Volatility in Agricultural Prices

Dr. Arun P. Kulkarni

Volume 1

[Overview]

Centre of Studies
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Centre of Studies in Social Sciences, Pune (India)

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The book presents the findings of the study in progress by the author. Centre of Studies in Social Sciences, Pune is publishing these finding to encourage discussion on this subject of vital importance among academicians, farmers and other stakeholders. The presentation may not be fully polished or complete in all respects; comments are, therefore, welcome.

The book is available for download on: http://www.cssspune.org/

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To my three Gurus

Prof. Venkatasubbaih

Prof. D. R. Gadgil

Shri S. L. Kirloskar

They guided me in seeing beauty in Statistics, finding relevance in Economics,

and managing the two in practice, respectively

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Arun P. Kulkarni

Volatility in Agricultural Prices

Dr. Arun P. Kulkarni (Nov. 2019)

Executive Summary

Volatility in agricultural prices has been a subject of concern not only for India but also for all countries, whether developed or developing. The present study attempts to measure and compare volatility in monthly prices of 84 agricultural commodities in India during the period of 37 years between April 1982 and March 2019. For the sake of comparison, this period is divided into three sub-periods. The data used are the Wholesale Price Indices for individual commodities published by the Office of the Economic Adviser, Department for Promotion of Industry and Internal Trade, Government of India (https://eaindustry.nic.in/).

The selected 84 commodities include: Cereals (7), Pulses (7), Oilseeds (11), Spices (10), Fibres (4), Livestock and Livestock Products (7), Vegetables (17), Fruits (16), Flowers (3) and Others (2). In addition, the Wholesale Price Index for all Commodities, considered as indicator of general price level, is also subjected to analysis.

The Period of 37 years is subdivided into the following three Sub-periods:

Period 1: April 1982 to March 1994 (12 years)

Period 2: April 1994 to March 2005 (11 years) and

Period 3: April 2005 to March 2019 (14 years)

Fluctuations in monthly prices for each commodity are analysed for the three sub-periods separately.

Three components of price fluctuations are examined. One, which is caused by seasonality in supply, another that is the result of secular trend in prices and the third consisting of remaining cyclical and irregular fluctuations (called Residual Fluctuations). The presence and extent of seasonality is estimated by using X-13ARIMA-SEATS methodology developed by the U. S. Department of Commerce, U. S. Census Bureau. The trend is estimated from the deseasonalized series by calculating the annual compound growth rates in the series in both nominal and real terms.

Volatility is measured by calculating coefficient of variation of the original series as also of the residual series (after removing seasonality and trend). Seasonality, trend and volatility are calculated for each commodity and each sub-period.

The study provides commodity-wise data on seasonality, trend and volatility for the period under consideration.

Following conclusions emerge from the analysis:

1. The seasonality in prices of almost all commodities has been declining over years. In the latest period (April 2005 – March 2019), it is ***not*** present in as many as 42 commodities (out of 84). This is because of increasing fluctuations in prices within the year as also due to factors like globalization.

2. Seasonality in several perishables like vegetables and fruits, however, continues to remain high.

3. The growth rates indicate the opportunities of increasing or decreasing supply. The commodities like Tamarind, Pepper, Inland Fisheries, and Ragi are showing relatively high rates of increase in real prices in the recent period.

4. Volatility is least for most Cereals, Eggs, Milk and Fruits like Banana. It is highest for Guar seed, Garlic, Turmeric, Tomato, and Onion. It has also increased over the years for Pulses and Spices.

5. The study underlines the importance of the policy of Minimum Support Prices and procurement/distribution in keeping price fluctuations under control. It advocates building buffer stocks of pulses, onion and potato.

6. There is a need of controlling volatility of prices of vegetables and fruits. It suggests efficient aggregation of these commodities at the local level, better facilities of grading, cleaning and packaging of produce, better storage and transport facilities and increased processing of commodities near production centres. Some of the APMCs can divert their resources to fulfil these functions and become potential hubs of these activities. They will be able to even out the market supplies and increase demand during the seasons, the way dairy industry has done. The dairy products have indicated lowest volatility in prices because of such interventions.

7. The study recommends providing as much market information as possible to all stakeholders. It suggests an institutional arrangement to systematically collect all the relevant market information, analyse it and provide market advisories, dashboards, market signals and forecasts to all the functionaries. This would avoid speculation on the basis of rumours and incorrect information.

8. The study also urges to include more commodities in the Futures markets. This is probably the only way for the stakeholders to protect their interests from wild fluctuations in the international markets.

9. The study emphasises the need for further on-going research in this important subject. It lists out important topics as also expresses the need of providing suitable academic training.

This first volume has attempted a univariate price analysis. The second volume in the series will examine the influence of various factors like acreage, production, imports/exports, procurement and distribution of individual commodities on the fluctuations in their prices. It will also include individual commodity policy suggestions for the stakeholders.

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Pune (India)

The book "Volatility in Agricultural Prices" in pdf format can be downloaded from:
http://cssspune.org/e-book-download/

The comments and suggestions should be sent to the author, Dr. Arun P. Kulkarni, at
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Chapter 1
Introduction

> "One ought, every day at least, to hear a little song, read a good poem, see a fine picture, and, if it were possible, to speak a few reasonable words."
>
> – ***Johann Wolfgang von Goethe***, *German Writer*

1.1 Background

The need for this study has both academic as well as practical background. Volatility in agricultural prices has been discussed during the last two decades both at national and international levels. Several academic studies have been carried out on the measurement of volatility of important agricultural commodities. Different approaches have been tried out. But there has been no standardized method which would enable international comparisons of volatility in different commodities. The present study is a beginning, but certainly, not an end in that direction.

The second reason for this study is the increasing demand for 'forecasting' agricultural prices. In India, at present, almost all agricultural production takes place for commercial purposes. Farmers increasingly consider the prices they would receive while taking planting decisions. They also store the produce, if the current prices do not satisfy them. Other partners in the value chain also wish to have more and more 'professional' forecasting services to base their decisions on procurement of agricultural commodities. The policy makers are also increasingly aware of the political and social implications of wide fluctuations in agricultural prices. They would require to be forewarned before the sudden surges would occur.

The success of any forecasting exercise would depend on the intrinsic volatility in prices. Chances of forecasts going wrong, irrespective of any sophisticated method used, would

increase if the commodity is very volatile. Some kind of 'mapping' of volatility, therefore, was found necessary. It would be based on historical data and would cover as many agricultural commodities as possible.

The present study is, therefore, originated with these twin objectives: initiate effort in finding a standard methodology for estimating volatility; and using this method, measure and map volatility for as many crops as possible. It is not the purpose of the study to find the factors leading to volatility observed in the prices. This would be taken up in a later exercise. However, if any broad implications could emerge from this study, they are pointed out.

It should be noted that this is only the beginning. In evolving standard methodology, more rigour will be required and close institutional understanding and efforts will be necessary. We are aware of the limitations of the approach adopted.

1.2 Volatility in Agricultural Prices

Unlike other commodities, supply of agricultural commodities depends almost entirely on the natural factors. The year-to-year fluctuations in production and the peculiarities arising from individual crop cycles get reflected in the behaviour of agricultural prices. The classical theory of agricultural prices assumes, therefore, that they include four components: Seasonality, Trend, Cycle and Irregular fluctuations. Out of these, the first three are natural, expected components. Seasonality arises out of the seasonal nature of production; trend reflects the secular changes in supply and demand; cyclical fluctuations are the result of climatic factors and/or the producers' response to prices and the irregular fluctuations are the result of short term, often random, changes in factors influencing prices.

If we assume this model, volatility is a combination of all these four influences. It becomes necessary to decompose the series and examine the nature of these components individually. These influences would vary from commodity to commodity and from one period of time to another. In any mapping exercise, such influences also would need separate mapping.

Then, how to define volatility? Is it fluctuations in the given prices or is it in the prices after the influences of the first three components are removed?

Merriam – Webster dictionary defines volatility as 'a tendency to change quickly and unpredictably'. Inter-agency report on Price Volatility discusses under '*What is volatility*' as follows:

"In a purely descriptive sense volatility refers to variations in economic variables over time …. Here we are explicitly concerned with variations in agricultural prices over time. Not all price variations are problematic, such as when prices move along a smooth and well-established trend reflecting market fundamentals or when they exhibit a typical and well

known seasonal pattern. But variations in prices become problematic when they are large and cannot be anticipated and, as a result, create a level of uncertainty which increases risks for producers, traders, consumers and governments and may lead to sub-optimal decisions. Variations in prices that do not reflect market fundamentals are also problematic as they can lead to incorrect decisions."[1]

Although measuring volatility in the original series is simple and less time consuming, our position is clear. Firstly, we believe, if volatility is to be compared across commodities, time or region, the four components should be separated and the measure of volatility should include only the irregular fluctuations. This would avoid any confounding of different influences. Secondly, if volatility is to be measured for policy decisions, again, the series should be decomposed and the volatility should be measured only for the irregular fluctuations. This is because each of these components would invite different policy interventions.

In this study, therefore, we have tried to separate two components, seasonality and trend and measured their influence separately for each commodity. Then we have calculated volatility both for original price series as also for the price series after removing the effect of seasonality and trend. This we have called 'Residual' series.

We have not separated the influence of cycle from the series mainly because it would require an independent research, right from defining cycle. Not much literature is available on the subject nor sufficient empirical research has been conducted in India. Lot of field research is also involved in investigating crop cycles, farmers' response to prices and the influence of climate factors on supply. The measurement of cycle is also a subject that is least investigated.

We have assumed the multiplicative relationship between the four components, as usually done in economic research.

1.3 Measuring Volatility

There are several measures of volatility used. We have used Coefficient of Variation, expressed as percentage. The difference between the CVs of the two series would indicate the contribution of seasonality and trend in volatility in the original series.

CV is independent of unit of measurement and comparable across commodities and time.

[1] 'Price Volatility in Food and Agricultural Markets: Policy Responses', Policy Report including contributions by FAO, IFAD, IMF,OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI and the UN HLTF, 2 June 2011, Page 6

1.4 Data Used

India, with its varied climate and a large vegetarian population, is blessed with production and consumption of many agricultural commodities. They consist of cereals, pulses, spices, livestock and livestock products, oilseeds, fibres, vegetables, fruits, flowers, etc. Each of these commodities has several varieties with different market segments. The exact number of these commodities and varieties is probably not known; however, most of them are produced for marketing and livelihood and employment of many small farmers and women is dependent on them. Processing is very limited and restricted to those commodities where it is essential.

Market of agricultural produce in India is essentially a spot market. Forward trading or trading in futures is as yet in infancy and limited to very few products. The spot markets, in the form of village and weekly markets, organized Agricultural Produce Market Committees (APMCs) and direct selling to traders, are spread over throughout the country. There is an organized system established to collect these prices (mostly from APMCs) and publish them on the internet daily (https://agmarknet.gov.in/). One can download prices and arrivals data from this and other similar State Government sites.

Government of India also publishes the price data in the form of monthly indices for agricultural and non-agricultural commodities, called Wholesale Price Index (WPI) (https://eaindustry.nic.in/). The site publishes historical data also.

We have used this data source and analysed monthly prices of 84 agricultural commodities. The period of analysis is of 37 years between April 1982 and March 2019. The prices reported in this source are regarded as proxy of prices received by producers, for the reasons explained in the next chapter. The seasonality is identified and measured by using the X-13 methodology.

The detailed methodology and findings are presented in the subsequent chapters.

1.5 Way Ahead

As said earlier, this is only the initial exercise. It does validate the approach we have adopted and brings out interesting results and policy implications. However, more systematic research on these lines is required and a standardized methodology for calculating and monitoring volatility at international level needs to be evolved.

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Chapter 2
Approach and Methodology

> "I did not mean to suggest that stories literally reside in data, or, if I did, I was mistaken. Rather, facts reside in data from which stories can sometimes be woven"
>
> – ***Stephen Few***, *Information Technologist*

Background

Agricultural prices, like all commodity prices, experience fluctuations from transaction to transaction. They are reflected in the daily, weekly or monthly averages. Some part of these fluctuations is normal, or even desirable. However, when such fluctuations are sudden, unpredictable and violent, they are categorised as volatile. Volatility in prices, therefore, is equated with risk. It affects all the stakeholders in the commodity value chain.

More the volatility in prices more will be fluctuations in incomes of farmers. The processors, manufacturers and exporters as also consumers also face the problems of meeting their requirements at fair prices. During the last 20 years, it is believed that the agricultural prices have become more volatile than before. A vast amount of literature is available on the subject. International organizations like FAO and European Union have suggested various measures to reduce volatility and its impact on farmers and consumers. Among the measures that have been adopted by various Governments, import-export restrictions, minimum support prices, establishing Commodity Exchanges for futures trading, forward marketing, and providing timely and accurate market information stand out as important. Increasing volatility also makes the task of forecasting and future planning extremely risky.

India is not an exception to this rising phenomenon of volatility. Governments (both Central and State) are increasingly facing farmers' (and consumers') agitations for sudden and sharp rise or fall in the prices of essential commodities like pulses, onion, tomato and economic problems arising out of them. Increasing intervention by them is now seen in the fields of

trade control, covering a larger number of commodities in the Minimum Support price programs and increasing activities like procurement, public storage and distribution.

However, the empirical studies on volatility in agricultural prices in India are very few and limited to a small number of commodities. No systematic study of all important commodities is ever attempted in India.
The present study attempts to fulfil the void. It considers as many as 84 agricultural commodities during the period of last 37 years. It also tries to standardize the methodology which is amenable for updating on an annual basis.

Objective of the Study:

The principal purpose of the analysis is to measure commodity-wise volatility in prices during the three periods under study.

Study Period:

The present study analyses the behaviour of individual *monthly* agricultural commodity prices in India during the 37 years between April 1982 and March 2019. This period is further divided in three periods as follows:

1. Period 1: April 1982 to March 1994 (Base 1981-82): 12 years, 144 months
2. Period 2: April 1994 to March 2005 (Base 1993-94): 11 years, 132 months
3. Period 3: April 2005 to March 2019 (Base 2011-12): 14 years, 168 months

Commodities Covered:

The number of agricultural commodities considered for the study is 84. Their list is given in Table 2.1 (at the end of Chapter).

Data Used:

The data used for this analysis is the Wholesale Price Indices (WPI) of Individual Commodities, as published by Economic Adviser, Government of India, Ministry of Commerce and Industry, Department of Promotion of Industry and Internal Trade [https://eaindustry.nic.in/home.asp].

[More details of the data used are given in Annexure 1 to this Chapter]

For the purpose of this study, the WPI of individual agricultural commodities are considered as proxy for the prices received by producers (farmers).

Concept of Volatility

Volatility in prices is defined as those fluctuations in prices which are 'sudden', 'unpredictable' or 'irregular'.

The agricultural prices experience changes over time due to changes in supply and demand. However, not all these changes are 'sudden', or 'unpredictable'. Some of them are due to long term changes in demand and supply (called trend), some of them are due to regular monthly/quarterly/calendar changes in supply and demand (called seasonality) and some are due to cyclical changes in demand and supply (due to cycles in weather, farmers' response to prices, etc.). It is only after we remove these 'predictable' fluctuations, we have what we could call 'sudden' or 'unpredictable' changes.

Out of these three components, seasonality and trend are expected in all agricultural commodities to differing extents. The reasons for their presence are also well documented and studied. The measurement of these components has also been well researched and experimented.

The cyclical element, however, is not so established. It is found in some commodities like hogs where it is explained as due to farmers' supply response to prices. The cyclical behaviour is also sometimes stated to be influenced by business cycles, or by climatic cycles. However, the study into the presence of such cycles in Indian commodity prices is not adequate. The methodology for identifying and measuring it is also not established.

Our attempt in this exercise is, therefore, to identify the predictable influences due to seasonality and trend, remove their effects and measure the residual fluctuations. For this purpose, we assume that each monthly Price (P) consists of Trend (T), Seasonality (S), Cycle (C) and Irregular components (R) with a multicative relationship, P=TxSxCxR

Methodology

For separating the influence of seasonality, we have used the methodology provided by 'X-13ARIMA-SEATS Seasonal Adjustment Program' prepared by the United States Census Bureau. Their website [https://www.census.gov/srd/www/x13as/] explains the methodology in detail and provides download facility for manuals, instructions, and the program itself.

Although the US Census Bureau provides the program, the program is also available in several popular software packages like R, SAS, Eviews, Gretl, etc. We have used the facility provided by Gretl (Gnu Regression, Econometrics and Time-series Library). Gretl is an open source statistical package and can be downloaded from http://gretl.sourceforge.net/.

This program is run for each of the 84 individual commodity series for each period, as also for the series of 'WPI (All Commodities)'. *The series are all in nominal form and not deflated. The X-13 program is run assuming the multiplicative relationship.*

The study first identifies the presence of monthly seasonality in a given series. It is examined for statistical significance both for its variation between months as also for variation between years (X-13 procedure provides the results of the tests as also the conclusion). If the month-to-month differences are large enough, and if they do not vary too much among all years considered, it is concluded that there is seasonality in the price series; then the seasonal indices are calculated for each month. The difference between the maximum index and minimum index is called Range and is taken as a measure of the extent of seasonality. The seasonal indices for all commodities in Period 3 are shown in Charts Set 2.

The trend is then identified by finding secular change in prices in the deseasonalized series. If the seasonality is not present, it is estimated from the original series. It is measured in terms of monthly compound rate of growth in prices (in per cent). This measure enables comparison between different time periods as also between commodities. It is also subjected for statistical significance. If it is significantly large, it is subjected to further discussion. We posit that the trend after the influence of inflation – measured by trend in WPI for all commodities – is removed, measures the influence of demand relative to supply in the long run. If positive, it shows that demand is increasing relative to supply and that there is further scope in increasing production or supply. On the other hand, if it is negative, it shows that demand is relatively decreasing and probably the supply should also likewise decrease. These trend values are expressed as annual compound growth rates (CGR) and expressed both in nominal and real form. The annual rates are calculated from the monthly rates. The real growth rates are calculated by deducting the WPI growth rates from the nominal growth rates. For calculating the real growth rates of the commodities for which only seven years' data was available, the growth rates of WPI for these seven years were used.

The original series was then divided by seasonal ratios and nominal rates of growth, provided they were significant. This was called Residual Series.

Both the original series and the Residual series for all commodities in Period 3 are shown in Charts Sets 1 and 3.

The volatility in prices is measured by calculating Coefficient of Variation (CV), expressed in percentages. The standard formula for the same is:

CV = (Standard Deviation/Mean)*100

CV is independent of unit of measurement and comparable across time and commodities.

There are two Coefficients calculated. CV1 measures the coefficient of variation of the original series. It is termed as 'Gross Volatility'. It includes all fluctuations – Seasonal, Trend, Cycle and Irregular. CV2 measures the coefficient of variation of the Residual series, after the influence of Seasonality and Trend is removed (Y/S*T). In other words, CV2 excludes the fluctuations caused by Seasonality and Trend but includes the influence of Cycle and irregular fluctuations. It is called by us as "Residual volatility".

Presentation of Findings

The report is presented in two volumes. Volume 1 presents the findings in consolidated form. It is divided into following chapters:

Chapter 3 examines the seasonal fluctuations in prices of agricultural commodities. After discussing the factors influencing seasonal fluctuations in prices, it finds the extent of seasonality in individual commodities (within each commodity group) and how it has changed over time.

Chapter 4 examines the trend in prices of agricultural commodities as measured by the compound rates of growth in them in different periods. The trends are compared for individual commodities within each commodity group.

Chapter 5 examines the volatility in prices as measured by the two indicators: Gross and Residual Volatility. They are compared across commodities within each commodity group. The commodities are ranked according to volatility in Period 3.

Chapter 6 consolidates the findings and suggests policies to be followed to mitigate the risks arising out of volatility.

Volume 2 provides Commodity Price Profiles for each commodity. The period of study taken is from April 2005 onward. Each profile can be read independently. It describes the importance of the commodity, its production in India, major states producing the commodity, season of production, usage, processing, commodity-flow, international trade and India's share, trend in consumption, Government policy concerning regulating prices and distribution, presence of the commodity in the Commodity Markets, behaviour of prices during the period and an econometric analysis of factors affecting the prices.

The profiles are expected to be useful for both producers as also other stakeholders in the value chain.

Limitations of the Study

The present study has following limitations:

1. The study is based on the wholesale price indices. They are aggregates of prices prevailing in different markets. Naturally, they would underestimate the extent of fluctuations in individual market prices.
2. It is assumed that the price indices used are proxy for prices received by producers. This assumption is based on the methodology used for constructing these prices. The price fluctuations at retail or any intermediary level should be different from the findings of this study
3. The study is exploratory. The method used for calculating volatility is tentative. It needs to be refined and standardized for all commodities.

Table 2.1 Commodities covered in the study

Commodity Group	SrNo	Commodity	Data Availability
0. All Commodities	0	WPI (ALL)	All Periods
1. Cereals (7)	1	Rice/Paddy	All Periods
	2	Wheat	All Periods
	3	Jowar	All Periods
	4	Bajra	All Periods
	5	Maize	All Periods
	6	Barley	All Periods
	7	Ragi	All Periods
2. Pulses (7)	8	Gram	All Periods
	9	Arhar	All Periods
	10	Moong	All Periods
	11	Masur	All Periods
	12	Urad	All Periods
	13	Peas/Chawali	Period 3 *
	14	Rajma	Period 3 *
3. Oilseeds (11)	15	Groundnut Seed	All Periods
	16	Rape & Mustard Seed	All Periods
	17	Cotton Seed	All Periods
	18	Copra (Coconut)	All Periods
	19	Gingelly Seed (Sesame Seed)	All Periods
	20	Linseed	All Periods
	21	Castor Seed	All Periods
	22	Niger Seed	All Periods
	23	Safflower (Kardi Seed)	All Periods
	24	Sunflower	All Periods
	25	Soybean	All Periods

Table 2.1 Commodities covered in the study (Continued)

Commodity Group	SrNo	Commodity	Data Availability
4. Spices (10)	26	Black Pepper	All Periods
	27	Chillies (Dry)	All Periods
	28	Turmeric	All Periods
	29	Cardamom	All Periods
	30	Ginger (Dry)	All Periods
	31	Betelnut/Arecanut	All Periods
	32	Cumin	All Periods
	33	Garlic	All Periods
	34	Coriander	Periods 2 and 3
	35	Tamarind	Period 3 *
5. Fibres (4)	36	Raw Cotton	All Periods
	37	Raw Jute	All Periods
	38	Mesta	All Periods
	39	Raw Silk	All Periods
6. Livestock and Livestock Products (7)	40	Milk	All Periods
	41	Egg	All Periods
	42	Fish-Inland	Periods 2 and 3
	43	Fish-Marine	All Periods
	44	Mutton	All Periods
	45	Poultry Chicken	All Periods
	46	Pork	All Periods

Table 2.1 Commodities covered in the study (Continued)

Commodity Group	SrNo	Commodity	Data Availability
7. Vegetables (17)	47	Potato	All Periods
	48	Onion	All Periods
	49	Tapioca	All Periods
	50	Ginger (Fresh)	Periods 1 and 3
	51	Brinjal	Periods 2 and 3
	52	Okra (Ladies' fingers)	Periods 2 and 3
	53	Cabbage	Periods 2 and 3
	54	Tomato	Period 3 *
	55	Carrot	Period 3 *
	56	Radish	Period 3 *
	57	Cucumber	Period 3 *
	58	Pointed gourd	Period 3 *
	59	Bitter gourd	Period 3 *
	60	Bottle gourd	Period 3 *
	61	Beans	Period 3 *
	62	Pumpkin	Period 3 *
	63	Drumstick	Period 3 *

Table 2.1 Commodities covered in the study (Concluded)

Commodity Group	SrNo	Commodity	Data Availability
8. Fruits (16)	64	Banana	All Periods
	65	Cashew nut	All Periods
	66	Coconut (Fresh)	All Periods
	67	Papaya	All Periods
	68	Pineapple	Periods 2 and 3
	69	Guava	Periods 2 and 3
	70	Lemon	Periods 2 and 3
	71	Sapota	Periods 2 and 3
	72	Apple	Period 3 *
	73	Sweet Orange(Mosambi)	Period 3 *
	74	Pomegranate	Period 3 *
	75	Amla	Period 3 *
	76	Jackfruit	Period 3 *
	77	Pear	Period 3 *
	78	Almonds	Period 3 *
	79	Walnut	Period 3 *
9. Flowers (3)	80	Rose	Period 3
	81	Jasmine	Period 3
	82	Marigold	Period 3
10. Others (2)	83	Guar Seed	Period 3
	84	Fodder	All Periods

Period 1 : April 1982 - March 1994 (12 Years)
Period 2 : April 1994 - March 2005 (11 Years)
Period 3 : April 2005 - March 2019 (14 Years)
Period 3* : April 2012 - March 2019 (7 Years)

[Figures in brackets refer to number of commodities in the Group]

The data is available for 49 commodities and WPI (All) for all the three periods.

ANNEXURE TO CHAPTER 2

Data and Data Sources

Data Used

The study uses the data on monthly price indices for individual agricultural commodities, called Wholesale Price Indices (WPI). They are the aggregates of prices prevailing in major markets in the entire country.

The monthly Wholesale Price Indices for individual agricultural commodities are obtained from the website of Office of the Economic Adviser, Government of India, Ministry of Commerce and Industry, Department of Promotion of Industry and Internal Trade [https://eaindustry.nic.in/home.asp]. The website is updated regularly and provides indices as well as the methodology of their calculation. Particularly of interest are the WPI Manual and Technical Paper of Working Group constituted for revising the series with base 2011-12, both of which are available on this website. The Goldar Committee Report on Producer Price Index is also available on this website.

The website has data on Wholesale Price Indices for the following periods:

1. 1952-53 Base series: April 1953 to March 1962 (Monthly)
2. 1961-62 Base series: April 1962 to March 1971 (Monthly)
3. 1970-71 Base series: April 1971 to March 1982 (Monthly)
4. 1981-82 Base series: April 1982 to March 2000 (Monthly)
5. 1993-94 Base series: April 1994 to August 2010 (Monthly)*
6. 2004-05 Base series: Jan 2005 to March 2017 (Monthly)*
7. 2011-12 Base series: April 2012 to current month (Monthly)

[* These series also give weekly indices]

The first three series provide data for only very few agricultural commodities individually. From 1981-82 series, a large number of commodities are included. The commodity-wise analysis is therefore attempted by us from April 1982 onwards, or, till March 2019, for 37 years.

We have divided these data in three periods as follows:

1. Period 1: April 1982 to March 1994 (Base 1981-82): 12 years, 144 months (From series 4 above)
2. Period 2: April 1994 to March 2005 (Base 1993-94): 11 years, 132 months (From series 5 above)
3. Period 3: April 2005 to March 2019 (Base 2011-12): 14 years, 168 months (From series 6 and 7 above)

Each of these periods is reasonably large, around 12 years. Each period starts with a normal year.

The data for the first two periods is available continuously for the respective base years. There is therefore no need for converting data from one base year to another for these two periods.

The series for the third period is, however, not available entirely for base 2011-12. The data for the period April 2005 to March 2012 is converted from base 2004-05 to base 2011-12 by using the common data available for the two series as linking factor. The common data is available for 5 years (60 months) from April 2012 to March 2017 for each commodity. The ratio of the averages of the two series for this period is used as linking factor for converting data from base year 2004-05 to base year 2011-12 base. These linking factors are calculated for each commodity separately.

Commodities Covered:

The number of agricultural commodities covered in the WPI series for the last period (Base 2011-12) is 104. Some commodities (Green Peas, Cauliflower, Mango, Orange, Grapes and Litchi) have data only for their marketing seasons (lasting for around 3 to 4 months in a year). They are excluded from the analysis. From the remaining, 84 commodities were subjected to analysis in this study after examining the quality of data and the importance of the commodities. The list of the selected commodities is given in the Table 2.1.

Not all these commodities are covered in the earlier periods. The common commodities number 49. Moreover, some commodities were introduced only since 2012. Their data is, therefore, available only for 7 years (April 2012 to March 2019). Table 2.1 mentions the periods for which each commodity data is available.

Along with the selected commodities, the WPI for all commodities were also taken as proxy for general price level in the three Periods and analysed in the same way as the individual commodities.

Wholesale Price Indices as indicators of Producer Prices

The study analyses wholesale price indices (WPI) of individual commodities. What is the wholesale Price Index? The 'Technical Report of the Working Group on Wholesale Price Indices' mentions: "The universe of wholesale price index (is defined) as comprising, as far as possible, all transactions of goods at the first point of bulk sale in the domestic market… By definition, all prices must be collected at the first point of bulk sale, i.e., from the primary markets, including for agricultural goods as the latter are currently collected from different types of markets and also include administered minimum support prices. .. It can, therefore, be seen that in the Indian context, the WPI measure is closer to the PPI (Producer Price Index) measure." (Page 27, Technical Report of the Working Group).

For each commodity, a number of quotations are received every week. They are then averaged to give the commodity index for each week and then for each month. The methodology is explained in the Manual on Wholesale Price Index. The Annexure 1 of the Manual provides commodity-wise weights and number of quotations.

The proper 'Producer Price Index' is not yet constructed in India. The Goldar Committee on Producer Price Index in its report (Report of the Working Group on Producer Price Index, Government of India, August 2017) has suggested that PPI should initially be constructed on an experimental basis and then " switching over from WPI to PPI should be undertaken after the PPI series stabilizes and due consultation with the stakeholders is done. .... It is also recommended that for compilation of experimental PPI, price quotations collected under the current WPI series should be used" (page 39 of the Report). The recommendations of this Committee are yet to be implemented.

We have, therefore, used the WPI of individual agricultural commodities as proxy for the prices received by producers (farmers).

Of course, the usual difficulties of using aggregate data as against individual market data will be present in our analysis. For example, the seasonality in prices, probably, will be more pronounced in the individual market or for a given variety than that in the prices which are aggregated over markets and over varieties. We, however, believe that the aggregate analysis that is being attempted in this study could be used as a benchmark for comparing it with individual market and variety-wise analysis and could be of help while studying subjects like market and commodity integration.

Chapter 3
Seasonality in Agricultural Prices

> "I wonder if the snow loves the trees and fields, that it kisses them so gently? And then it covers them up snug, you know, with a white quilt; and perhaps it says "Go to sleep, darlings, till the summer comes again."
>
> – ***Lewis Carrol**, English Writer*

Introduction

Seasonality in agricultural production is a common phenomenon. Many agricultural commodities are seasonally produced. A large proportion of the produce arrives in the market immediately after the harvest. This marketing season is called Peak Marketing Season (PMS) and lasts for around 3 months. After the PMS is over, the arrivals come to the market in smaller quantities from the stocks held by the producers or traders. Prices are lowest in the PMS and go on increasing in the subsequent months. A regular pattern of such behaviour, which is observed every year, is called seasonality in prices. The seasonality is expected, within a year in daily, weekly, monthly or quarterly prices.

There are mainly two cropping seasons in India: Kharif and Rabi. In the Kharif season, crops are sown in June – July and harvested after September. The PMS for these crops would start in September and end in March. Rabi crops are sown in October – November and harvested after April. Their PMS would be between April and June. The heavy monsoon rainfall occurs in June – July and the market arrivals decrease significantly during these months.

The extent of seasonality in prices would vary from commodity to commodity. It would depend on the duration of production cycle, its perishability, storage cost, its use in processing and manufacturing, quality of the produce marketed, restrictions on foreign trade and seasonality in demand.

The commodity like wheat, for example, is produced in India as a Rabi crop and its PMS is April – June. It is not perishable, it can be stored. It is consumed throughout the year, almost evenly. Apart from its household consumption, it is used in processing and manufacturing bakery and other food products. Naturally, the price-rise in such products after PMS is expected to reflect storage costs including wastages in storage. The yearly prices will fluctuate on the basis of demand and supply of wheat between years; within the year, the monthly (or quarterly) prices will increase after PMS on the basis of storage costs.

The commodity like Rice (or Jowar, Maize) is produced in two seasons in India– both Kharif and Rabi (There is also a summer season in some regions for producing this crop). Again, rice is non-perishable and stored for consumption throughout the year. The seasonal fall in prices will indicate the relative importance of these two seasons and their storage costs.

Onion is produced in three seasons (Kharif, Late Kharif and Rabi) with their PMS in Nov-Dec, Jan-Feb and April-May respectively. However, out of these three crops, only the Rabi crop can be stored. Other two crops are perishable with shelf-life of not more than two to three months. The prices therefore are lowest in April – May and reach their highest level just before the arrivals from Kharif season starts. The period between August and November is very sensitive to supply situation and prices in these months depend heavily on the stocks of Rabi crop, progress of Monsoon and the expected Kharif output. Most of the spikes in onion prices, therefore, take place during this period.

Vegetables have their own individual crop cycle. So have fruits. Some are produced once a year (like mangoes, grapes). They are very perishable; hence they are not marketed in the rest of the year. Some are produced throughout the year, but with varying quantity. The prices for them are expected to fall when there are heavy arrivals; they would rise when the arrivals decrease.

Seasonality is also caused by the quality considerations. In the early marketing season of Kharif crops, which follows the rainy season, agricultural produce is often immature; it also contains high moisture content and a large foreign material like mud. It depresses price; later, as the produce dries up and makes it easy to clean, the prices improve.

The seasonal rise in prices is not only dependent on the storage costs; it is also influenced by the trade expectations of prices and production in future months. Thus for a Kharif crop, the prices need not reach their peak just before the arrivals of the new crop. They may reach their highest level even before it, if the traders expect better crop in the next season.

Seasonal fluctuations are also affected by the international trade. PMS for wheat in India, for example, is April – June. In North America and Europe, it starts from August. In Australia, it is from November onward. Thus, if international trade expands, new sources of supply and demand are opened up; the local short supply can be compensated by imports and excess supplies can be diverted to foreign destinations. In such a situation, the extent of seasonality would be low or seasonality would even be absent.

The seasonality would also be influenced by the Government policy in controlling prices. In India, since 1960s, the Government of India is not only announcing the Minimum Support Prices for essential commodities but actively pursuing a system of procurement and distribution of commodities like Wheat and Rice in an organized way. This system is aimed to ensure stability in prices both within the year as also between years. The quantities procured under the system are sizeable and are likely to reduce the extent of seasonality in prices of such commodities.

It is also expected that if over the years, production gets more evenly distributed within year, or if there are improvements in marketing structure, storage infrastructure and increase in the processing and manufacturing activities, the seasonality would reduce.

In the following sections, we examine seasonality in prices of 84 selected agricultural commodities in India. All these commodities are traded throughout the year; hence their price data is available for all months. The commodities like Mango, Grapes, etc. which have price data only for few months in a year are excluded.

For identifying and measuring seasonality, we have used, as explained earlier, the X-13 methodology. This method enables us to decide, by using appropriate statistical tests, whether the seasonality is identifiable. For this purpose the calculated seasonal indices should pass two tests: first, they should be significantly different between months (called by X-13 as 'test of seasonality assuming stability') and second, the seasonality should not vary significantly between years (called by X-13 as 'moving seasonality'). If the seasonality indices pass both the two tests, X-13 output reports "Identifiable seasonality Present". If not, it reports either "Identifiable seasonality probably not Present ", or "Identifiable seasonality not Present". We use the short forms '**Present**' in the first case and '**np**' (for Not Present) in the second and third cases.

Seasonality is measured by calculating monthly **seasonal indices**. They are averages for the period selected and presented in percentages. A seasonal index of 106 for say, March, indicates that the March prices are more than annual average by 6 per cent. Similarly, a seasonal index of 76 in November indicates that prices in November are lower by 24 per cent than annual average. The ratio of the two indices indicates the relative change between the two months. Thus, in the above example, March indices are above November prices by 39.5 per cent (106 divided by 76). This indicates that if a producer, instead of

selling in November, sells in March, she would get, on an average, a price rise of 39.5 per cent over the November price.

Of course, this finding is based on an historical analysis. Further, it is an average index; the change in prices reflected by the index may not happen in all years.

The **extent of seasonality** is measured by **Range**. It is the difference between the maximum index value and minimum index value. In the above example, if March index is the maximum index value and the minimum index is in November, then **Range** is 30 (106 minus 76) for that commodity. **Larger the Range, larger is the seasonality.**

We have calculated, for each commodity, the seasonal indices (and Range) for the following three periods:

- Period 1: April 1982 to March 1994 (12 years)
- Period 2: April 1994 to March 2005 (11 years) and
- Period 3: April 2005 to March 2019 (14 years)

Period 3 is also referred as 'latest period' or 'current period'.

In the following sections, we present and discuss these indices for each Commodity Group. The presentation of findings on presence of seasonality, values of Minimum and Maximum Indices along with their months and the value of Range for each commodity in Period 3 are presented first. It is followed by the comparison of the extent of seasonality (Range) for each commodity in the three Periods. The values of Indices and Range are shown only if seasonality is present.

Charts Set 2 presents the Charts for Monthly Seasonal Indices for all commodities for Period 3. Here also, if the seasonality is not present, the charts are excluded.

3.0 Seasonality in WPI (All Commodities)

Seasonality during Period 3:

WPI (All) is the Index of Prices for all agricultural and non-agricultural commodities. When subjected to seasonality analysis, WPI (All) showed presence of seasonality in Period 3 (April 2005 – March 2019). (See following Table)

Table 3.1: Seasonality in Period 3 (WPI (All))

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
0	WPI (All)	3	Present	100.7	99.2	1.5	Jul	Feb

The Index is highest in July (100.7) and lowest in February (99.2). The Range is rather narrow at 1.5, which is expected. By February, most of the Kharif arrivals are over and the prospects of Rabi crop also clearer. The peak of monsoon rains is in July. The results indicate Indian economy's dependence on the Monsoon rainfall and agriculture.

This result is not unique to the Period 3. In earlier periods also WPI showed similar significant seasonality. (See following Table).

Table 3.2: Range in Seasonality in All Periods (WPI (All))

	WPI (All)
Period 1	2.3
Period 2	1.1
Period 3	1.5

During the three periods, the range was between 2.3 and 1.1, with highest seasonal prices in July - August and lowest prices in February – March.

3.1 Seasonality in Prices of Cereals

Seasonality during Period 3:

Out of the seven cereal crops considered, Bajra and Ragi are Kharif, and Wheat and Barley are Rabi crops. Rice, Jowar and Maize are taken in both seasons.

Minimum Support Prices are announced for all the commodities in the Group. The procurement and public distribution of commodities like Rice, Wheat and to some extent, Jowar is a regular feature of the Government policy.

All the commodities are stored; they are consumed throughout the year. India's International trade is limited.

Processing is limited to conversion to flour. In the case of wheat, bakery industry is a major, but secondary purchaser. Increase in use of Maize in animal feed industry is also noticeable.

The seasonality in Prices of Cereals during Period 3 (April 2005 – March 2019) is presented below:

Table 3.3: Seasonality in Period 3 (Cereals)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
1	Rice	3	np					
2	Wheat	3	Present	102.3	98.2	4.0	Jan	May
3	Jowar	3	np					
4	Bajra	3	Present	102.3	97.3	5.0	May	Oct
5	Maize	3	Present	101.3	98.4	2.8	Mar	Dec
6	Barley	3	Present	102.6	98.0	4.6	Mar	Jun
7	Ragi	3	np					

In Period 3, there is no identifiable seasonality in the prices of Rice, Jowar and Ragi.

The range in seasonality for all other commodities is quite low.

The months of minimum and maximum prices are consistent with the marketing seasons of the commodities.

Comparison with earlier Periods:

The range in seasonality in the three Periods is shown in the following Table.

Table 3.4: Range in Seasonality in All Periods (Cereals)

	Rice	Wheat	Jowar	Bajra	Maize	Barley	Ragi
Period 1	5.7	12.3	5.2	7.8	11.2	14.1	4.1
Period 2	4.1	6.4	5.7	8.4	9.8	7.5	4.1
Period 3	np	4.0	np	5.0	2.8	4.6	np

The seasonality was present in all commodities in Periods 1 and 2. It is only in Period 3 that we could find its absence in Rice, Jowar and Ragi.

There is an unmistakable trend in the reduction of seasonality in prices of Rice, Wheat, Maize, Barley and Ragi. In Jowar, there is a slight increase in Period 2 but then it could not be identified in Period 3. In Bajra, the seasonality in Period 3 is lower than that in Period 1.

In Period 1, among all commodities, the maximum range was for Barley, at 14.1. It decreased to 4.6 in Period 3. In Maize also the decrease was from 11.2 to 2.8.

Overall, thus, the extent of seasonality in Cereals is seen to have decreased over years and currently stands at very low levels.

3.2 Seasonality in Prices of Pulses

Seasonality during Period 3:

Among Pulses, Arhar, Moong, Urad and Peas are Kharif crops while Barley, Gram and Masur are Rabi crops.

Minimum Support Prices are announced for all pulses excepting Peas/Chawali and Rajma.

Procurement is occasional and during crisis situations.

International trade is limited.

All commodities are stored. They are consumed as whole or split grains. They are the major accompaniments to cereals. They are consumed all over the country in various preparations. Processing (other than manufacture of split grains and flour) is limited.

The seasonality in Prices of Pulses during Period 3 (April 2005 – March 2019) is presented below:

Table 3.5: Seasonality in Period 3 (Pulses)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
8	Gram	3	Present	105.1	95.7	9.4	Nov	Apr
9	Arhar	3	np					
10	Moong	3	np					
11	Masur	3	np					
12	Urad	3	Present	102.9	96.8	6.0	Aug	Mar
13	Peas/Chawali*	3	Present	109.3	83.6	25.6	Sep	Feb
14	Rajma*	3	np					

(* Data available only for 7 years, between April 2012 – March 2019)

Out of the seven commodities covered by this Group, as many as 4 commodities did not show presence of seasonality in this period.

The other three commodities showed the months of minimum and maximum prices consistent with their cropping seasons.

Range was low for Gram and Urad; it was quite high for Peas/Chawali.

Comparison with earlier Periods:

The range in seasonality in the three Periods for Pulses is shown in the following Table:

Table 3.6: Range in Seasonality in All Periods (Pulses)

	Gram	Arhar	Moong	Masur	Urad
Period 1	10.7	8.6	7.3	12.3	6.3
Period 2	np	np	np	8.4	np
Period 3	9.4	np	np	np	6.0

The commodities Peas/Chawali and Rajma were introduced in WPI only during Period 3. Hence, their data is not available for earlier Periods.

During Period 1, all the commodities showed presence of seasonality. In Period 2, only Masur and in Period 3, only Gram and Urad showed the presence of seasonality.

Seasonality in Pulses shows an overall decreasing trend.

As a group, Pulses do not show much seasonality.

Seasonality in Prices of Spices

Seasonality during Period 3:

Minimum Support Prices are not announced for any of the commodities covered under Spices.

The commodities are stored, processed, blended and marketed throughout the year.

Spices from India are internationally known and traded. They are the major earners of foreign exchange.

The seasonality in Prices of Spices during Period 3 (April 2005 – March 2019) is presented below:

Table 3.7: Seasonality in Period 3 (Spices)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
15	Black Pepper	3	np					
16	Chillies(Dry)	3	np					
17	Turmeric	3	np					
18	Cardamom	3	np					
19	Ginger(Dry)	3	np					
20	Betelnut/Arecanut	3	np					
21	Cumin	3	Present	102.1	96.1	6.0	Sep	Mar
22	Garlic	3	Present	108.4	88.5	19.9	Dec	Apr
23	Coriander	3	np					
24	Tamarind*	3	np					

(* Data available only for 7 years, between April 2012 – March 2019)

Out of nine spices covered by WPI, only two, Cumin and Garlic, indicated presence of seasonality.

Both of them showed highest levels in March - April.

The range for Cumin was low, for Garlic, it was moderate.

Comparison with earlier Periods:

The range in seasonality in the three Periods for Spices is shown in the following Table:

Table 3.8: Range in Seasonality in All Periods (Spices)

	Black Pepper	Chillies (Dry)	Turmeric	Cardamom	Ginger(Dry)
Period 1	np	17.0	np	np	np
Period 2	np	11.4	np	np	np
Period 3	np	np	np	np	np

	Betelnut/ Arecanut	Cumin	Garlic	Coriander
Period 1	28.7	11.8	np	na
Period 2	26.8	np	np	np
Period 3	np	6.0	19.9	np

Black Pepper, Turmeric, Cardamom, and Ginger did not show seasonality in any of the three Periods. The data for Coriander was not available for Period 1; it also did not indicate seasonality in the subsequent two Periods. All other commodities showed decreasing seasonality over the years. Spices thus show either absence or decreasing level of seasonality.

3.4 Seasonality in Prices of Oilseeds

Seasonality during Period 3:

Groundnut, Soybean, Sunflower, Sesamum, Niger, Castor and Cottonseed are Kharif crops while Rape and Mustard Seed, Safflower and Linseed are Rabi crops. Copra is harvested year round.

Minimum Support Prices are announced for all Oilseeds except Cotton Seed, Linseed, and Castor Seed.

All the commodities are stored and used as and when required for manufacturing oils and oil meals. Oils produced are used both for edible and non-edible purposes. Within edible oilseeds, substitutions are possible.

There is significant international trade in these and other oils like palm oils. India depends on imports of edible oils for its consumption needs.

The seasonality in Prices of Oilseeds during Period 3 (April 2005 – March 2019) is presented below (Table 3.9):

Table 3.9: Seasonality in Period 3 (Oilseeds)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
25	Groundnut Seed	3	Present	102.4	97.2	5.3	May	Nov
26	Rape & Mustard Seed	3	Present	102.8	97.4	5.4	Dec	Apr
27	Cotton Seed	3	Present	103.7	97.4	6.4	Aug	Dec
28	Copra (Coconut)	3	np					
29	Gingelly Seed (Sesamum)	3	np					
30	Linseed	3	np					
31	Castor Seed	3	np					
32	Niger Seed	3	np					
33	Safflower (Kardi Seed)	3	np					
34	Sunflower	3	np					
35	Soybean	3	Present	106.6	92.5	14.1	May	Oct

During Period 3, only Groundnut Seed, Rape and Mustard Seed, Cotton Seed and Soybean showed the presence of seasonality. Their months of high and low prices were consistent with their cropping seasons. The Range for Groundnut Seed and Cotton Seed was quite low; for Soybean it was medium.

Comparison with earlier Periods:

The range in seasonality in the three Periods for Oilseeds is shown in the following Table:

Table 3.10: Range in Seasonality in All Periods (Oilseeds)

	Groundnut Seed	Rape & Mustard Seed	Cotton Seed	Copra (Coconut)	Gingelly Seed (Sesamum)	Linseed
Period 1	9.7	14.3	8.9	10.4	np	10.9
Period 2	8.8	8.1	6.7	16.4	np	5.8
Period 3	5.3	5.4	6.4	np	np	np

	Castor Seed	Niger Seed	Safflower (Kardi Seed)	Sunflower	Soybean
Period 1	np	11.2	11.7	np	10.8
Period 2	np	np	7.7	np	8.1
Period 3	np	np	np	np	14.1

Groundnut, Rape and Mustard seed, Cottonseed and Soybean showed the presence of seasonality in all the three Periods. Gingelly seed, Castor seed and Sunflower did not show seasonality in any Period. Only in the case of soybean, there was an increasing seasonality in Period 3 relative to earlier periods. In all other oilseeds, there was a decreasing trend.

3.5 Seasonality in Prices of Fibres

Seasonality during Period 3:

Cotton is a Kharif crop.

Cotton and Jute are subject to Minimum Support Price. Procurement of Cotton is also undertaken.

The seasonality in Prices of Fibres during Period 3 (April 2005 – March 2019) is presented below:

Table 3.11: Seasonality in Period 3 (Fibres)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
36	Raw Cotton	3	Present	105.1	96.9	8.1	Aug	Mar
37	Raw Jute	3	np					
38	Mesta	3	np					
39	Raw Silk	3	Present	103.3	95.8	7.5	Jan	Jul

The international trade in Jute, Cotton and Silk is important. They provide raw material to textile and packaging industries.

Only two of Commodities, Cotton and Raw Silk showed low seasonality in Period 3.

Cotton shows lowest prices in March. The highest level is reached in August. The range is 8.1. Raw Silk reaches its minimum price in July, then increasing to reach the highest in January. Its range is 7.5.

Comparison with earlier Periods:

The range in seasonality in the three Periods for Fibres is shown in the following Table:

Table 3.12: Range in Seasonality in All Periods (Fibres)

	Raw Cotton	Raw Jute	Mesta	Raw Silk
Period 1	8.7	np	np	13.0
Period 2	np	12.8	np	np
Period 3	8.1	np	np	7.5

Mesta did not show any seasonality in any of the three Periods. Raw Cotton and Raw Silk showed decreasing seasonality over the years.

3.6 Seasonality in Prices of Livestock and Livestock Products

Seasonality during Period 3:

Although none of the commodities are under Minimum Support Price regulations, Milk and Eggs/poultry chicken prices are regulated and set by their organizations (National Egg Coordination Committee, National Dairy Development Board) after considering interests of producers, industry and consumers. Milk enjoys largest weightage in the Wholesale Price Index series among the agricultural products.

The seasonality in Prices of Livestock and Livestock Products during Period 3 (April 2005 – March 2019) is presented below:

Table 3.13: Seasonality in Period 3 (Livestock and Livestock Products)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
40	Milk	3	np					
41	Egg	3	Present	105.3	94.8	10.4	Dec	Apr
42	Fish-Inland	3	np					
43	Fish-Marine	3	Present	104.1	95.9	8.2	May	Oct
44	Mutton	3	np					
45	Poultry Chicken	3	np					
46	Pork	3	np					

In this category only two commodities show the presence of seasonality: Eggs and Marine Fish. Eggs reached their minimum prices in April and maximum in December. The range is 10.4. The Marine Fish had lowest prices in October and highest in May. The Range is 8.2.

Comparison with earlier Periods:

The range in seasonality in the three Periods for Livestock and Livestock Products is shown in the following Table:

Table 3.14: Range in Seasonality in All Periods (Livestock and Livestock Products)

	Milk	Egg	Fish-Inland	Fish-Marine	Mutton	Poultry Chicken	Pork
Period 1	3.6	33.8	na	np	1.7	np	1.9
Period 2	np	20.5	np	12.6	4.8	np	np
Period 3	np	10.4	np	8.2	np	np	np

Poultry Chicken did not show seasonality in prices in any of the three Periods. Milk and Pork had a low seasonality only in the first Period. In the subsequent Periods, they did not show presence of seasonality. Eggs and Marine Fish showed a continuous decline in seasonality.

3.7 Seasonality in Prices of Vegetables

Seasonality during Period 3:

Of all the vegetables included in the Group, Potato and Onion are the only crops which can be stored for extended consumption. Potato is grown both as Rabi and Kharif crop. It is grown all over the country. Onion is grown in three seasons – Kharif, later Kharif and Rabi. Only Rabi crop is stored for around 4 to 6 months. The seasonality thus for these crops reflects storage costs. All other commodities are highly perishable and consumed fresh and without much processing (excepting Tapioca); the seasonality in their prices reflects the imbalance between demand and supply during the months. Tapioca is harvested during November to February, or even in March. The produce is immediately processed to produce starch, which has applications in food, textile and pharmaceutical industries.

The seasonality in Prices of Vegetables during Period 3 (April 2005 – March 2019) is presented below:

Table 3.15: Seasonality in Period 3 (Vegetables)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
47	Potato	3	Present	122.7	72.0	50.7	Nov	Feb
48	Onion	3	Present	125.0	73.1	51.9	Nov	May
49	Tapioca	3	np					
50	Ginger(Fresh)	3	Present	118.4	86.4	32.0	Jul	Dec
51	Tomato*	3	Present	131.1	63.4	67.7	Jul	Feb
52	Brinjal	3	Present	117.2	86.0	31.1	Aug	Feb
53	Okra (Ladies' fingers)	3	Present	123.6	81.3	42.3	Jan	Jun
54	Cabbage	3	Present	131.6	68.2	63.4	Aug	Apr
55	Carrot*	3	Present	124.5	72.6	51.9	Oct	Feb
56	Radish*	3	np					
57	Cucumber*	3	np					
58	Pointed gourd*	3	Present	130.9	81.3	49.6	Mar	May
59	Bitter gourd*	3	np					
60	Bottle gourd*	3	np					
61	Beans*	3	Present	127.0	86.2	40.8	May	Jan
62	Pumpkin*	3	np					
63	Drumstick*	3	Present	174.2	55.6	118.6	Jan	Apr

(* Data available only for 7 years, between April 2012 – March 2019)

During Period 3, out of 17 commodities covered in this category, seasonality is present in 11 commodities. The Range is also quite large, lying between 31.1 for Brinjal and 118.6 for Drumstick.

Comparison with earlier Periods:

The range in seasonality in the three Periods for Vegetable is shown in the following Table:

Table 3.16: Range in Seasonality in All Periods (Vegetables)

	Potato	Onion	Tapioca	Ginger(Fresh)	Brinjal	Okra (Ladies' fingers)	Cabbage
Period 1	62.3	61.5	np	14.6	na	na	na
Period 2	54.8	np	np	nc	47.6	59.6	87.8
Period 3	50.7	51.9	np	32.0	31.1	42.3	63.4

(na: data not available; nc: data not amenable for analysis)

Comparison is possible only for these commodities since the remaining commodities were introduced in the latest series of WPI.

Seasonality in Tapioca prices is not present in any of the three Periods. Seasonality is decreasing in all other commodities, excepting Ginger (Fresh).

3.8 Seasonality in Prices of Fruits

Seasonality during Period 3:

The seasonality in Prices of Fruits during Period 3 (April 2005 – March 2019) is presented below:

Table 3.17: Seasonality in Period 3 (Fruits)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
64	Banana	3	Present	104.1	95.8	8.2	Aug	Feb
65	Apple*	3	Present	120.8	84.7	36.1	Jun	Dec
66	Cashew nut	3	Present	102.4	97.4	4.9	Jan	Jun
67	Coconut(Fresh)	3	Present	101.9	98.0	3.9	May	Dec
68	Papaya	3	Present	106.3	92.8	13.5	Aug	Jan
69	Pineapple	3	Present	106.9	91.2	15.7	Apr	Dec
70	Guava	3	Present	112.2	85.6	26.6	Jun	Jan
71	Lemon	3	Present	124.5	78.4	46.1	Apr	Dec
72	Sapota	3	Present	118.0	88.4	29.6	Nov	May
73	Mosambi (Sweet Orange)*	3	np					
74	Pomegranate*	3	Present	106.5	91.3	15.2	Feb	Aug
75	Amla*	3	Present	134.7	72.3	62.4	Jul	Dec
76	Jackfruit*	3	Present	115.5	83.9	31.6	Jan	Jun
77	Pear*	3	Present	105.6	91.8	13.8	Dec	Aug
78	Almonds*	3	Present	101.8	98.1	3.7	Nov	May
79	Walnut*	3	np					

(* Data available only for 7 years, between April 2012 – March 2019)

Among the fruits included in this category, Cashew nut, Almonds and Walnut are stored, after some processing. The remaining commodities have very limited shelf life and mostly consumed (or exported) fresh. A limited quantity is processed.

Among the fruits considered, seasonality was not identified only in two commodities: Mosambi and Walnut. In other commodities, the variation in Range was between 3.7 for Almonds and for Coconut and 62.4 for Amla.

Comparison with earlier Periods:

The range in seasonality in the three Periods for Fruits is shown in the following Table:

Table 3.18: Range in Seasonality in All Periods (Fruits)

	Banana	Cashew nut	Coconut (Fresh)	Papaya	Pineapple	Guava	Sapota
Period 1	16.5	7.3	10.1	np	na	na	na
Period 2	np	np	9.0	23.3	15.8	np	20.1
Period 3	8.2	4.9	3.9	13.5	15.7	26.6	29.6

The data for Pineapple, Guava and Sapota are available only for Periods 2 and 3.

In all the commodities, excepting Sapota, the seasonality is seen to be decreasing.

3.9 Seasonality in Prices of Flowers

Seasonality during Period 3:

The seasonality in Prices of flowers during Period 3 (April 2005 – March 2019) is presented below:

Table 3.19: Seasonality in Period 3 (Flowers)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
80	Rose	3	Present	108.1	90.3	17.8	Dec	Jul
81	Jasmine	3	Present	147.1	72.3	74.8	Dec	Jun
82	Marigold	3	np					

Seasonality was present in Period 3 in Rose and Jasmine. The Range was very high at 74.8 in Jasmine. The lowest prices for flowers were in June – July. The maximum prices prevailed during winter months.

Comparison with earlier Periods:

All the three flowers were introduced in WPI during Period 3. Hence, comparison with earlier periods is not possible.

3.10 Seasonality in Prices of Others

Seasonality during Period 3:

There are two commodities included in this category. They are Guar Seed and Fodder. The seasonality in them is presented in the following table:

Table 3.20: Seasonality in Period 3 (Others)

SrNo	Commodity	Period	Seasonality	Max Index	Min Index	Range	Max Month	Min Month
83	Guar Seed	3	np					
84	Fodder	3	Present	102.4	95.2	7.2	Nov	May

No seasonality was observed in Guar Seed during Period 3. Fodder had a low seasonality with minimum prices in May and maximum in November.

Comparison with earlier Periods:

Guar Seed was introduced in WPI during Period 3. The Range in seasonality for Fodder is shown below:

Table 3.21: Range in Seasonality in All Periods (Others)

	Fodder
Period 1	22.4
Period 2	28.6
Period 3	7.2

Seasonality was observed in all Periods. It increased in Period 2 but then decreased by a large amount in Period 3.

SUMMARY OF FINDINGS ON SEASONALITY

For Period 3 (April 2005 to March 2019)

1. Seasonality was present in the WPI (All Commodities). The Index was highest in July - August and lowest in February – March. The range was 1.5.
2. Seasonality was present only in 45 commodities (out of 84) in Period 3. In the remaining 39 commodities, it was not present.
3. Out of 45 commodities where seasonality was not present, in 13 commodities, even the 'stable' seasonality was not significant. They were Moong (Pulses); Dry Ginger, Dry Chillies, Arecanut and Turmeric (Spices); Mutton, Inland Fish and Milk (Livestock and Livestock Products); Niger Seed, Gingelly Seed and Tamarind (Oilseeds); Mesta (Fibres) and Guar Seed (Others). In these commodities, thus, the seasonality was completely absent.
4. In all other 29 commodities, the 'stable' seasonality was significant but the 'moving' or year-to year variation was relatively more. The presence of seasonality in these commodities was not identifiable because of large year-to-year deviations from the 'stable' seasonality.
5. The extent of seasonality, measured by Range, was quite low in all commodities except Vegetables, Fruits and Flowers.
6. Minimum Range in seasonality during Period 3 was 2.8 for Maize; maximum Range was 118.6 for Drumstick.

The summary of seasonality in Period 3 is given in the following Charts (Figures in brackets refer to total number of commodities in the Commodity Group):

Chart 3.1

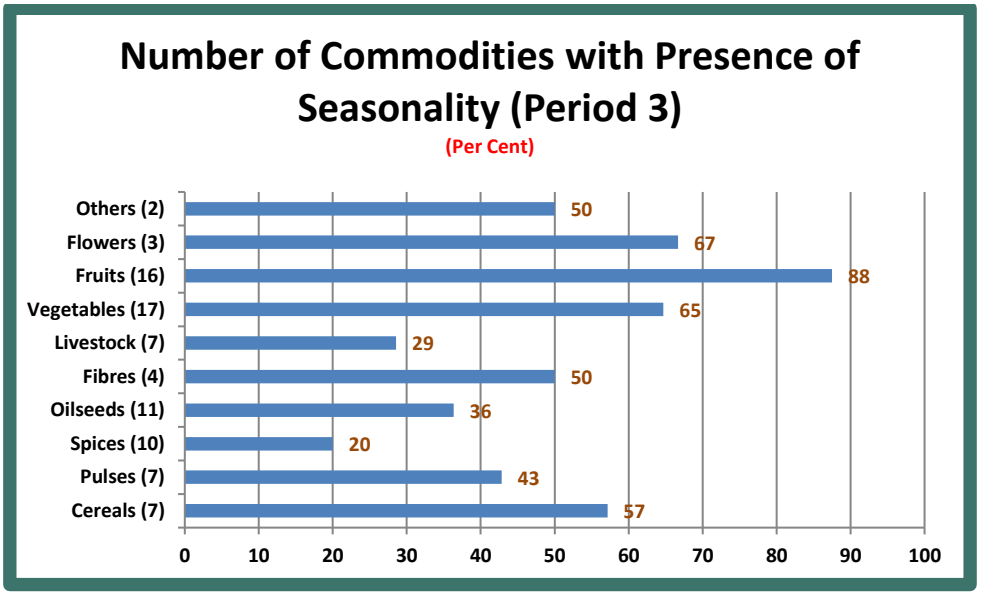
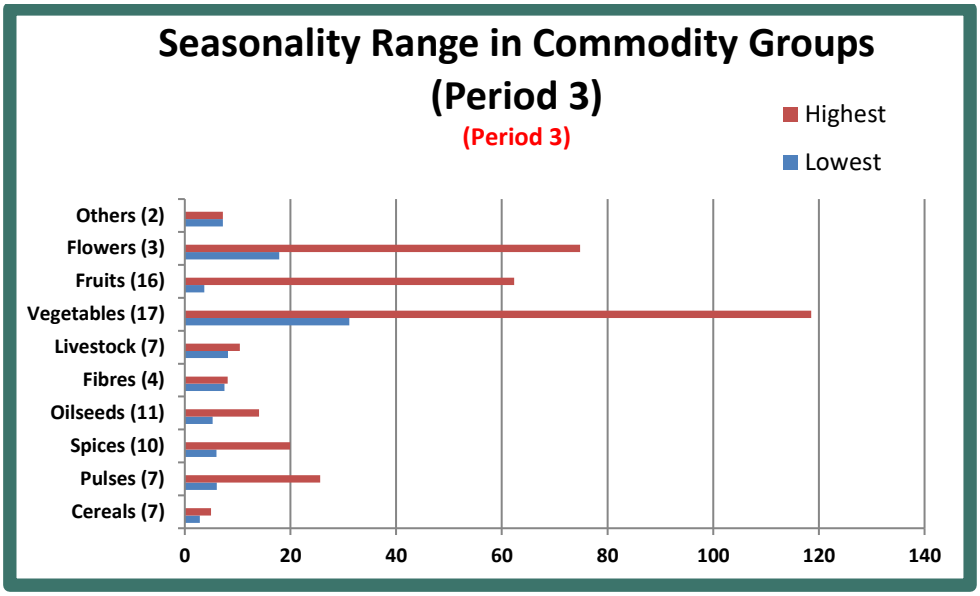


Chart 3.2



Comparison with other Periods

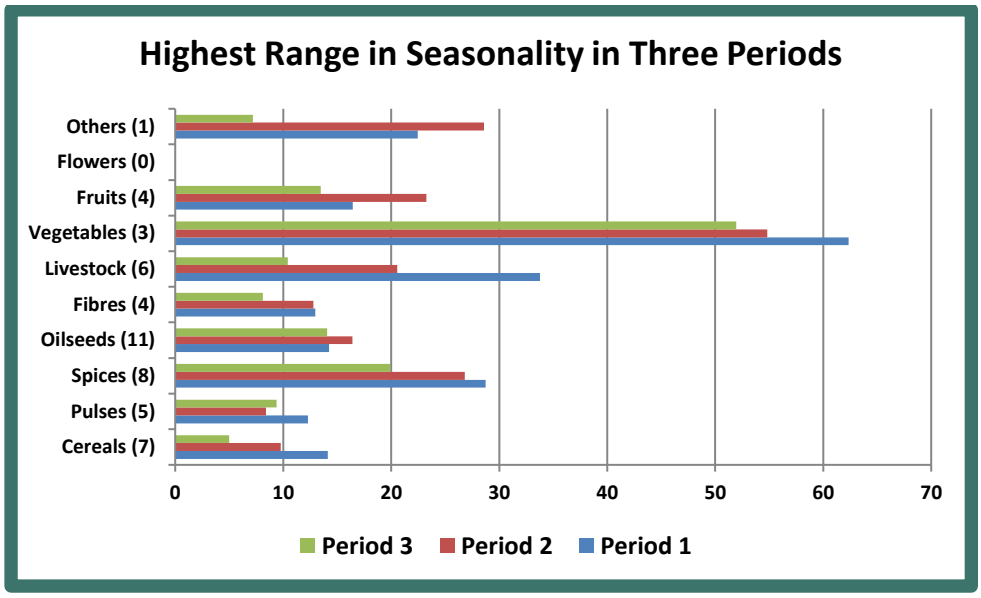
7. Seasonality in WPI (All Commodities) in Periods 1 and 2 was also significant. Its Range was at 2.3 and 1.1 respectively.
8. There were 49 commodities which were common to all Periods. The number of commodities for which seasonality was present in the three Periods for these commodities is shown below:

Table 3.22: Number of Commodities with Presence of Seasonality

SrNo	Commodity Group	Total	Presence of Seasonality (No. of Commodities)		
			Period 1	Period 2	Period 3
1	**Cereals**	7	7	7	4
2	**Pulses**	5	5	1	2
3	**Spices**	8	3	2	2
4	**Oilseeds**	11	8	7	4
5	**Fibres**	4	2	1	2
6	**Livestock and Livestock Products**	6	4	3	2
7	**Vegetables**	3	2	1	2
8	**Fruits**	4	3	2	4
9	**Flowers**	-			
10	**Others**	1	1	1	1
	Total	**49**	**36**	**26**	**24**
	Per Cent		**73.5**	**53.1**	**49.0**

9. The number of commodities which showed the presence of seasonality declined continuously from 36 in Period 1 to 24 in Period 3. There was not much decline in Vegetables, Fruits and Flowers; however, the decline in numbers was observed in Cereals, Pulses and Oilseeds.
10. The extent of seasonality, as measured by Range, in all these 49 commodities is shown in the following Chart (Chart 3.3).
11. The Chart shows highest level of seasonality in each commodity group. In almost all commodity groups, there is a decline in the Range in seasonality in Period 3 as compared to earlier two Periods.

Chart 3.3



Thus, the seasonality in agricultural prices, both in terms of numbers as also in its extent, is declining in India. It is, however, quite large in vegetables and fruits.

Chapter 4
Trend in Agricultural Prices

> "The data analysis must progress by approximate answers, at best, since its knowledge of what the problem really is will at best be approximate"
>
> – ***John W. Tukey***, *Statistician*

Introduction

Trend makes an important contribution to the fluctuations in a time series. It shows a systematic, medium to long term (depending on the length of the time series) change in the subject of study.

This change could be negative or positive; or there could be no change at all. In a price series, if the trend is positive, it shows the increasing tendency in prices over years. If negative, the prices are declining over years.

If there is an increasing trend in general price level, the individual agricultural commodity prices should also show an equal rate of growth in prices. This is required for the sustainability of production of the commodity. If the commodity prices do not increase in the same way as general price level, producers would in the long run incur losses; they may even stop producing them. On the contrary, if the commodity prices increase at a rate more than the general price level, it provides an incentive to produce more. To this extent, the trend performs an important function of giving market signals.

We estimate trend by calculating an annual compound growth rate (CGR). For this purpose, we take the original price series after, if seasonality is present, removing the effect of seasonality. CGR is estimated by fitting the appropriate regression equation to the data. The

procedure also provides us the significance of the trend value. The equation gives us the monthly CGR, which is converted into annual CGR. We call it Nominal CGR.

Along with calculation of Nominal CGR, we also calculate in similar way the CGR of Wholesale Price Indices for All Commodities (WPI (All)) and consider it as the growth rate in general price level. The difference between the Nominal CGR of a commodity and the CGR of the WPI (All) gives us the Real CGR for the commodity.

Thus, if the Nominal rate of growth in prices of a commodity is, say, 8 per cent, and that in WPI is 5 per cent per year, it means, the prices of the commodity in question has been increasing over and above the general price level by 3 per cent per year. The Real Rate of Growth for the commodity is thus 3 per cent. If the Nominal rate of growth is negative, say -2 per cent, the Real rate of growth of the commodity would then be -7 per cent.

The value of Trend was tested for significance at 5 per cent level. If the value for any commodity was not significant, its Nominal CGR was taken as zero.

Both Nominal Rates of Growth are calculated separately for each Period. The three Periods are:

- Period 1: April 1982 to March 1994 (12 years)
- Period 2: April 1994 to March 2005 (11 years) and
- Period 3: April 2005 to March 2019 (14 years)

For each of these Periods, the procedure adopted is as follows:

- Calculation of Nominal CGR for each commodity, including for WPI (All Commodities)
- Taking the difference between the two (CGR for WPI (ALL) *less* Nominal CGR for each commodity) and arriving at the Real CGR for the commodity.

During Period 3, data for some commodities is available only for 7 years (April 2012 – March 2019). The Real CGR for these commodities is obtained by using the CGR of WPI (All) for this Period.

The positive Real rate of growth in agricultural commodity prices would broadly indicate that during the period under study demand has been more than supply. It could show an opportunity of increasing supply. The negative Real rate of growth should indicate that during the period, supply has been relatively more than demand. If the Real rate of growth is equal to zero, it would indicate that the Nominal CGR for the commodity has been just equal to the CGR in the general price level.

The commodity-wise findings for the three Periods are discussed below:

4.0 Trend in WPI (All Commodities)

The values of Real CGR in the three Periods are given below:

Table 4.0: Annual Compound Growth Rates: WPI (All)

SrNo	Commodity	Period 1	Period 2	Period 3	Period 3*
0	WPI (All)	7.81	4.96	4.93	1.32

The rate of growth in prices was highest in Period 1 at 7.81 per cent per year. It decreased to 4.96 per cent in the second Period and then to 4.93 per cent in Period 3.

During the last 7 years (April 2012 – March 2019), the prices increased at a much lesser rate at 1.32 per cent per year.

4.1 Trend in Cereals

The values of Real CGR in the three Periods are given below:

Table 4.1: Annual Compound Growth Rates in Real Terms: CEREALS

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
1	Rice	-0.5	-0.5	3.1	*41*
2	Wheat	-0.5	0.6	1.5	*62*
3	Jowar	1.2	-0.7	3.7	*29*
4	Bajra	-0.2	-1.8	3.4	*34*
5	Maize	-0.3	-2.1	2.8	*45*
6	Barley	0.6	-0.9	2.2	*56*
7	Ragi	-1.2	-0.5	8.3	*5*

During **Period 3**, all the commodities showed positive real growth rates. The growth rate was highest for Ragi. This rate was fifth highest among all the 84 commodities considered for this study. The CGR for other commodities were between 1.5 and 3.4 per cent.

Comparison with Earlier Periods:

In Period 1, only Jowar and Barley had a positive CGR. In Period 2, all but Wheat had negative CGR. In Period 3, all Commodities showed positive growth rates.

4.2 Trend in Pulses

The values of Real CGR in the three Periods are given below:

Table 4.2: Annual Compound Growth Rates in Real Terms: PULSES

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
8	Gram	2.9	0.6	3.2	*36*
9	Arhar	3.6	-2.8	2.6	*49*
10	Moong	2.4	-0.7	2.9	*42*
11	Masur	3.4	-0.8	1.6	*61*
12	Urad	2.1	-2.2	2.5	*52*
13	Peas/Chawali*			1.4	*63*
14	Rajma*			-3.8	*83*

(* Data available only for 7 years, between April 2012 – March 2019)

In Pulses, all commodities, with the exception of Rajma, showed positive rates of growth in prices. The CGRs varied between 1.4 and 3.2 per cent per year.

Pulses exhibited positive trends in Period 1; they got substantially reduced in Period 2, when four out of five commodities posted negative trends.

4.3 Trend in Spices

The values of Real CGR in the three Periods are given below:

Table 4.3: Annual Compound Growth Rates in Real Terms: SPICES

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
15	Black Pepper	-0.4	-5.0	12.1	*2*
16	Chillies(Dry)	5.3	-3.8	4.5	*21*
17	Turmeric	0.7	3.2	4.1	*25*
18	Cardamom	19.2	3.2	7.8	*6*
19	Ginger(Dry)	-3.4	-1.6	-0.8	*70*
20	Betelnut/Arecanut	7.5	-3.4	6.2	*11*
21	Cumin	6.7	1.9	2.1	*58*
22	Garlic	5.8	3.9	-1.0	*71*
23	Coriander		-0.1	2.3	*55*
24	Tamarind*			13.1	*1*

(* Data available only for 7 years, between April 2012 – March 2019)

Spices showed very high rates of growth in Period 3. Tamarind posted the highest CGR among all 84 commodities at 13.1 in real terms. It was immediately followed by Black Paper at 12.1 per cent, which stood at the second rank. Cardamom was at the 6th rank at 7.8 per cent. Excepting Dry Ginger and Garlic, all the commodities showed positive rates of growth in real terms.

Turmeric, Cardamom and Cumin showed positive growth rates in all the three Periods.

Dry Ginger, on the other hand, showed negative growth rates in all the three Periods.

4.4 Trend in Oilseeds

The values of Real CGR in the three Periods are given below:

Table 4.4: Annual Compound Growth Rates in Real Terms: Oilseeds

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
25	Groundnut Seed	1.7	-1.4	2.5	*51*
26	Rape & Mustard Seed	0.9	-1.3	2.1	*57*
27	Cotton Seed	0.2	-1.0	2.3	*54*
28	Copra (Coconut)	0.2	-0.5	4.4	*22*
29	Gingelly Seed (Sesamum)	1.1	-2.3	5.3	*15*
30	Linseed	-1.2	-0.6	3.7	*30*
31	Castor Seed	-0.8	-0.4	3.1	*39*
32	Niger Seed	2.8	-5.0	2.9	*43*
33	Safflower (Kardi Seed)	3.0	0.7	0.7	*66*
34	Sunflower	3.0	0.3	0.2	*67*
35	Soybean	4.1	-1.9	3.1	*40*

All oilseeds posted positive rates of growth, ranging between 0.2 per cent and 5.3 per cent.

Comparison with Earlier Periods:

Safflower and Sunflower showed positive rates of growth in all the three Periods.

Period 2 was marked by a large number of commodities with negative growth rates.

4.5 Trend in Fibres

The values of Real CGR in the three Periods are given below:

Table 4.5: Annual Compound Growth Rates in Real Terms: FIBRES

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
36	Raw Cotton	1.8	-4.2	2.8	*46*
37	Raw Jute	-2.7	-5.0	6.0	*12*
38	Mesta	-2.6	-1.1	2.7	*48*
39	Raw Silk	4.5	-5.6	3.6	*32*

All the four commodities in Period 3 showed positive rates of growth. They ranged between 2.7 per cent and 6 per cent. Jute was among the first 15 commodities posting highest rates of growth.

Here, also, all commodities showed negative rates of growth in Period 2.

4.6 Trend in Prices of Livestock and Livestock Products

The values of Real CGR in the three Periods are given below:

Table 4.6: Annual Compound Growth Rates in Real Terms: LIVESTOCK AND LIVESTOCK PRODUCTS

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
40	Milk	1.0	0.7	3.9	*27*
41	Egg	-1.3	-3.0	2.6	*50*
42	Fish-Inland		5.6	8.8	*4*
43	Fish-Marine	0.1	-1.2	4.9	*19*
44	Mutton	1.9	-0.5	3.3	*35*
45	Poultry Chicken	-2.2	-7.3	1.1	*65*
46	Pork	1.9	-2.5	3.8	*28*

All the Livestock prices showed a growth in real prices in Period 3. The growth in Inland Fish was highest, followed by Marine Fish. The CGR of Inland Fish prices was also the 4th highest among all the 84 commodities.

The prices of Inland Fish were not included in the series studied for Period 1. However, in both subsequent Periods they showed positive rates of growth. Milk prices also exhibited positive rates of growth in all Periods.

Period 2 witnessed negative rates of growth in all commodities excepting Milk and Inland Fish.

4.7 Trend in Vegetables

The values of Real CGR in the three Periods are given below:

Table 4.7: Annual Compound Growth Rates in Real Terms: VEGETABLES

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
47	Potato	-0.3	-1.9	-0.2	*69*
48	Onion	-0.6	0.0	3.2	*38*
49	Tapioca	2.6	0.1	7.7	*7*
50	Ginger(Fresh)	-3.4		2.4	*53*
51	Tomato*			2.0	*59*
52	Brinjal		-1.5	2.7	*47*
53	Okra (Lady finger)		-1.9	3.2	*37*
54	Cabbage		-1.8	4.1	*24*
55	Carrot*			-1.3	*73*
56	Radish*			-1.3	*74*
57	Cucumber*			3.6	*31*
58	Pointed gourd*			-1.3	*75*
59	Bitter gourd*			-1.3	*76*
60	Bottle gourd*			-1.3	*77*
61	Beans*			-1.3	*78*
62	Pumpkin*			-1.3	*79*
63	Drumstick*			3.9	*26*

(* Data available only for 7 years, between April 2012 – March 2019)

In Period 1, there were only four vegetables included in the WPI series. In Period 2, 3 more commodities (Brinjal, Okra and Cabbage) were added. All other vegetables, including Tomato, were included from April 2012.

The period after April 2012 also witnessed a lower growth rate in general price level.

On this background, we see positive rates of growth in Onion, Tapioca, Fresh Ginger, Tomato, Brinjal, Okra, Cabbage, Cucumber and Drumsticks.

Potato showed negative rates of growth in all Periods. During Period 1 and Period 2, its prices just managed to keep pace with the general price level.

4.8 Trend in Prices of Fruits

The values of Real CGR in the three Periods are given below:

Table 4.8: Annual Compound Growth Rates in Real Terms: FRUITS

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
64	Banana	1.3	-0.4	4.2	*23*
65	Apple*			-1.3	*80*
66	Cashew nut	5.1	-2.4	5.6	*14*
67	Coconut(Fresh)	0.9	-1.5	5.0	*18*
68	Papaya	2.5	5.7	-1.7	*82*
69	Pineapple		2.4	5.1	*17*
70	Guava		2.1	6.5	*10*
71	Lemon			-1.7	*81*
72	Sapota		1.3	3.5	*33*
73	Mosambi (Sweet Orange)*			1.9	*60*
74	Pomegranate*			-7.9	*84*
75	Amla*			7.5	*8*
76	Jackfruit*			2.8	*44*
77	Pear*			6.8	*9*
78	Almonds*			9.7	*3*
79	Walnut*			5.9	*13*

(* Data available only for 7 years, between April 2012 – March 2019)

Like in Vegetables group, there were four fruits included in the series considered for Period 1 (Banana, Cashew nut, Fresh Coconut and Papaya. Three more were added in Period 2 (Pineapple, Guava and Sapota). The remaining fruits were included from April 2012 onwards.

Overall, the prices of most fruits posted positive Real CGRs in Period 3. Almonds and Amla, particularly, had even obtained the ranks of 3 and 8 respectively. Four more fruits (Cashew nut, Guava, Pear and Walnut) were in the list of top 15 commodities showing highest rates of increase in prices.

On the other hand, Apple, Papaya, Lemon and Pomegranate showed negative rates of growth. The CGR for Pomegranate was lowest among all 84 commodities (Its nominal rate of growth was -6.6 per cent during the Period).

Pineapple, Guava and Sapota showed positive rates of growth in both Periods 2 and 3.

4.9 Trend in Prices of Flowers

The values of Real CGR in the three Periods are given below:

Table 4.9: Annual Compound Growth Rates in Real Terms: FLOWERS

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
80	Rose			1.3	*64*
81	Jasmine			-0.1	*68*
82	Marigold			-1.2	*72*

All the three commodities were included only in Period 3. Out of them, only Rose showed a positive rate of growth in real terms.

4.10 Trend in Prices of Others

The values of Real CGR in the three Periods are given below:

Table 4.10: Annual Compound Growth Rates in Real Terms: OTHERS

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
83	Guar Seed			5.2	*16*
84	Fodder	2.3	0.3	4.8	*20*

Guar Seed was introduced in the WPI series only in Period 3. It showed a positive and high rate of growth in Period 3.

Fodder also posted a high positive CGR in Period 3. Moreover, the CGR was positive in all the three Periods.

SUMMARY OF FINDINGS ON TREND

For Period 3 (April 2005 to March 2019)

1. During Period 3, Wholesale Price Index (All Commodities) had shown an annual compound rate of growth of 4.93 per cent.
2. Out of 84 agricultural commodities selected for the study, prices of 67 commodities showed the annual compound rate of growth more than the WPI growth rate. The remaining 17 commodities had a growth rate less than the WPI growth rate, or had a negative Real growth rate.
3. Top 5 commodities which indicated highest Real rates of growth were: Tamarind (13.1%), Black Pepper (12.1%), Almonds (9.7%), Inland Fish (8.8%) and Ragi (8.3%).

Comparison with other Periods

4. The annual CGR in WPI (All Commodities) was 7.81 per cent in Period 1; it decreased to 4.96 per cent in Period 2 and further to 4.93 per cent in Period 3.
5. Out of 84 commodities, 49 commodities were common in all Periods. The following Table shows the number of commodities with positive Real growth rates in the three Periods:

Table 4.11: Number of Commodities with Positive Real CGR (Common Commodities)

SrNo	Commodity Group	No. of Commodities	Period 1	Period 2	Period 3
1	Cereals	7	2	1	7
2	Pulses	5	5	1	5
3	Spices	8	6	4	6
4	Oilseeds	11	9	2	11
5	Fibres	4	2	0	4
6	Livestock and Livestock Products	6	4	1	6
7	Vegetables	3	1	2	2
8	Fruits	4	4	1	3
9	Flowers	-			
10	Others	1	1	1	1
	Total	**49**	**34**	**13**	**45**
	Per Cent		**69.4**	**26.5**	**91.8**

6. Out of 49 commodities covered in all Periods, the number of commodities with positive Real growth rates was 34 in Period 1; it decreased to 13 in Period 2 and increased to 45 in Period 3, accounting for 92 per cent of total commodities. The only commodities which showed negative real CGR in Period 3 were Ginger (Dry), Garlic, Potato and Papaya.
7. Period 3, therefore, marks an overall increase in demand compared to both Period 1 and Period 2. Period 2 was particularly characterized by a large number of commodities with negative real CGR.

Chapter 5
Volatility in Agricultural Prices

> "Faced with a choice between a theory which predicts well but gives us little insight into how the system works and one which gives us this insight but predicts badly, I would choose the latter, and I am inclined to think that most economists would do the same."
>
> – ***Ronald Coase***, *Economist*

Introduction

We have assumed that the time series of each commodity price (Y) consists of four components: Seasonality (S), Trend (T), Cycle (C) and Irregular fluctuations (R). The relationship between them is considered multiplicative in the form:

$$Y = S \times T \times C \times R$$

When we remove seasonality and trend from Y, we have, what we call, Residual Series (RS): Y/(S x T). The Residual Series consists of two remaining components, Cycle and Irregular fluctuations.

We have calculated, for each commodity, the Residual Series for the following three periods:

- Period 1: April 1982 to March 1994 (12 years)
- Period 2: April 1994 to March 2005 (11 years) and
- Period 3: April 2005 to March 2019 (14 years)

The commodity charts for Y and RS for each commodity in Period 3 are presented in Charts Set 1 and Charts Set 3, respectively. They show the nature of volatility in the commodities studied.

RS contains both cyclical and irregular fluctuations. So far, both cannot be explained or expected and hence are taken to indicate the incidence of volatility. However, for the sake of comparability, the volatility is calculated for both the series and called Gross Volatility and Residual Volatility respectively.

Volatility is estimated by calculating Coefficient of Variation (CV) of the two series. It is expressed as percentage. The formula used is:

CV = (Standard deviation of the series/Mean of the series) x 100

CV is independent of the unit of measurement and number of observation; hence it can be compared across commodities and time.

CV for original series is called 'Gross Volatility (GV) and that for residual series is called "Residual Volatility' (RV) respectively.

It is expected that RV is lower than GV. The difference between the two depends on the contribution of Seasonality and Trend to the overall fluctuations. For many commodities, seasonality is not present. Even for those commodities where seasonality is found significant, its extent is small; hence their influence on RV is also small. However, where seasonality is pronounced (like in Peas, Garlic, Potato, Onion, Fresh Ginger, Tomato, Brinjal, Okra, Cabbage, Carrot, Drumstick, Amla and Jasmine in Period 3), its removal has sharply reduced the RV.

The trend is significant in most cases; naturally its removal has reduced RV.

In all Periods, RV is found to be lower than GV. There are, however, six exceptions where RV is slightly more than GV. They are: Turmeric in Period 1, Garlic and Onion in Period 2 and Black Pepper, Raw Jute and Mesta in Period 3. Each of these commodities has experienced peculiar fluctuations in these Periods. These are discussed in Volume 2.

In the following sections, we present and discuss the values of RV for each Commodity Group. In some cases, like in WPI (All), the values of GV are also mentioned. We first present the findings for Period 3 and then follow it up with comparison with other Periods.

The Residual Volatility was also given Ranks for all 84 commodities (1 standing for highest volatility and 84 for lowest volatility). These are mentioned in the Tables.

Both the values of GV and RV for all commodities for Period 3 are given in Table 5.11 at the end of the chapter.

5.0 Volatility in WPI (All)

The values of Gross Volatility and Residual Volatility are given in the following Table:

Table 5.0: Gross and Residual Volatility in Monthly Prices: WPI (All)

SrNo	Commodity	Period 1	Period 2	Period 3	Period 3*
0	Gross Volatility (GV)	19.3	15.4	28.3	3.7
0	Residual Volatility (RV)	3.8	1.3	6.2	2.5

(Period 3* is of 7 years between April 2012 and March 2019. Data for some commodities is available only for this Period)

The Gross Volatility in Period 3 was at 28.3 per cent. After the removal of seasonality and trend, it came down to 6.2 per cent. This could serve as a benchmark for comparing the commodity-wise volatility.

During the previous 7 years, the volatility was lower at 2.5 per cent.

Compared to earlier Periods, Period 3 experienced highest volatility in agricultural prices.

5.1 Volatility in Prices of Cereals

The values of Residual Volatility are given in the following Table:

Table 5.1: Residual Volatility in Monthly Prices: CEREALS

Sr No	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
1	Rice	8.3	7.1	6.2	***82***
2	Wheat	8.9	8.1	6.3	***81***
3	Jowar	15.8	12.2	9.7	***67***
4	Bajra	15.8	11.6	9.5	***69***
5	Maize	13.7	8.2	10.1	***64***
6	Barley	9.6	12.0	6.1	***83***
7	Ragi	9.1	8.9	12.4	***57***

Among all Cereals, Ragi experienced highest volatility at 12.4. It was followed by Jowar, Bajra and Maize, all at around 10. The lowest volatility was observed in Rice, Wheat and Barley, at around 6. It was at the same level as that of general price level. All the Ranks were in the third and fourth quartile, with Rice, Wheat and Barley almost at the level of lowest volatility of all commodities.

The volatility of Rice, Wheat, and Bajra continuously decreased during the three Periods.

The volatility of Ragi in Period 3 was, however, an all Period high.

5.2 Volatility in Prices of Pulses

The values of Residual Volatility are given in the following Table:

Table 5.2: Residual Volatility in Monthly Prices: PULSES

Sr No	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
8	Gram	17.4	15.1	19.7	***34***
9	Arhar	12.7	14.4	22.8	***23***
10	Moong	10.7	9.1	20.9	***28***
11	Masur	9.8	9.8	20.3	***30***
12	Urad	9.1	16.0	22.9	***22***
13	Peas/Chawali*			8.1	***76***
14	Rajma*			7.5	***80***

The data for Peas/Chawali and Rajma are available for Period 3 and that too for seven years between April 2912 and March 2019.

As compared to Cereals, the volatility was higher for all Pulses, lying between 20 and 23. All ranks were thus nearly in the second quartile. The volatility in the second period was slightly higher than that in the general price level.

All the pulses, for which data are available, experienced a very sharp rise in the volatility in prices in Period 3 as compared to earlier Periods. It was a continuous rise for Arhar and Urad.

5.3 Volatility in Prices of Spices

The values of Residual Volatility are given in the following Table:

Table 5.3: Residual Volatility in Monthly Prices: SPICES

Sr No	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
15	Black Pepper	39.7	45.7	25.7	*17*
16	Chillies(Dry)	38.1	18.6	16.4	*43*
17	Turmeric	33.4	29.2	45.3	*3*
18	Cardamom	33.4	26.7	27.7	*11*
19	Ginger(Dry)	27.5	23.6	18.0	*39*
20	Betelnut/Arecanut	19.3	23.4	11.4	*59*
21	Cumin	33.8	23.2	9.1	*70*
22	Garlic	68.5	44.6	45.4	*2*
23	Coriander		26.5	28.9	*8*
24	Tamarind*			9.8	*65*

Coriander prices are available from Period 2. Tamarind was introduced in WPI in April 2012.

There are extremes in the volatility of Spices. On the one hand, Garlic, Turmeric, Coriander and Cardamom experienced very high volatility, ranging from 27.7 to 45.4, the commodities like Cumin and Tamarind witnessed low volatility below 10.

In all the three Periods, Garlic experienced very high volatility. In Period 1, its rank, at 68.1, was first; in Period 2, at 44.6, its rank was third and in Period 3, its rank was second. Chillies, Dry Ginger and Cumin recorded a decline in volatility.

Spices as a Commodity Group require a detailed investigation.

4. Volatility in Prices of Oilseeds

The values of Residual Volatility are given in the following Table:

Table 5.4: Residual Volatility in Monthly Prices: OILSEEDS

Sr No	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
25	Groundnut Seed	10.5	7.0	12.9	*55*
26	Rape & Mustard Seed	15.0	12.4	10.5	*61*
27	Cotton Seed	11.7	6.7	7.6	*79*
28	Copra (Coconut)	24.8	21.0	19.8	*33*
29	Gingelly Seed (Sesamum)	15.4	12.2	23.9	*20*
30	Linseed	17.8	8.8	10.6	*60*
31	Castor Seed	24.1	10.3	20.6	*29*
32	Niger Seed	13.2	11.0	28.0	*9*
33	Safflower (Kardi Seed)	13.9	11.9	9.6	*68*
34	Sunflower	14.4	12.8	12.7	*56*
35	Soybean	14.2	12.9	18.3	*38*

Among all oilseeds considered, Niger seed showed highest volatility, at 28. It was ninth highest in Period 3. It was in the first quartile range. The lowest seasonality was witnessed by Cotton seed (7.6), followed by Safflower (9.6), Rape and Mustard seed (10.5) and Linseed (10.6). The remaining commodities were between 13 and 24.

Over the three Periods, Rape and Mustard seed, Copra, Safflower and Sunflower experienced a decline. The Volatility in Groundnut, Gingelly, Niger and Soybean was highest in Period 3 than any other previous Periods.

Volatility in Oilseeds is fluctuating over years. It is also not very low. Farmers need to formulate effective risk mitigating measures.

5.5 Volatility in Prices of Fibres

The values of Residual Volatility are given in the following Table:

Sr No	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
36	Raw Cotton	16.6	10.0	19.7	***35***
37	Raw Jute	44.7	25.7	15.2	***48***
38	Mesta	39.9	23.5	16.1	***45***
39	Raw Silk	16.9	10.5	16.2	***44***

All the commodities experienced, during Period 3, volatility ranging between 16 and 20. Cotton among them was highest, with a Rank of 35.

Jute and Mesta witnessed a decline in volatility over the three Periods. The volatility for cotton was an all Period high in Periodn3.

Volatility in Fibres needs a careful investigation.

5.6 Volatility in Prices of Livestock and Livestock Products

The values of Residual Volatility are given in the following Table:

Table 5.6: Residual Volatility in Monthly Prices: LIVESTOCK AND LIVESTOCK PRODUCTS

Sr No	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
40	Milk	3.2	3.5	8.0	***78***
41	Egg	7.9	6.4	8.1	***75***
42	Fish-Inland		12.5	21.0	***27***
43	Fish-Marine	12.8	11.2	15.1	***49***
44	Mutton	4.2	7.6	10.2	***63***
45	Poultry Chicken	9.5	12.2	9.7	***66***
46	Pork	6.9	10.7	8.5	***73***

Data for Inland Fish is available only from Period 2 onwards.

Excepting Fish, all other products had a low volatility.

However, the volatility for Milk, Egg, Fish, and Mutton was highest in Period 3 than in any other previous Periods.

The reasons for this increase needs to be studied further.

5.7 Volatility in Prices of Vegetables

The values of Residual Volatility are given in the following Table:

Table 5.7: Residual Volatility in Monthly Prices: VEGETABLES

Sr No	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
47	Potato	24.4	36.9	25.8	*16*
48	Onion	31.0	54.9	41.2	*5*
49	Tapioca	24.4	15.3	27.5	*12*
50	Ginger(Fresh)	27.7		36.3	*6*
51	Tomato*			45.1	*4*
52	Brinjal		19.7	16.6	*42*
53	Okra (Lady finger)		16.6	18.3	*37*
54	Cabbage		31.0	30.9	*7*
55	Carrot*			19.5	*36*
56	Radish*			26.3	*14*
57	Cucumber*			15.0	*50*
58	Pointed gourd*			22.5	*24*
59	Bitter gourd*			25.6	*18*
60	Bottle gourd*			26.4	*13*
61	Beans*			17.4	*41*
62	Pumpkin*			17.5	*40*
63	Drumstick*			25.5	*19*

Only four vegetables were included in Period 1. Three were added in Period 2 and nine were added in Period 3 from 2012.

The volatility in Vegetables is quite high. It is highest in Tomato, followed by Onion in Period 3. Even in Potato, which is stored for a long time, it is high.

The high volatility of vegetables does show their importance in consumption and inefficient marketing infrastructure, including lack of transport, processing and appropriate storage facilities.

5.8 Volatility in Prices of Fruits

The values of Residual Volatility are given in the following Table:

Table 5.8: Residual Volatility in Monthly Prices: FRUITS

Sr No	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
64	Banana	8.9	12.3	10.5	*62*
65	Apple*			8.3	*74*
66	Cashew nut	12.5	6.8	8.1	*77*
67	Coconut(Fresh)	23.4	18.0	14.0	*53*
68	Papaya	22.6	15.1	21.9	*25*
69	Pineapple		11.1	12.2	*58*
70	Guava		35.5	25.9	*15*
71	Lemon			20.2	*31*
72	Sapota		12.6	15.0	*51*
73	Mosambi (Sweet Orange)*			13.2	*54*
74	Pomegranate*			8.6	*72*
75	Amla*			15.5	*47*
76	Jackfruit*			23.1	*21*
77	Pear*			21.7	*26*
78	Almonds*			5.6	*84*
79	Walnut*			8.7	*71*

For Period 1, data for four commodities is available. Three more commodities were added in Period 2. Lemon was introduced in April 2005; others were added in WPI from April 2012 onwards.

Compared to Vegetables, the volatility in Fruits is low; it is lowest for Almonds, Walnut, Cashew nut, Pomegranate and Apple. It is highest in more perishable products like Guava and Lemon.

Most Fruits were introduced in WPI after April 2012. Among the four fruits where comparison is possible, Fresh Coconut shows decreasing trend in volatility.

5.9 Volatility in Prices of Flowers

The values of Residual Volatility are given in the following Table:

Table 5.9: Residual Volatility in Monthly Prices: FLOWERS

SrNo	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
80	Rose			15.5	***46***
81	Jasmine			27.7	***10***
82	Marigold			20.1	***32***

All the flowers were introduced in WPI in Period 3.

Among all flowers, volatility is high in Jasmine. It is in Top 10 in terms of ranking.

5.10 Volatility in Prices of Others

The values of Residual Volatility are given in the following Table:

Table 5.10: Residual Volatility in Monthly Prices: OTHERS

Sr No	Commodity	Period 1	Period 2	Period 3	*Rank (Period 3)*
83	Guar Seed			56.5	***1***
84	Fodder	19.6	17.3	14.8	***52***

Guar seed was introduced only in Period 3. It is grown mostly in Rajasthan and its prices are almost completely influenced by international demand. It is experiencing highest volatility among all 84 commodities considered for the study. Even its Gross Volatility at 61.9 is second only to Onion (whose GV is 62.3).

Fodder has a low volatility; it is decreasing over years.

Summary of Findings

In terms of **Gross Volatility**, the first ten commodities showing the highest values are:

1. Onion
2. Guar Seed
3. Black Pepper
4. Guava
5. Cabbage
6. Garlic
7. Ragi
8. Tapioca
9. Drumstick
10. Inland Fish

In terms of **Residual Volatility**, the top ten commodities are:

1. Guar Seed
2. Garlic
3. Turmeric
4. Tomato
5. Onion
6. Fresh Ginger
7. Cabbage
8. Coriander
9. Niger Seed
10. Jasmine

Thus, although the commodities differ among these rankings, the high volatility among vegetables, flowers, some spices and Guar Seed is noticeable. These commodities need careful attention in the next few years.

The values of Gross and Residual Volatilities for all commodities are given in the following Table.

Table 5.11 Values of Gross and Residual Volatility for all Commodities (Period 3)

SrNo	Commodity	Commodity Group	Gross Volatility	Residual Volatility
0	WPI (All)	WPI (All)	19.3	6.2
1	Rice	Cereals	29.7	6.2
2	Wheat	Cereals	24.6	6.3
3	Jowar	Cereals	32.0	9.7
4	Bajra	Cereals	31.9	9.5
5	Maize	Cereals	29.7	10.1
6	Barley	Cereals	27.7	6.1
7	Ragi	Cereals	48.8	12.4
8	Gram	Pulses	40.7	19.7
9	Arhar	Pulses	36.7	22.8
10	Moong	Pulses	33.5	20.9
11	Masur	Pulses	30.5	20.3
12	Urad	Pulses	38.5	22.9
13	Peas/Chawali*	Pulses	12.9	8.1
14	Rajma*	Pulses	9.0	7.5
15	Black Pepper	Spices	56.4	25.7
16	Chillies(Dry)	Spices	34.8	16.4
17	Turmeric	Spices	44.6	45.3
18	Cardamom	Spices	42.4	27.7
19	Ginger(Dry)	Spices	24.9	18.0
20	Betelnut/Arecanut	Spices	43.7	11.4
21	Cumin	Spices	27.3	9.1
22	Garlic	Spices	51.2	45.4
23	Coriander	Spices	35.9	28.9
24	Tamarind*	Spices	30.5	9.8

Table 5.11 Values of Gross and Residual Volatility for all Commodities (Period 3) (continued)

SrNo	Commodity	Commodity Group	Gross Volatility	Residual Volatility
25	Groundnut Seed	Oilseeds	29.0	12.9
26	Rape & Mustard Seed	Oilseeds	27.9	10.5
27	Cotton Seed	Oilseeds	28.3	7.6
28	Copra (Coconut)	Oilseeds	45.1	19.8
29	Gingelly Seed (Sesamum)	Oilseeds	40.0	23.9
30	Linseed	Oilseeds	34.2	10.6
31	Castor Seed	Oilseeds	31.9	20.6
32	Niger Seed	Oilseeds	38.5	28.0
33	Safflower (Kardi Seed)	Oilseeds	23.5	9.6
34	Sunflower	Oilseeds	22.0	12.7
35	Soybean	Oilseeds	32.6	18.3
36	Raw Cotton	Fibres	31.0	19.7
37	Raw Jute	Fibres	44.2	15.2
38	Mesta	Fibres	31.7	16.1
39	Raw Silk	Fibres	35.4	16.2
40	Milk	Livestock and Livestock Products	32.1	8.0
41	Egg	Livestock and Livestock Products	28.4	8.1
42	Fish-Inland	Livestock and Livestock Products	47.8	21.0
43	Fish-Marine	Livestock and Livestock Products	35.2	15.1
44	Mutton	Livestock and Livestock Products	30.3	10.2
45	Poultry Chicken	Livestock and Livestock Products	24.5	9.7
46	Pork	Livestock and Livestock Products	31.7	8.5

Table 5.11 Values of Gross and Residual Volatility for all Commodities (Period 3) (continued)

SrNo	Commodity	Commodity Group	Gross Volatility	Residual Volatility
47	Potato	Vegetables	38.9	25.8
48	Onion	Vegetables	62.3	41.2
49	Tapioca	Vegetables	48.6	27.5
50	Ginger(Fresh)	Vegetables	47.5	36.3
51	Tomato*	Vegetables	46.5	45.1
52	Brinjal	Vegetables	37.0	16.6
53	Okra (Lady finger)	Vegetables	39.8	18.3
54	Cabbage	Vegetables	53.5	30.9
55	Carrot*	Vegetables	25.3	19.5
56	Radish*	Vegetables	27.1	26.3
57	Cucumber*	Vegetables	17.6	15.0
58	Pointed gourd*	Vegetables	34.1	22.5
59	Bitter gourd*	Vegetables	25.6	25.6
60	Bottle gourd*	Vegetables	26.4	26.4
61	Beans*	Vegetables	22.4	17.4
62	Pumpkin*	Vegetables	17.5	17.5
63	Drumstick*	Vegetables	47.8	25.5
64	Banana	Fruits	35.1	10.5
65	Apple*	Fruits	14.8	8.3
66	Cashew nut	Fruits	41.1	8.1
67	Coconut(Fresh)	Fruits	42.9	14.0
68	Papaya	Fruits	24.0	21.9
69	Pineapple	Fruits	36.4	12.2
70	Guava	Fruits	55.3	25.9
71	Lemon	Fruits	29.8	20.2
72	Sapota	Fruits	35.8	15.0
73	Mosambi (Sweet Orange)*	Fruits	14.5	13.2
74	Pomegranate*	Fruits	17.3	8.6
75	Amla*	Fruits	32.9	15.5
76	Jackfruit*	Fruits	29.0	23.1
77	Pear*	Fruits	24.6	21.7
78	Almonds*	Fruits	20.7	5.6
79	Walnut*	Fruits	15.0	8.7

Table 5.11 Values of Gross and Residual Volatility for all Commodities (Period 3) (continued)

SrNo	Commodity	Commodity Group	Gross Volatility	Residual Volatility
80	Rose	Flowers	28.2	15.5
81	Jasmine	Flowers	41.1	27.7
82	Marigold	Flowers	22.7	20.1
83	Guar Seed	Others	61.9	56.5
84	Fodder	Others	37.6	14.8

*(The commodities marked with * have data only for 7 years between April 2012 – March 2019)*

Chapter 6
Mitigating Price Risks

> "It is wrong to suppose that if you can't measure it, you can't manage it – a costly myth"
>
> – ***W. Edwards Deming**, Economist*

6.0 Introduction

We have decomposed the commodity price series into 3 components, Seasonality, Trend and Residual. The purpose was not only to remove the influence of Seasonality and Trend and estimate volatility in commodity prices in the residual series; we also wanted to study the nature of these components and how they affected prices. This was done in the previous chapters. We also examined the volatility in the residual prices in the last chapter.

In this Chapter, we will bring all our observations together and explore the nature of price risks that farmers face and the measures to mitigate them to maximum extent. We will first summarise our findings on Seasonality and Trend and the learning from them; this will be followed by the discussion on the price risks arising from the volatility. This will be followed by brief recommendations on Disseminating Price Information and Research on Agricultural Prices.

6.1 Seasonality in Agricultural Prices in India

We have studied seasonality in monthly prices of 84 commodities during the period of 37 years. Of course, not all commodities were available for all these years. However, some unmistakable findings do emerge from this analysis:

1. Out of 84 commodities, 41 commodities are **non-perishable**. They can be stored for the year-long consumption. They include Cereals (7), Pulses (7), Spices (10),

Oilseeds (11), Fibres (4) and others (2). Out of these 41 commodities, seasonality was not present or was not identified in 25 commodities in the current period. It was present only in 16 commodities.

2. The extent of seasonality (measured by Range) was also low. It varied between 2.8 and 25.6 for the 16 commodities.
3. Further, the number of commodities for which seasonality is present is decreasing over the years for all the commodity groups.
4. Among the **perishable** commodities, the group 'Livestock and Livestock Products' stands out because of its low seasonality. It has 7 commodities (Milk, Egg, Inland Fish, Marine Fish, Mutton, Poultry and Pork). But the seasonality was present only in 2 commodities (Egg and Marine Fish). The extent of seasonality was also moderate ranging between 8.2 and 10.4. This group also experienced decrease in seasonality over the years.
5. Many In the remaining 36 perishable commodities, grouped under 'Vegetables '(17), 'Fruits' (16) and 'Flowers' (3), were introduced in the WPI after 2012. Out of them, the seasonality was significantly present in 27 commodities. The extent of seasonality was also very high, ranging between 31.1 and 118.6 for vegetables, 3. 7 and 62.4 for fruits and 17.8 and 74.8 for flowers.

These findings indicate following learnings:

1. For non-perishable commodities, at least, the 'End of Seasonality' is nearer. It will be risky to assume that the prices in the off-season would always be higher than those in the peak marketing season. The reasons for this phenomenon would vary with commodities. This is discussed in the second volume. But neither the farmers nor other stake holders involved in the storage of commodities should expect regular returns for their services.
2. The efficiency of storage will play a significant role in the years to come. The future storages will have to provide services at minimum cost and minimum wastages. Their locations and logistics also will have to be planned carefully.
3. The commodity- group 'Livestock and Livestock Products' is dominated by the dairy industry. It seems to have handled satisfactorily the problems arising in meeting even demand from uneven supply of perishable commodities. With sufficient price and supply management, it has eliminated seasonality in milk prices, for the benefit of both producers and consumers.
4. The remaining three sectors (Vegetables, Fruits and Flowers) will have to manage their supplies more efficiently. Tomato and Onions stand out particularly in these sectors as more vulnerable commodities. But other commodities are equally important. The high seasonality is due to uneven quantity *and* quality of supply. The wastages also play their part. Since the demand for them will continue to rise in future, the control of seasonality in prices will be a crucial task in days to come.

6.2 Trend in Agricultural Prices

We have estimated trend by calculating Compound Annual Rates of Growth in each commodity and then adjusting them to WPI of all commodities. This gave us the real annual growth rates.

The findings of this exercise for the current period (April 2005 onwards) can be summarized below:

1. The factor Trend does contribute to significant variation in prices for most of the agricultural products.
2. There was a positive trend in all commodities excepting Rajma and Pomegranate.
3. Tomato witnessed a rising trend in nominal prices. However, the rate was negative in real terms. **All other commodities experienced a growth rate higher than that in the general price level (as measured by WPI for all commodities).**

In other words, during the current Period, there is a general rise in demand for agricultural commodities relative to supply. The rise is highest in Tamarind, Black Pepper, Inland fish and Ragi. This provides an opportunity of increasing supply of these commodities.

The Trend factor has also contributed to the fluctuations in commodity prices. This contribution is more than that of seasonality.

6.3 Volatility in Agricultural Prices

The volatility in Agricultural Prices has been estimated by us by calculating coefficient of variation of the series of the observed prices after removing seasonality and trend. The residual series still contains the influence of: Cycle, irregular fluctuations and sudden occurrences of rise or fall, often termed as Spikes.

The following are the top 20 commodities in terms of Residual volatility in Period 3. (The commodities marked with * also figure in the top 20 commodities ranked according to Gross Volatility).

1. Guar Seed*
2. Garlic*
3. Turmeric*
4. Tomato*
5. Onion*
6. Fresh Ginger*
7. Cabbage*
8. Coriander
9. Niger Seed
10. Jasmine*
11. Cardamom*
12. Tapioca*
13. Bottle Gourd
14. Radish
15. Guava*
16. Potato
17. Black Pepper*
18. Bitter Gourd
19. Drumstick*
20. Gingelly Seed (Sesamum)

This list covers Guar Seed, 10 commodities in Vegetables, 5 in Spices, 2 in Oilseeds and one each in Fruits and Flowers.

Some commodities do not figure in this list; however, as we have seen in Chapter 5, all pulses (except Peas and Rajma) also have high volatility.

6.4 Measures to Mitigate Volatility

Generally, two types of measures are used to meet volatility: one, to reduce the extent of volatility and the other to reduce the consequences of volatility.

In the former category, the public measures that are adopted include: fixing minimum and maximum prices, procurement of commodities, building buffer stocks, restricting imports and exports, and direct participation in marketing of commodities. Private measures include better aggregation, storage of commodities and efficient transportation and distribution, and processing of commodities.

In the second category, the public measures include direct payments to producers / consumers, and supporting incomes of producers. The private measures include forward selling, engaging in futures transactions, and hedging the selling and purchasing transactions.

6.5 Minimum Support Prices

In India, the tradition of fixing minimum prices and procurement and distribution of essential commodities dates is very old. Right from the early sixties, when India had to import large quantities of wheat and rice, India started the distribution of these commodities through fair prices. Later, the Government started procuring these commodities from the markets at procurement prices and distribute them through the fair prices shops. Since then, the Government of India announces the Minimum Support Prices for selected commodities before the sowing seasons of Kharif and Rabi crops. As of now, the following commodities are covered under this program:

1. Paddy
2. Wheat
3. Jowar
4. Bajra
5. Barley
6. Ragi
7. Maize
8. Gram
9. Arhar
10. Moong
11. Masur
12. Urad
13. Groundnut
14. Sunflower Seed
15. Rape Seed
16. Safflower
17. Copra
18. Soybean
19. Sesamum
20. Niger Seed
21. Cotton
22. Jute
23. Sugarcane

Some of these crops are regularly procured and distributed. Others are procured on an ad hoc basis, when the market prices fall below the Minimum Support Prices and the demand for procurement increases.

It has been the experience of India that if the announcement of minimum support prices is accompanied by procurement and distribution and if there is no significant international trade, the price fluctuations can be kept under control. The experience of wheat and rice

stand testimony to this. However, even the announcement of minimum support prices seems to have reduced volatility of the above crops. Excepting Niger Seed, none of the MSP commodities has figured in the top 20 commodities.

The commodities like pulses, soybean and other oilseeds are marginally out of the Top 20 list. They are also subject to MSP, but have witnessed noticeable volatility. The recent wide fluctuations in pulses were the result of decrease in production; when it was corrected and after some effective procurement, it is brought under control. This only highlights the importance of building buffer stock.

The prices of all oilseeds are influenced by international factors and the announcement of MSP for them serves only limited purpose. To safeguard the interests of stakeholders, the measures like forward and futures trading are then helpful.

6.6 Futures Trading

At present, the following commodities are traded in the major futures markets of India:

1. Paddy
2. Wheat
3. Maize
4. Barley
5. Gram
6. Moong
7. Rape and Mustard Seed
8. Castor Seed
9. Soybean
10. Turmeric
11. Cumin
12. Coriander
13. Cotton
14. Guar Seed

The following commodities were once traded but then discontinued:

1. Bajra
2. Arhar
3. Masur
4. Urad
5. Peas

6. Groundnut Seed
7. Gingelly Seed
8. Black Pepper
9. Chillies (Dry)
10. Jute
11. Silk
12. Potato
13. Cashew Nut
14. Almonds

The facilities of option trading are allowed currently in Guar Seed, Gram and Soybean.

The major problem of the futures trading is liquidity. There are very few transactions in many agricultural commodities. In fact, the agricultural commodities are yet to find a place in the entire Commodity market of India.

A firm Government policy and systematic efforts to promote the use of futures markets by all stakeholders, including farmers and their associations/companies is necessary. This will promote forward trading, hedging and taking supply decisions by all the concerned agencies. The Government agencies would also take advantage of these markets for reducing their risks in procurement and storage of commodities.

6.7 Reducing risks in Perishable Commodities

The study very prominently points out the increasing volatility in perishables, especially vegetables and fruits. The WPI has just started to include vegetables in its portfolio. More volatile commodities like leafy vegetables, custard apple, strawberries, etc. are yet to be introduced. On the other hand, some other commodities, like milk and dairy products, have shown a way as to how to stabilize prices of perishable commodities.

Vegetables have a special place in Indian diet. They are not just salads; they are as essential as cereals and pulses in meeting the dietary needs of a vegetarian population. The commodities like potato and onion have repeatedly experienced spikes in prices and the lessons are not yet fully learnt.

Vegetables are also important for farmers. They are a source of ready cash and have a short product cycle. And, it is the same sector which finds maximum wastages, unscientific storages, disorganized distribution and lack of any guidance to the farmers.

If proper price and marketing policies are followed, these commodities should go a long way in increasing farmers' income.

While a detailed study is recommended, major suggestions could be in the following areas of improvement:

1. Scientific aggregating the produce before it is offered for sale. The produce should be cleaned, graded and scientifically packed before it is auctioned and despatched.
2. Location of aggregation centres near the producing regions. The centres should be equipped with proper, modern equipment; should be able to take care of all wastages and should provide necessary primary processing and storage facilities. Some of the existing APMCs could be entrusted with these responsibilities.
3. Encouraging primary processing and treatment for vegetables and fruits, preferably at the aggregation centres. Several export destinations require pre-treatment on the produce before it is despatched. The present practices of open drying of the produce like chillies are also found to be unhealthy. The pre-processing of ginger is also not standardized. There is a great deal of scope for dehydration of vegetables, particularly leafy vegetables. Establishment of pulping centres, manufacturing of by-products would also benefit producers in realizing better returns for the producers. All such activities, if scientifically pursued and located, will increase demand for the produce and reduce both seasonality as also volatility.
4. The aggregation centres would provide a platform not only for selling vegetables and fruits; they can also provide facilities for marketing the processed products and linking bulk consumers to their activities. They can ultimately initiate forward marketing and even futures trading of the processed vegetables and fruits.

In short, it is time to start a reform in the entire marketing and value chain of vegetables and fruits in the country.

6.8 Disseminating Reliable Market and Price Information

Volatility is also due to lack of timely information on supply, demand and prices. If such information is not available, it is replaced by misinformation and rumours. In India, a major part of volatility in onion prices, and even sharp spikes in them, take place during August - October. At that time, no adequate information is available on the acreage under onion, yield of onion or likely production of onion. Even the information on stocks of onion held from the previous Rabi season is not available. A wrong turn of climate then turns into a panic, which soon spreads like wild fire and pushes the consumers, producers and policy makers into a chaotic situation.

At present, thanks to internet and social media, the news spreads rapidly. It is a perfect food for volatility. At the same time, the same internet tools have opened up several data resources and provided access to price and market information as never before. It is now necessary to institutionalize, on the lines of United Department of Agriculture, the activities

of collecting data using *state of art methods*, collating it from different sources, analysing it by using advanced data mining tools, preparing price forecasts and market reports, and releasing them timely to *all* stakeholders in a simple, easy to understand, *regional* languages. The emphasis on the two words (*all* and *regional)* is intentional. And emphasis on *state of art methods* is also important, in view of the emergence of remote sensing, big data arising from ventures like e-NAM, and use of smart phones for surveys.

As markets expand and goods travel far and wide, prices tend to integrate if proper and reliable information is available timely; if not, volatility is certain to haunt weak and mighty!

6.9 Research in Agricultural Prices

Unfortunately adequate research in agricultural prices and marketing is lacking. No effective policies can be formulated unless they are preceded by analysis of the relevant data. The following areas are suggested on sample basis:

1. Defining agricultural price volatility and publishing standard methodology of creating time series of commodity prices (both spot and futures) on the lines of X-13, with components like seasonality, trend, etc.
2. APMCs have a huge data on prices and arrivals of commodities. Digitizing the same and making it available to researchers.
3. Studies on market and price integration for different commodities
4. Price elasticity studies for different commodities
5. Price forecasting studies for different commodities
6. Studies on cycles in agricultural prices
7. Studies on patterns of arrivals and their effects on prices
8. Price Differentials for different varieties, qualities and grades
9. Impact of futures prices on volatility
10. Relationship between spot and futures prices
11. Prices at different stages of value chains
12. Econometric studies on the behaviour of agricultural prices

There is also shortage of courses and course material for studying Agricultural Price Analysis at post-graduate level in the Universities.

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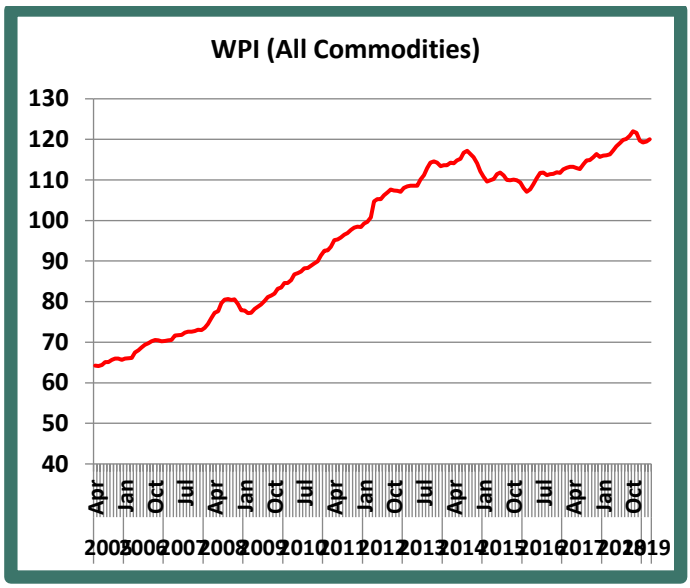
Charts Set 1

Monthly Commodity-wise Price Indices during April 2005 – March 2019 (Period 3)

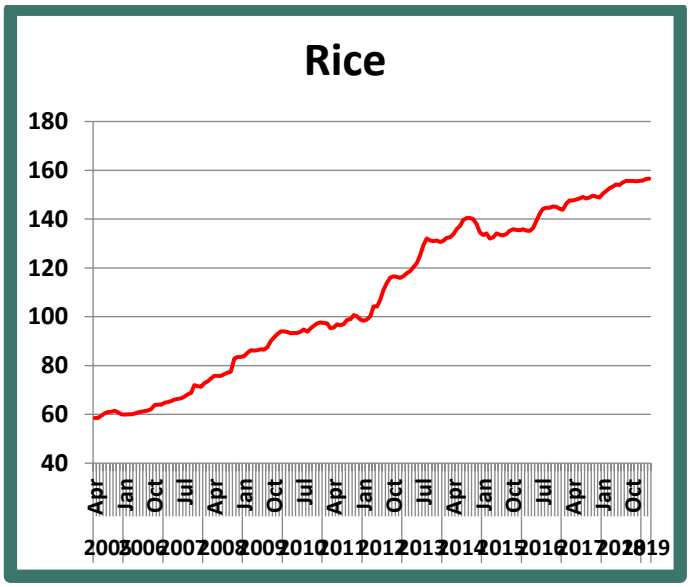
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

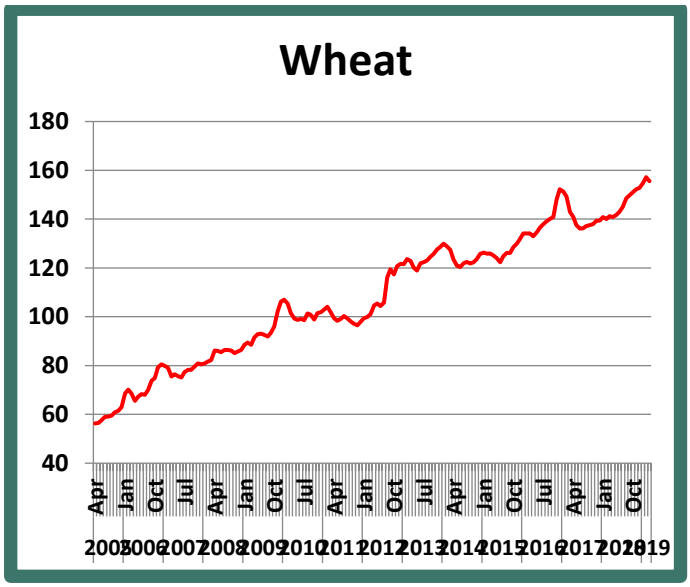
0. WPI (All Commodities)

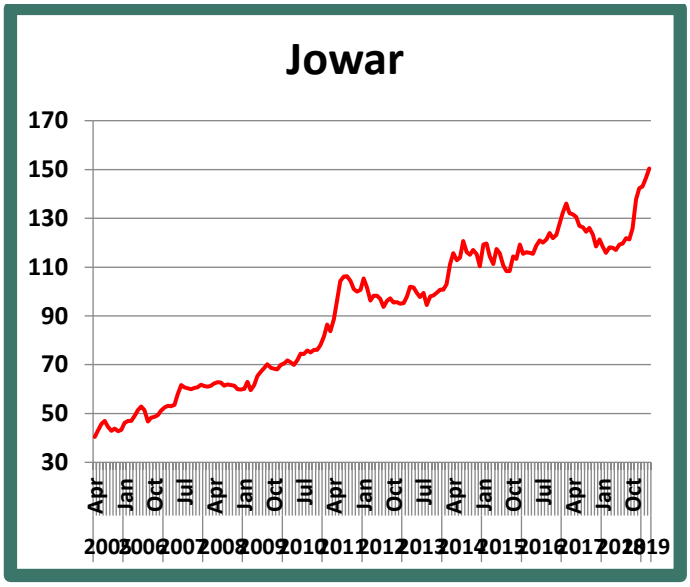


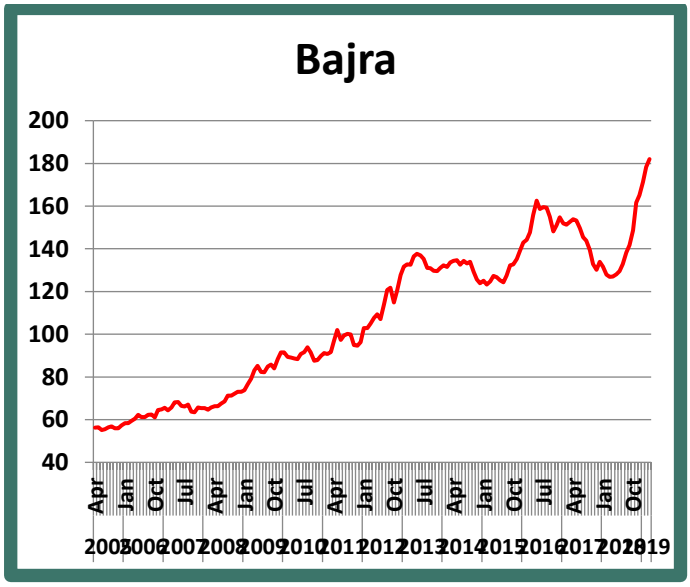
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

1. Cereals



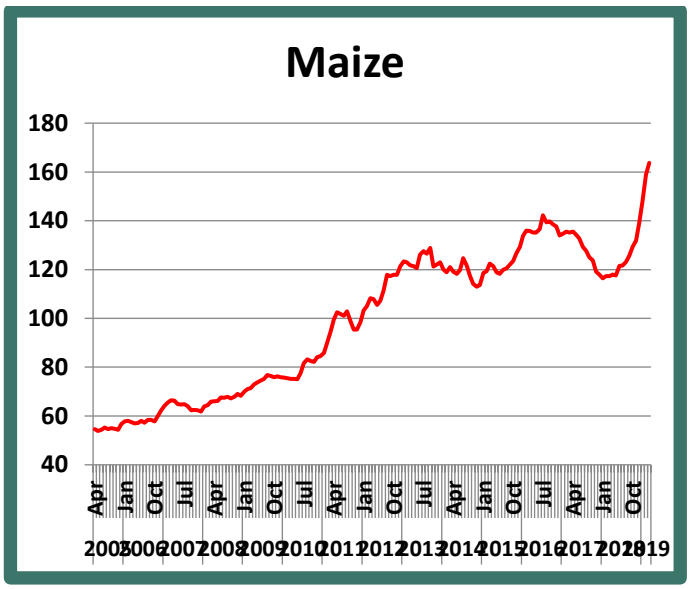


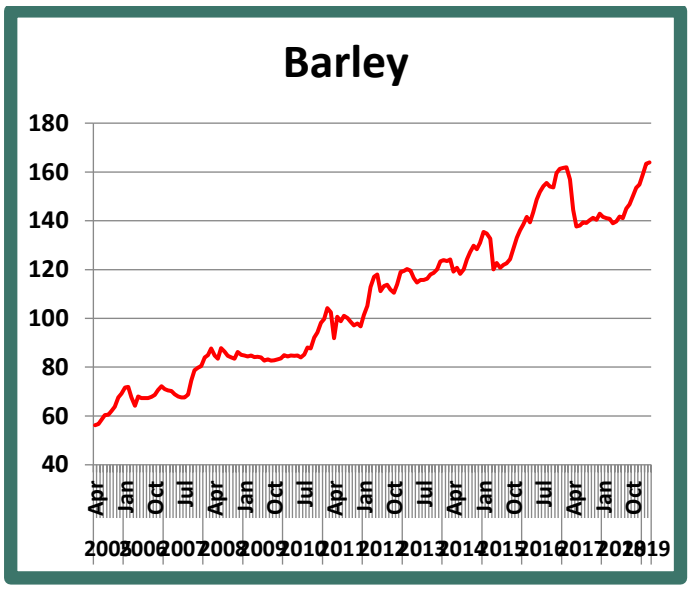


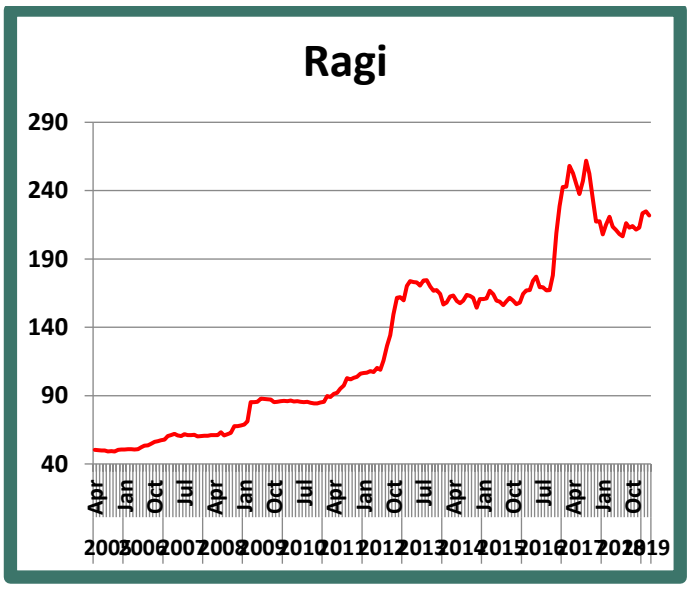


Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

1. Cereals (Contd.)

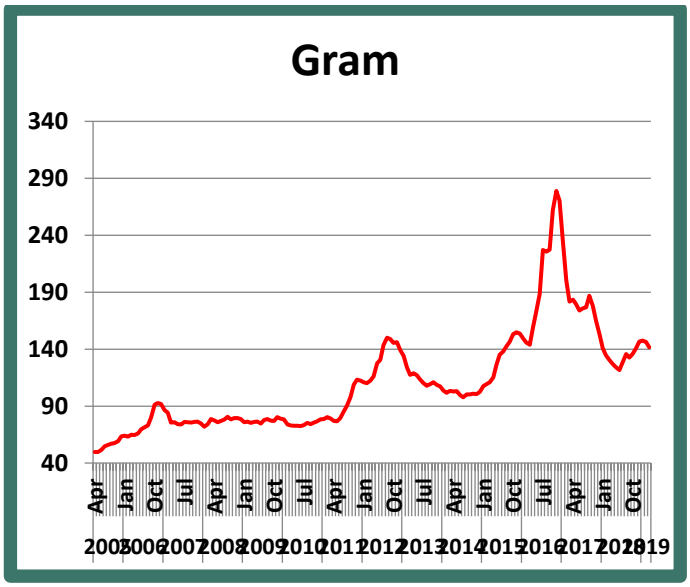


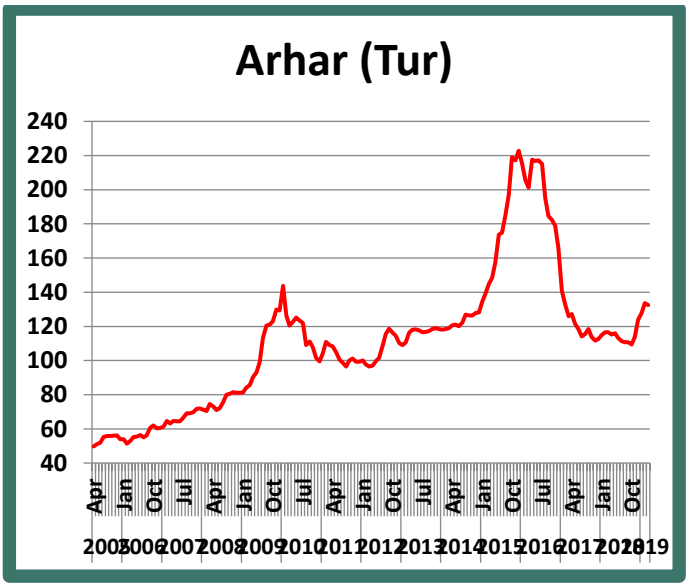


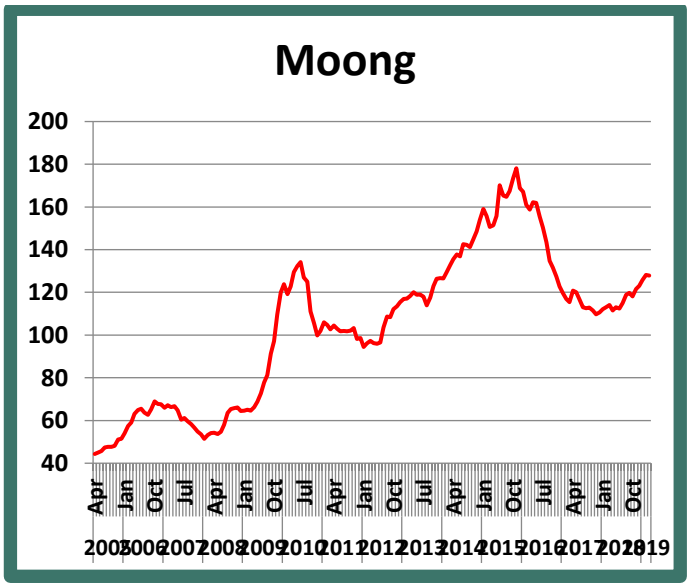


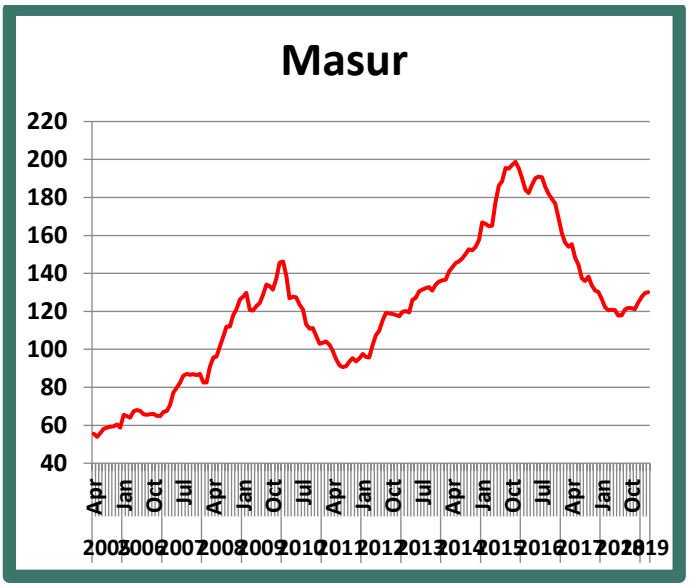
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

2. Pulses



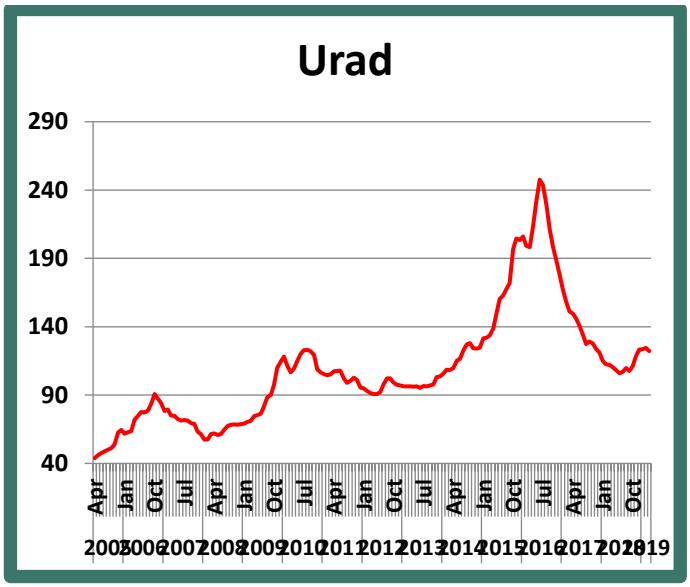


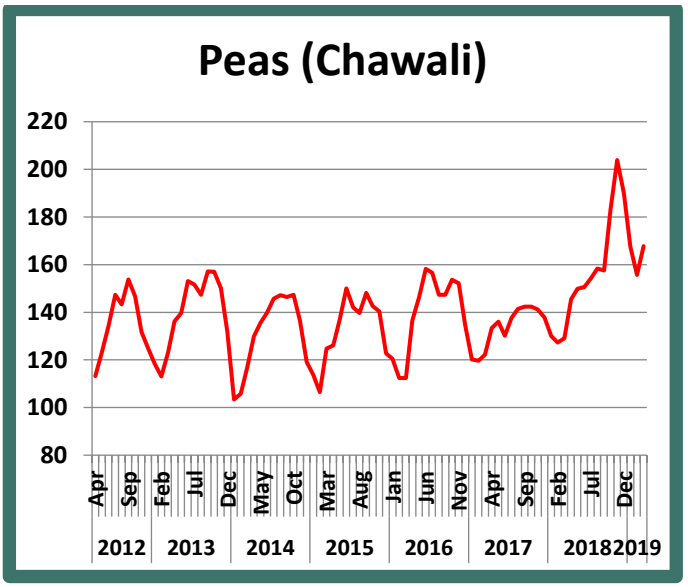


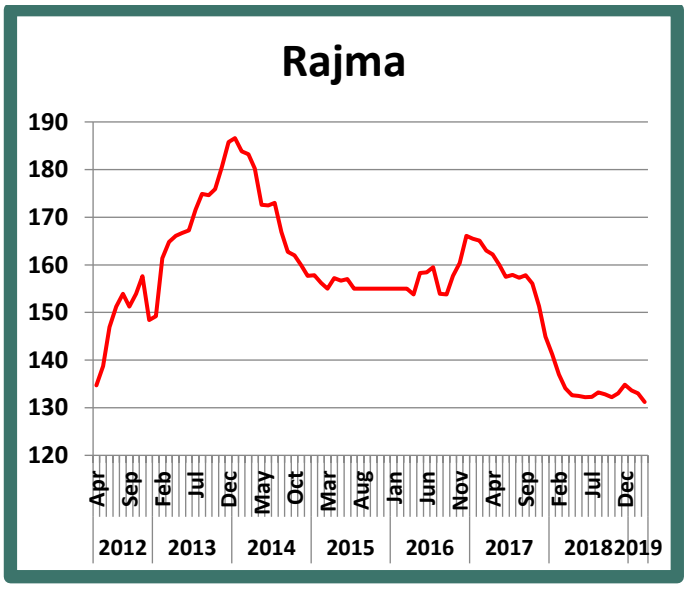


Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

2. Pulses (Contd.)



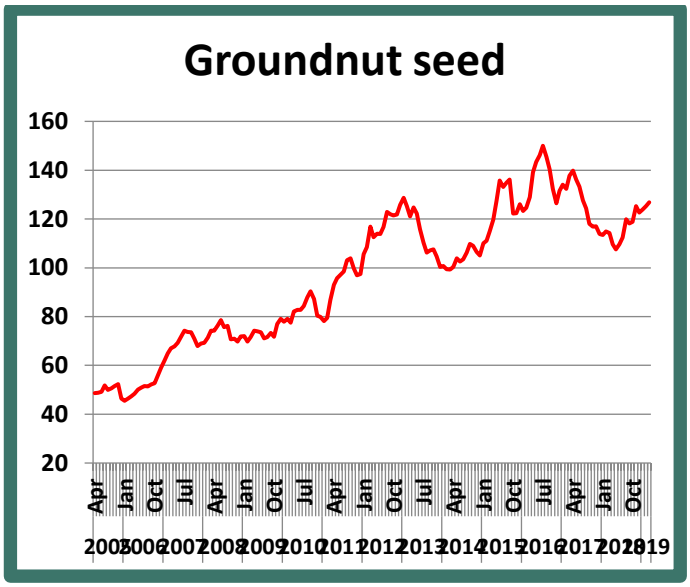


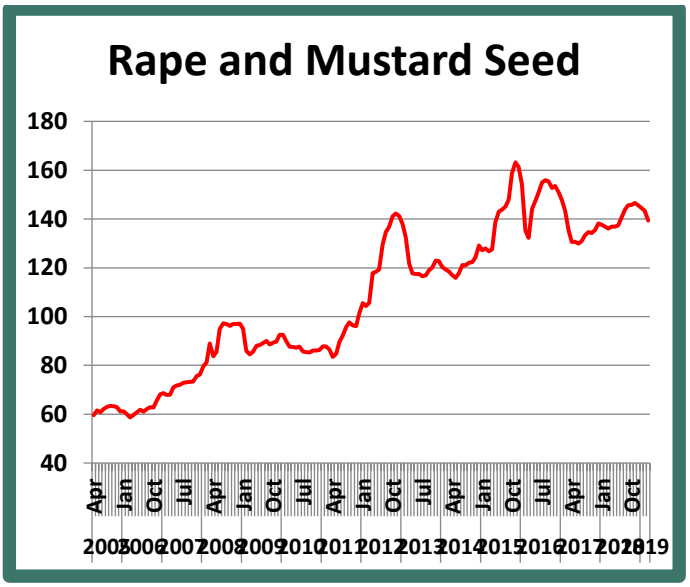


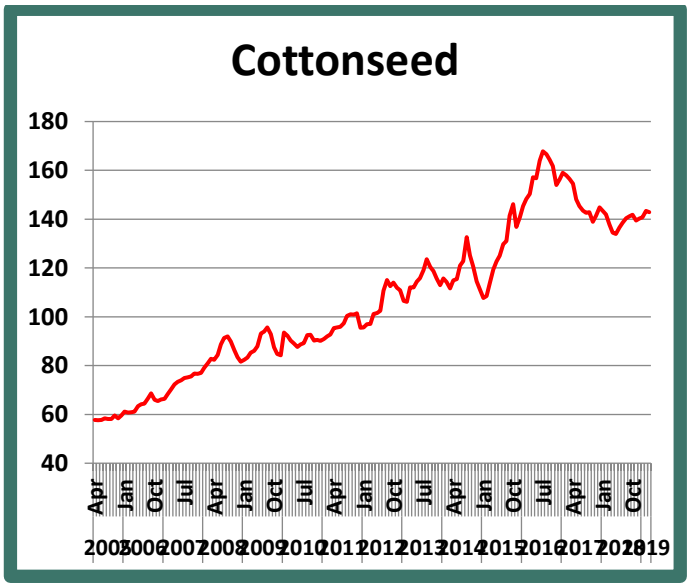
*Period mentioned in above graphs for **Peas and Rajma** is Apr-2012 to Mar-2019.

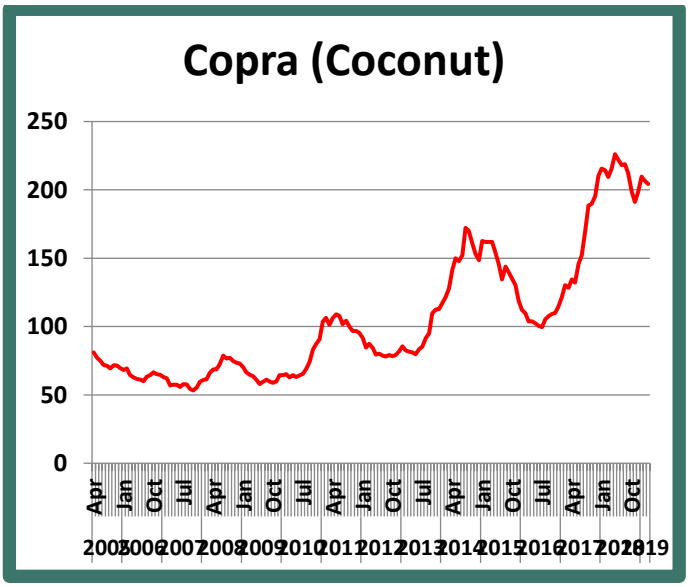
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

3. Oilseeds



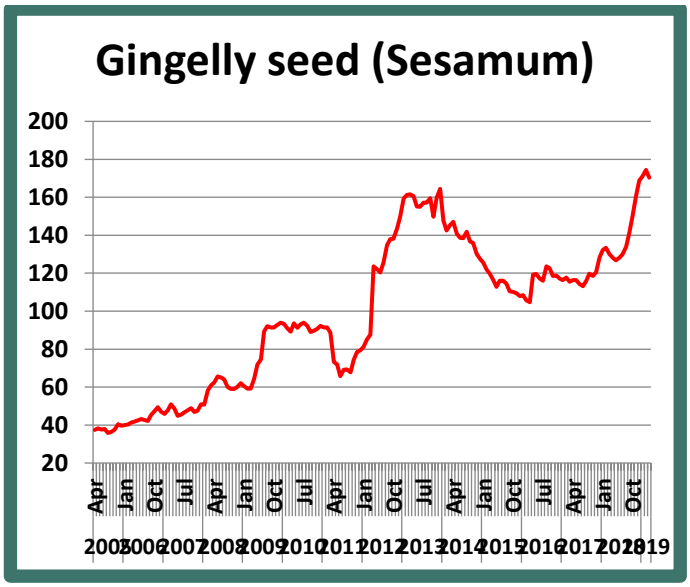


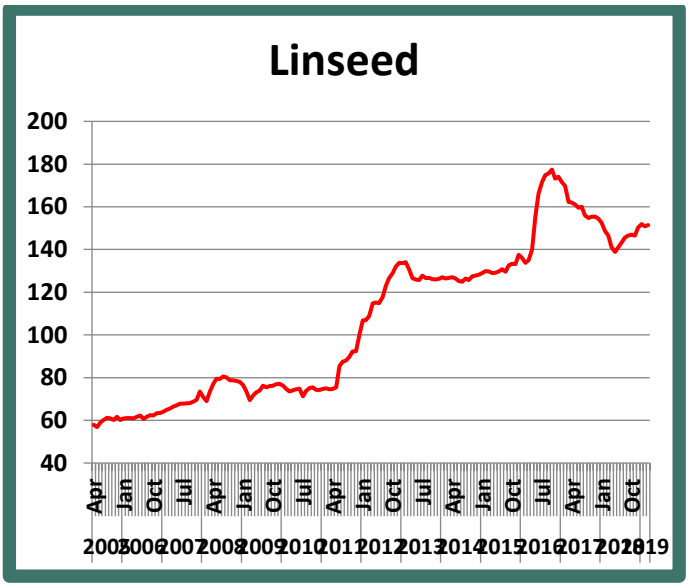


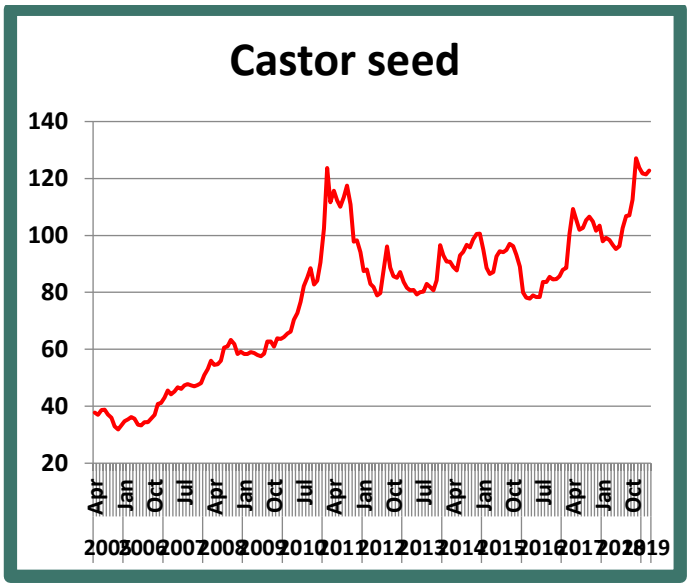


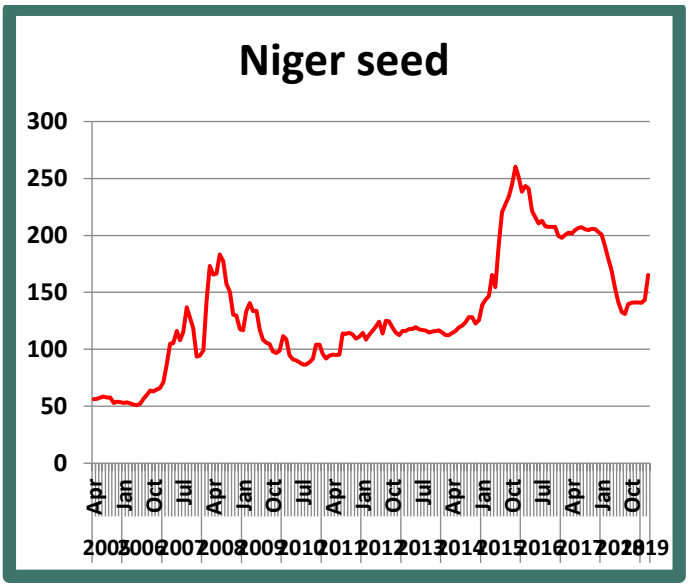
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

3. Oilseeds (Contd.)



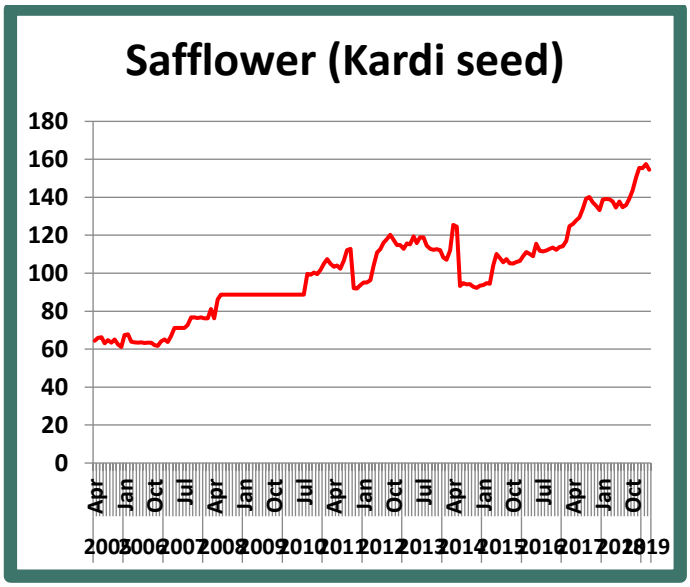


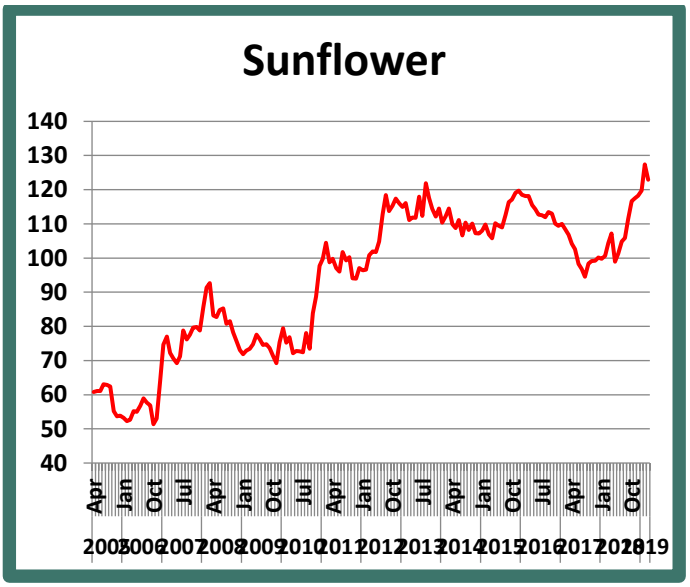


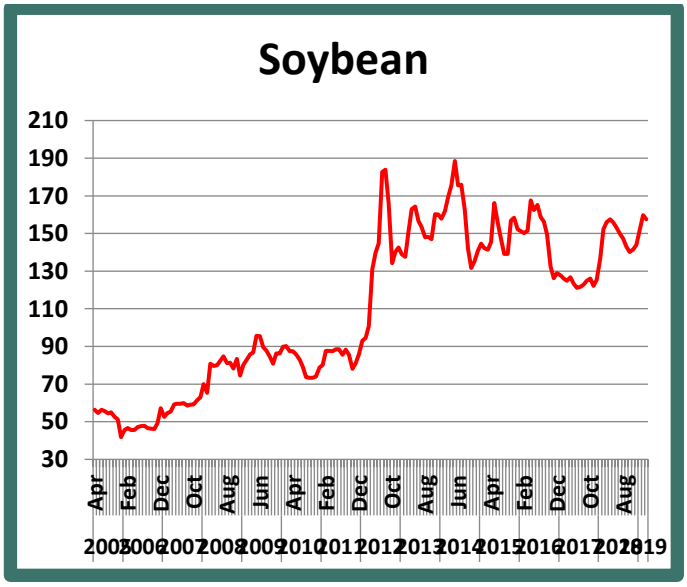


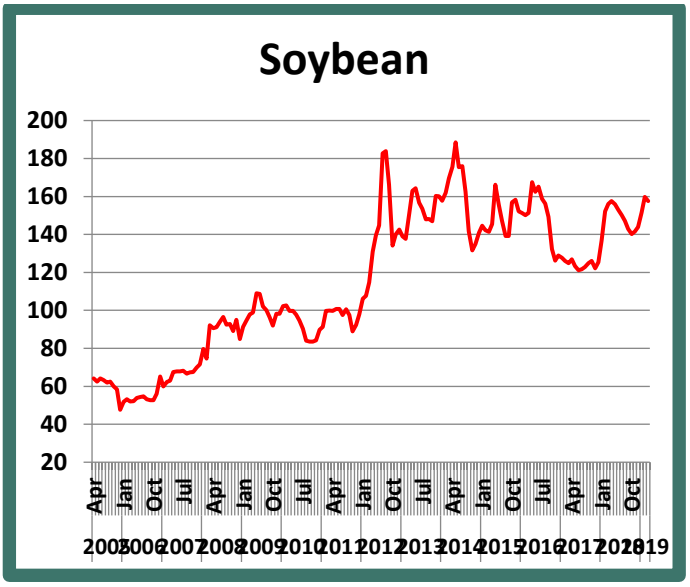
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

3. Oilseeds (Contd.)



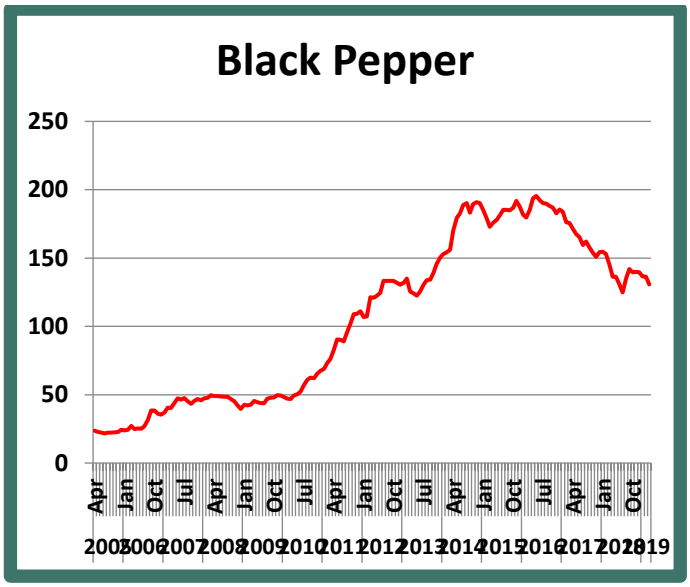


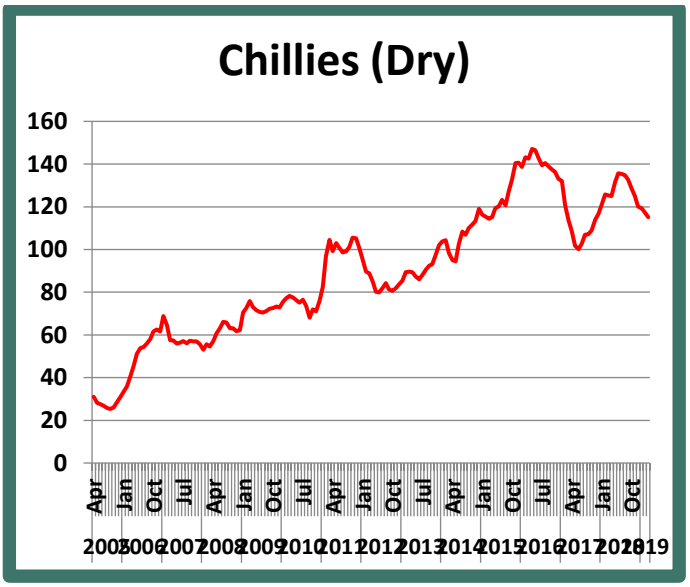


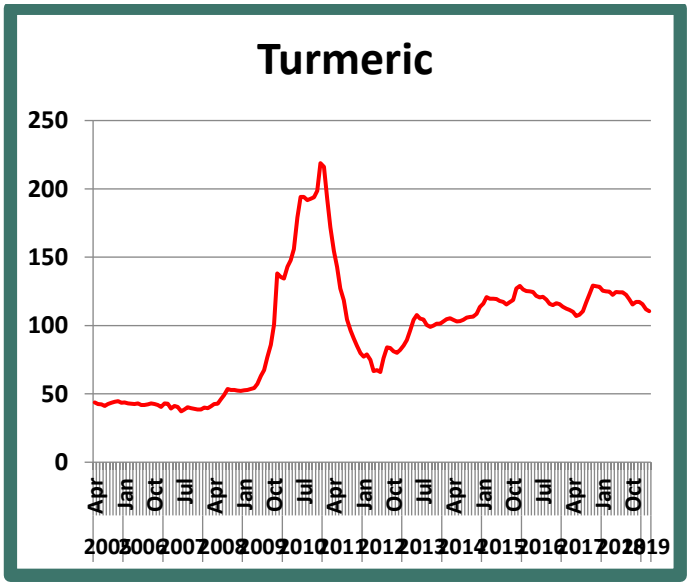


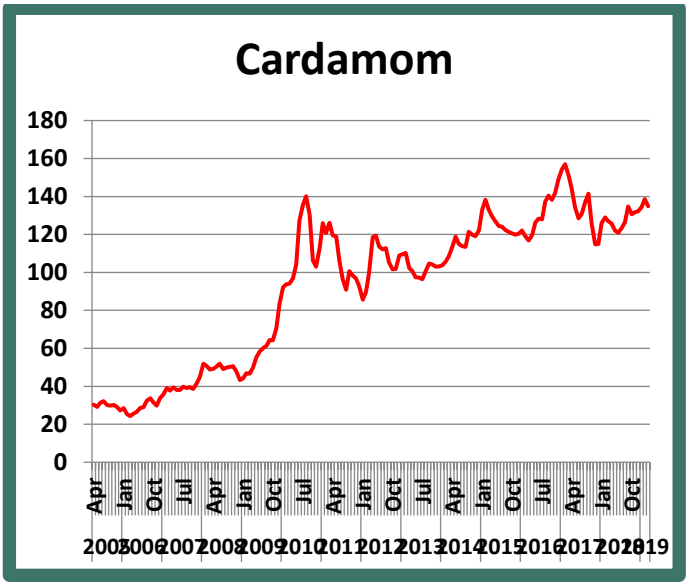
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

4. Spices



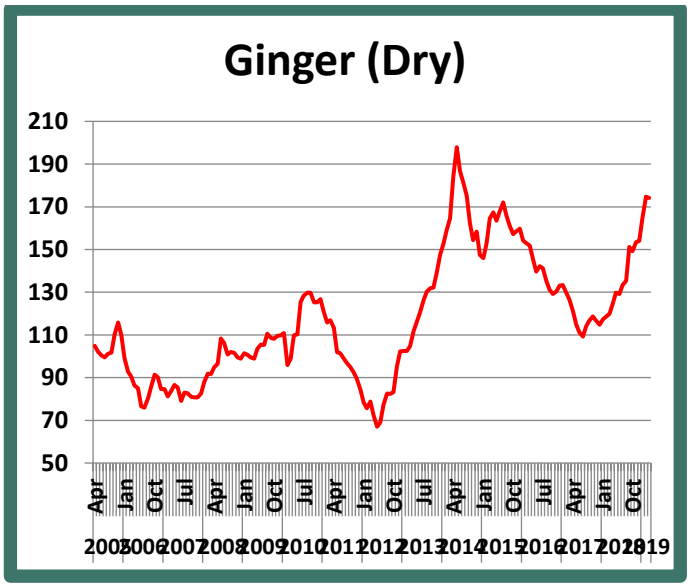


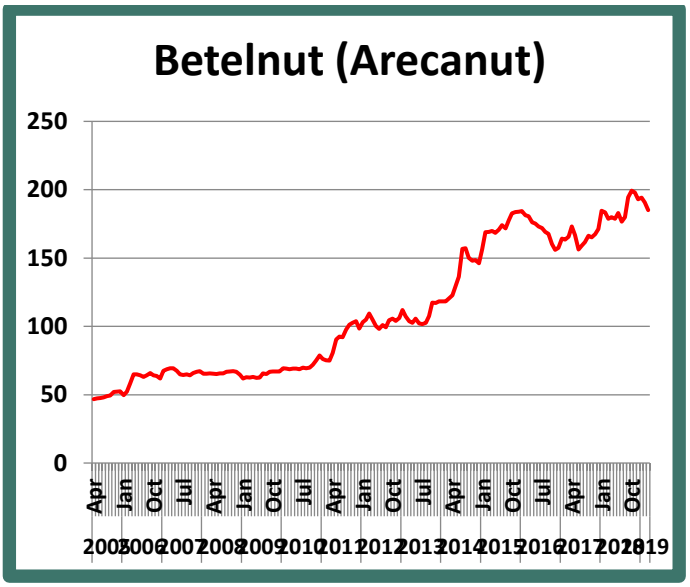


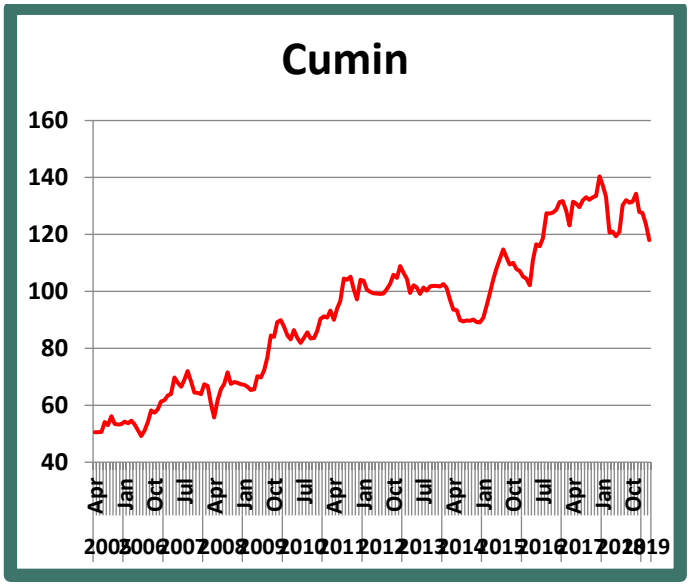


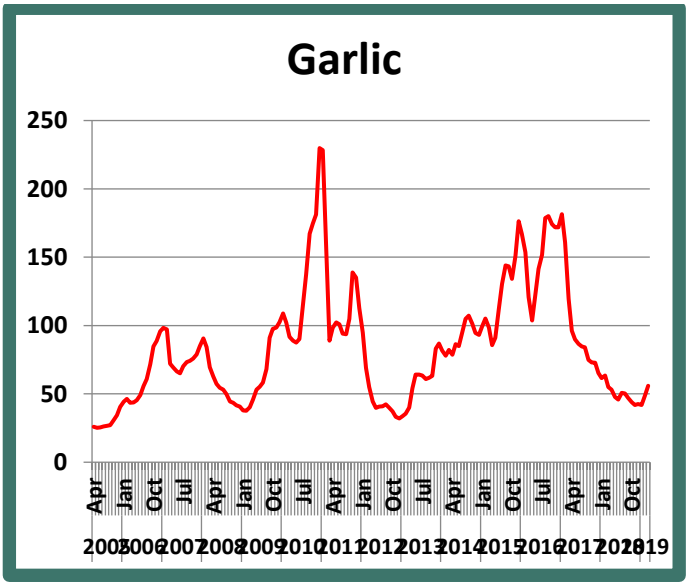
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

4. Spices (Contd.)



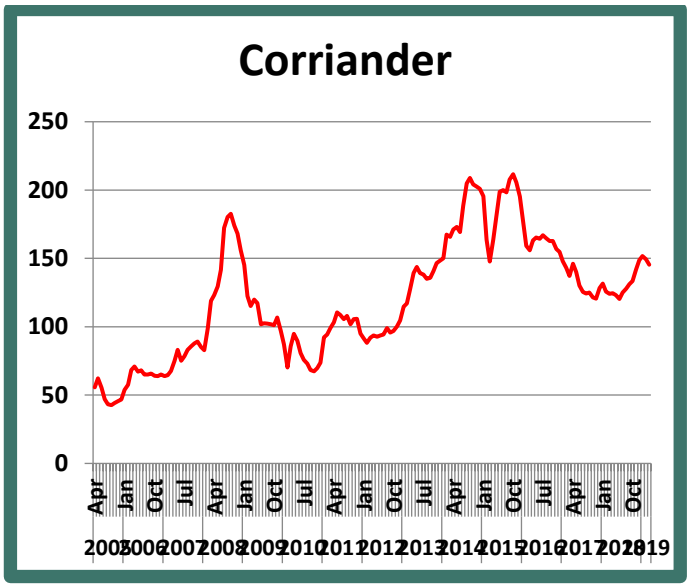


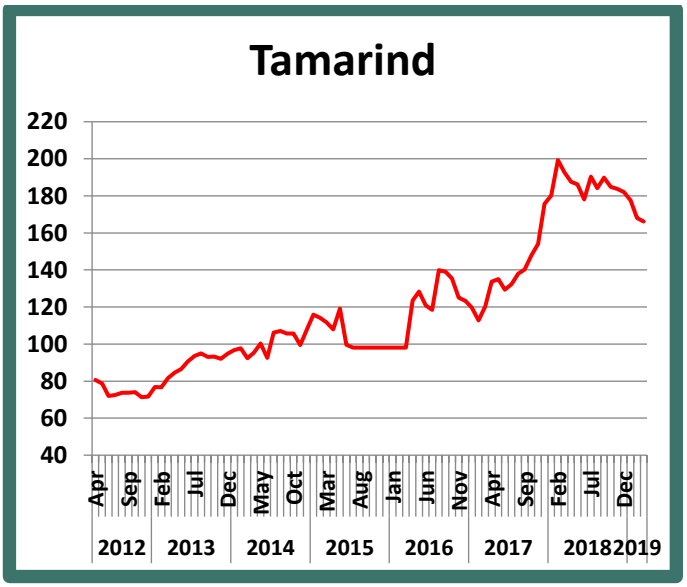




Charts-Set 1: Monthly Wholesale Price Indices during April 2005 - March 2019

4. Spices (Contd.)

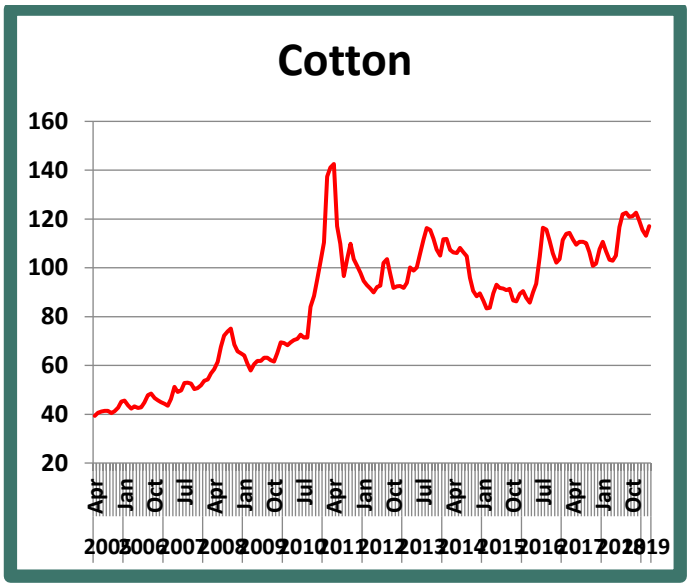


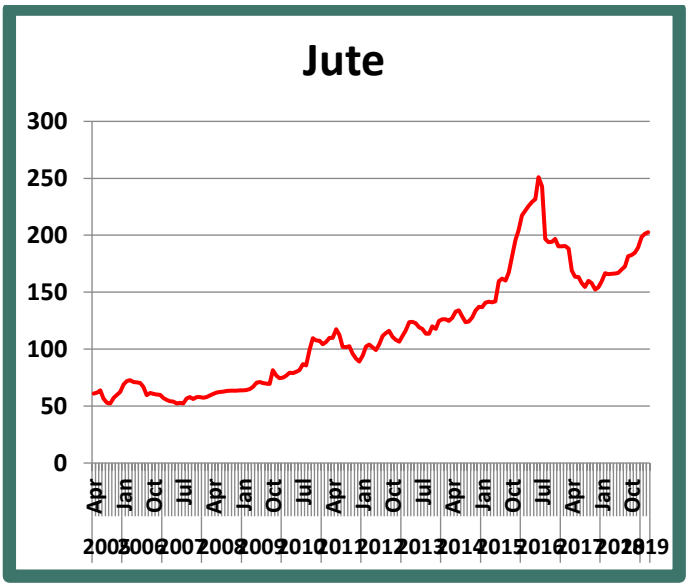


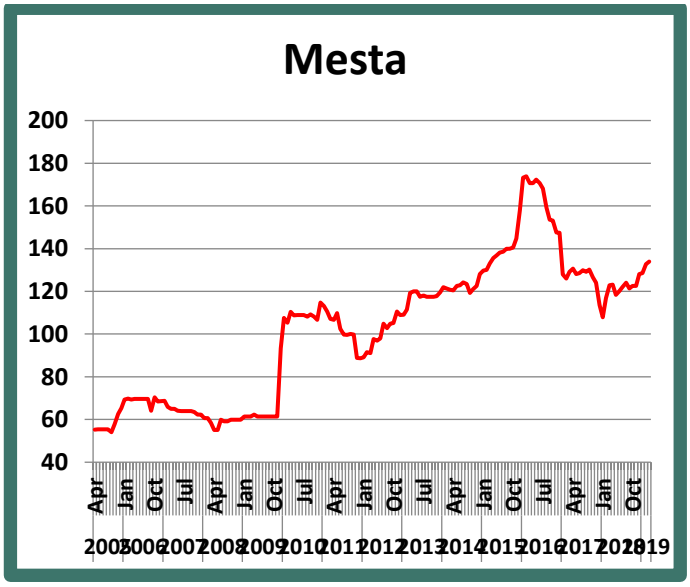
*Period mentioned in above graphs for **Tamarind** is Apr-2012 to Mar-2019.

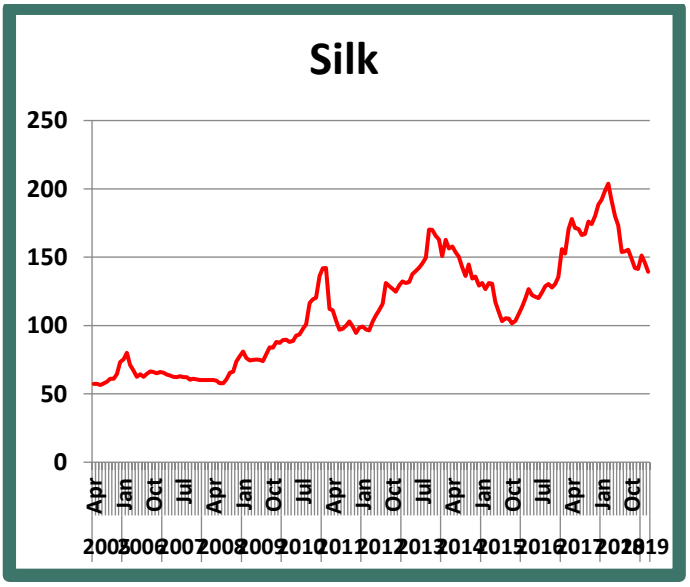
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

5. Fibres



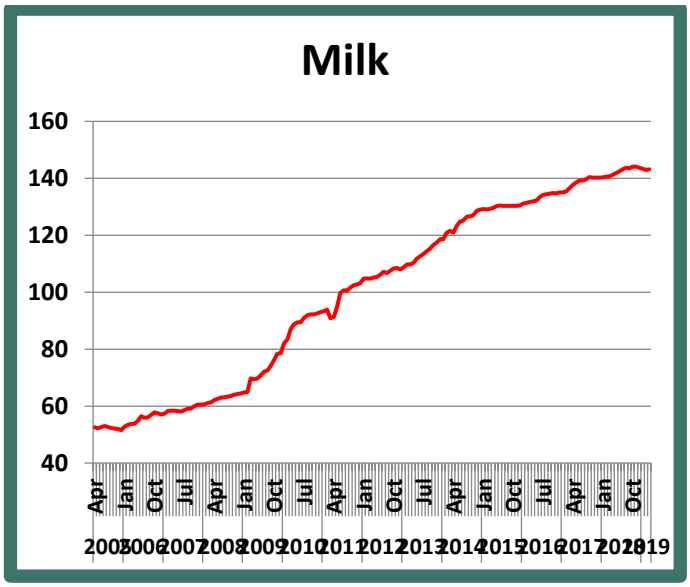


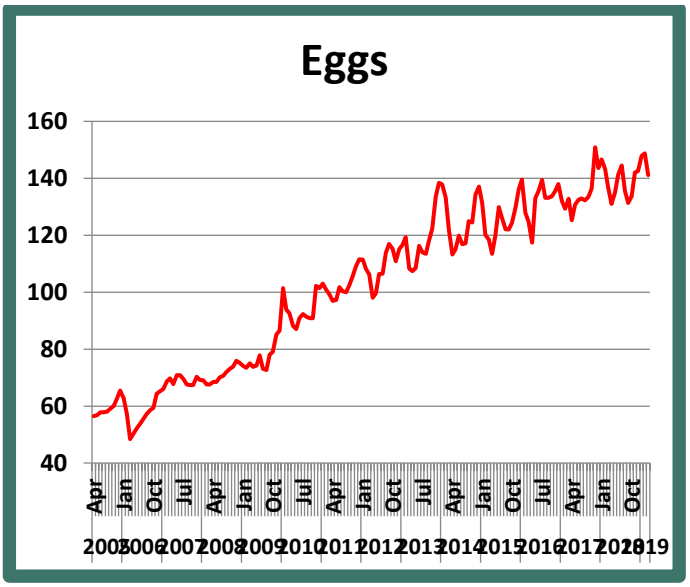


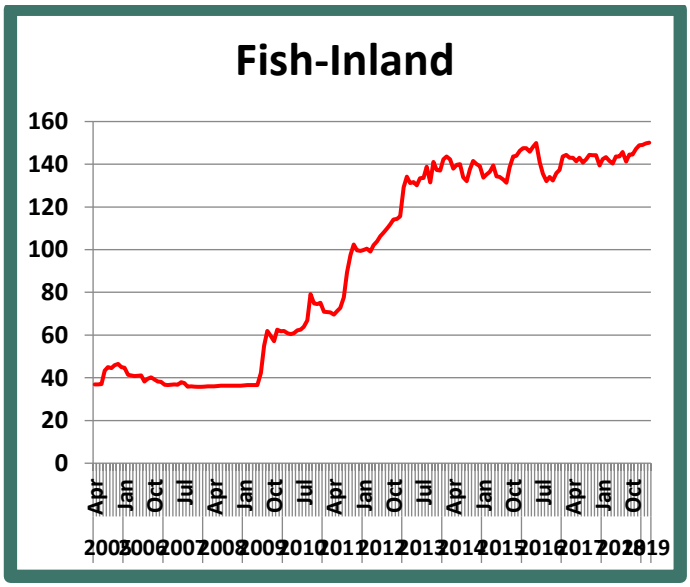


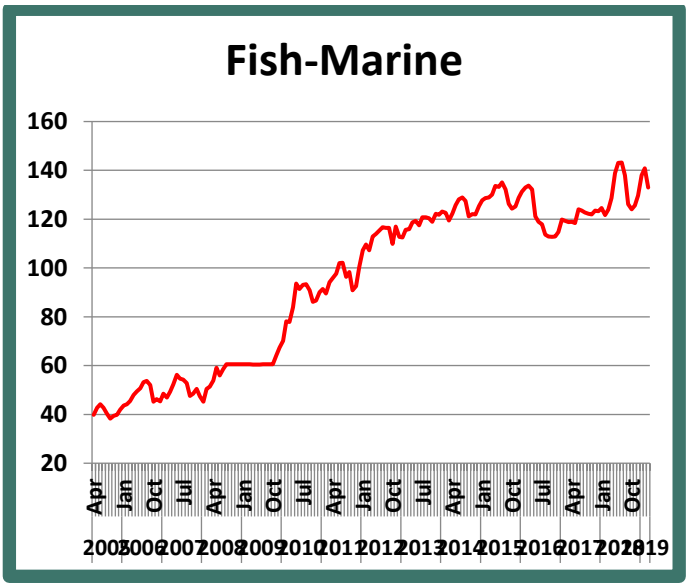
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

6. Livestock and Livestock Products



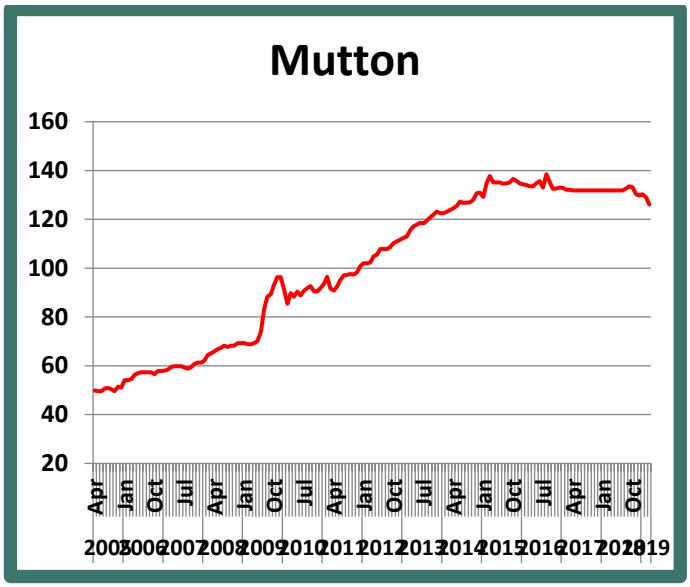


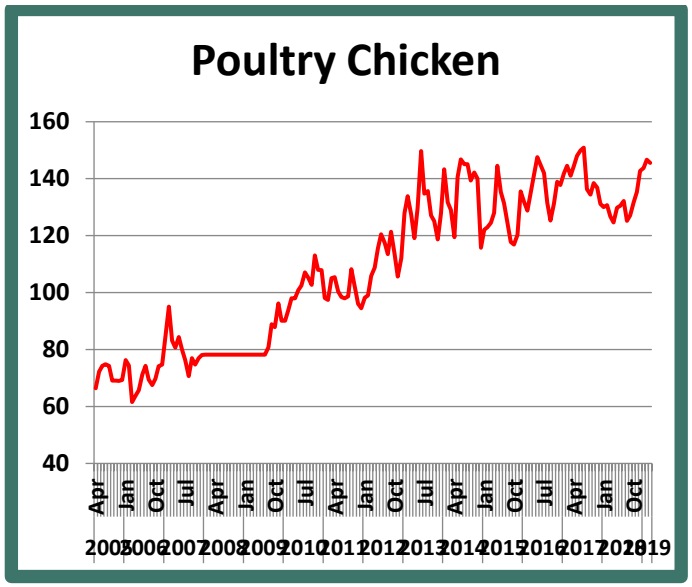


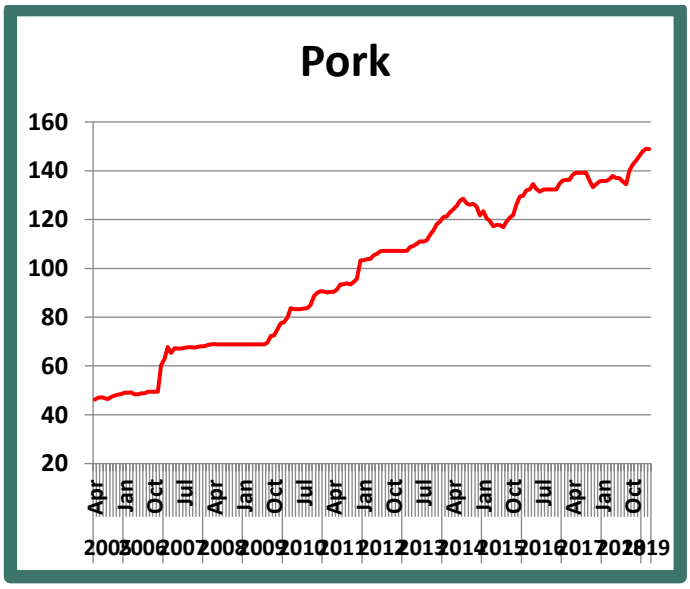


Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

6. Livestock and Livestock Products (Contd.)

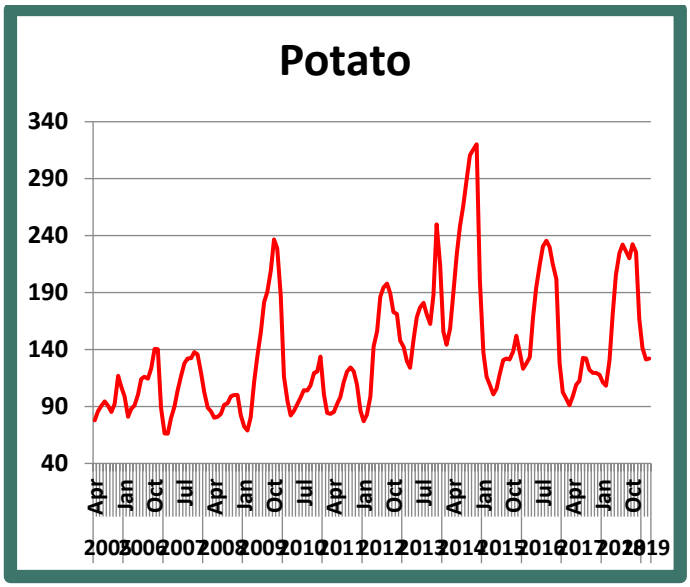


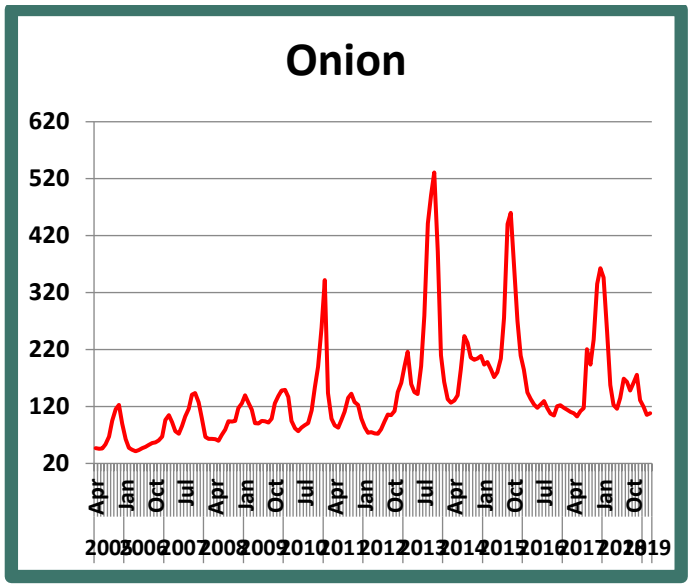


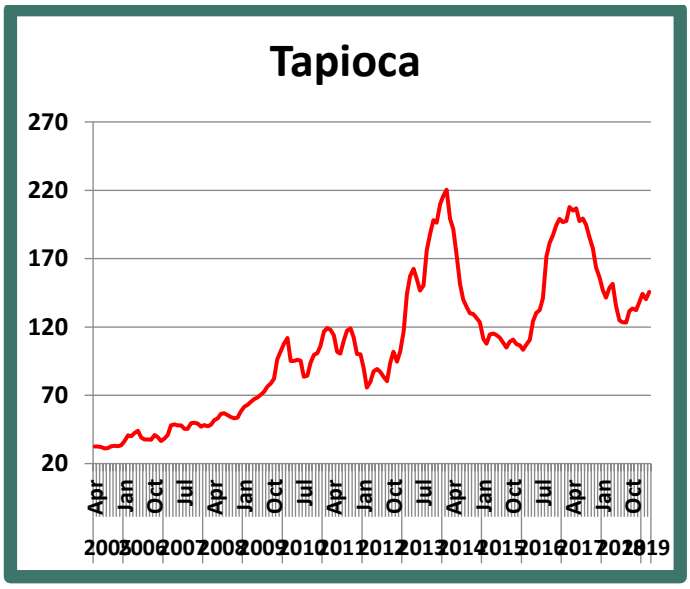


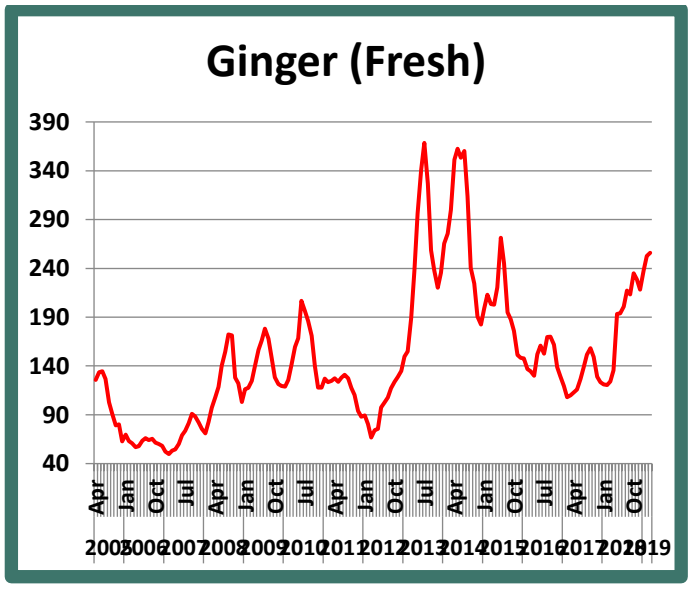
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

7. Vegetables



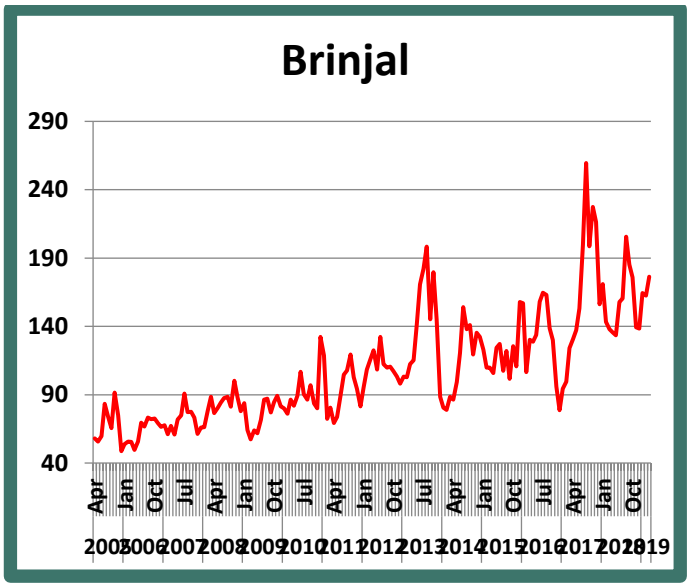


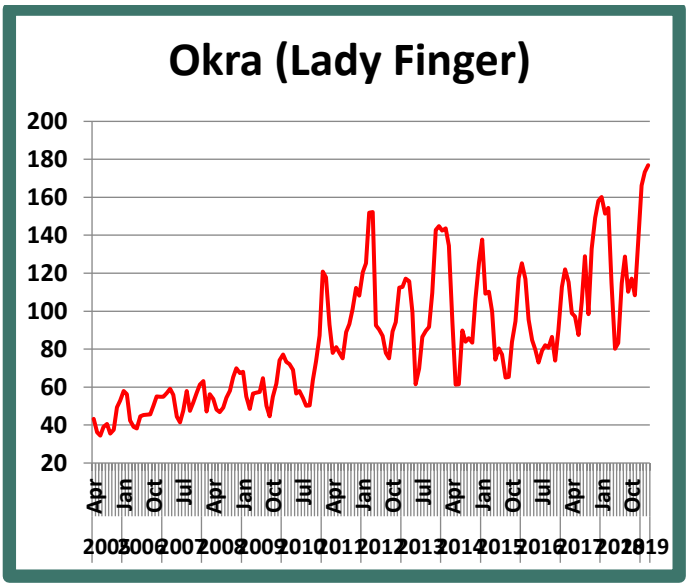


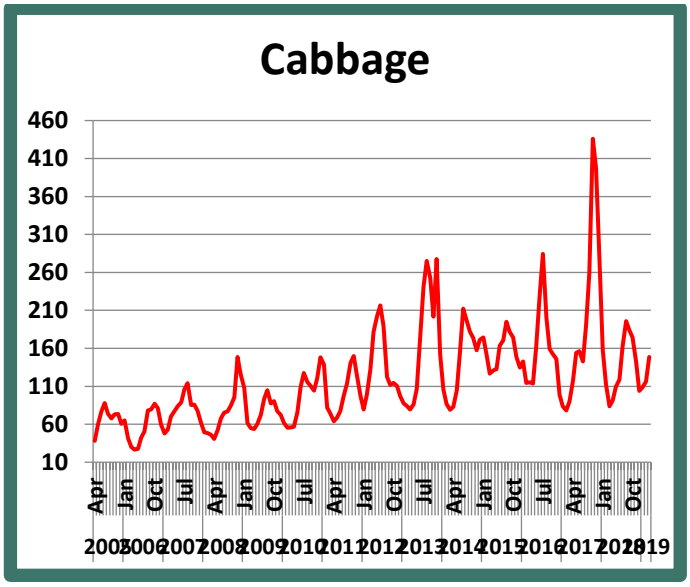


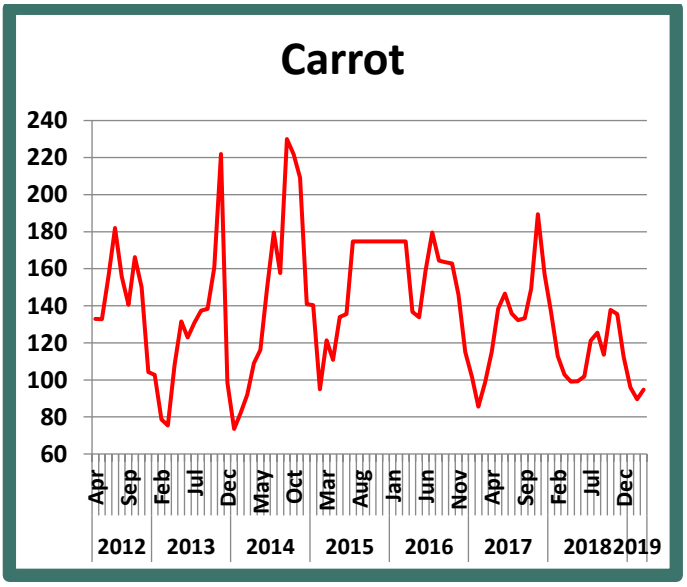
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

7. Vegetables (Contd.)





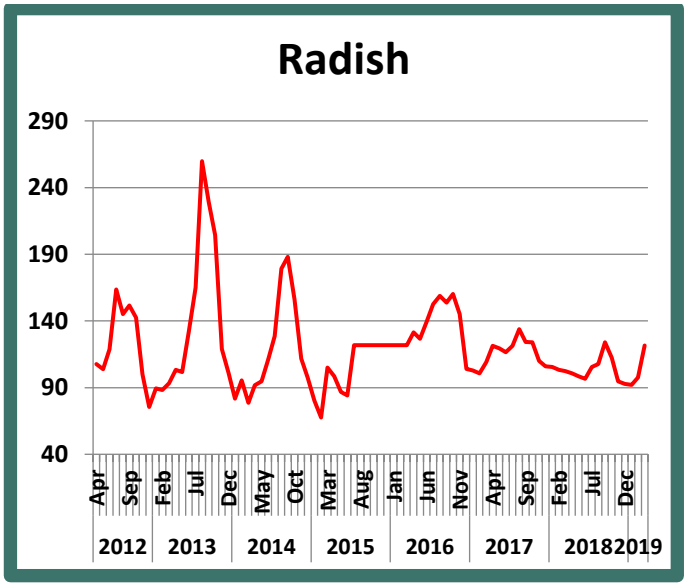


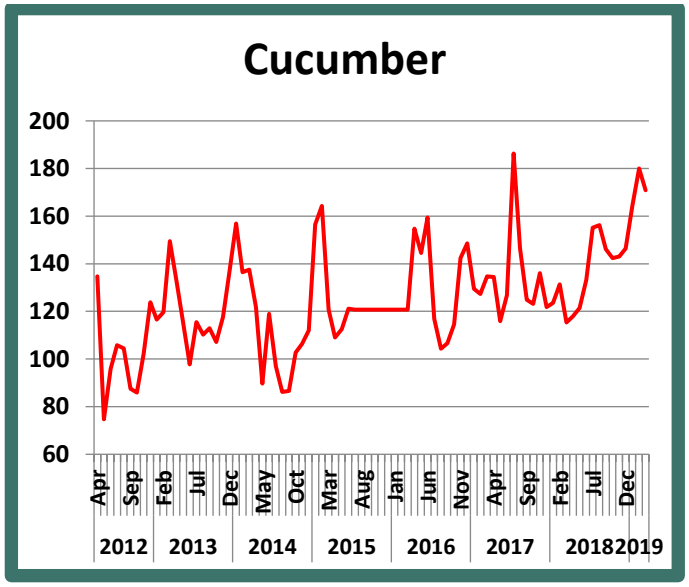


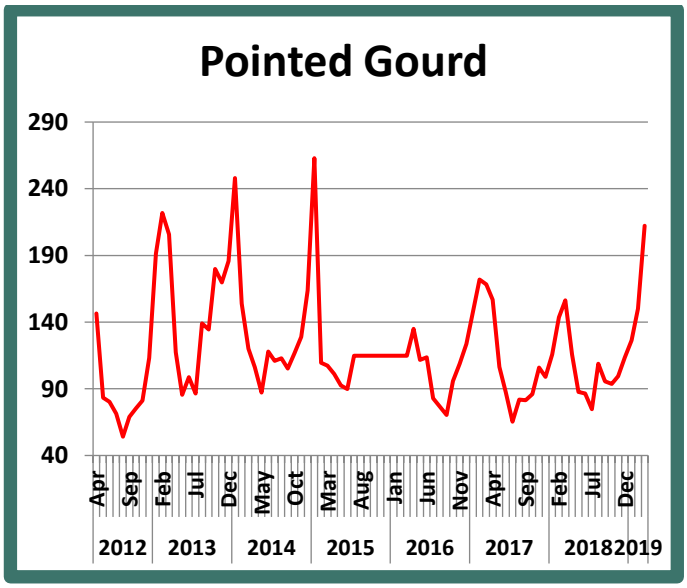
*Period mentioned in above graphs for **Carrot** is Apr-2012 to Mar-2019.

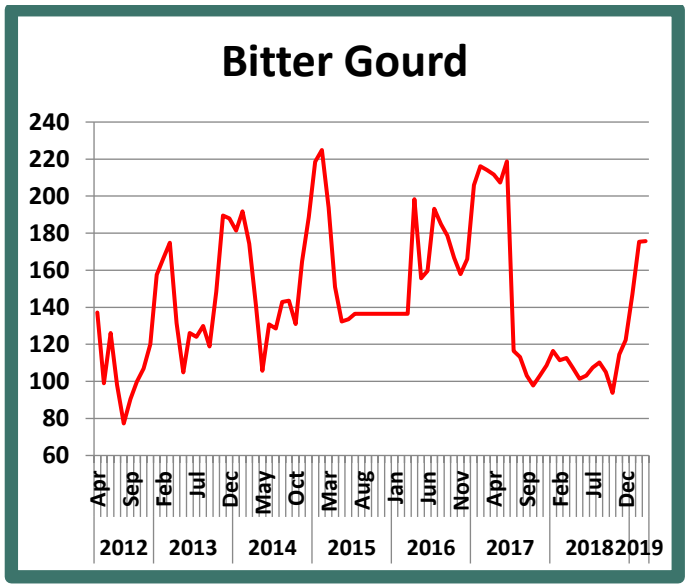
Charts-Set 1: Monthly Wholesale Price Indices during April 2012 to March 2019

7. Vegetables (Contd.)



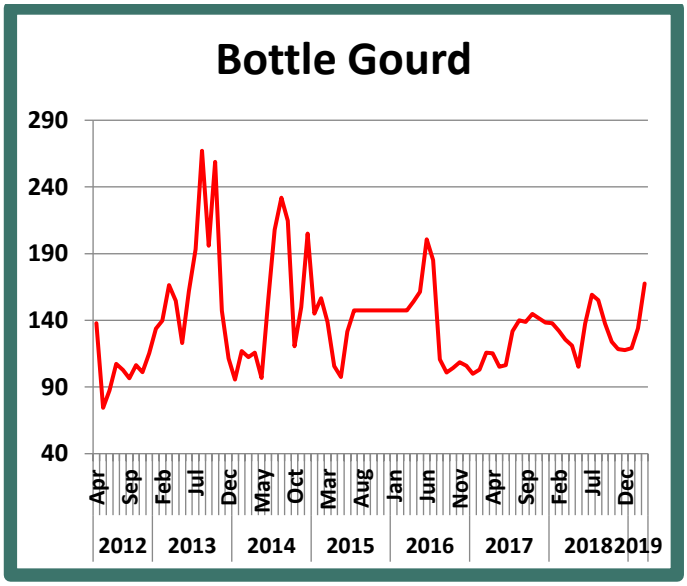


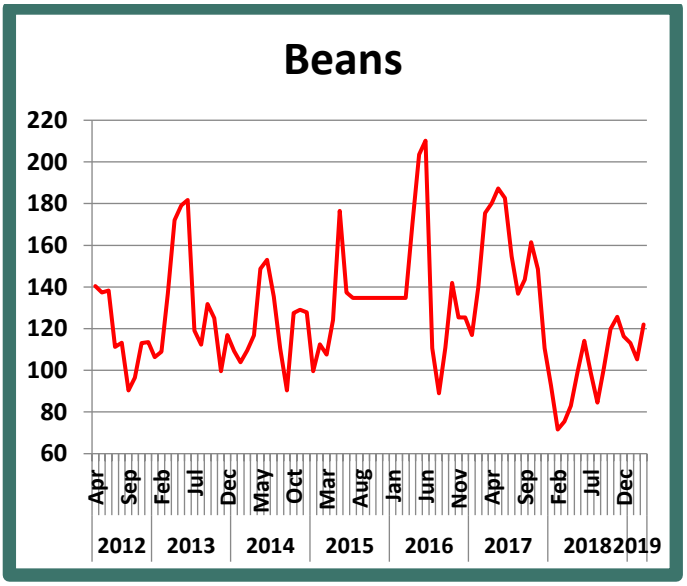


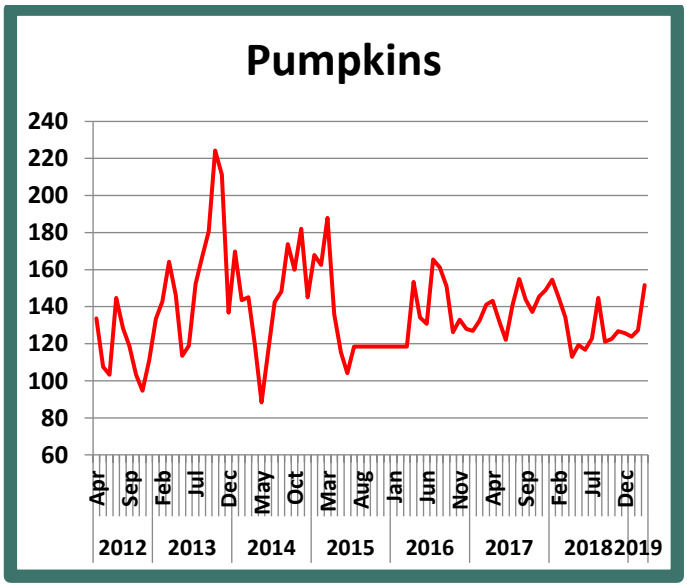


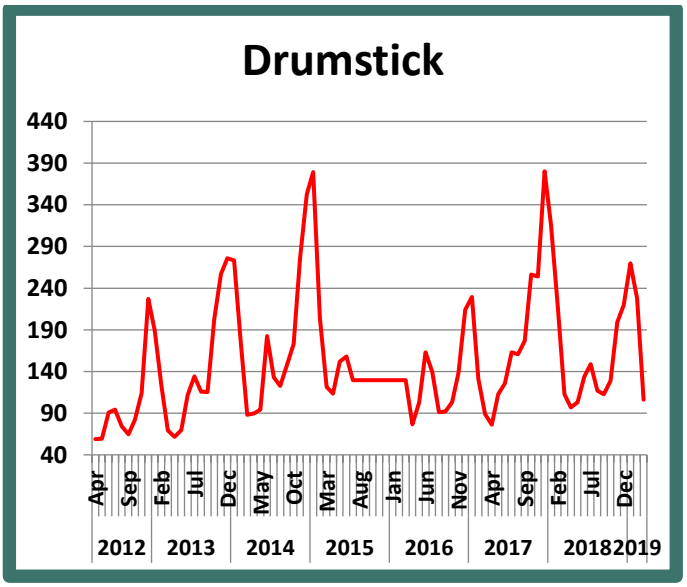
Charts-Set 1: Monthly Wholesale Price Indices during April 2012 to March 2019

7. Vegetables (Contd.)



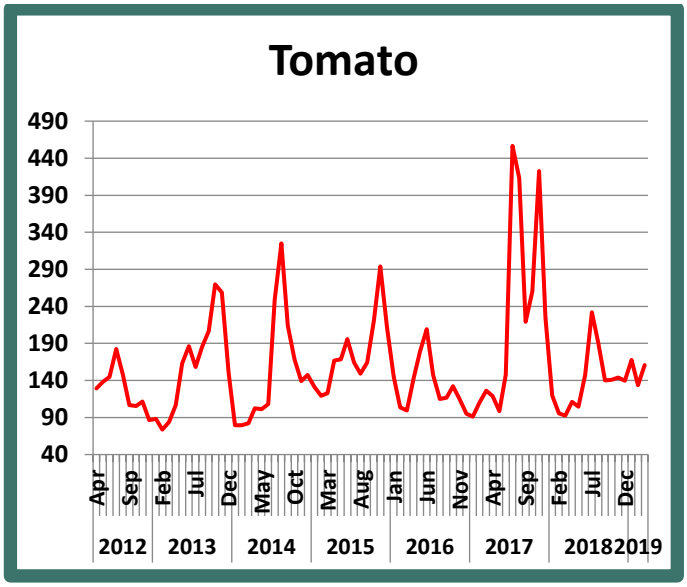






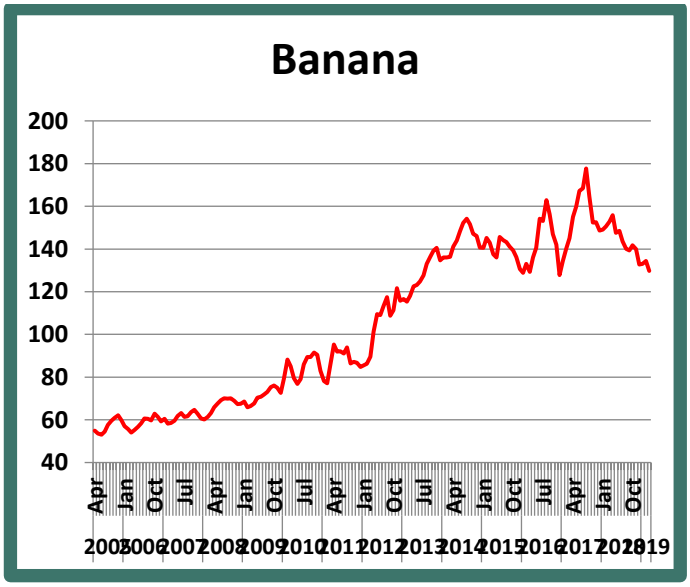
Charts-Set 1: Monthly Wholesale Price Indices during April 2012 to March 2019

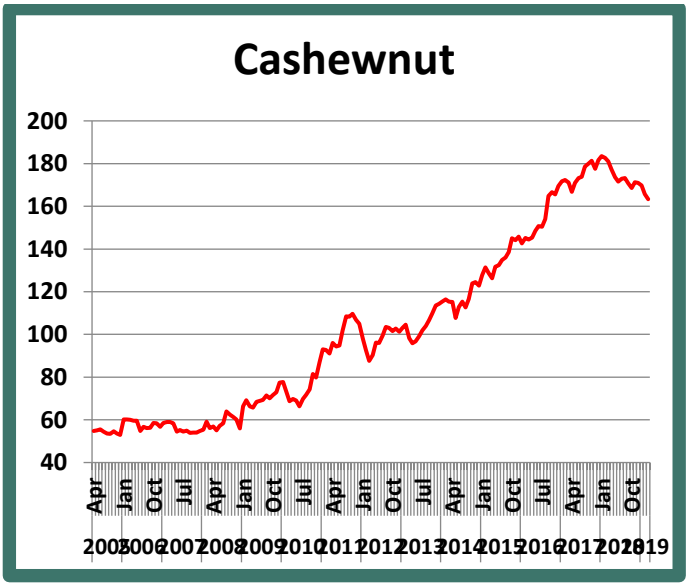
7. Vegetables (Contd.)

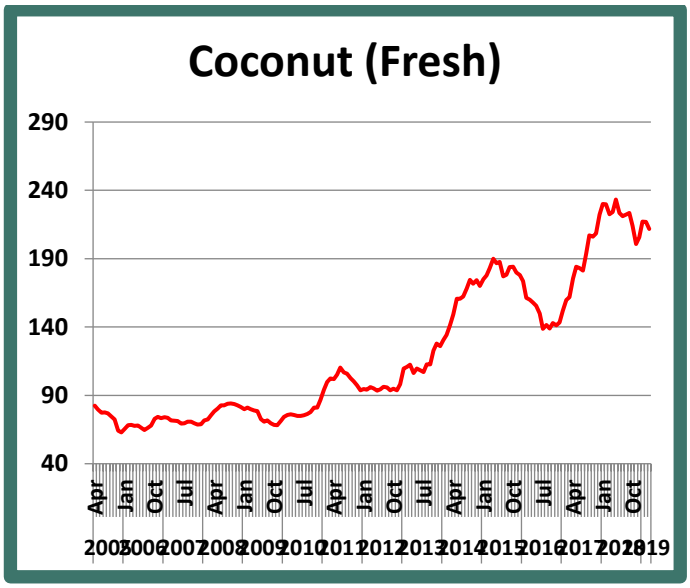


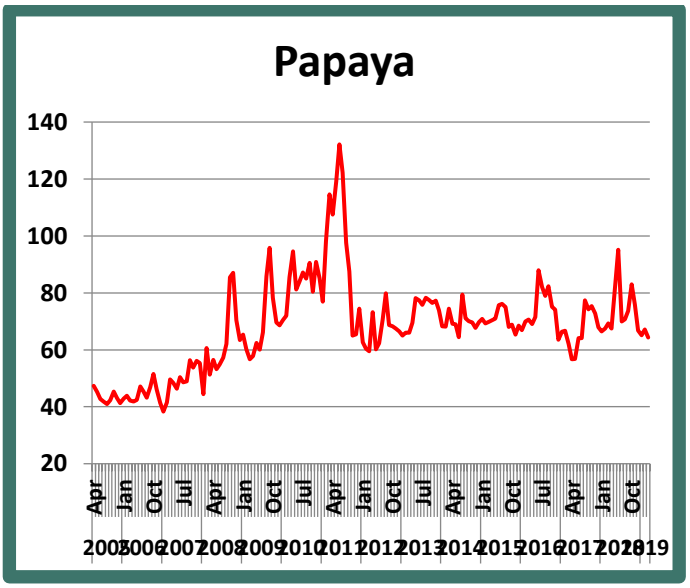
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

8. Fruits



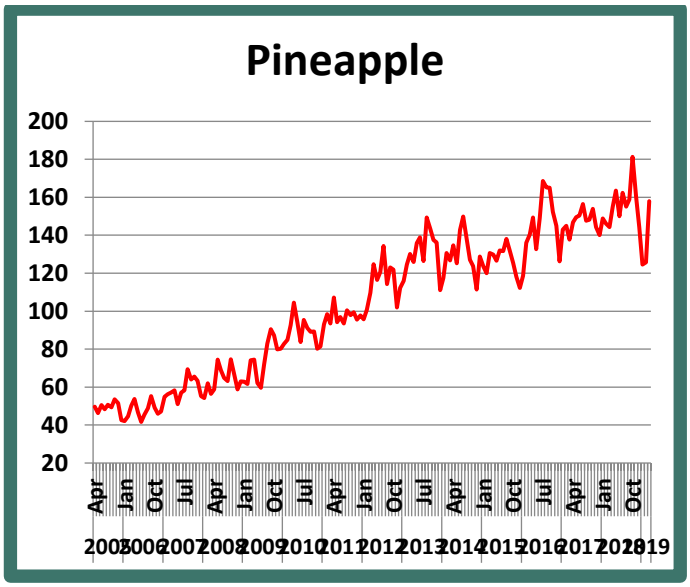


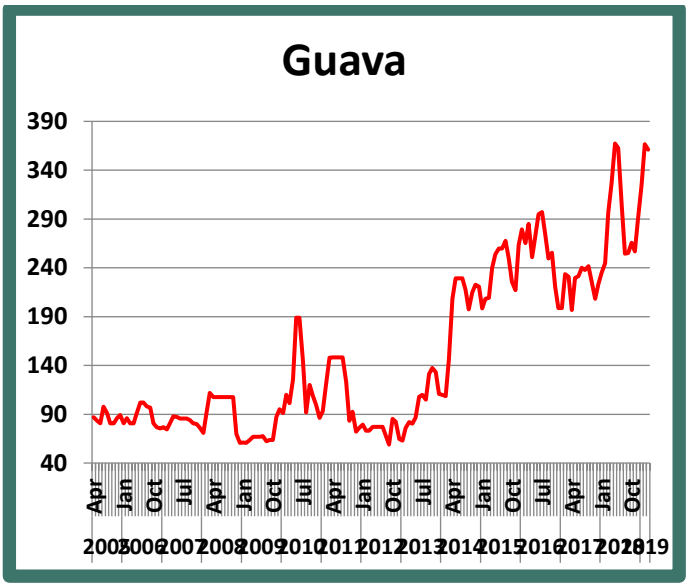


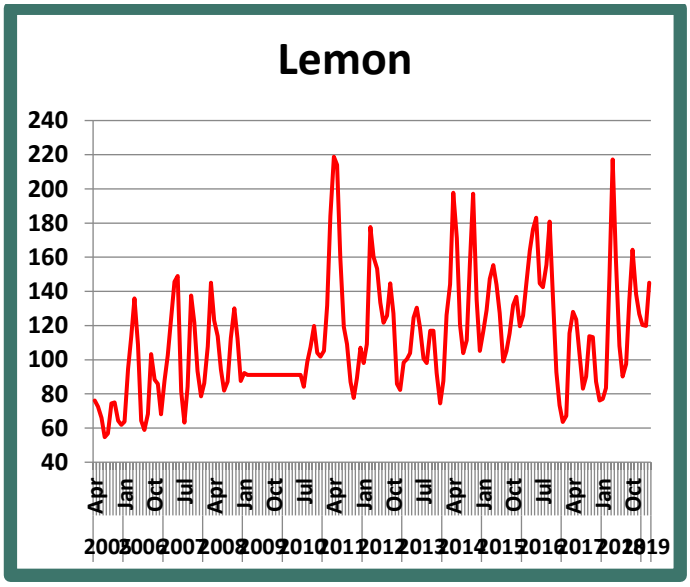


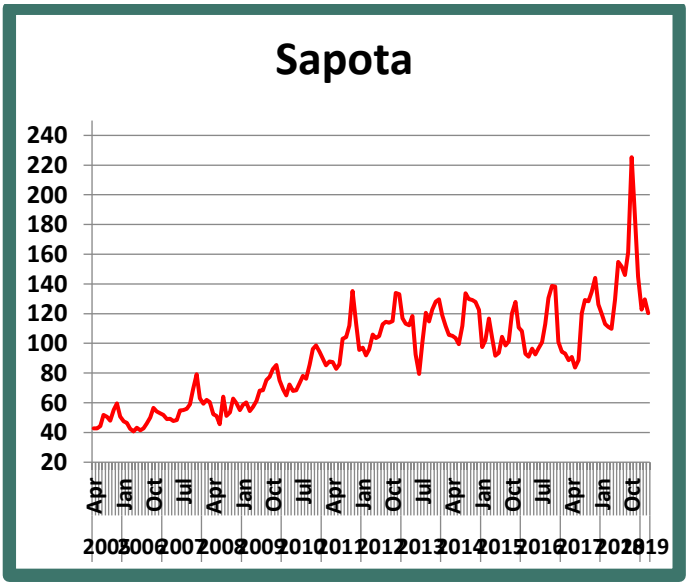
Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

8. Fruits (Contd.)



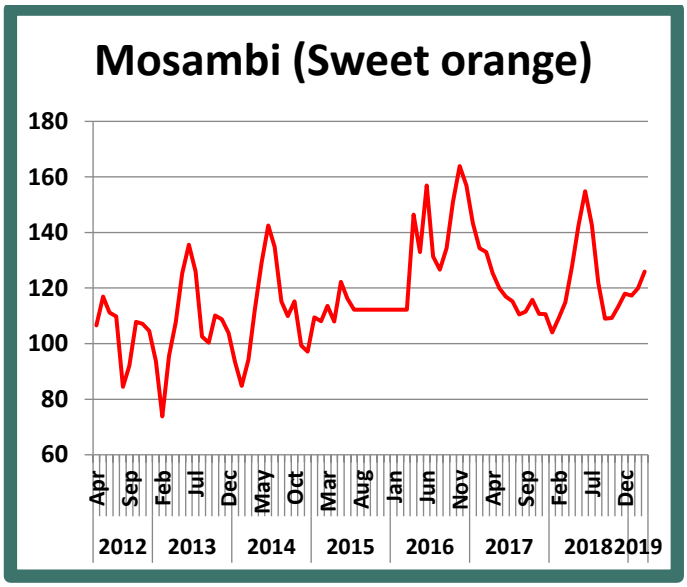


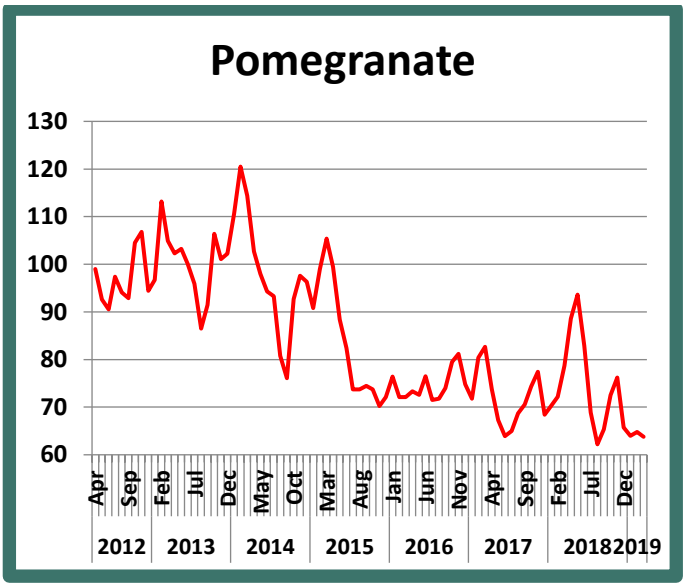


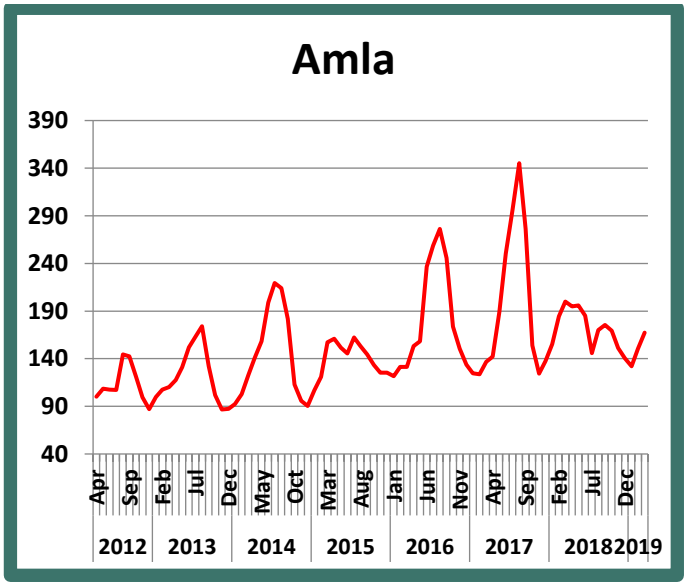


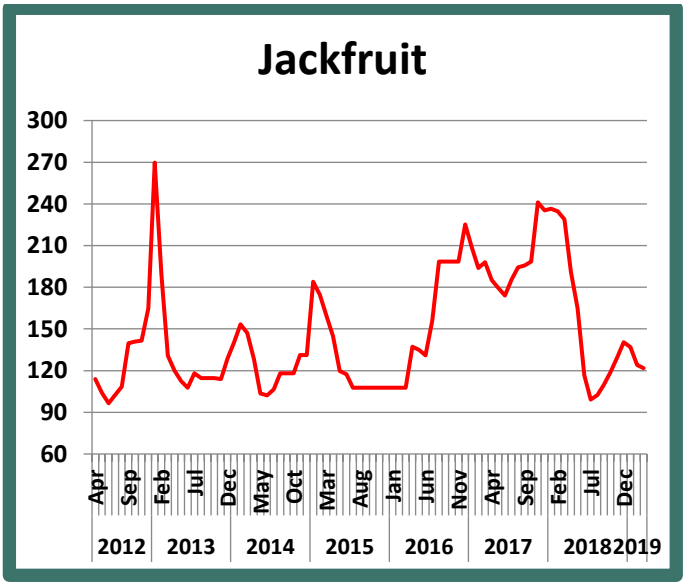
Charts-Set 1: Monthly Wholesale Price Indices during April 2012 to March 2019

8. Fruits (Contd.)



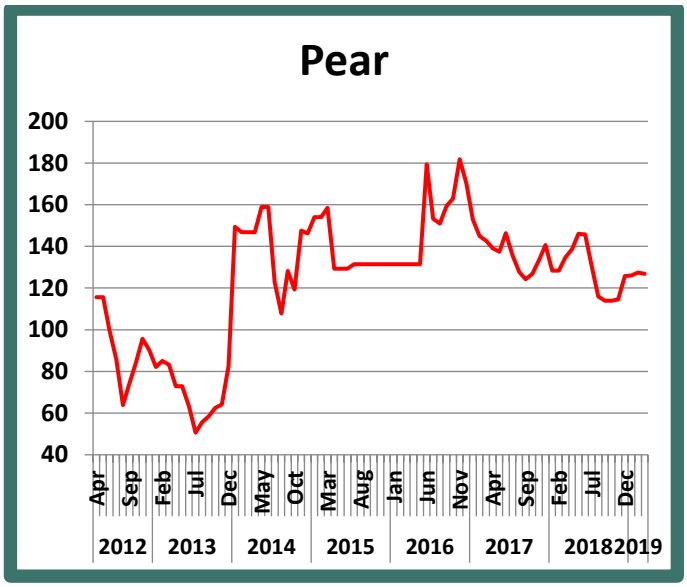


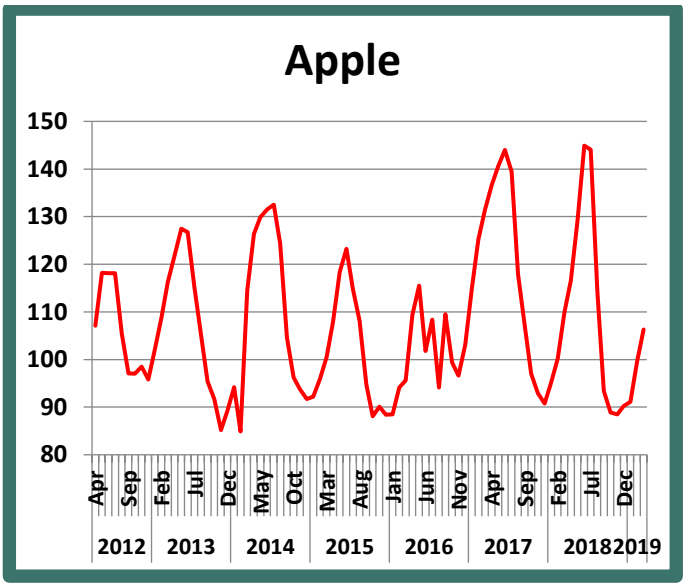


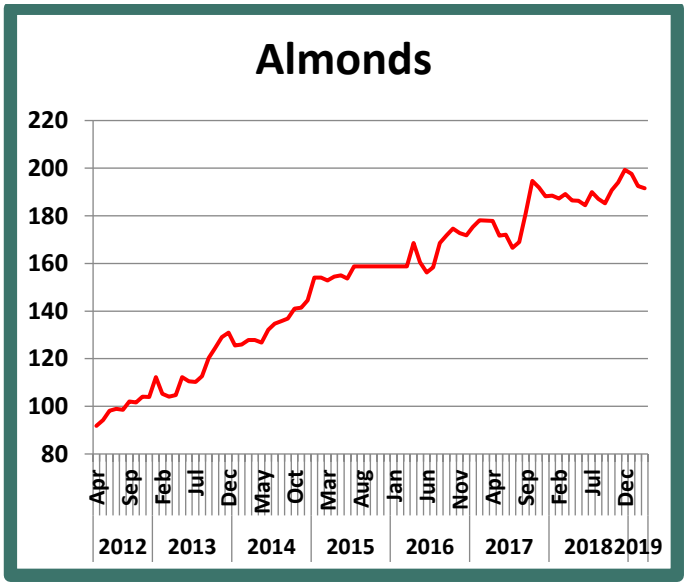


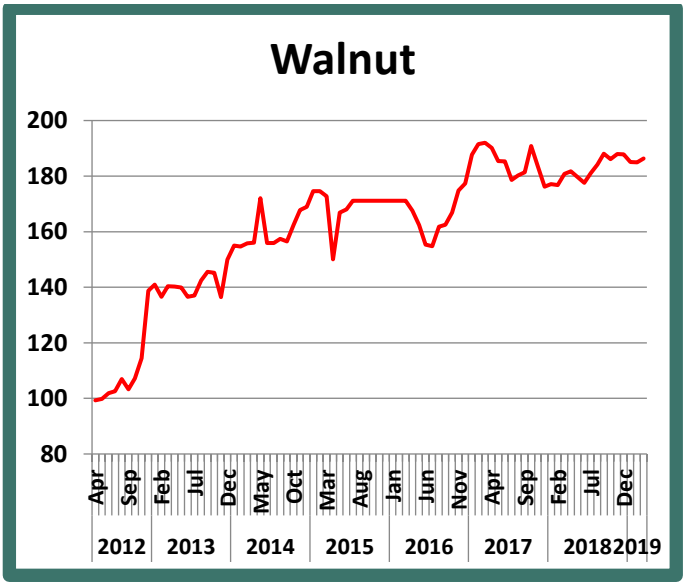
Charts-Set 1: Monthly Wholesale Price Indices during April 2012 to March 2019

8. Fruits (Contd.)



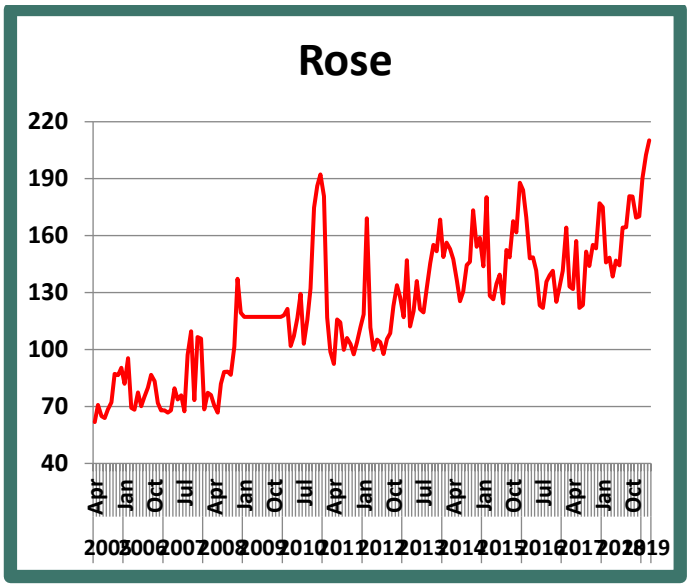


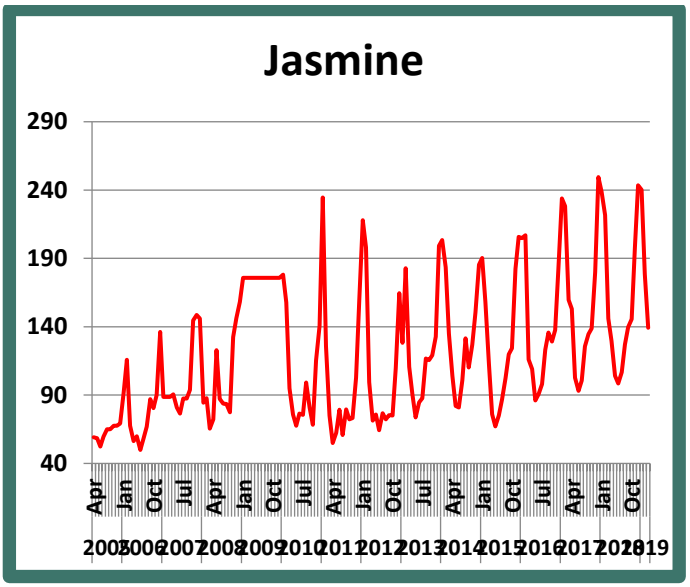


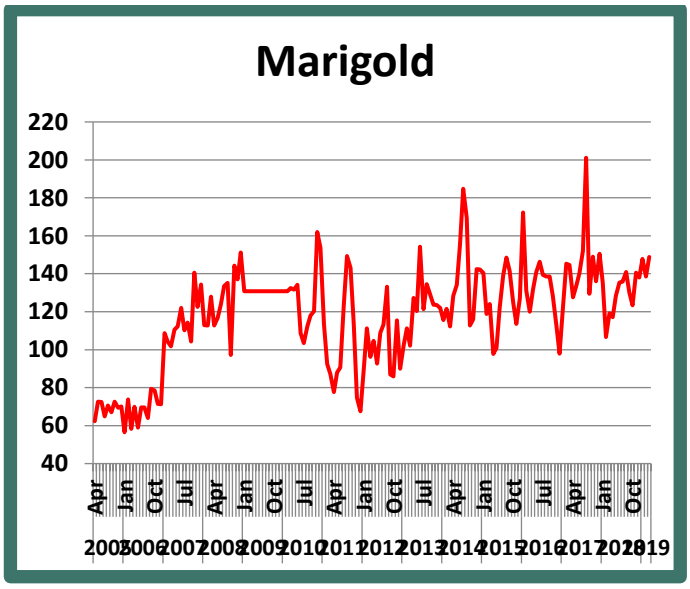


Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

9. Flowers

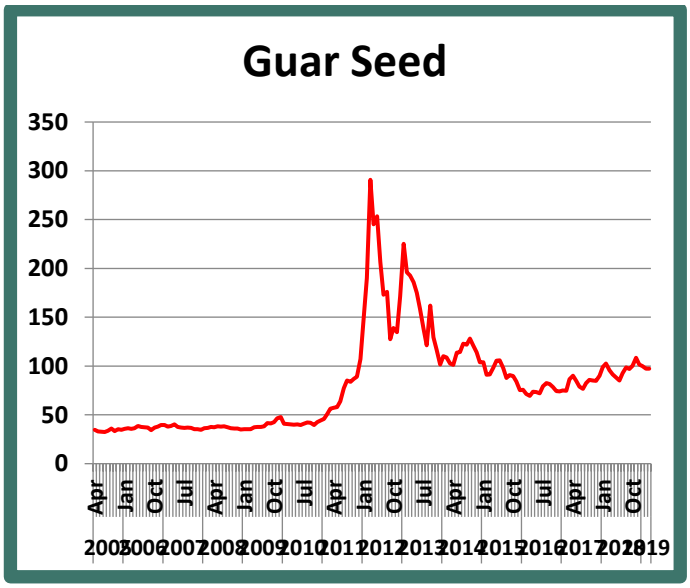


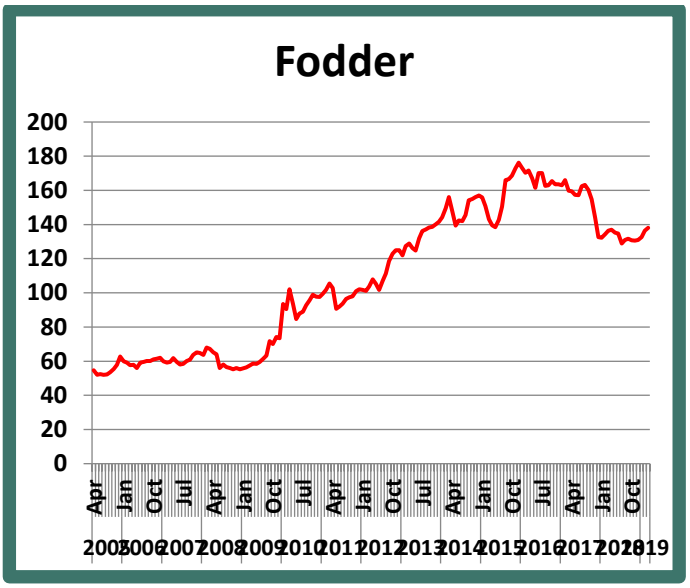




Charts-Set 1: Monthly Wholesale Price Indices during April 2005 to March 2019

10. Others





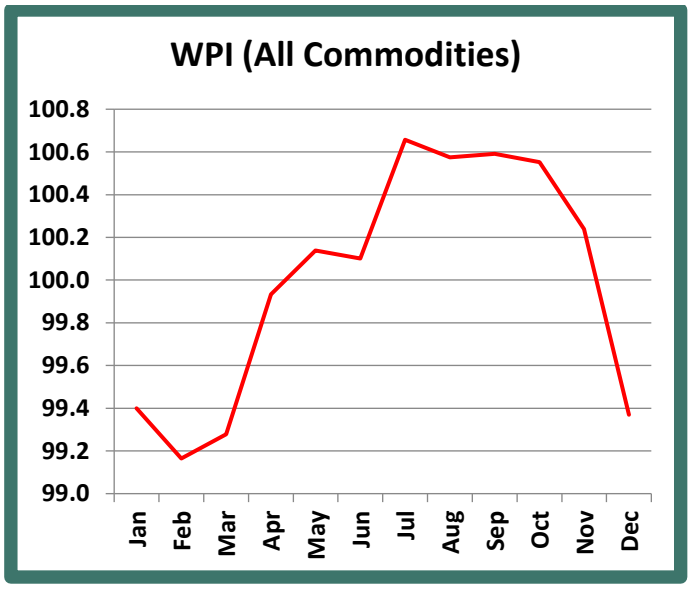
Charts Set 2

Monthly Seasonal Indices during April 2005 – March 2019 (Period 3)

[Only for those commodities in which Seasonality was Present]

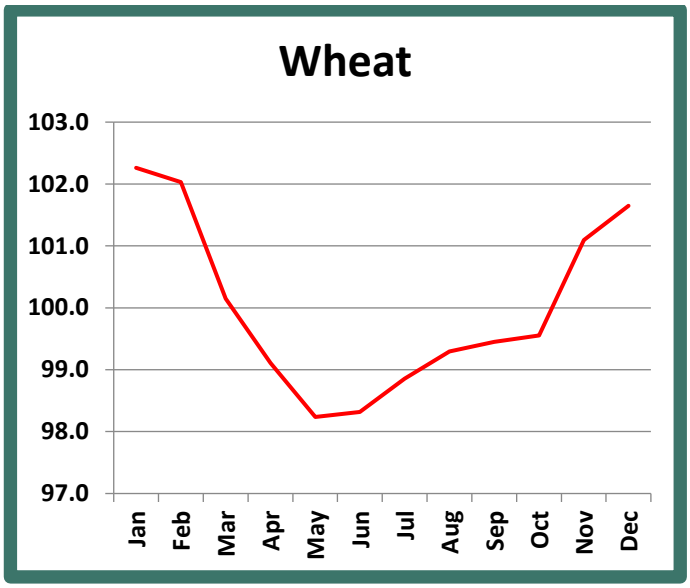
Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

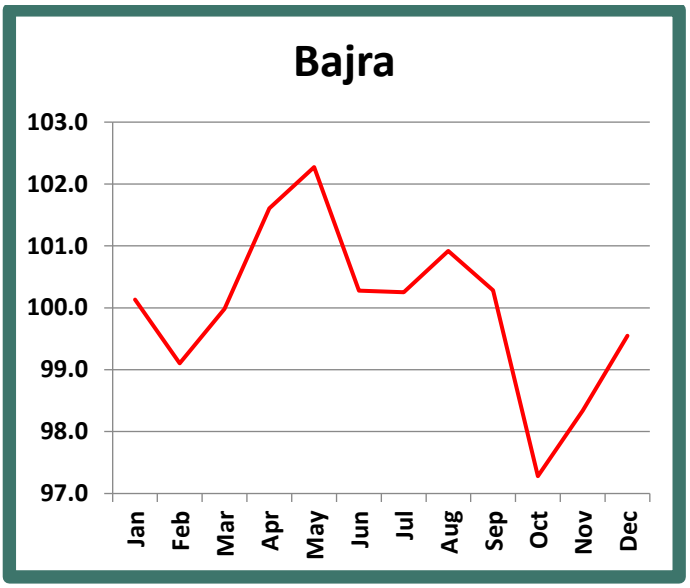
0. WPI (All Commodities)

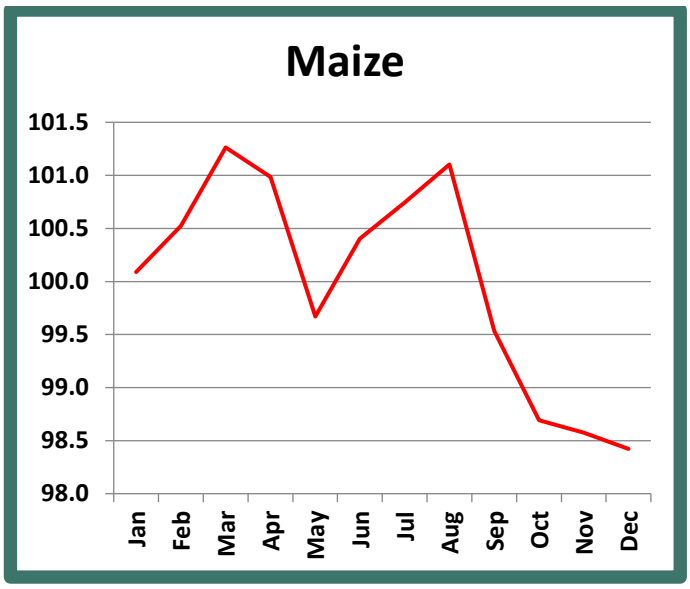


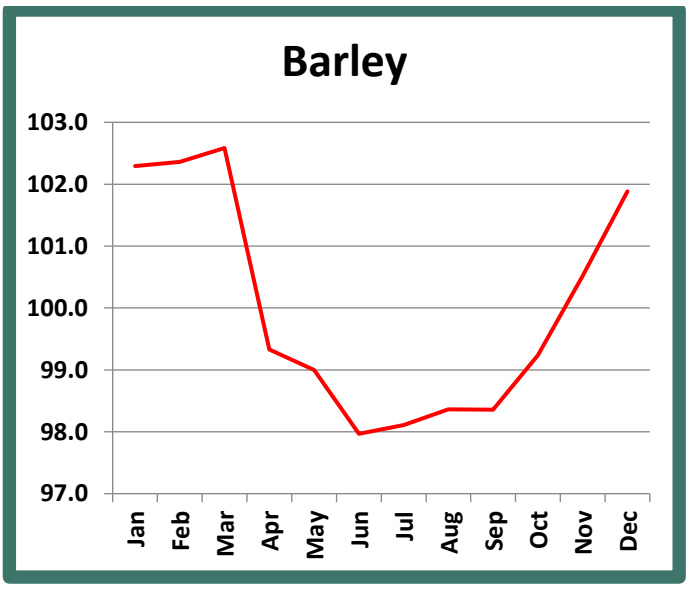
Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

1. Cereals



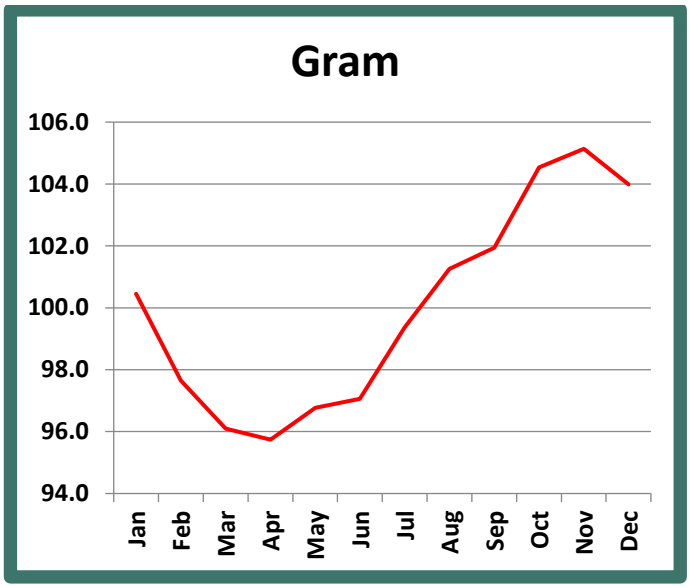


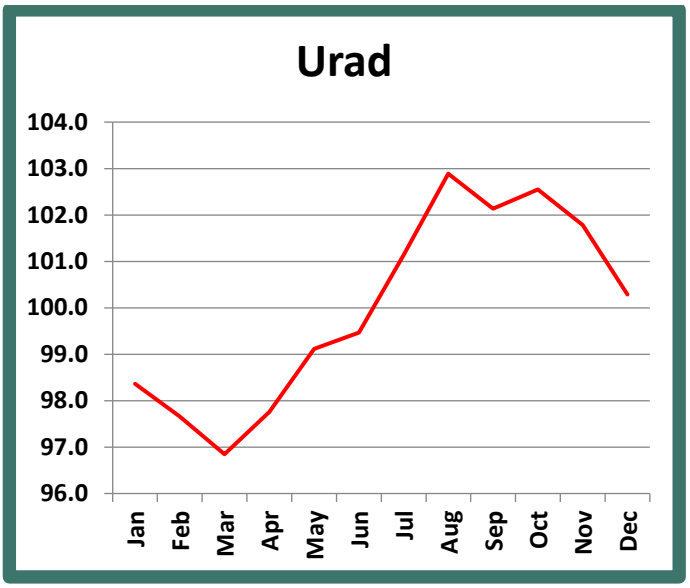


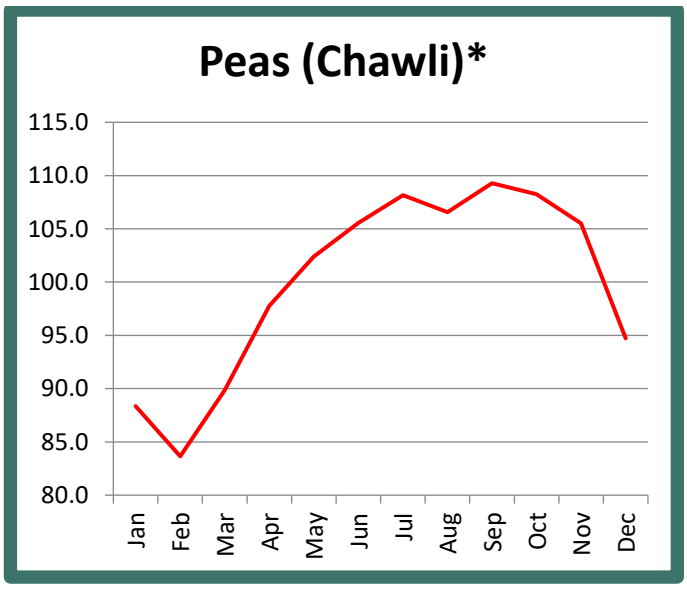


Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

2. Pulses



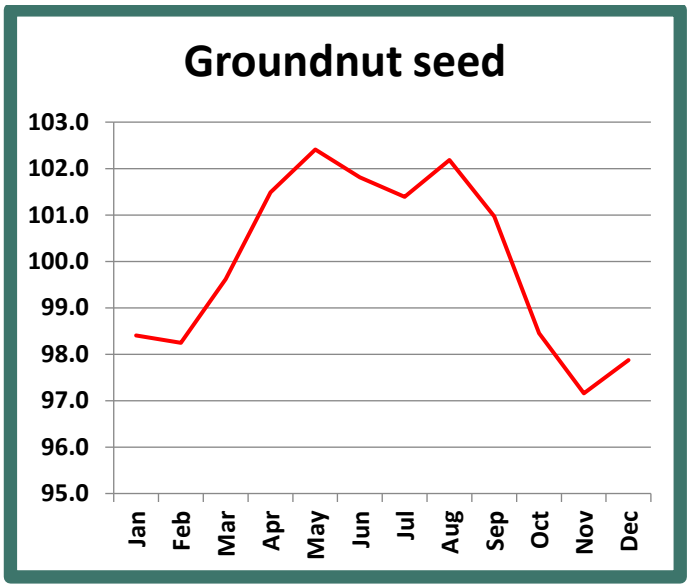


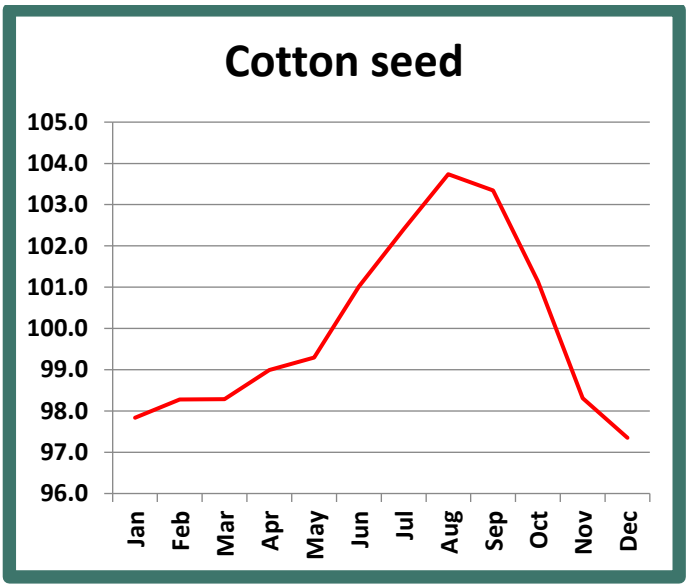


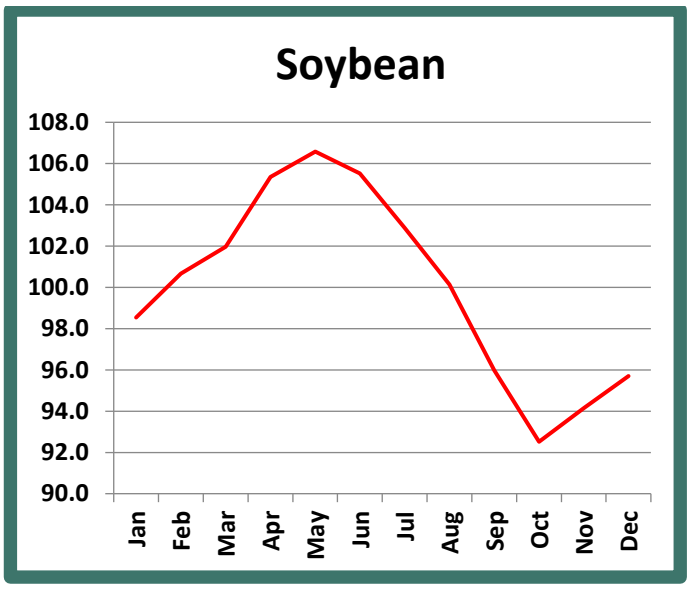
(* Data available only for 7 years, between April 2012 – March 2019)

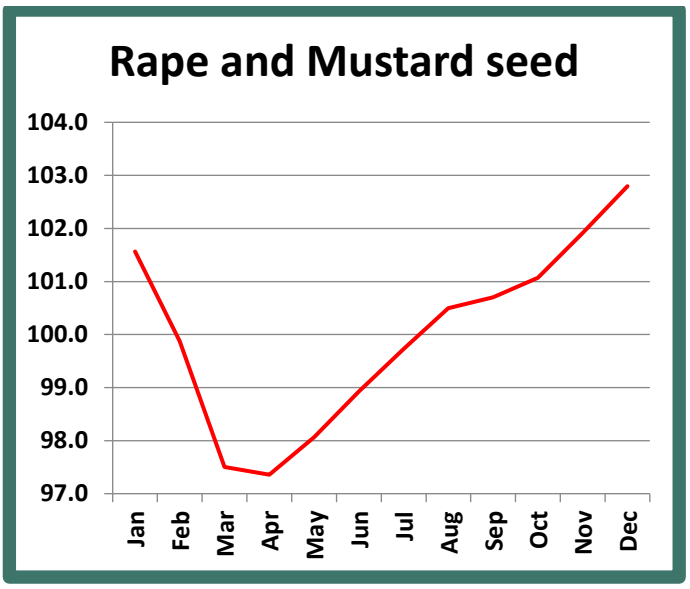
Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

3. Oilseeds



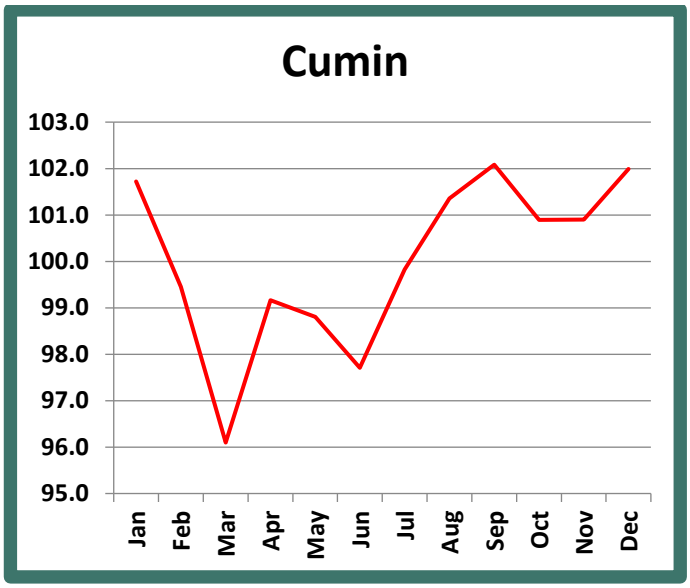


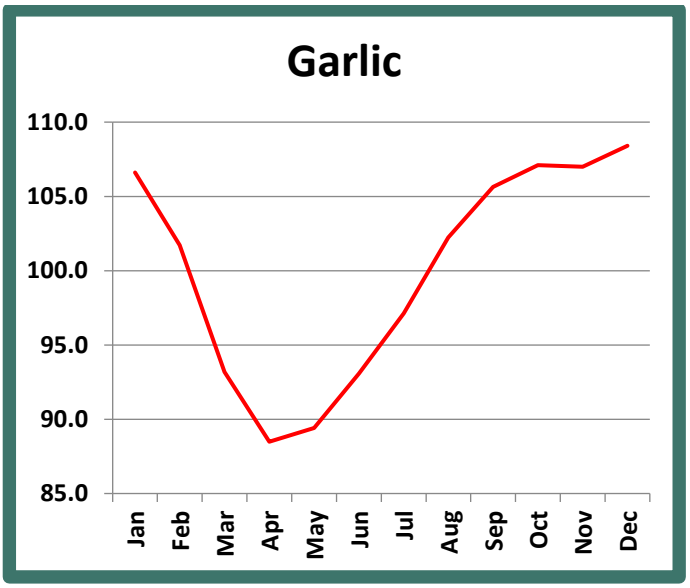




Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

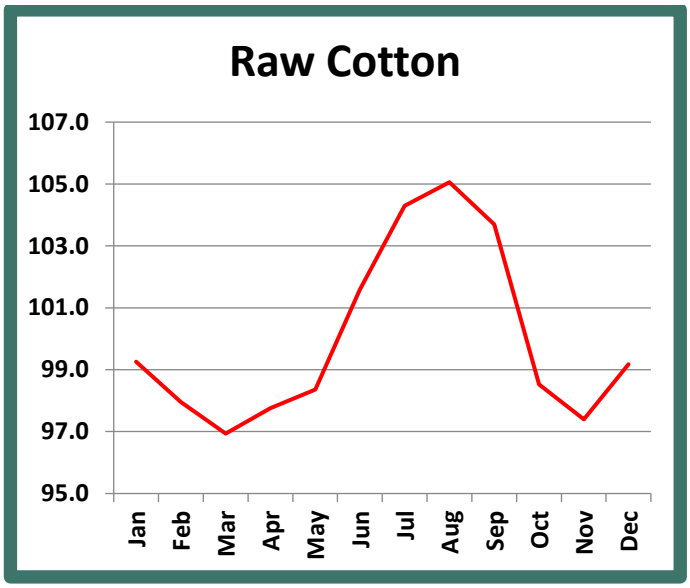
4. Spices

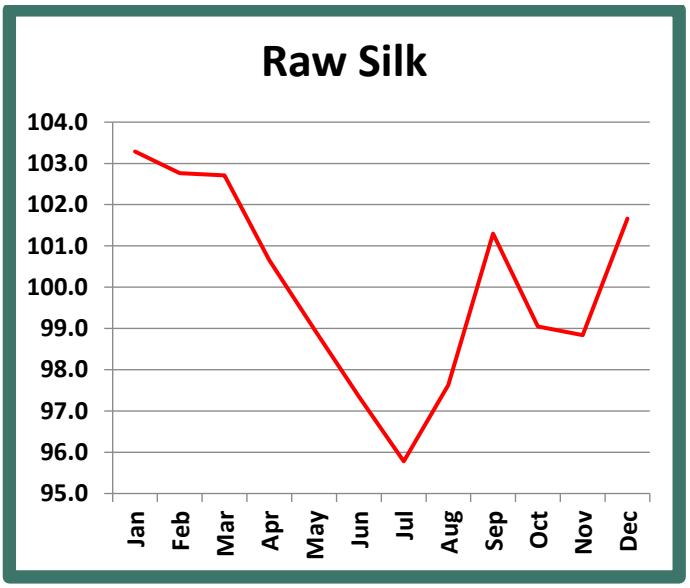




Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

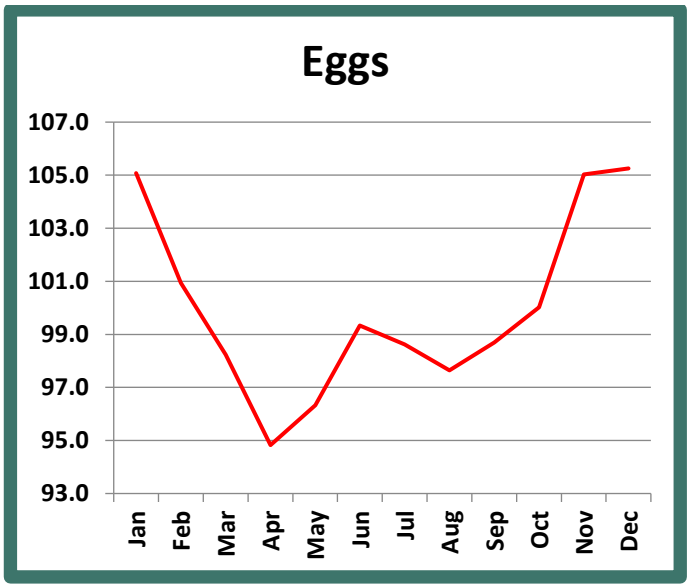
5. Fibres

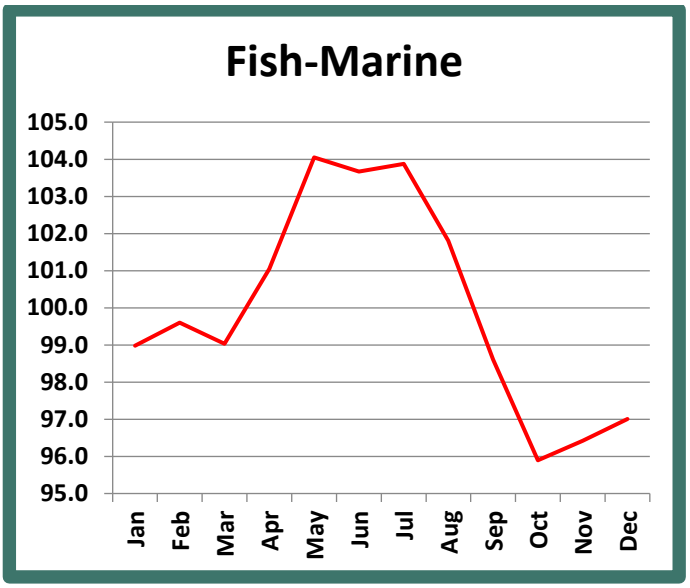




Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

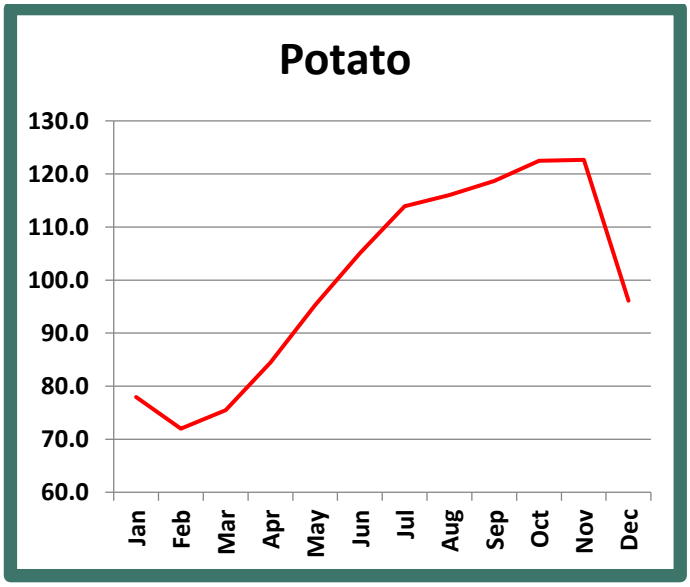
6. Livestock and Livestock Products

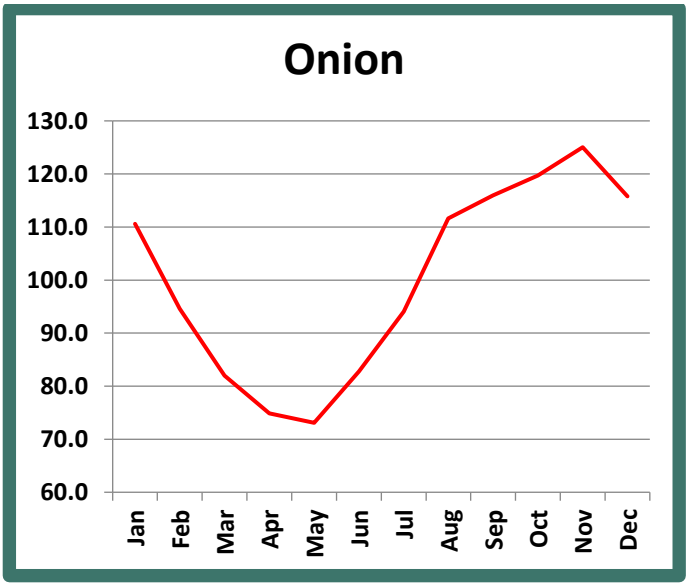


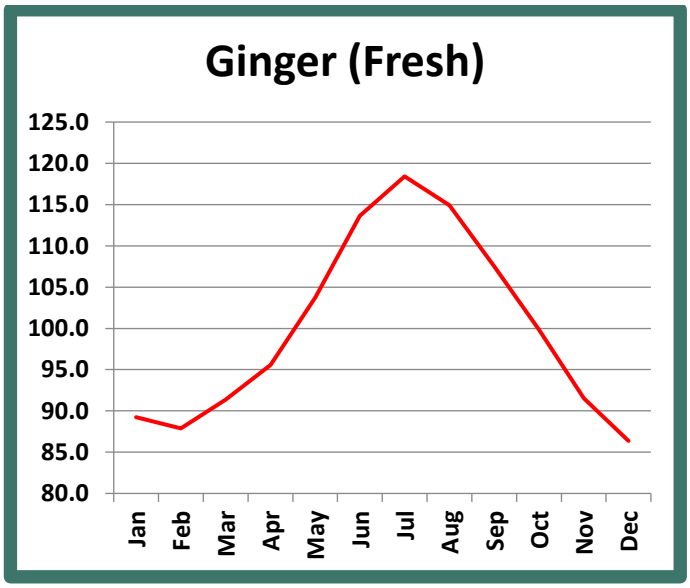


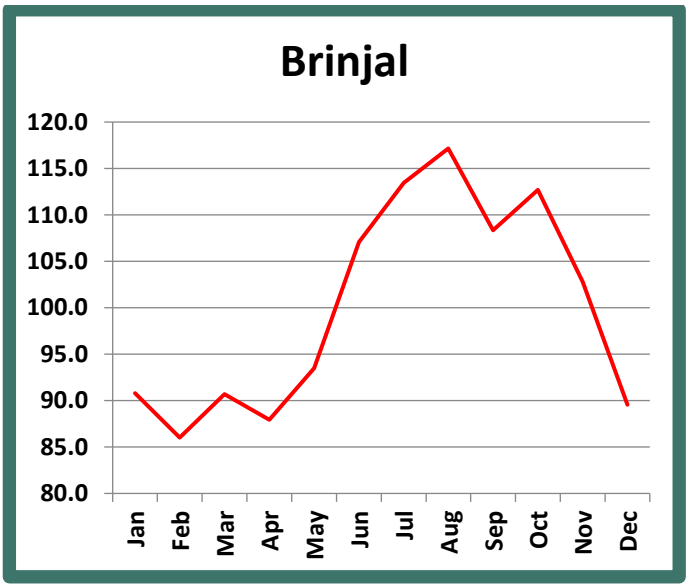
Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

7. Vegetables



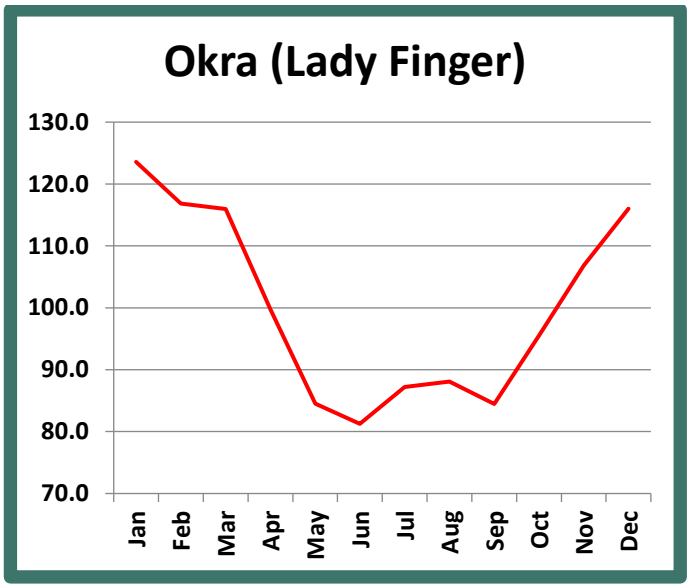


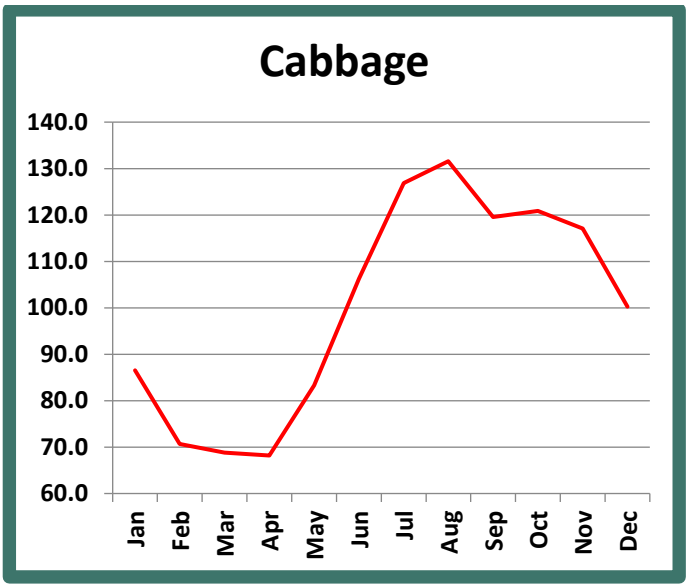


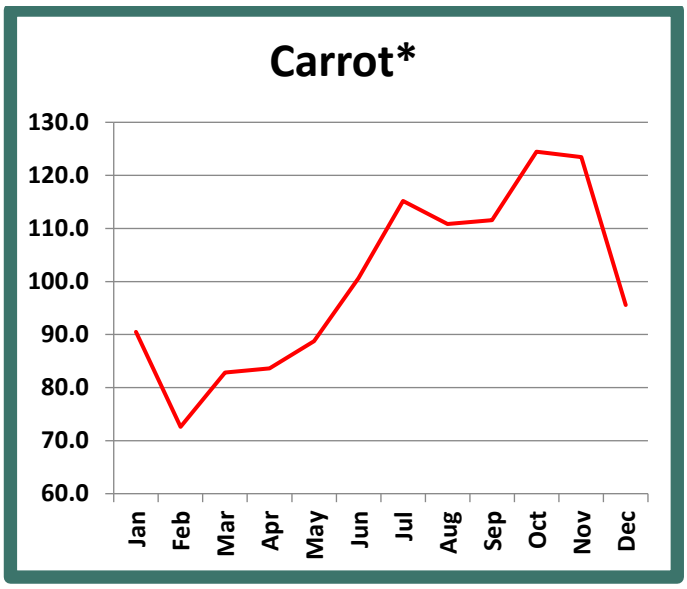


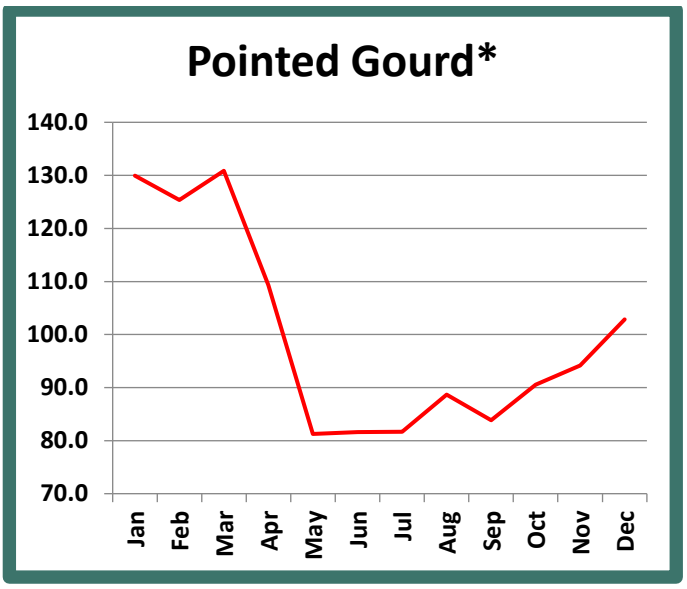
Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

7. Vegetables (Contd.)





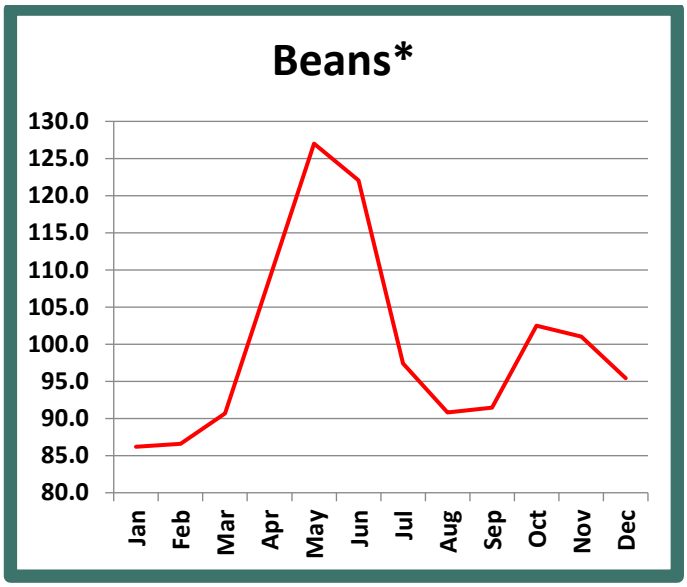


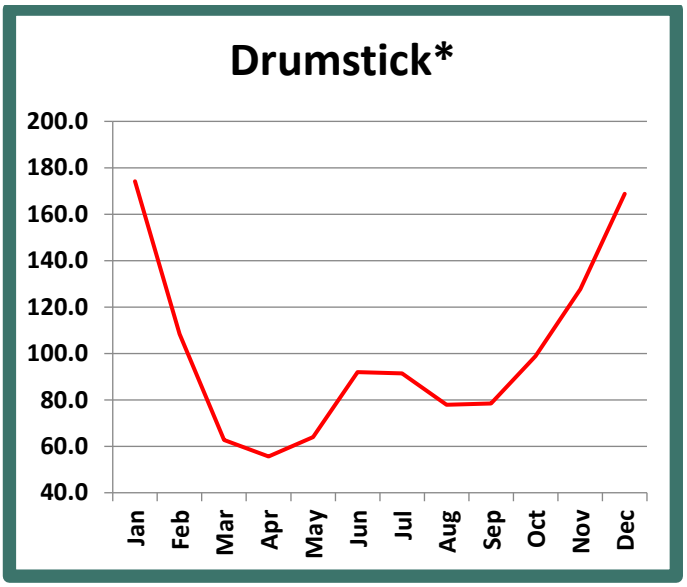


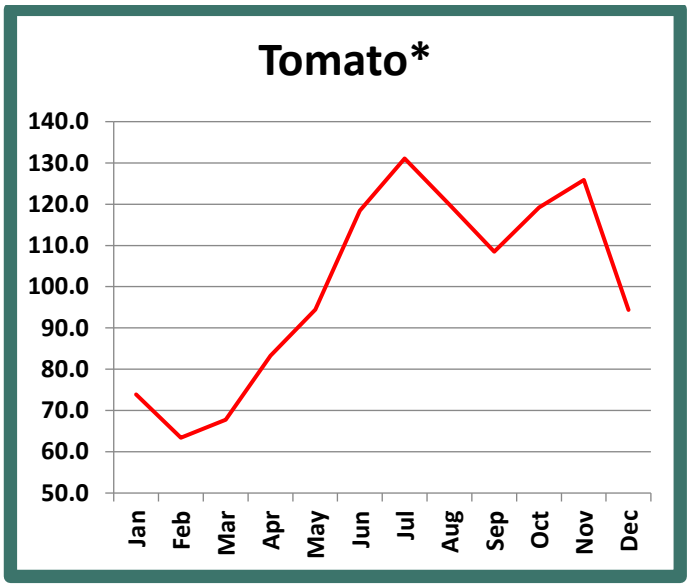
(* Data available only for 7 years, between April 2012 – March 2019)

Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

7. Vegetables (Contd.)



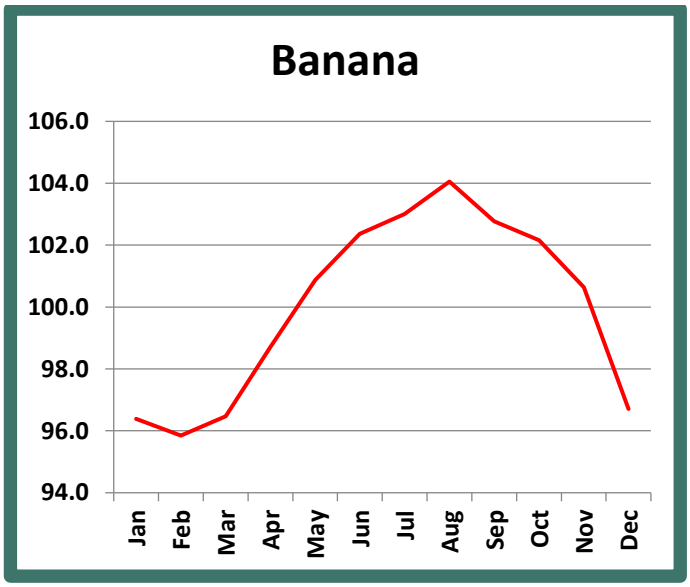


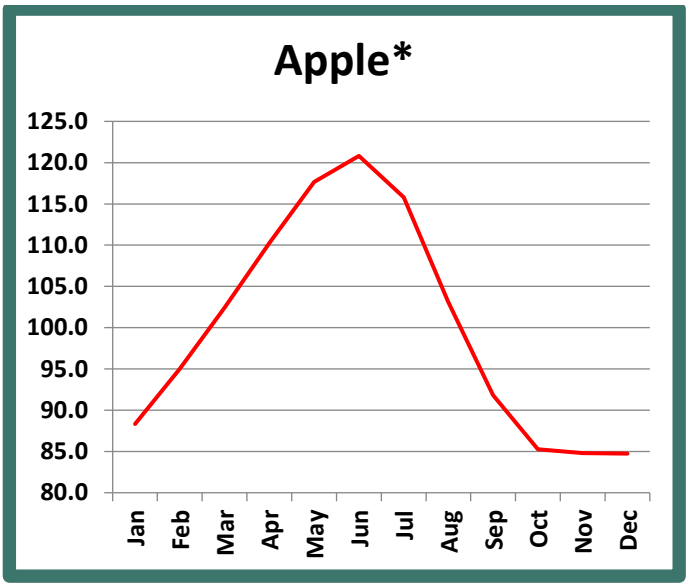


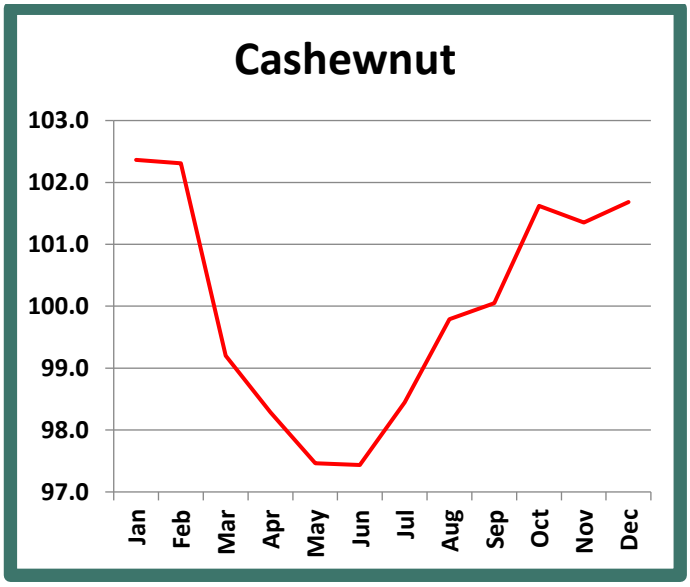
(* Data available only for 7 years, between April 2012 – March 2019)

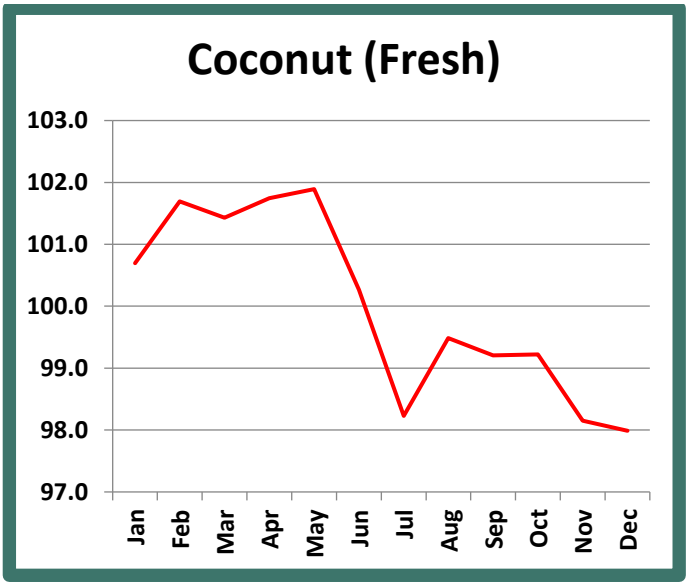
Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

8. Fruits





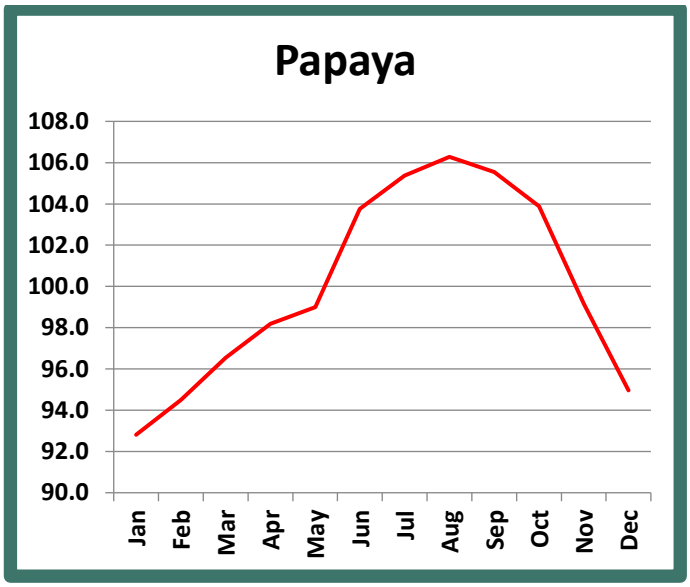


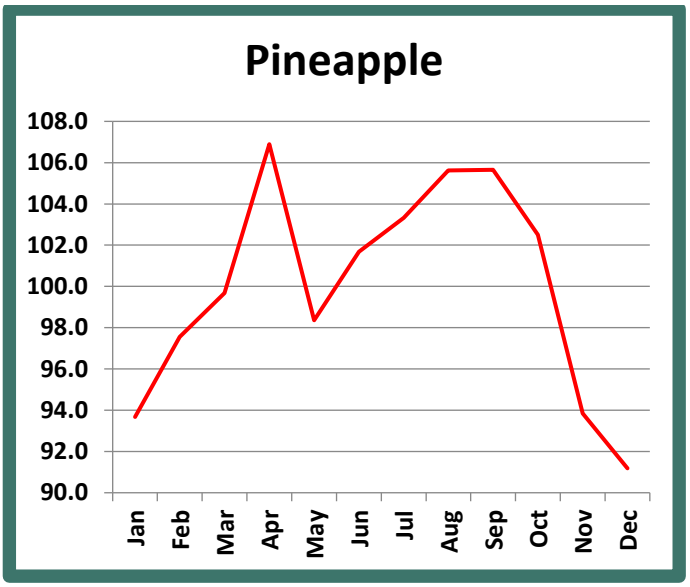


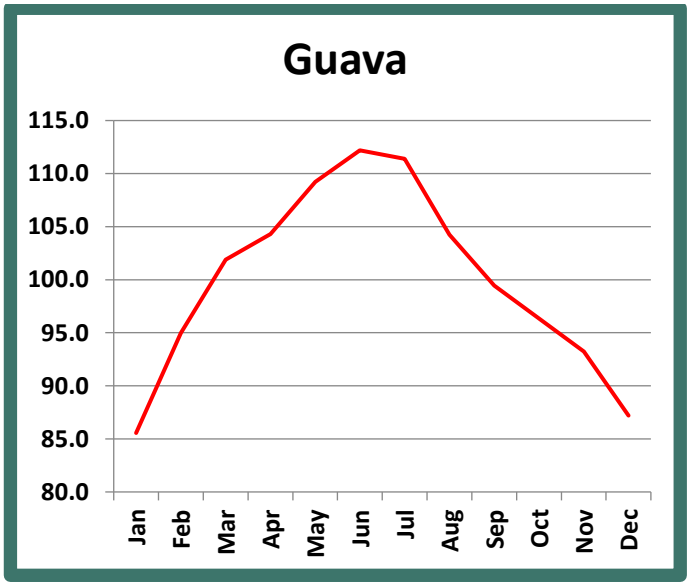
(* Data available only for 7 years, between April 2012 – March 2019)

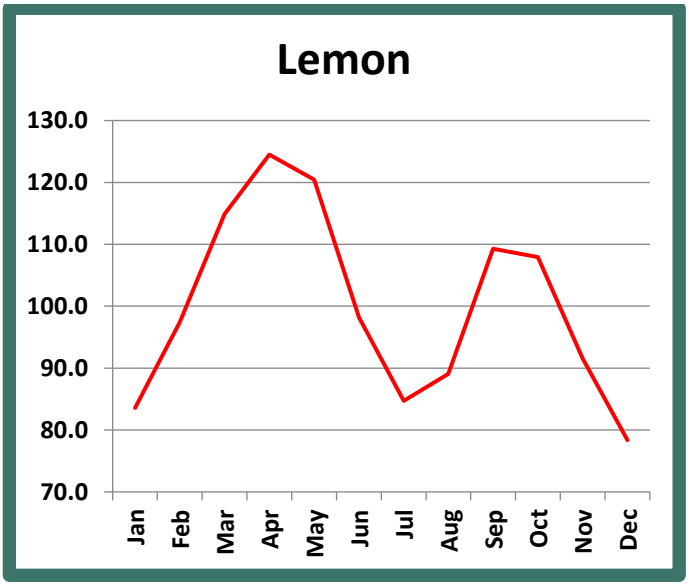
Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

8. Fruits (Contd.)



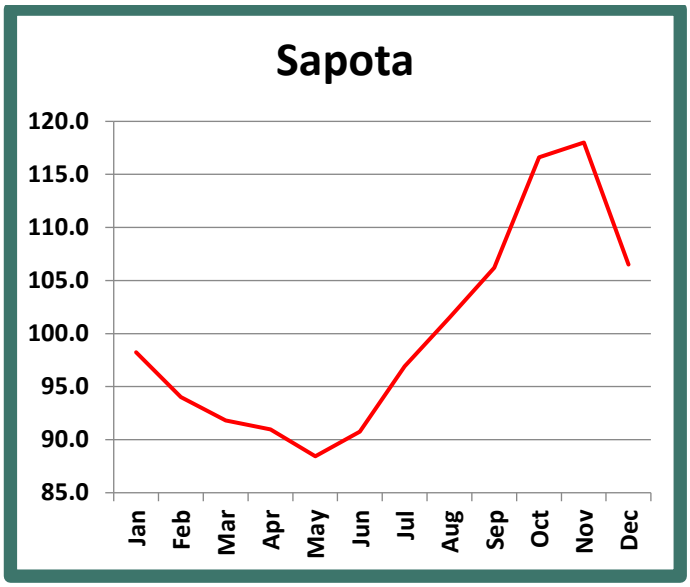


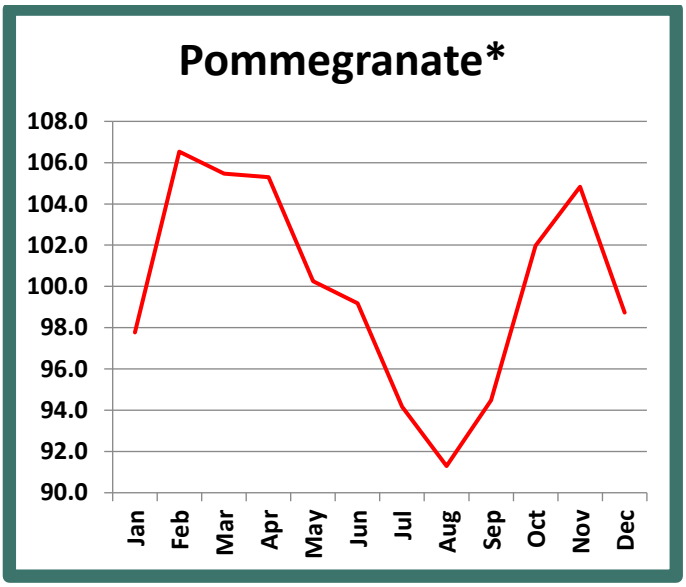


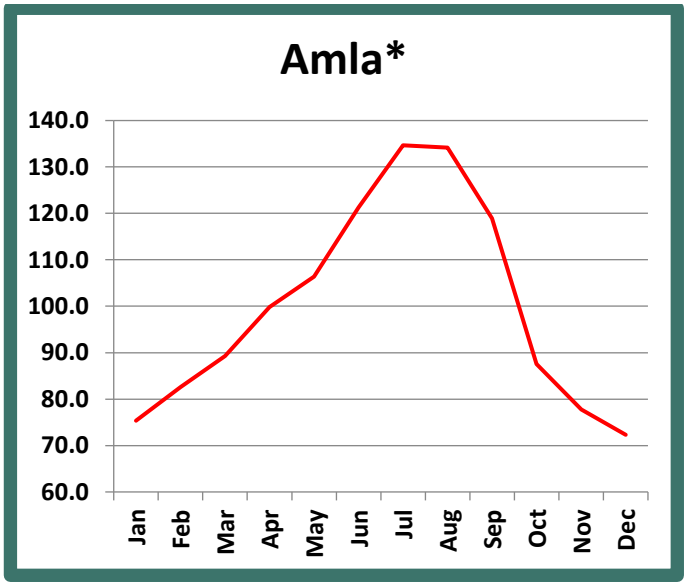


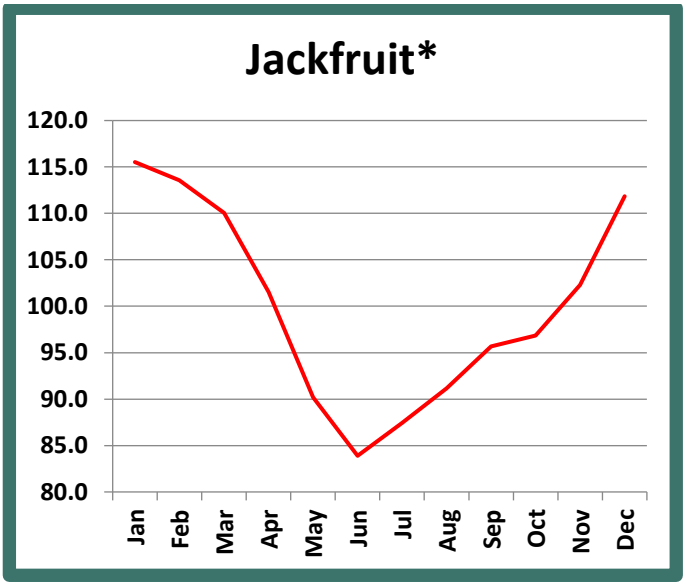
Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

8. Fruits (Contd.)





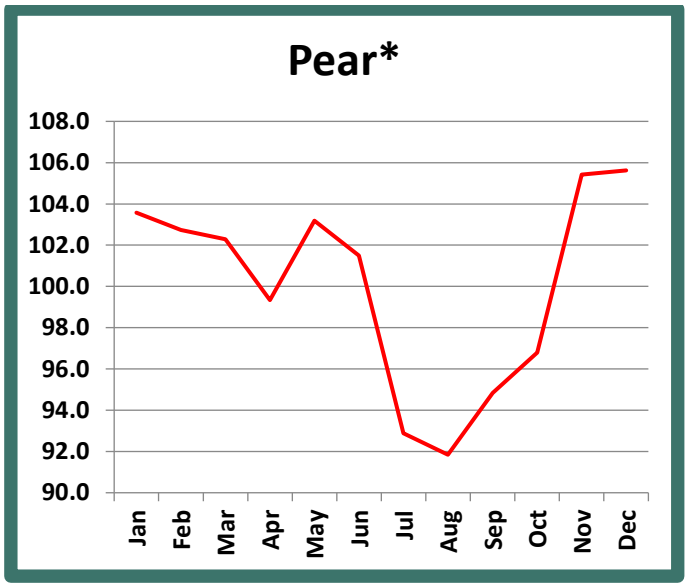




(* Data available only for 7 years, between April 2012 – March 2019)

Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

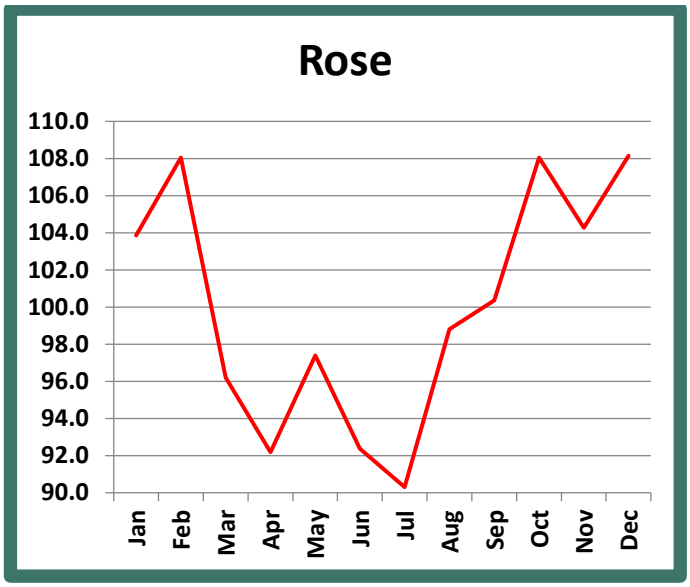
8. Fruits (Contd.)

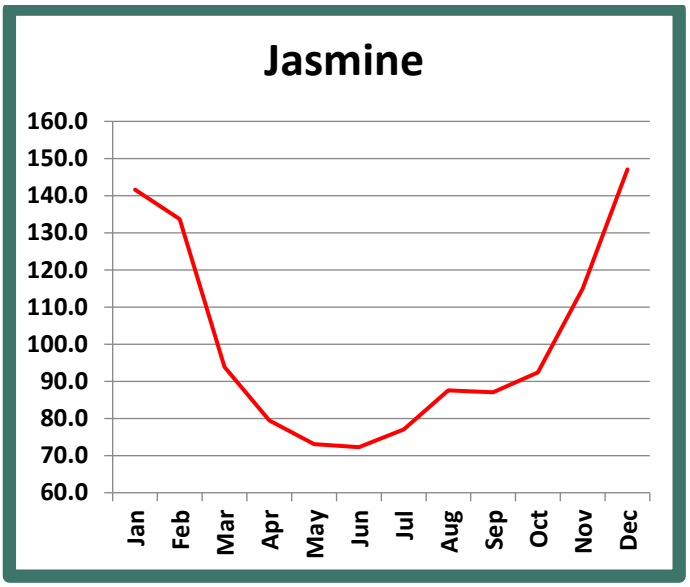


(* Data available only for 7 years, between April 2012 – March 2019)

Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

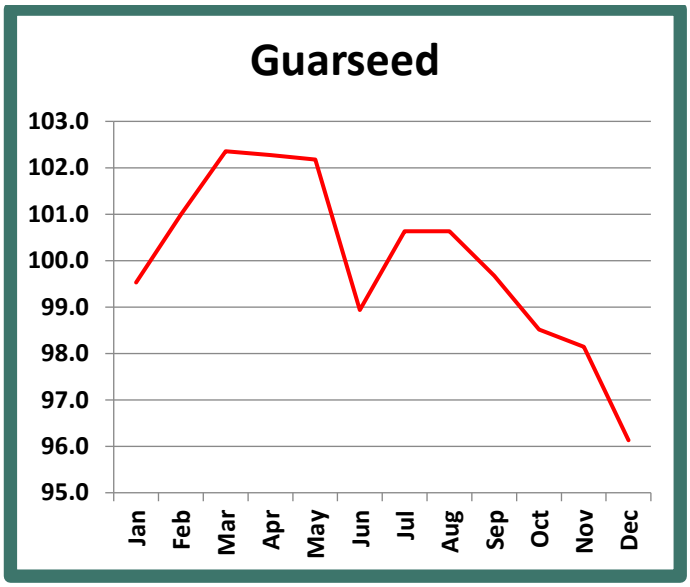
9. Flowers

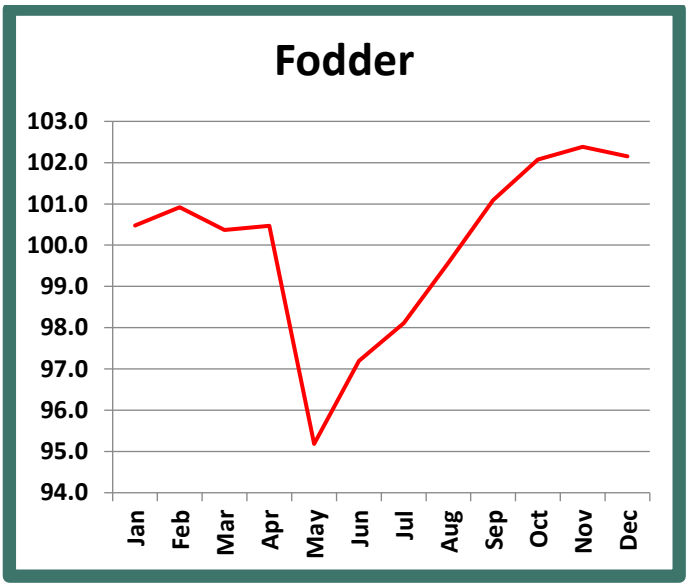




Charts-Set 2: Monthly Seasonal Price Indices during April 2005 to March 2019

10. Others



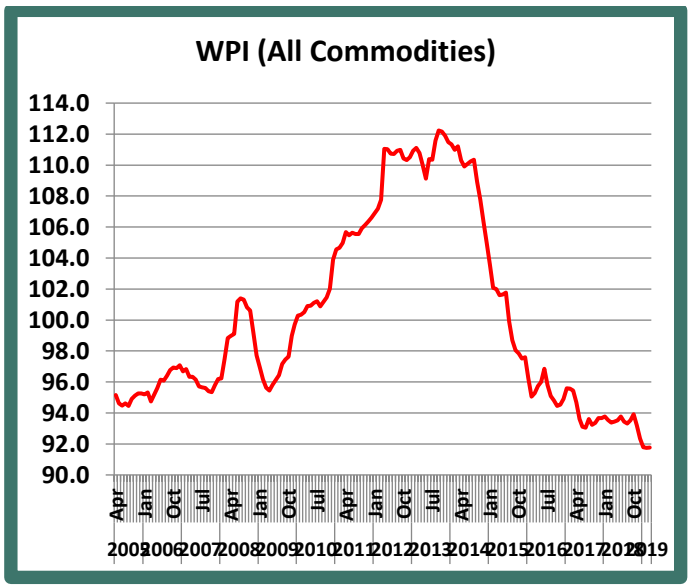


Charts Set 3

Monthly Residual Prices during April 2005 – March 2019 (Period 3]

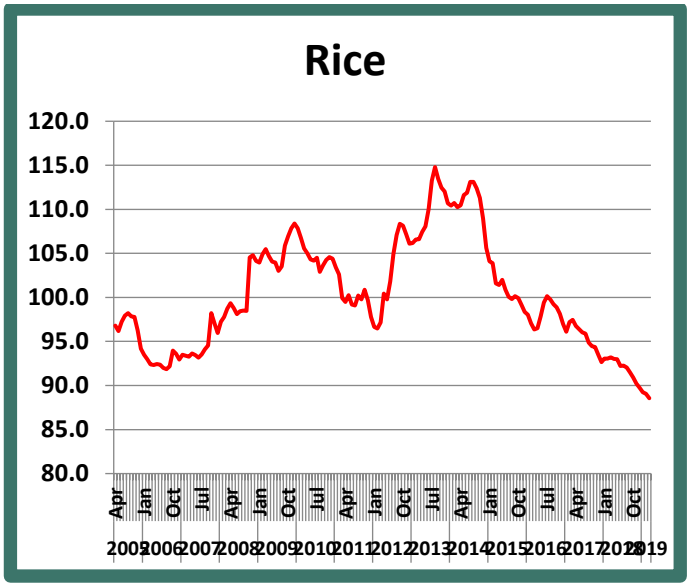
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

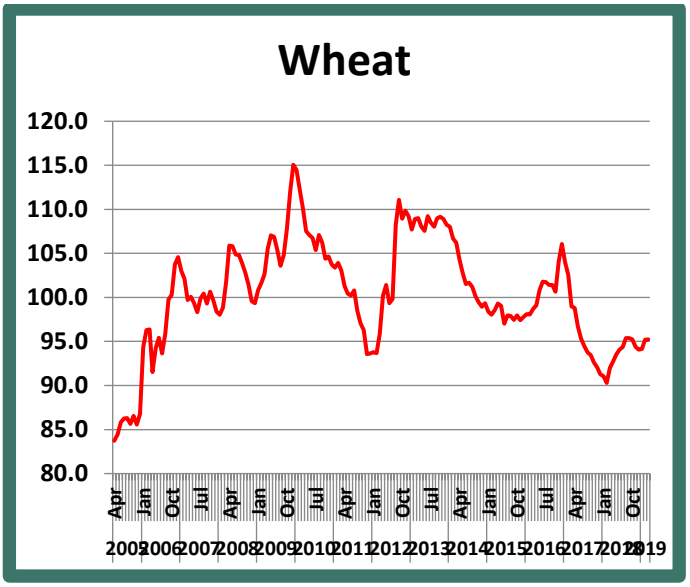
0. WPI (All Commodities)

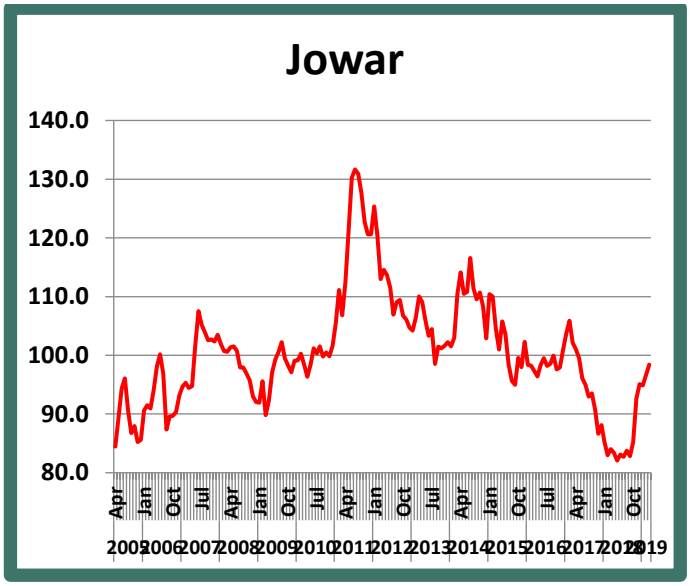


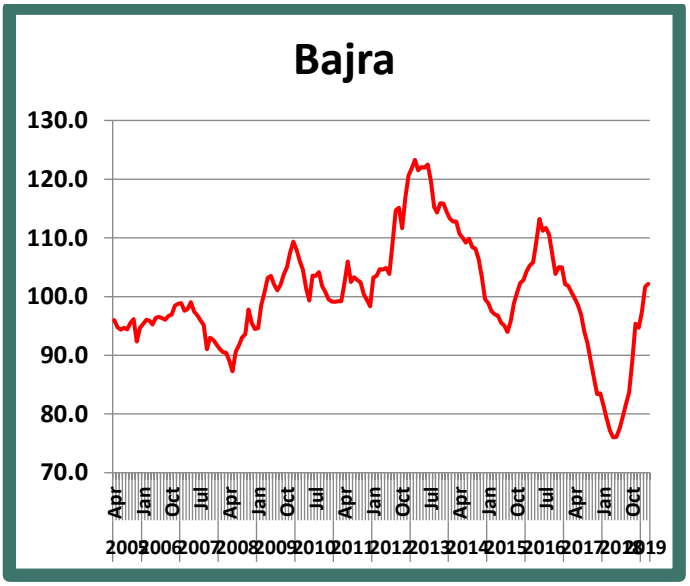
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

1. Cereals



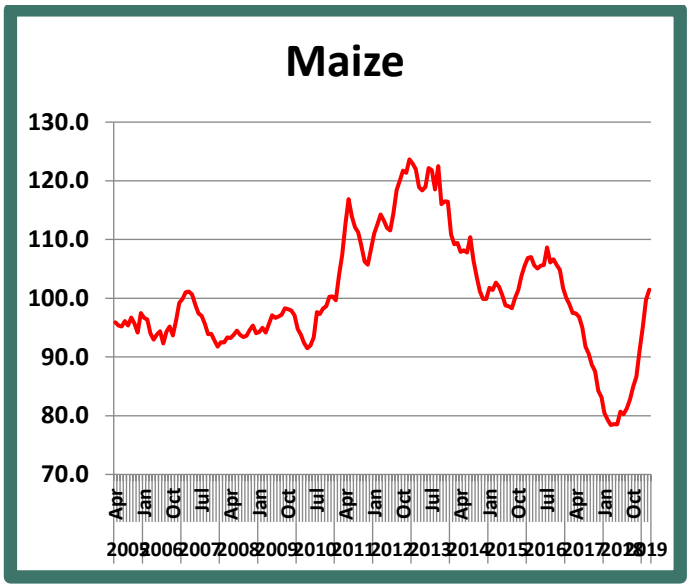


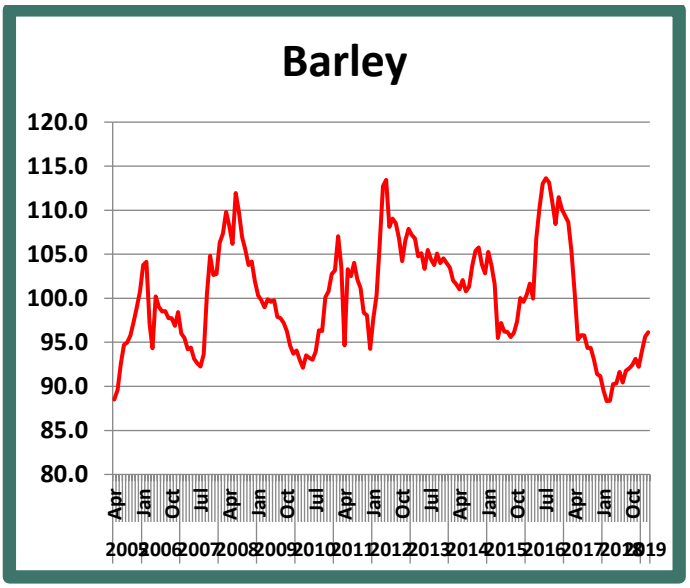


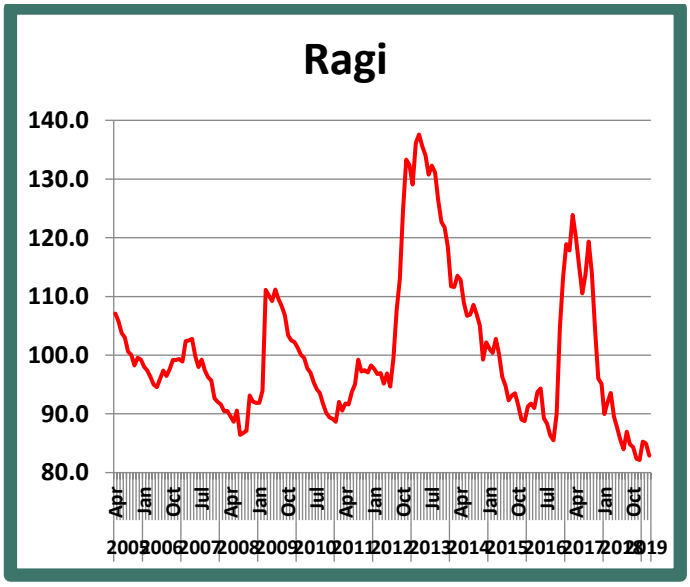


Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

1. Cereals (Contd.)

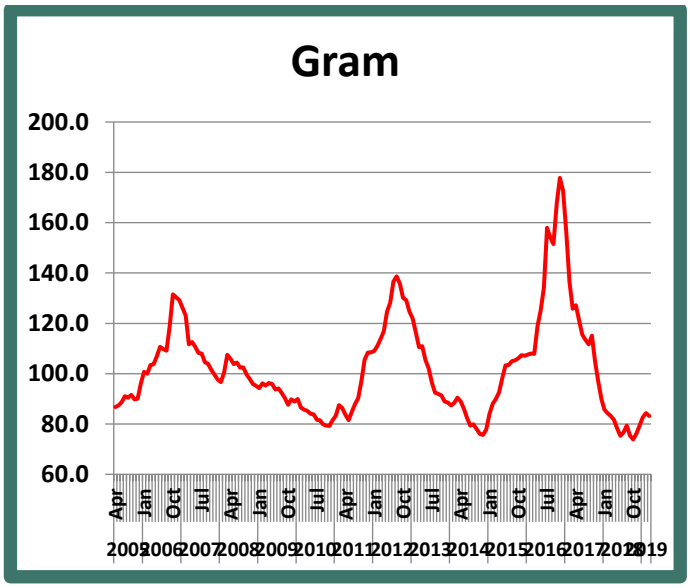


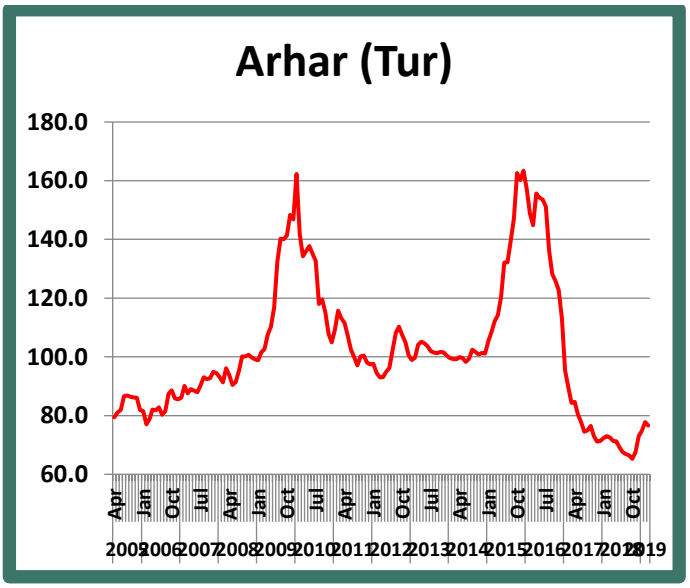


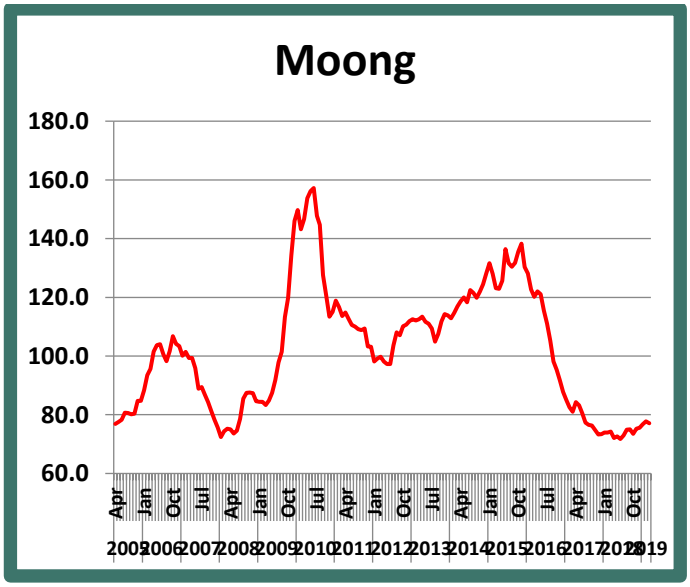


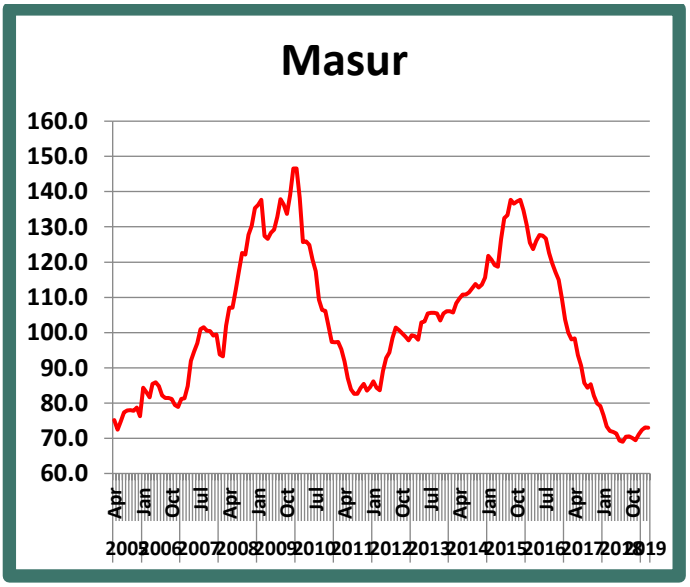
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

2. Pulses





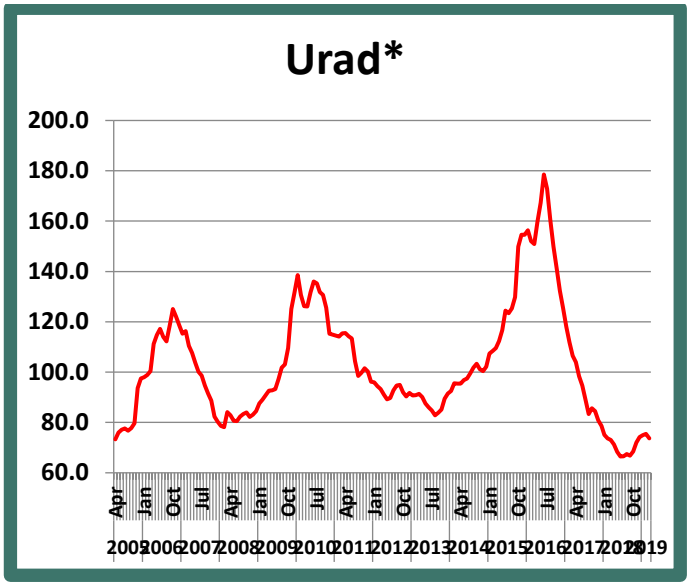


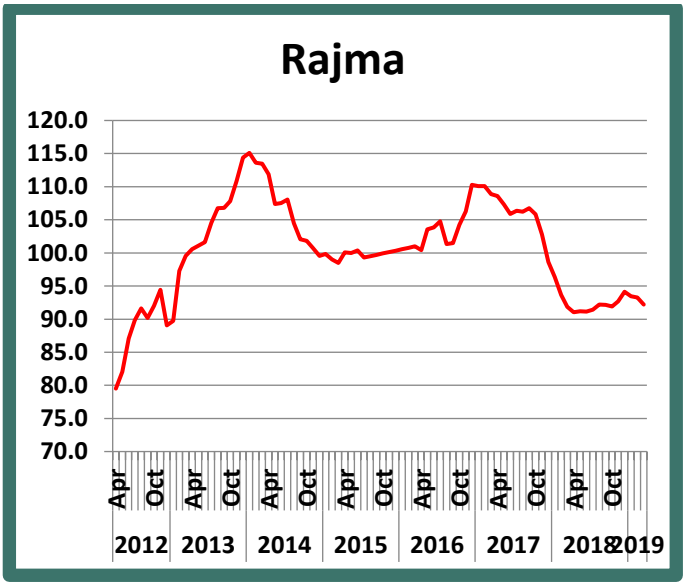


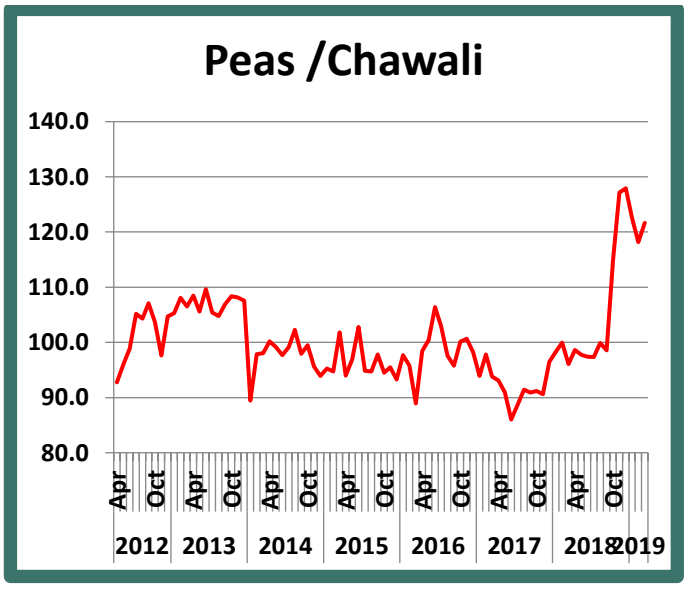
Charts-Set 3: Monthly Residual Prices during April 2012 to March 2019

2. Pulses (Contd.)

* Period for **Urad** is April 2005 to March 2019

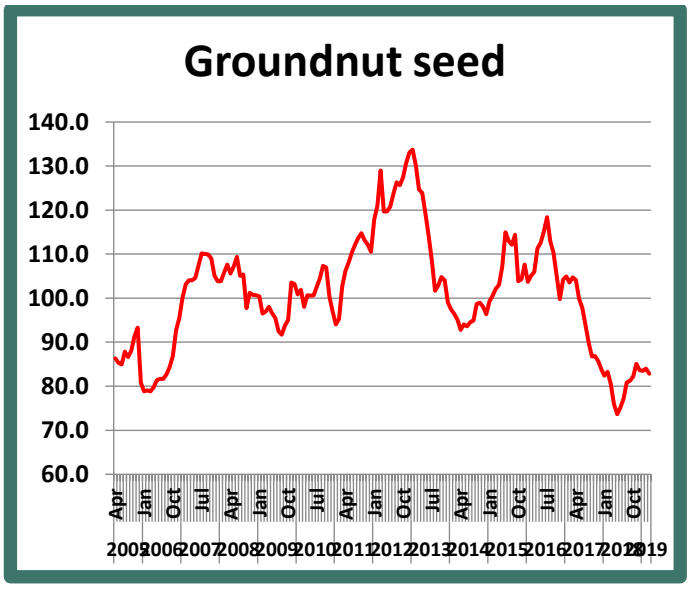


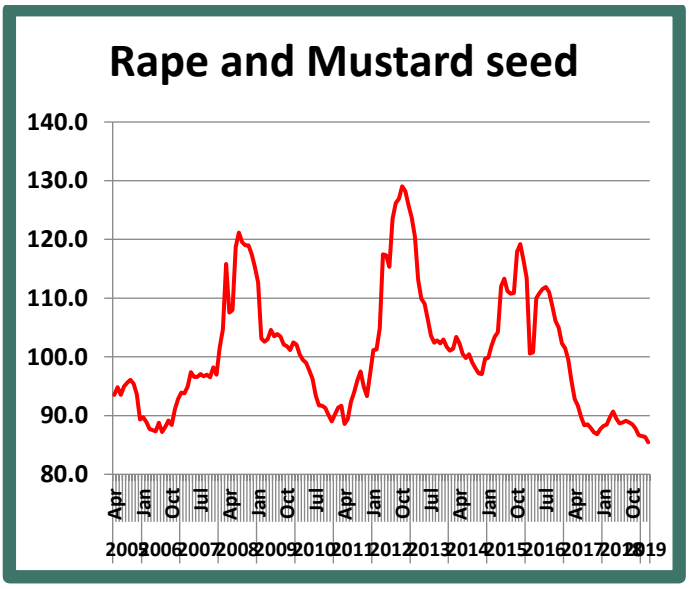


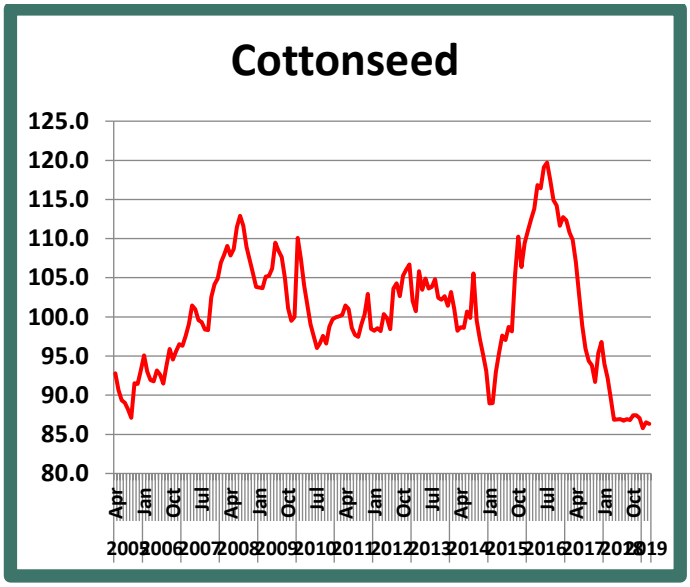


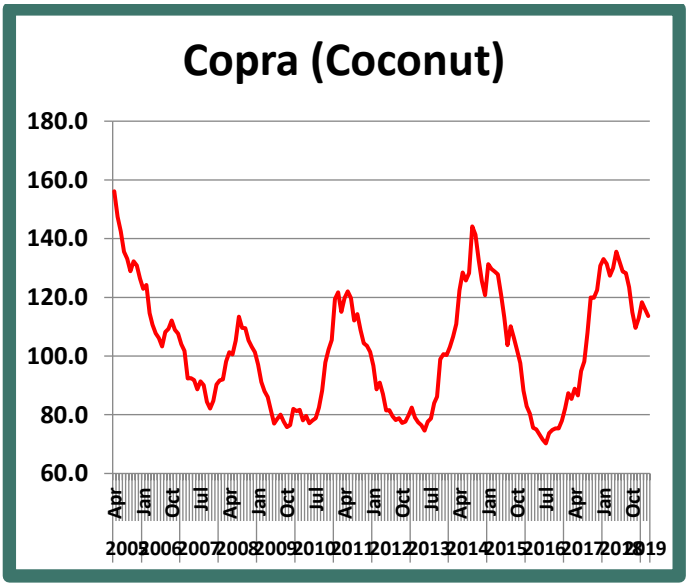
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

3. Oilseeds



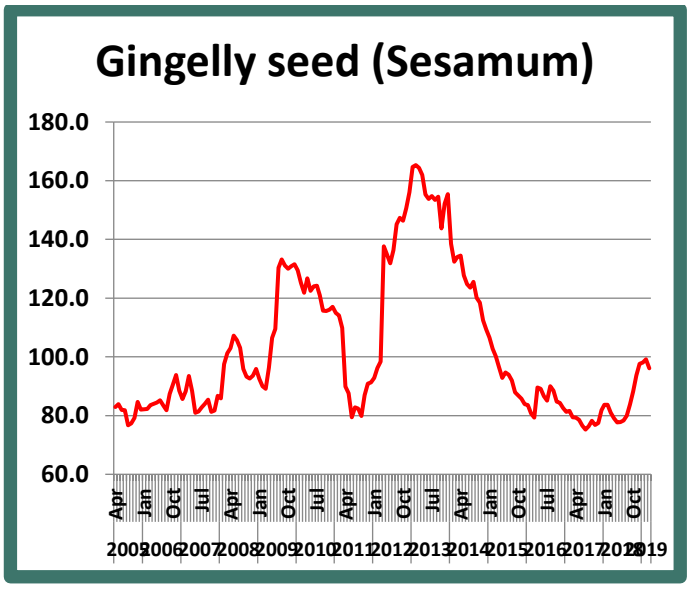


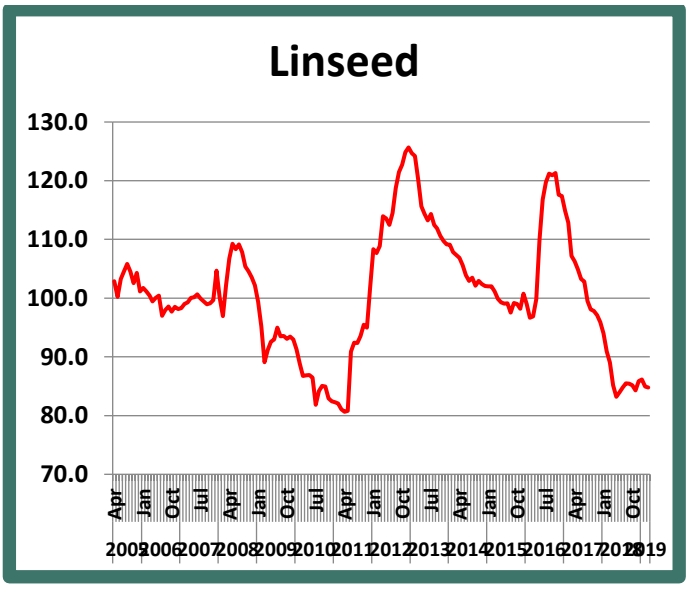


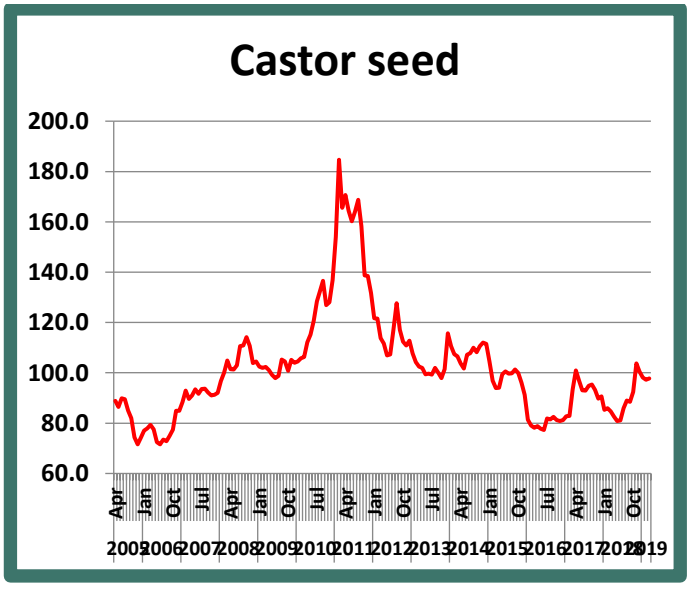


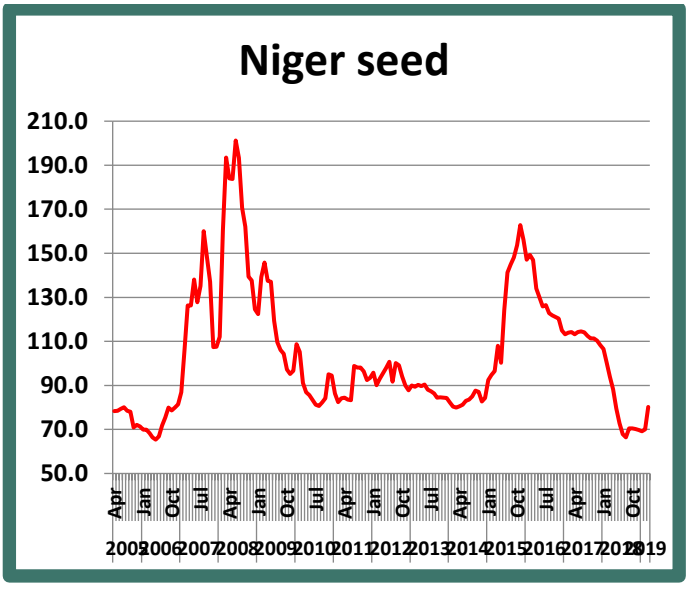
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

3. Oilseeds (Contd.)



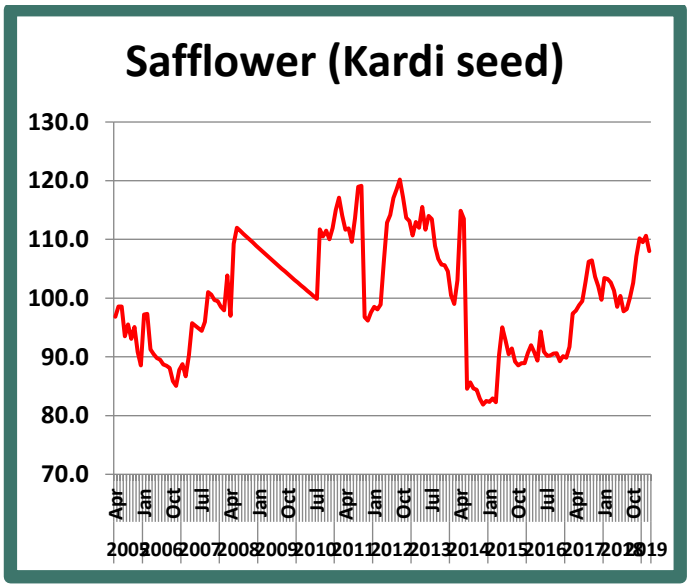


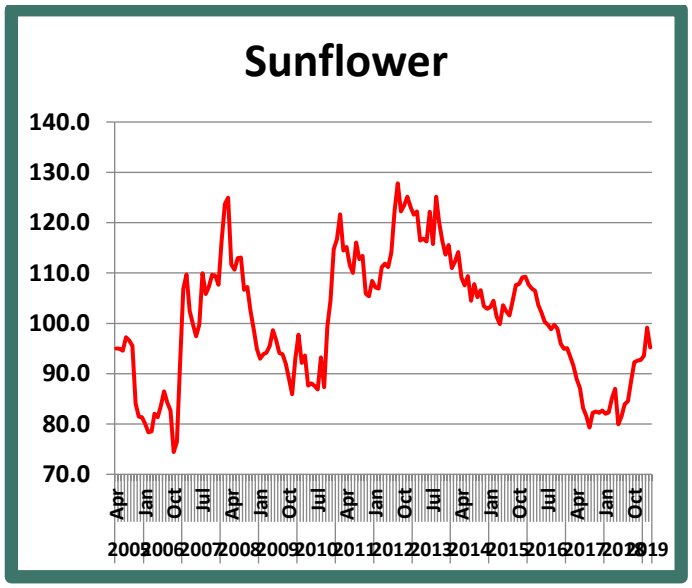


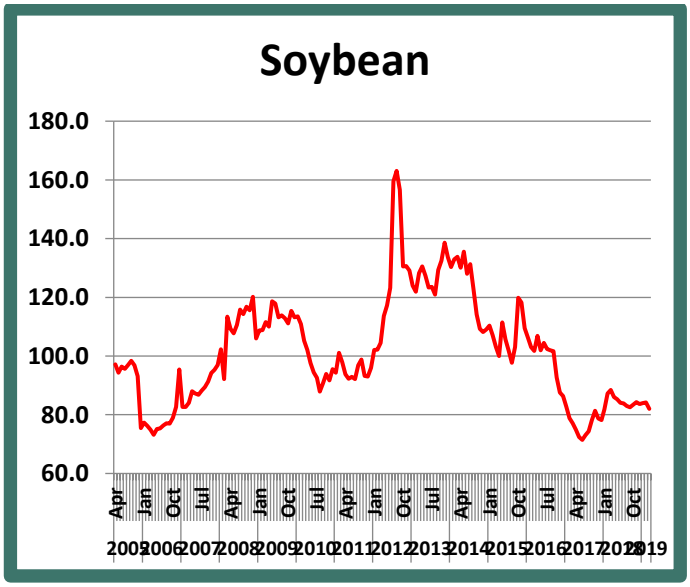


Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

3. Oilseeds (Contd.)

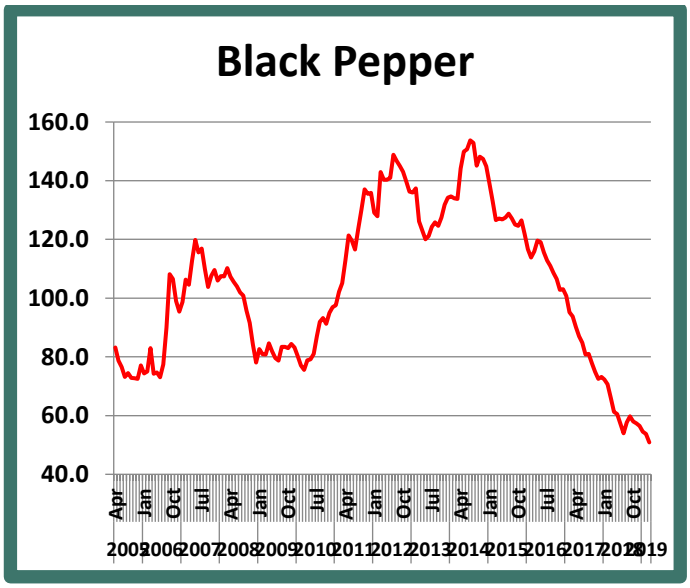


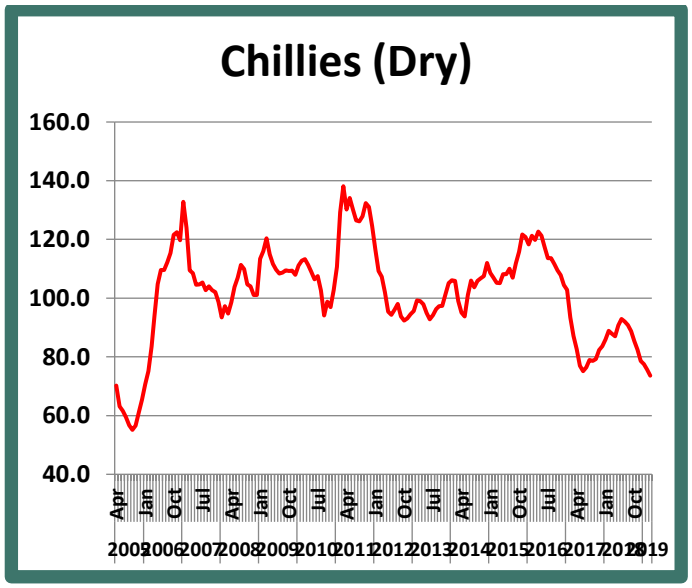


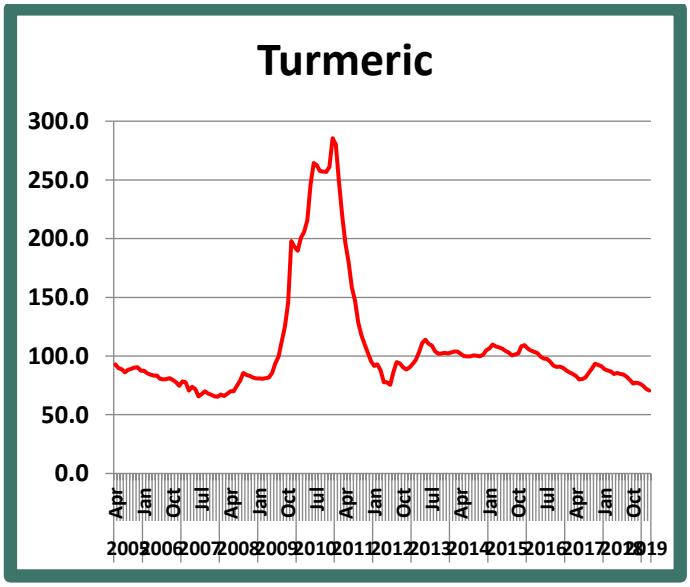


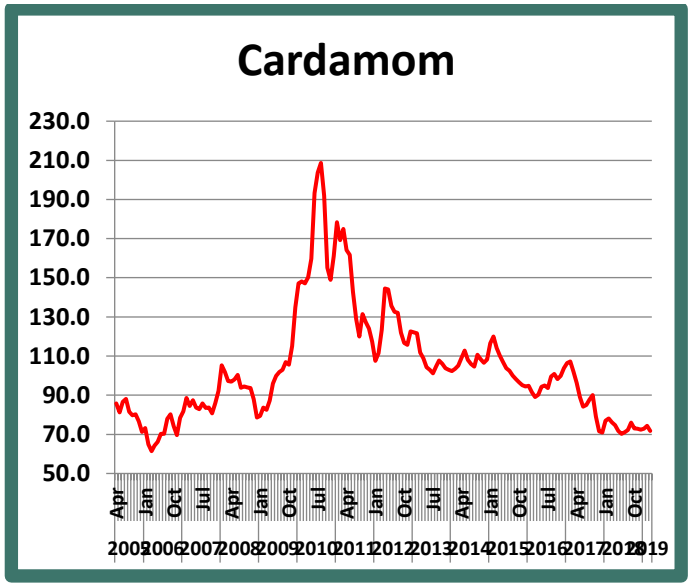
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

4. Spices



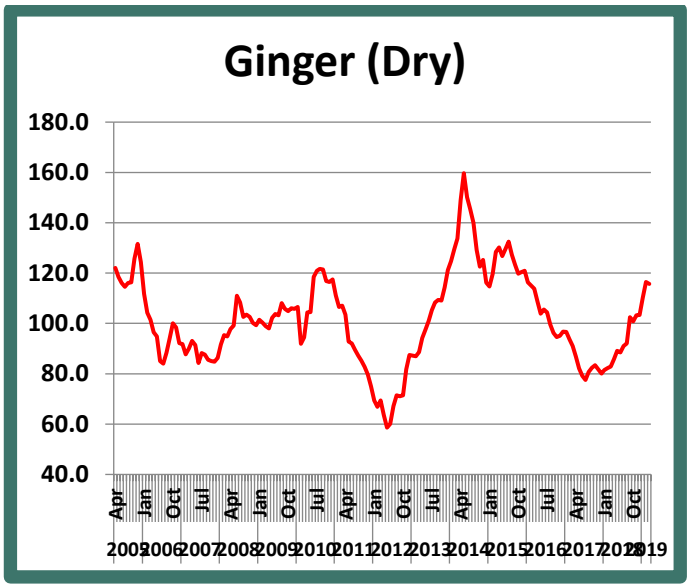


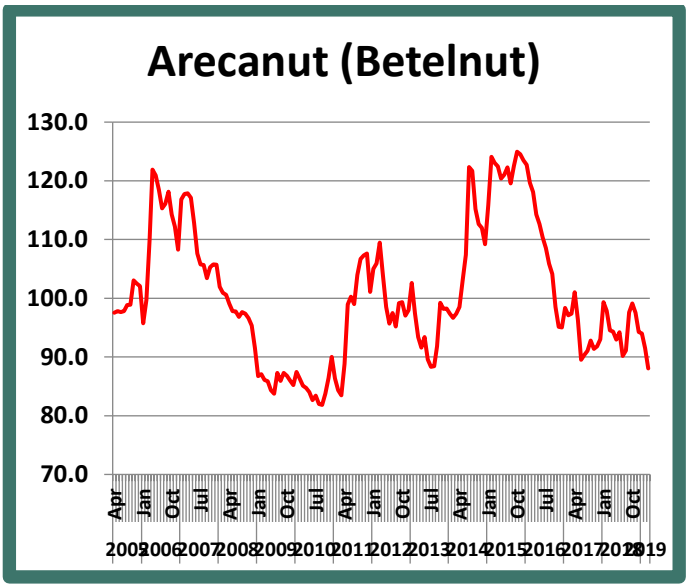


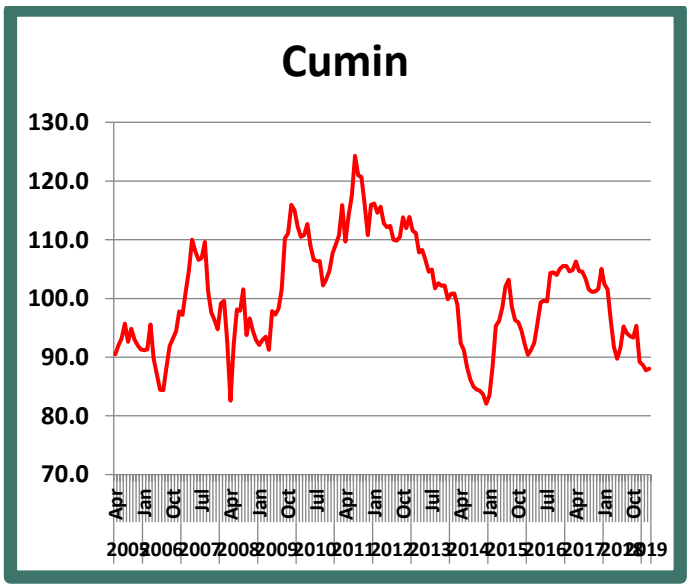


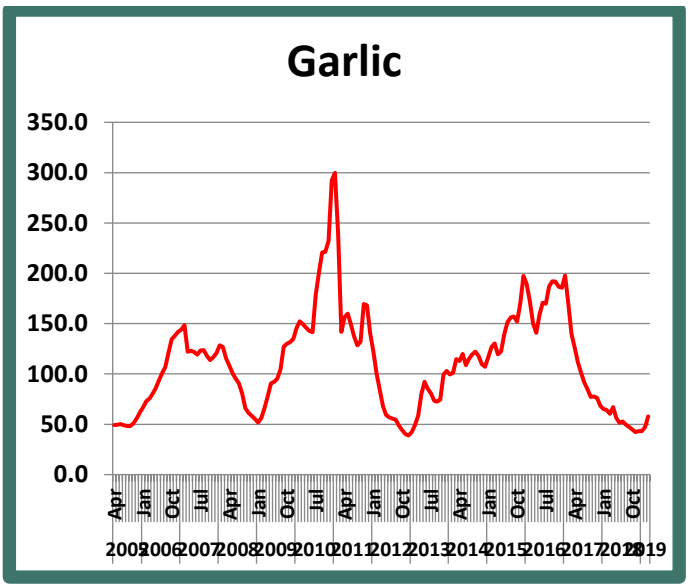
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

4. Spices (Contd.)





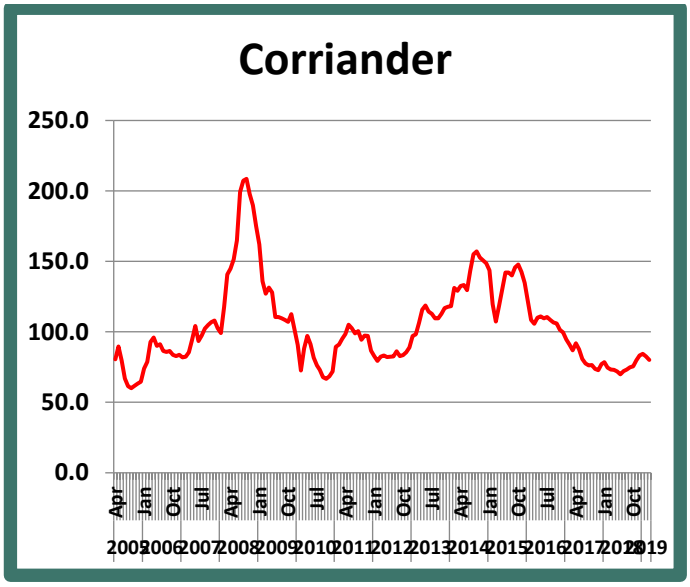


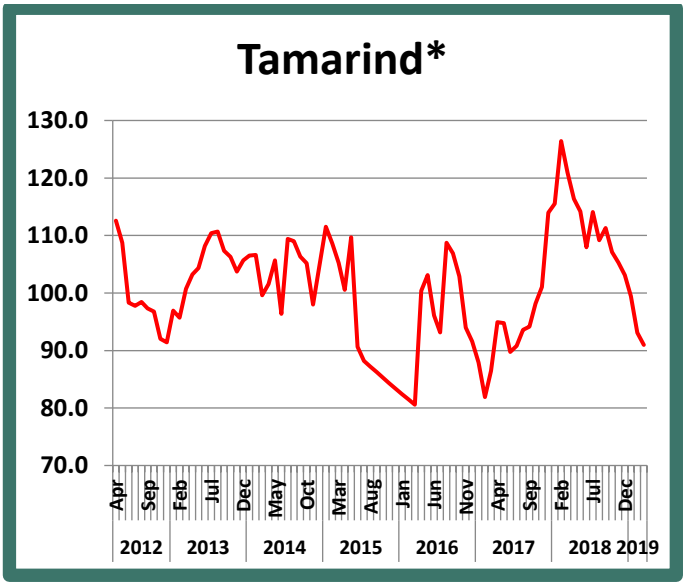


Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

4. Spices (Contd.)

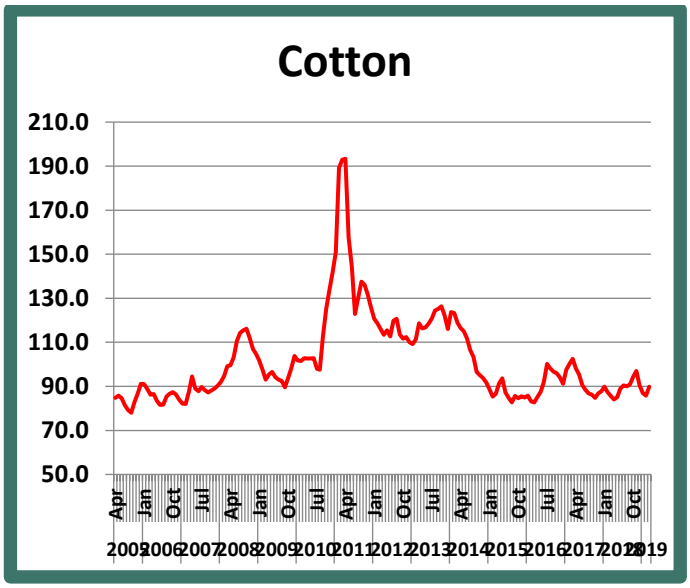
* Period for **Tamarind** is April 2012 to March 2019

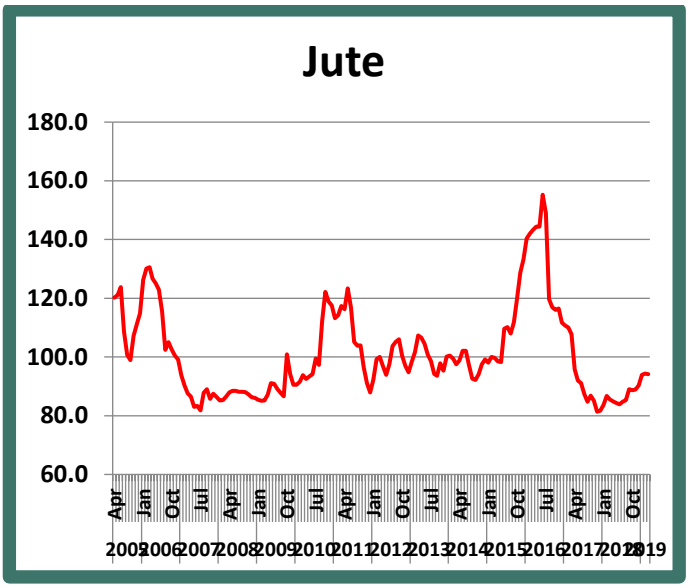


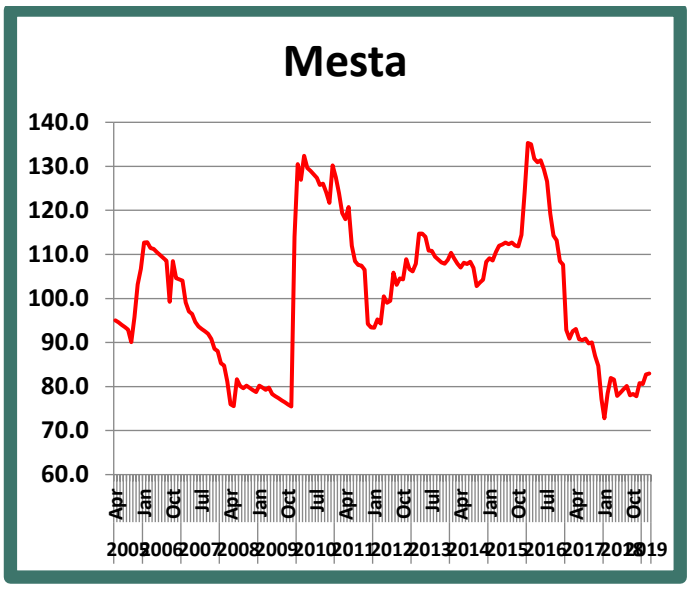


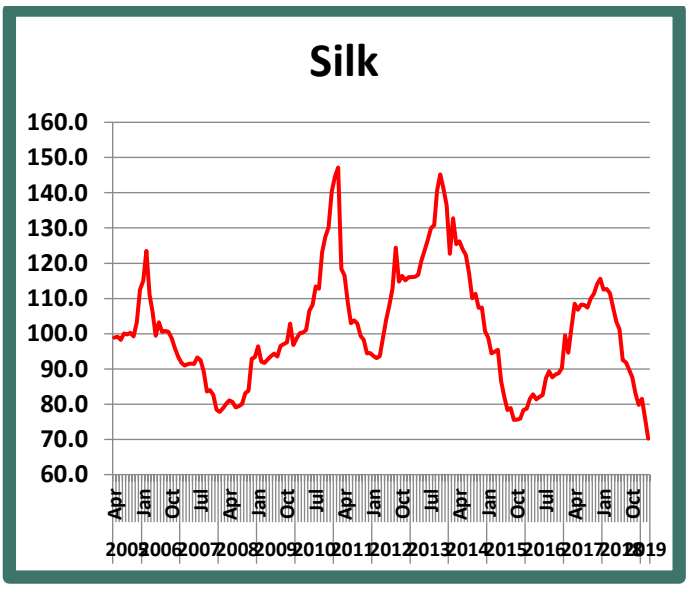
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

5. Fibres



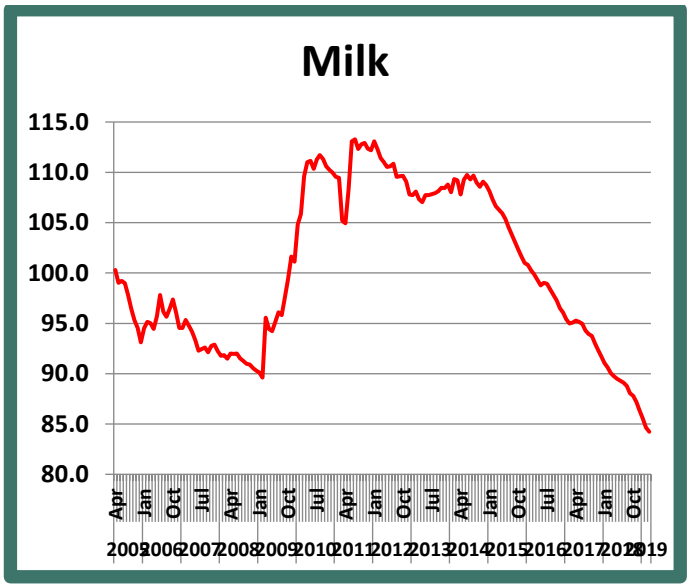


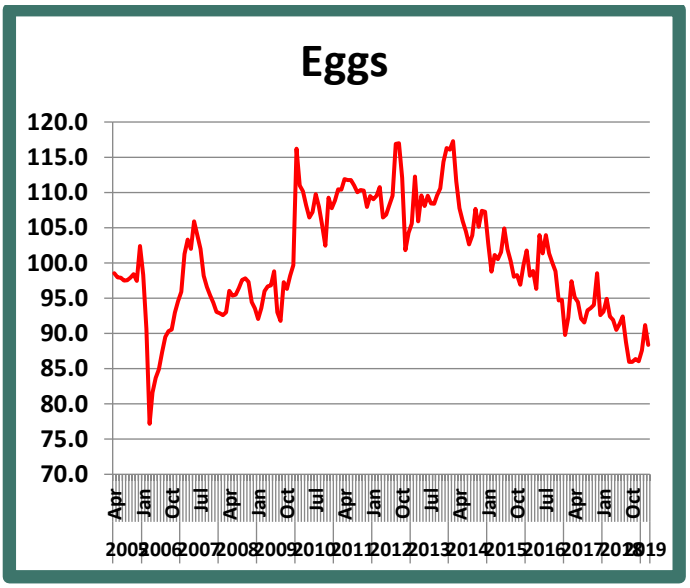


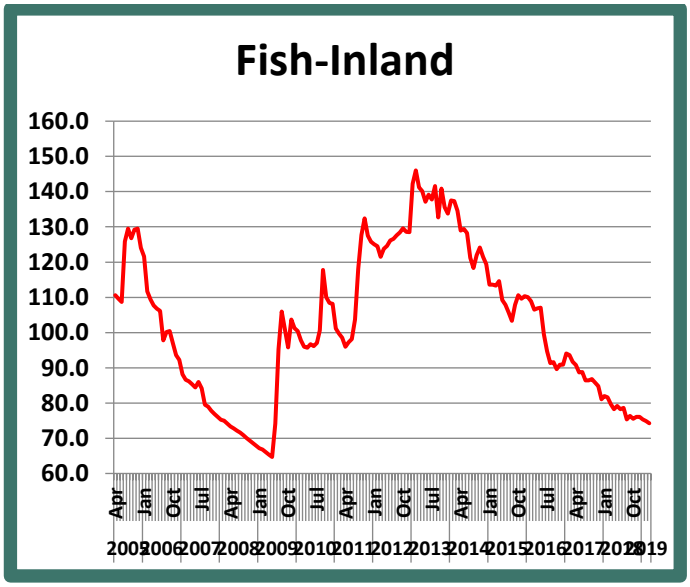


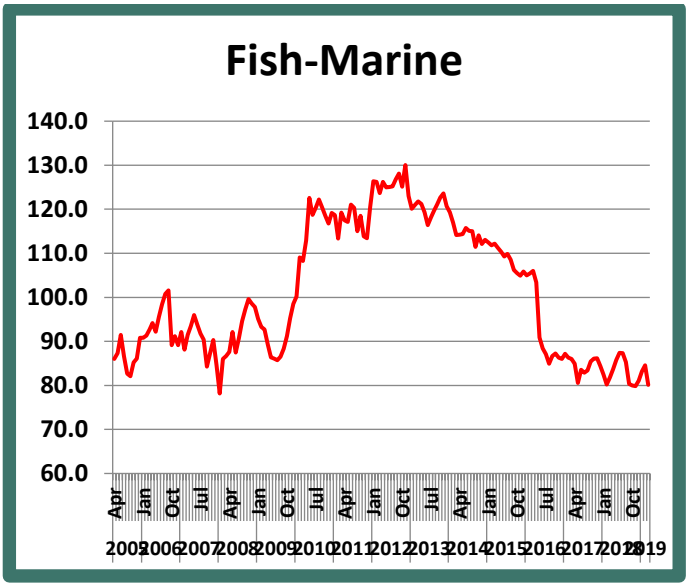
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

6. Livestock and Livestock Products



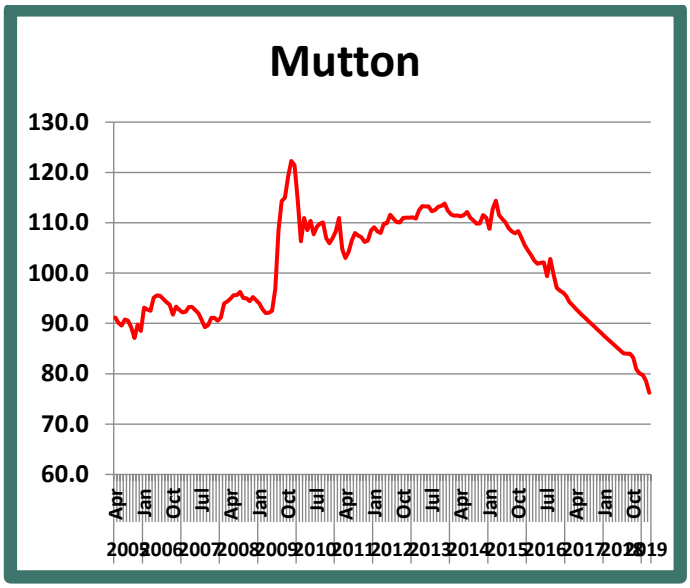


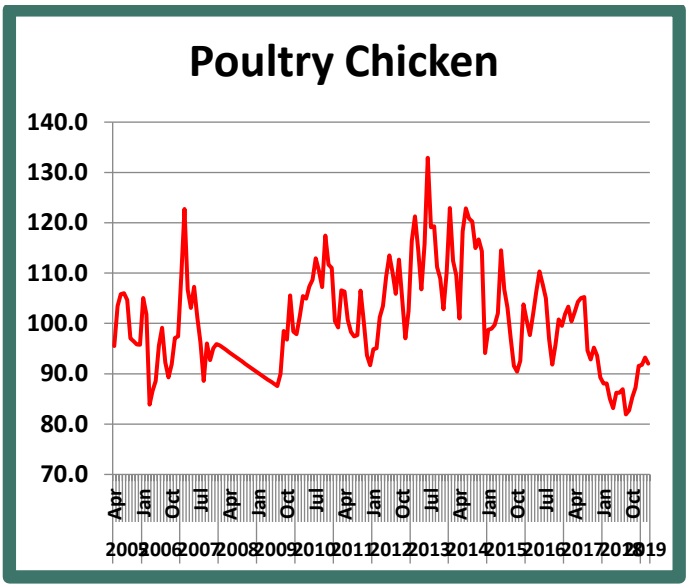


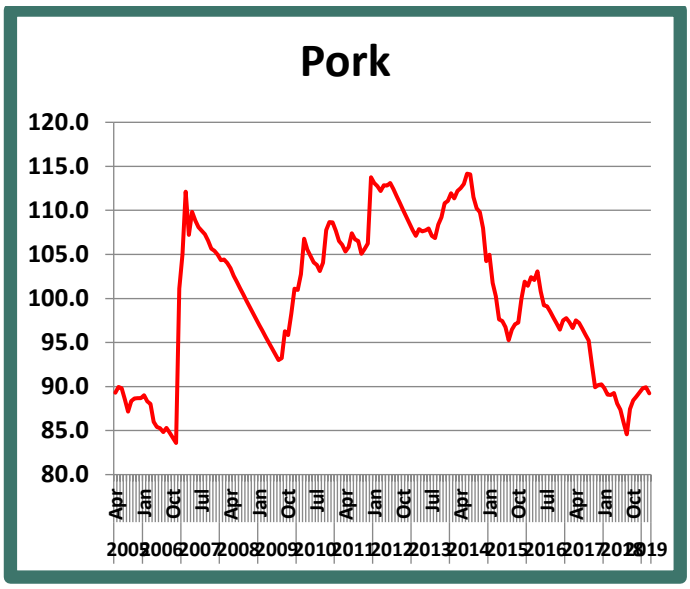


Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

6. Livestock and Livestock Products (Contd.)

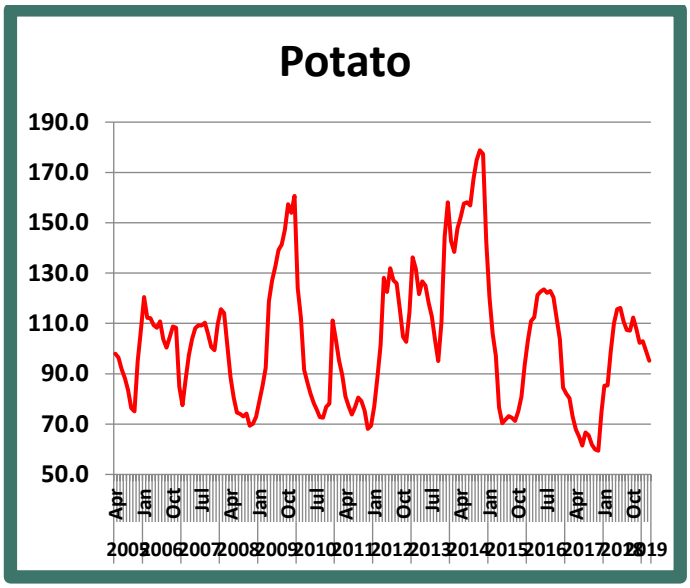


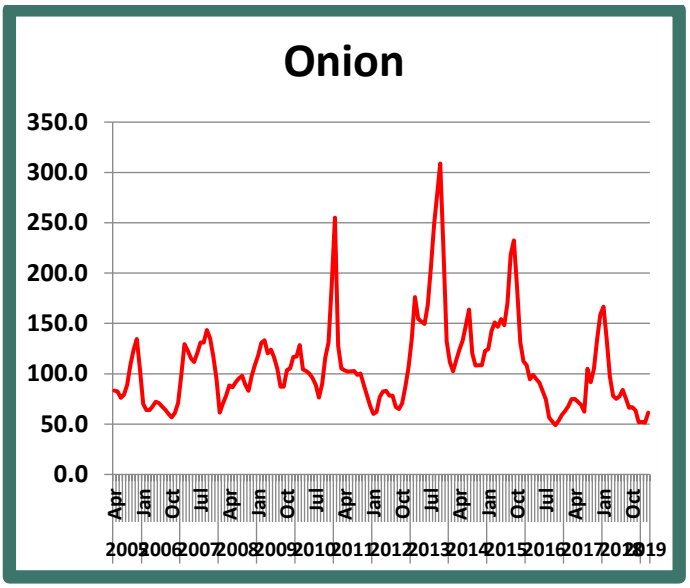


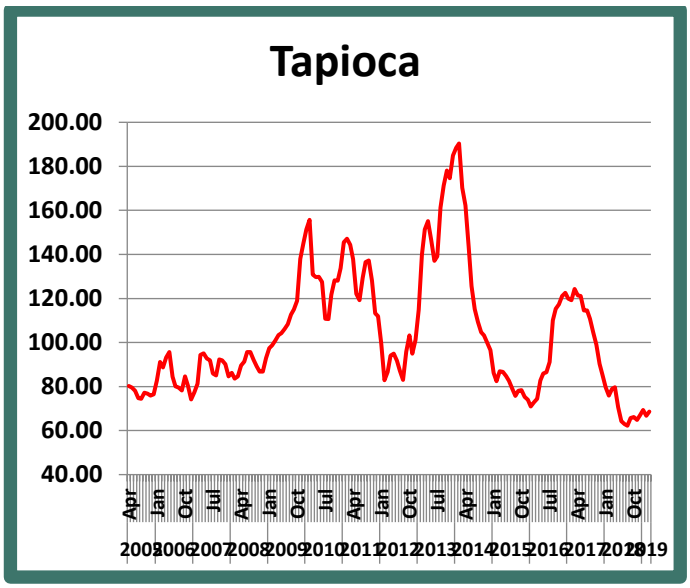


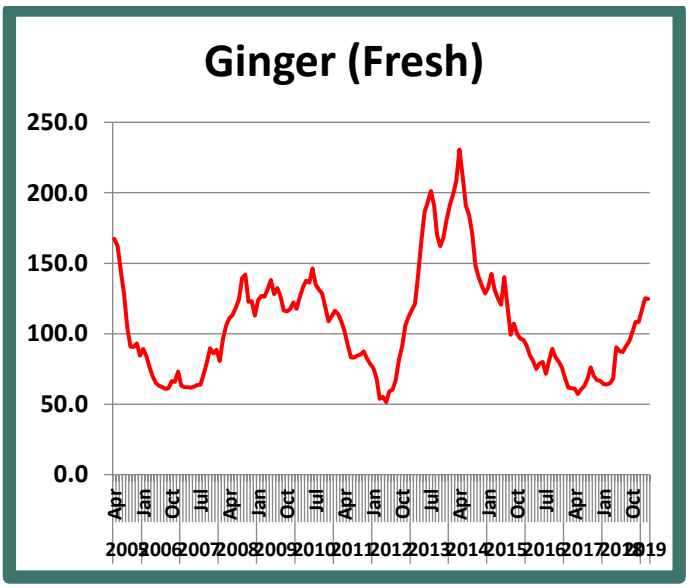
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

7. Vegetables



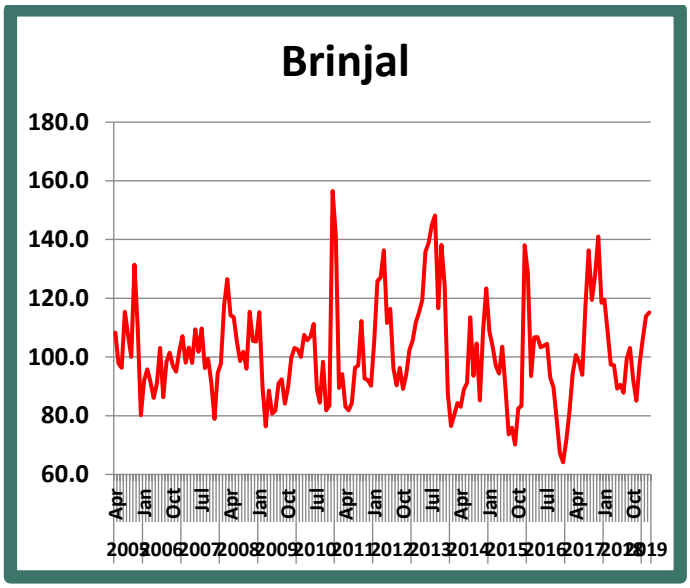


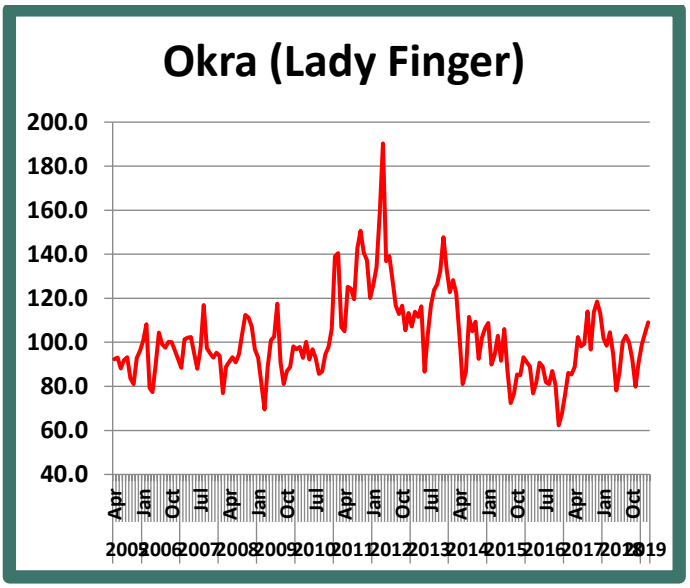


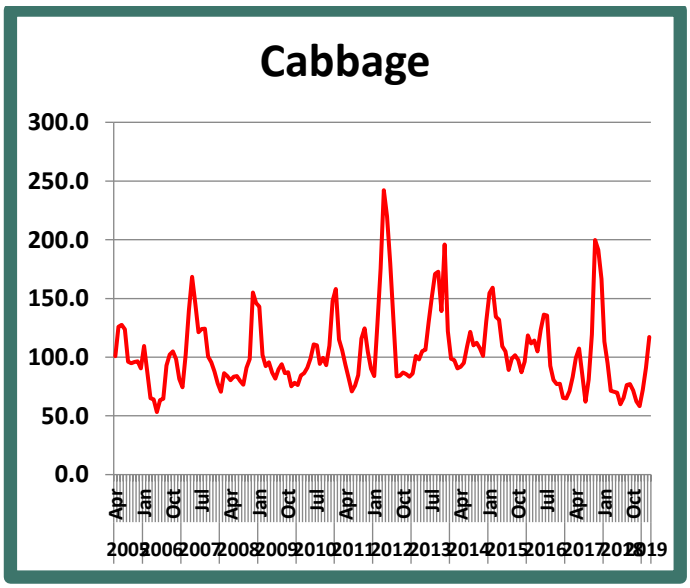


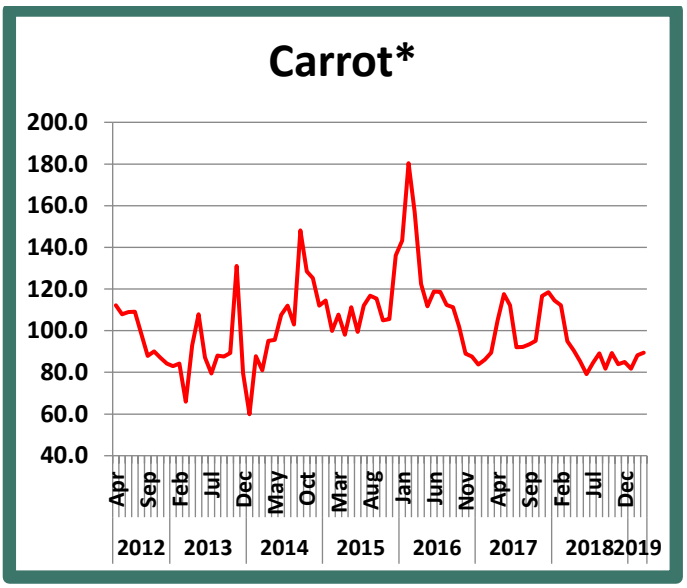
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

7. Vegetables (Contd.)





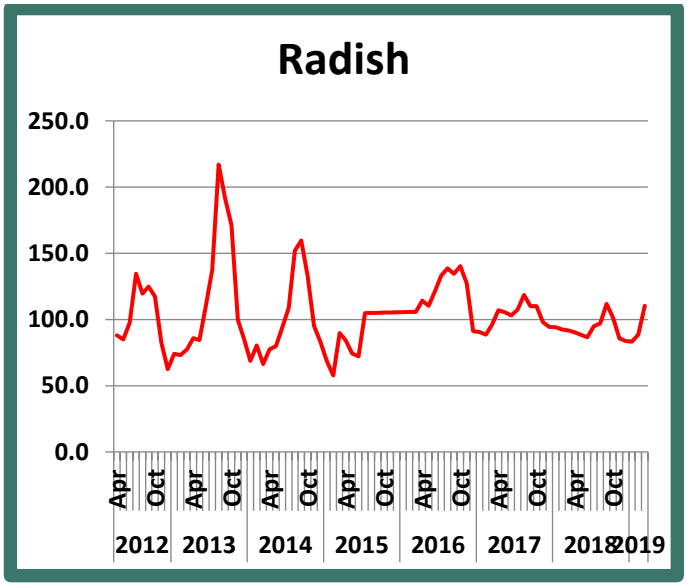


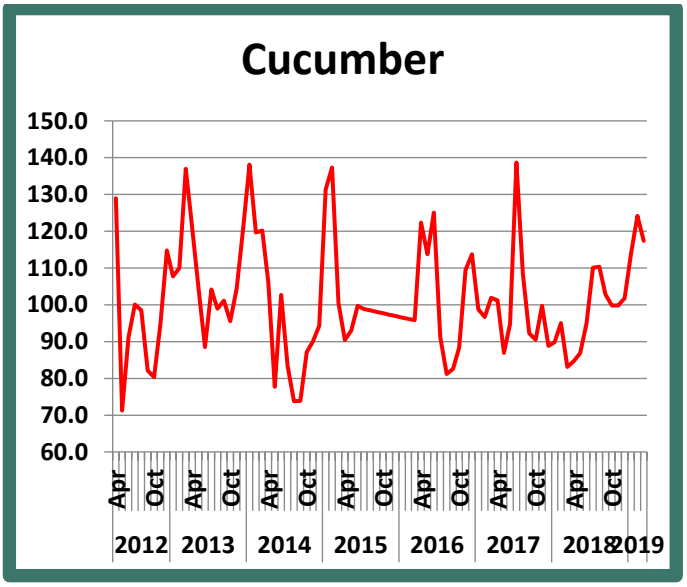


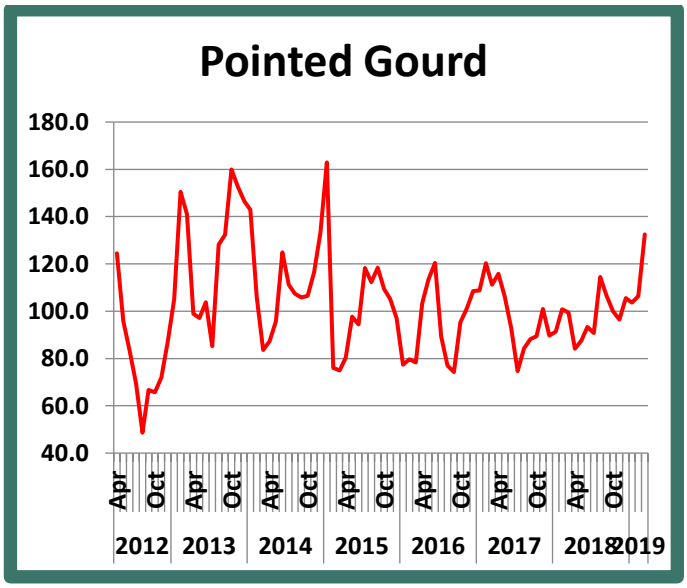
* Period for **Carrot** is April 2012 to March 2019

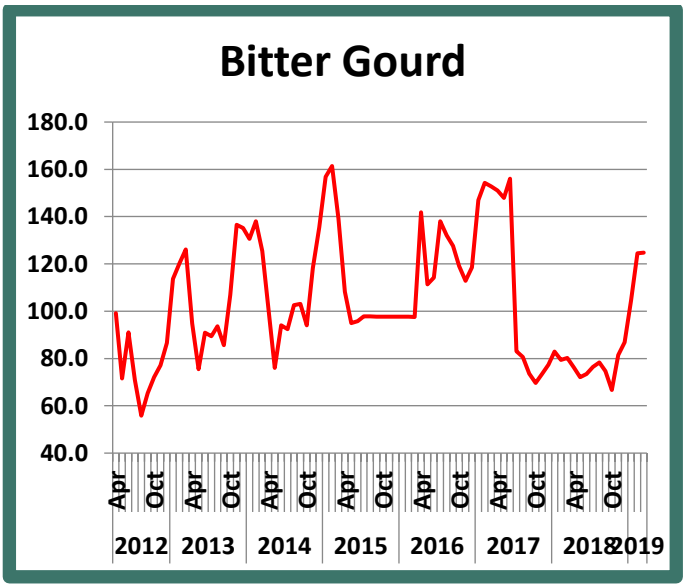
Charts-Set 3: Monthly Residual Prices during April 2012 to March 2019

7. Vegetables (Contd.)



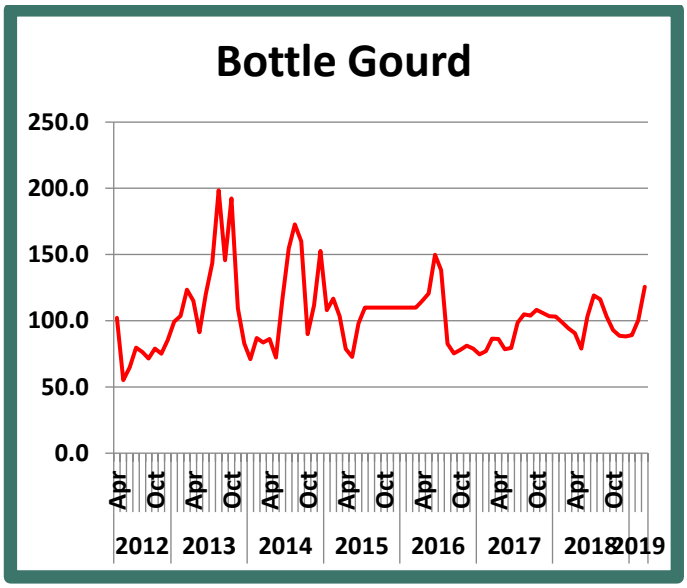


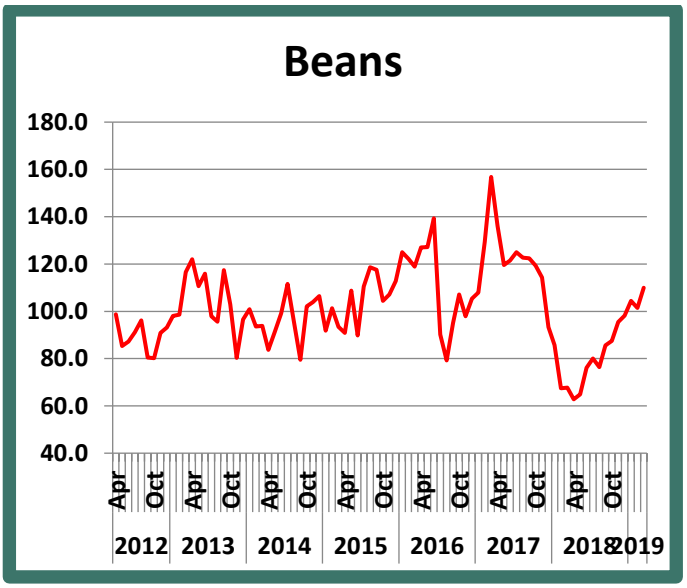


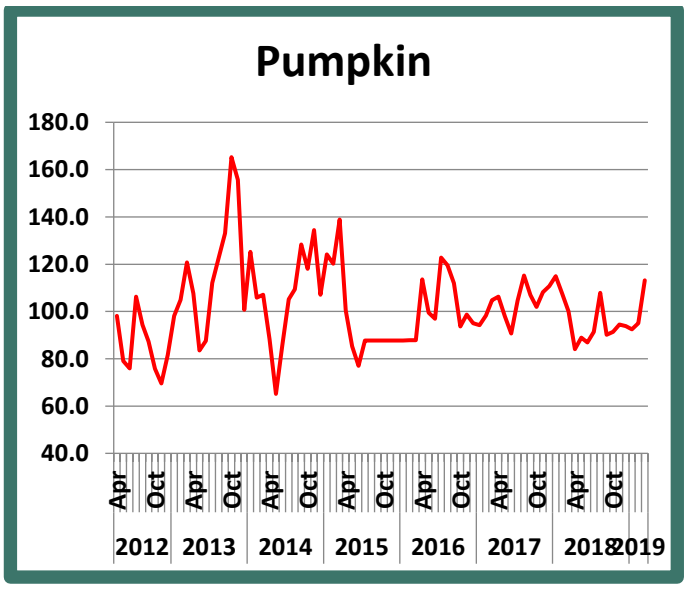


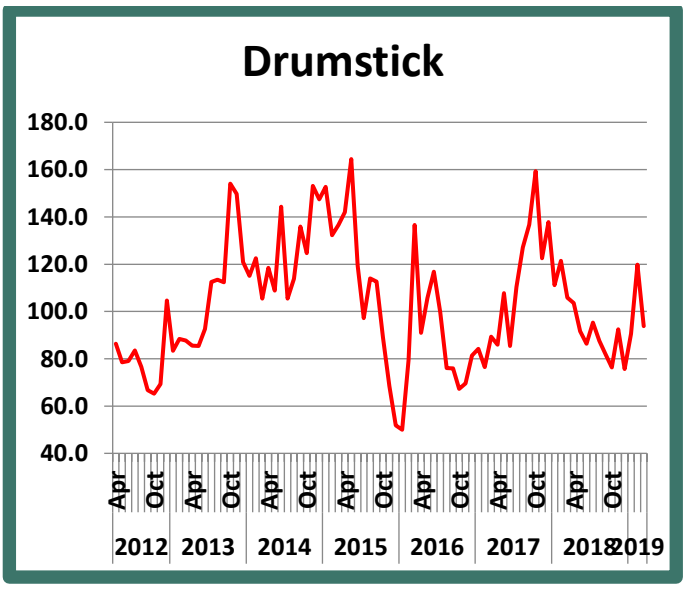
Charts-Set 3: Monthly Residual Prices during April 2012 to March 2019

7. Vegetables (Contd.)



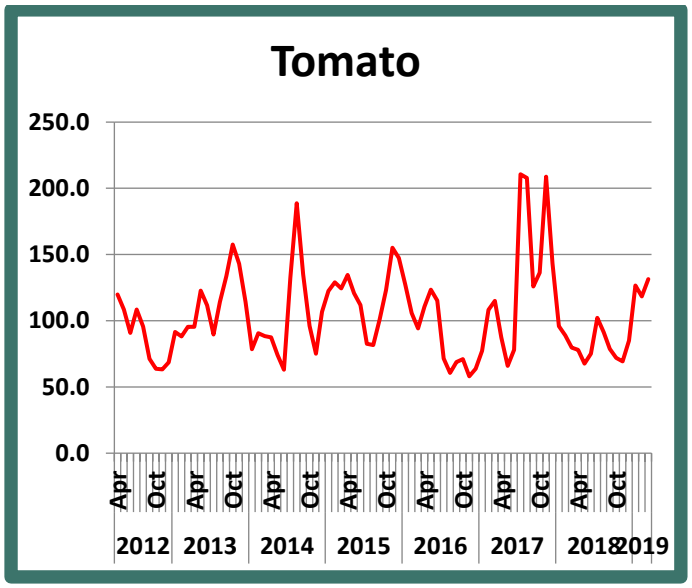






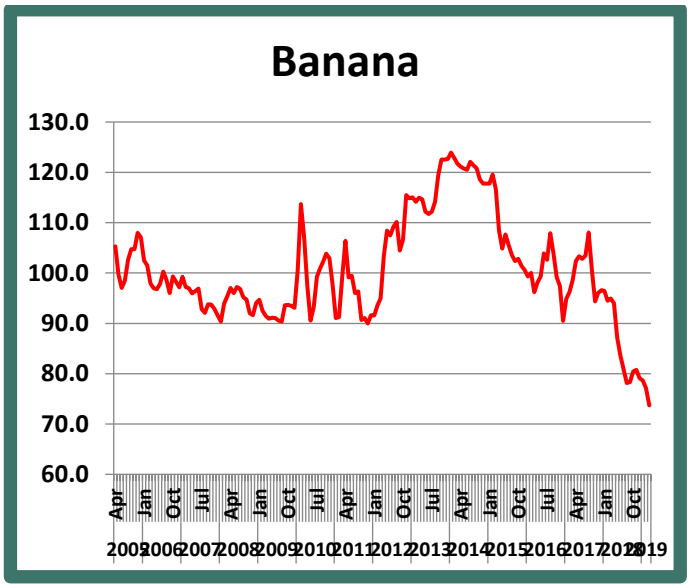
Charts-Set 3: Monthly Residual Prices during April 2012 to March 2019

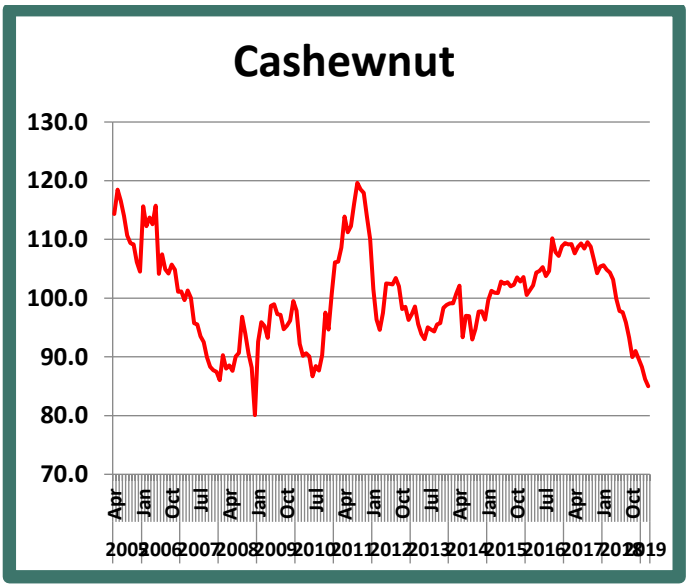
7. Vegetables (Contd.)

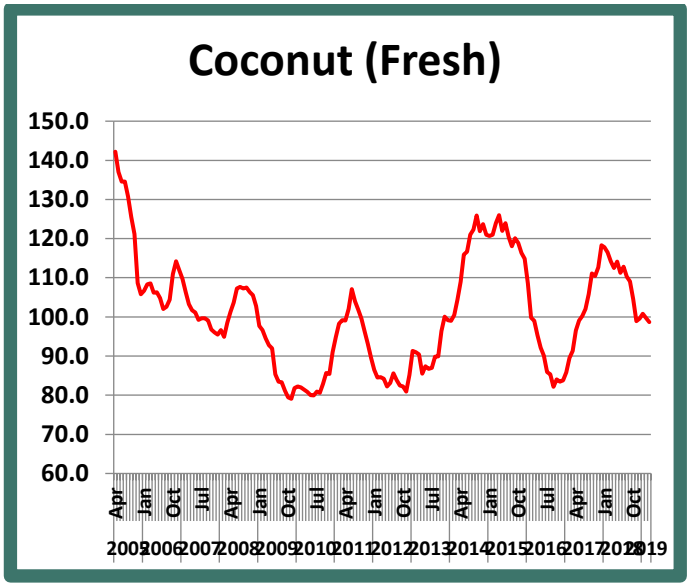


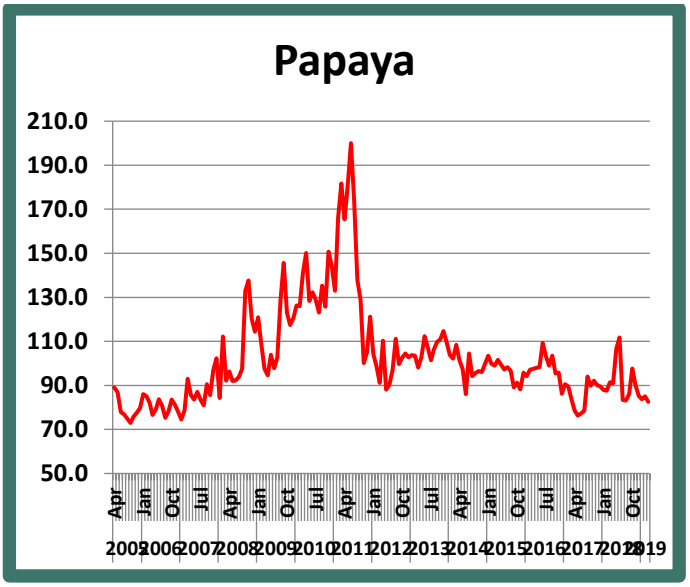
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

8. Fruits



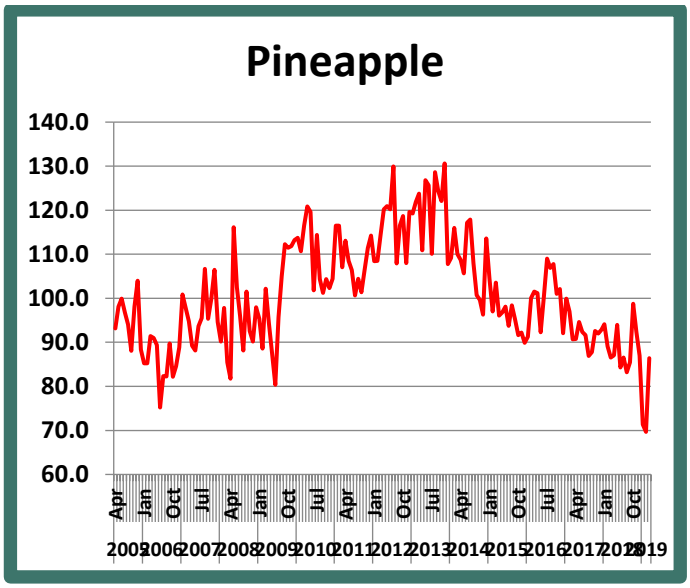


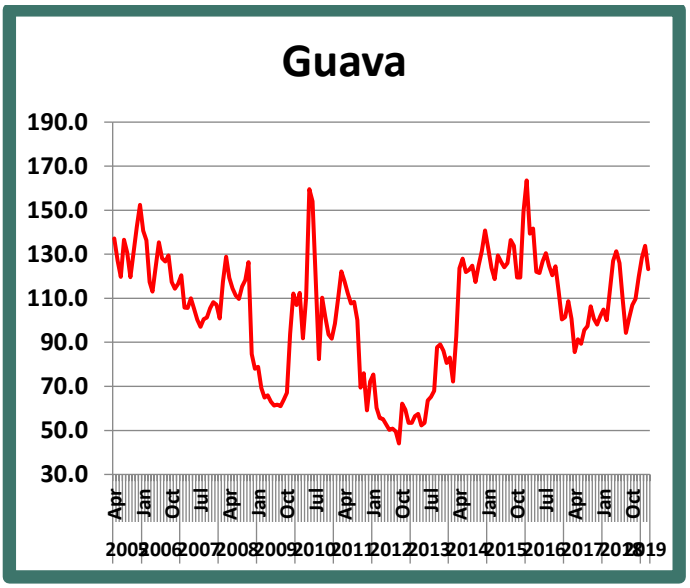


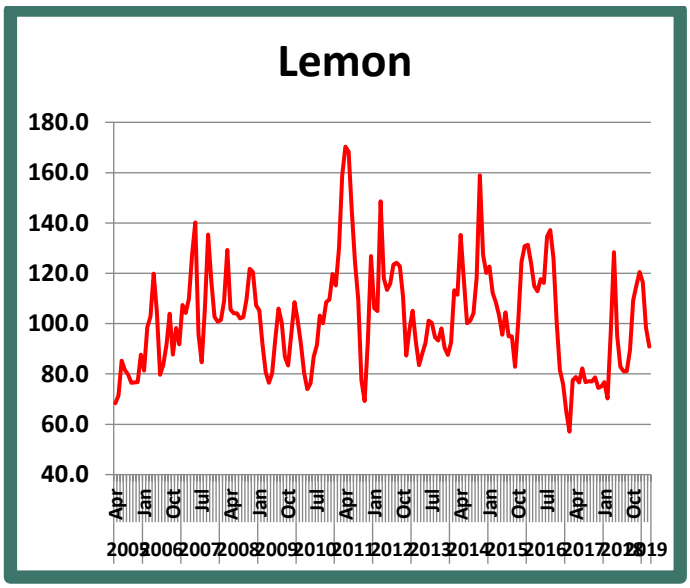


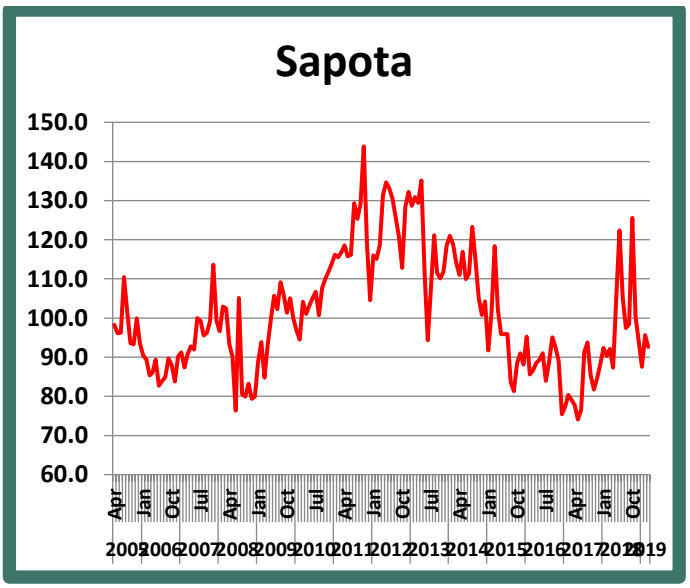
Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

8. Fruits (Contd.)



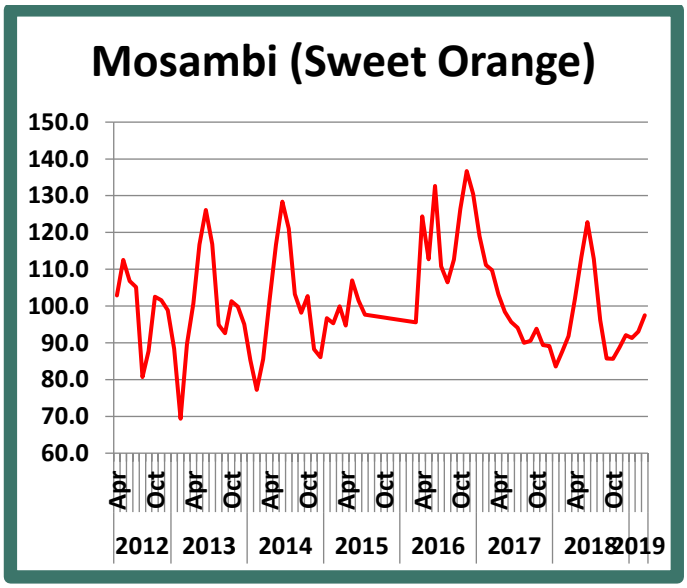


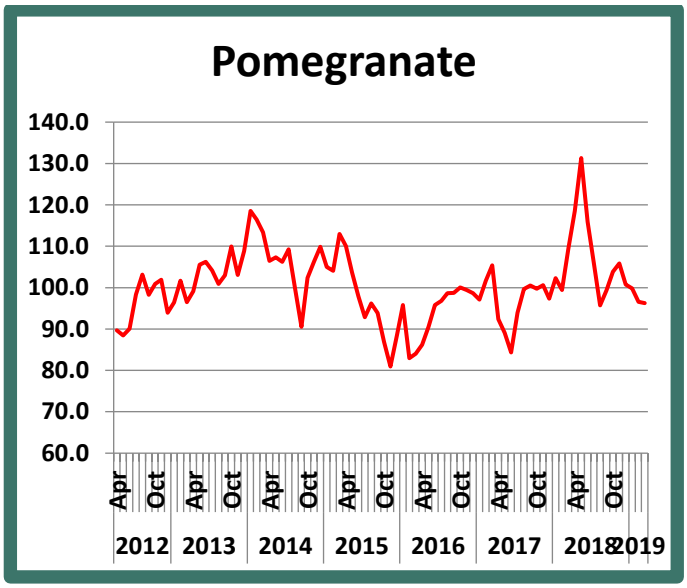


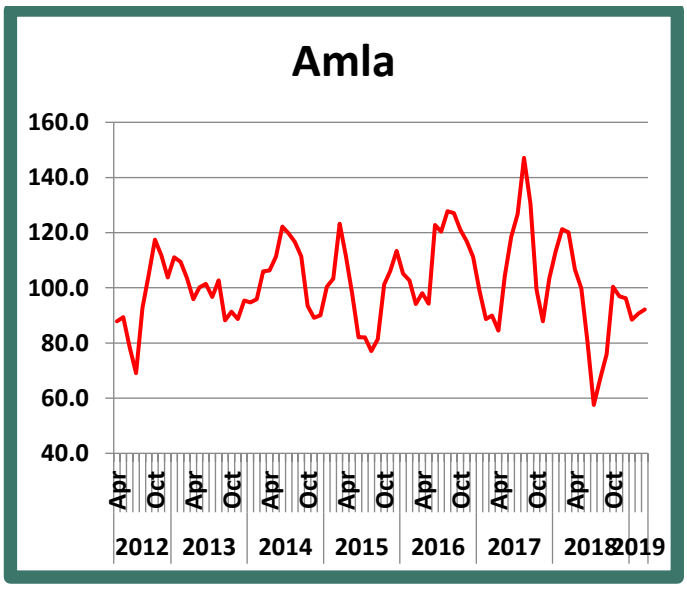


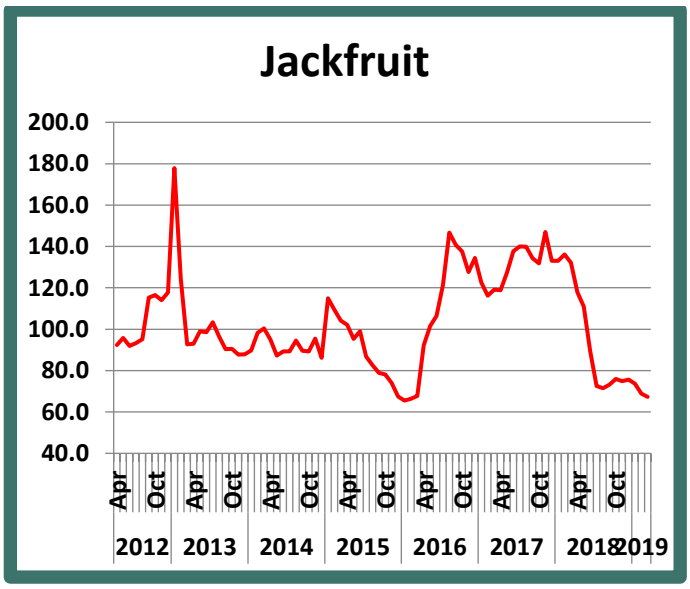
Charts-Set 3: Monthly Residual Prices during April 2012 to March 2019

8. Fruits (Contd.)



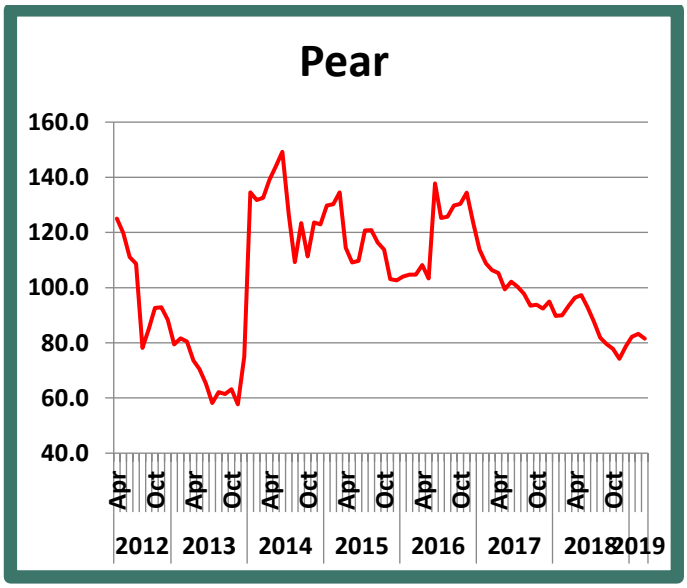


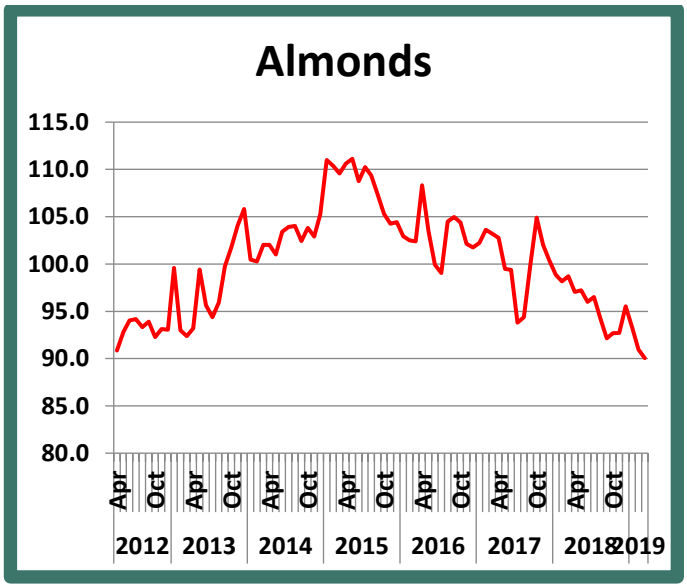


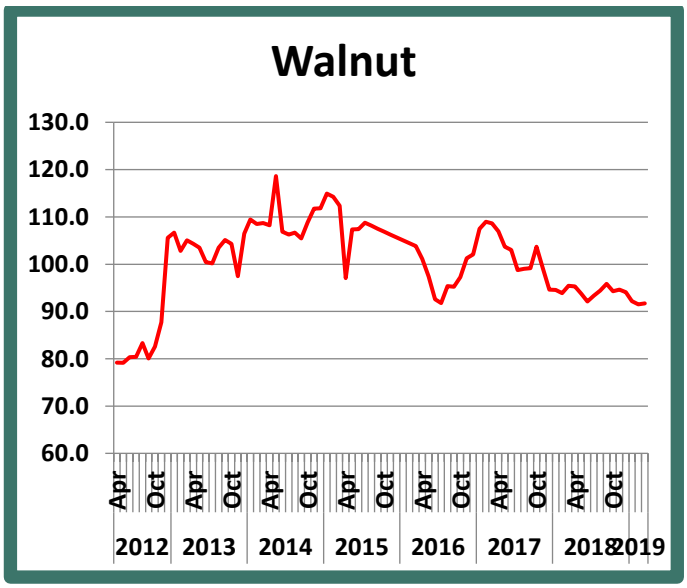


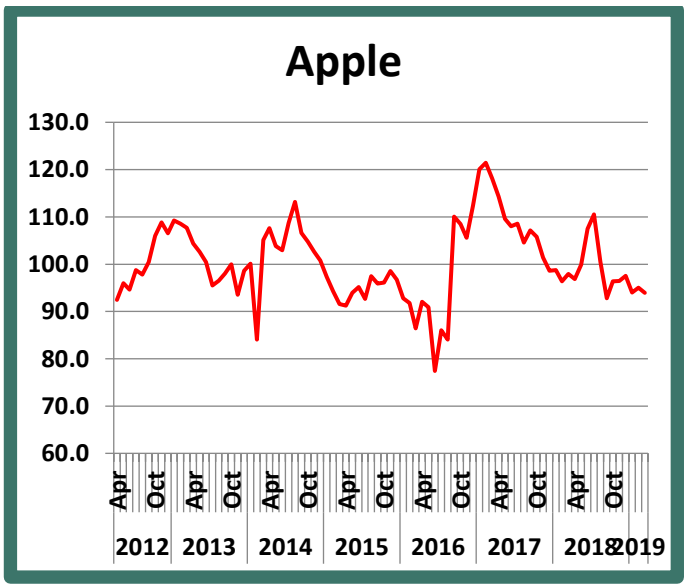
Charts-Set 3: Monthly Residual Prices during April 2012 to March 2019

8. Fruits (Contd.)



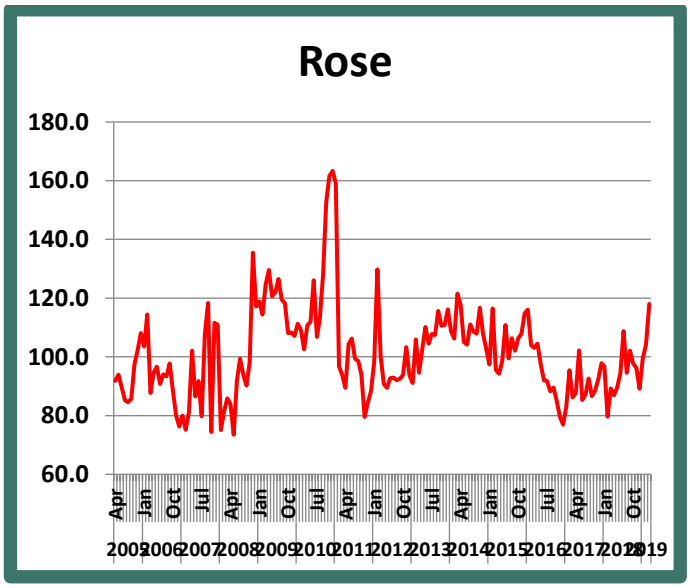


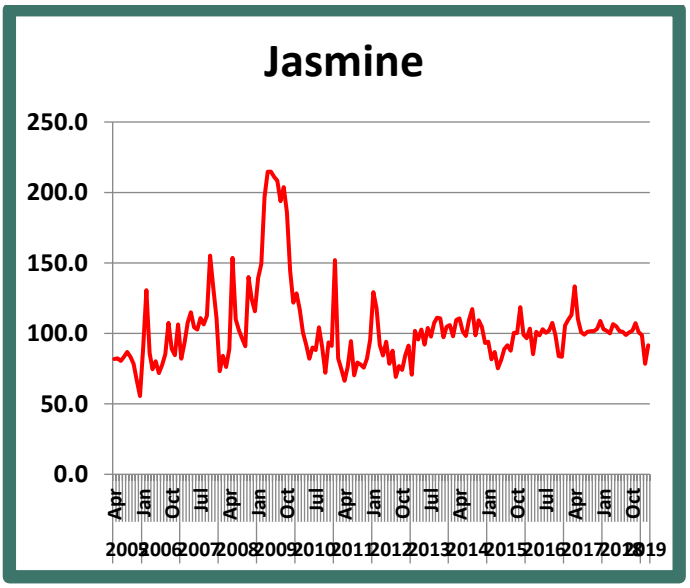


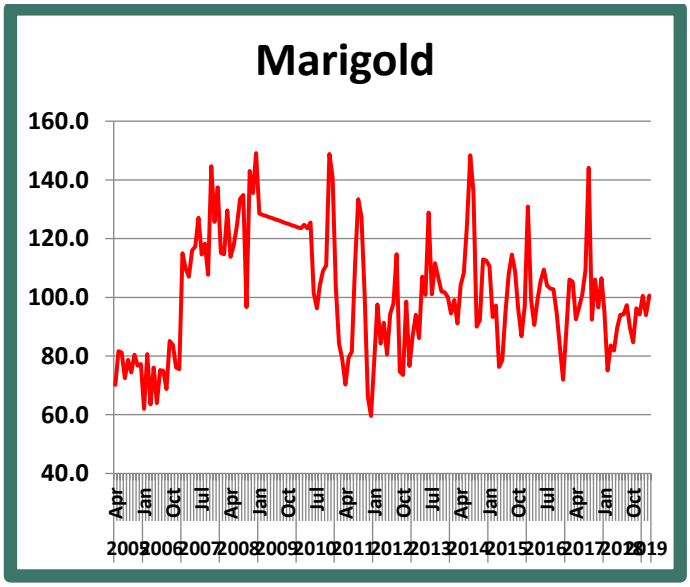


Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

9. Flowers

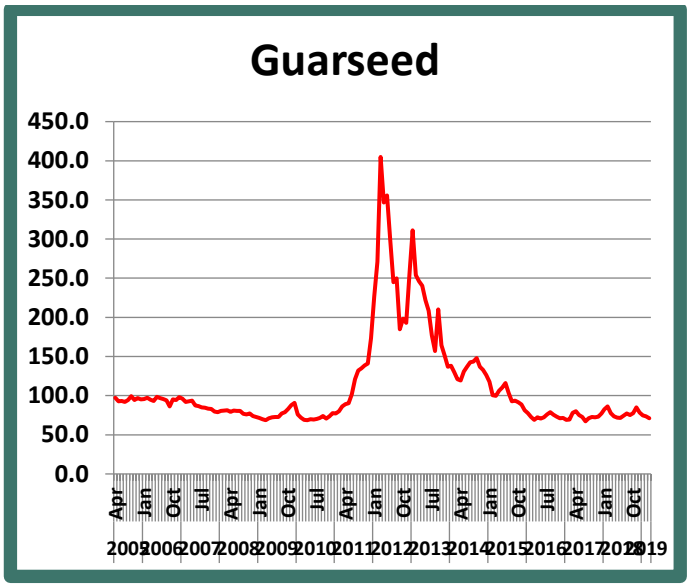


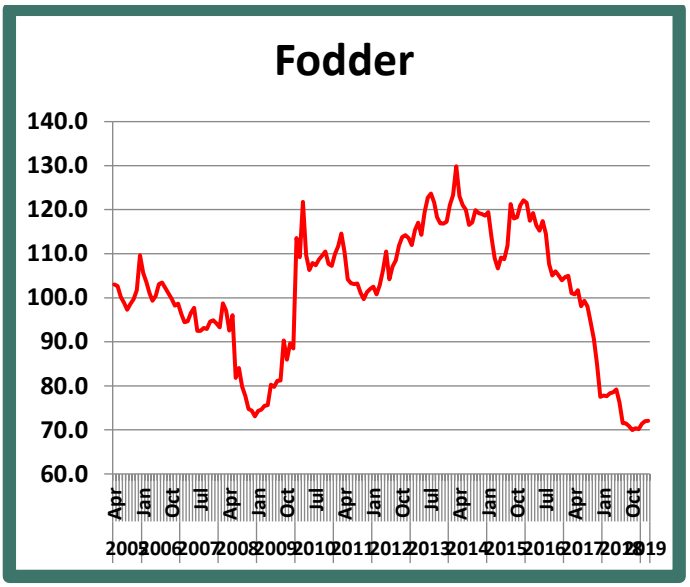




Charts-Set 3: Monthly Residual Prices during April 2005 to March 2019

10. Others





Quotations used in the book:

1. "One ought, every day at least, to hear a little song, read a good poem, see a fine picture, and, if it were possible, to speak a few reasonable words."

--Johann Wolfgang von Goethe

[A quote popularly attributed to Goethe. Source:

https://www.goodreads.com/quotes/441814-one-ought-every-day-at-least-to-hear-a-little]

2. "I did not mean to suggest that stories literally reside in data, or, if I did, I was mistaken. Rather, facts reside in data from which stories can sometimes be woven"

--Stephen Few.

[Stephen Few was attributed to a quote: *"Numbers have an important story to tell. They rely on you to give them a voice." Later he corrected it by saying, "*I did not mean to suggest that stories literally reside in data, or, if I did, I was mistaken. Rather, facts reside in data from which stories can sometimes be woven."] Source:

http://www.stephen-few.com/blog/2017/02/06/tell-me-a-story-or-not/

3. "I wonder if the snow loves the trees and fields, that it kisses them so gently? And then it covers them up snug, you know, with a white quilt; and perhaps it says "Go to sleep, darlings, till the summer comes again."

--Lewis Carrol, *Alice's Adventures in Wonderland and Through the Looking-Glass,* page 126. Source:

https://www.gradesaver.com/through-the-looking-glass/study-guide/quotes

4. "The data analysis must progress by approximate answers, at best, since its knowledge of what the problem really is will at best be approximate"

-- John W. Tukey (1962). *The Future of Data Analysis,* Ann. Mathematical Statistics. Volume 33, Number 1, page 14.

5. “Faced with a choice between a theory which predicts well but gives us little insight into how the system works and one which gives us this insight but predicts badly, I would choose the latter, and I am inclined to think that most economists would do the same.”

--Ronald Coase (1982). *How should economists choose?* American Enterprise Institute, Washington, D. C.). Page 6

6. “It is wrong to suppose that if you can’t measure it, you can’t manage it – a costly myth”

– W. Edwards Deming (2000)**,** *The New Economics, For Industry, Government, Education*, The MIT Press; 2 edition (July 31, 2000) second edition, page 35); Source : https://quotes.deming.org/authors/W._Edwards_Deming/quote/10147

All sources are gratefully acknowledged.