 3727-5271, 4195-4652 and 3635-4850 rupees per quintal for the Mumbai, Solapur, Washim and Akola markets respectively.
- 22) The forecasted prices of Chickpea for the month of April 2020 was predicted as 4272, 4301, 4317 and 4343 rupees per quintal and the actual minimum-maximum prices range between for the months of January 2020 was rupees 3408-4224, 3654-4277, 3552-4409 and 3687-4318 rupees per quintal for the Buldana, Washim, Latur and Amravati markets respectively.
- 23) There was no price causality observed between Pigeon pea and Dal prices. Pigeon pea prices were not affecting the current Dal prices.

- 24) There was no price causality seen between Green gram and Dal prices. Green gram prices were not affecting the current Dal prices.
- 25) There was bidirectional causality observed between Black gram and Dal prices. Black gram prices were affecting the current Dal prices.
- 26) There was no price causality observed between Dal and Chickpea prices. The prices of Flour and Chickpea exhibited no causality and not affecting the prices of each other.

Policy Implications

Based on the results of the study following policy implications are suggested.

1. In order to minimise the price risk and to protect the price security of farming community and also to stabilise the acreage under pulses of Maharashtra State which are the volatile commodities in terms of pulses market prices. It is suggested that long term procurement policy should be adopted to maintain price stability throughout the year at least for major pulses markets of the state.
2. Government should regularly disseminate the information regarding the future prices of pulses to the farmers and create awareness about the future prices, which will be very helpful to the farmers for taking appropriate selling decisions of pulses for fetching remunerative price.

CHAPTER VII

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