

EMPIRICAL

Price Analysis and Forecasting of Apple: An Empirical Study on Fruit Market of Jammu and Kashmir

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ABSTRACT

Apple is commercially one of the most important temperate fruits and is fourth among the most widely produced fruits in the world with India contributing 2.05 per cent of the total apple production in the world. This study focuses on the behaviour analysis of apple prices, their arrivals and trends from 2003 to 2022. AGMARK (Agriculture marketing) and National Horticulture Board were the secondary data sources for the study. For the empirical study, the seasonal index was calculated to evaluate seasonal trends in the demand for apples annually and a polynomial regression model was used for accessing the trends and predictive analysis. Besides, two-period and three-period moving averages were taken as technical indicators to determine the future course of the market. The findings of this study unraveled that June has the highest seasonal index for price with 2.25 followed by May and April with 1.78 and 1.39, respectively, whereas quarterly, the second quarter shows the highest seasonality of 1.63. For arrivals, the month of October records the highest seasonality of 5.39 followed by November and September with 2.43 and 2.38 respectively and if taken quarterly, the fourth quarter shows the highest seasonality of 2.91. CAGR was used as an instrument of analysis to figure out the growth in minimum, maximum and modal prices which were found to be 7.71%, 9.52% and 8.75% respectively. The forecasting model predicted the prices for the next eight years i.e., from 2023 to 2030 where the prices for the year 2023, 2025 and 2030 will be ₹ 6379.21/qtl, ₹ 7154.02/qtl and ₹ 9293.78 /qtl, respectively. Therefore, the novelty of the research is that the growth rate in the maximum prices of apples is higher than the minimum prices. Besides, the other indicators like the polynomial regression model and moving average also indicate uptrend signals. Hence, all analytical tools show a noteworthy hike and viable market potential.

HIGHLIGHTS

- The study highlights that apple prices peak in the second quarter (April–June), with June being the most profitable month, while arrivals are highest in October due to harvest season.
- Improved storage and logistics have enabled year-round supply, stabilizing prices.
- Market trends predict a 60% price increase by 2030, indicating strong future potential.

Keywords: Apple, Seasonal index, Polynomial regression, Price and arrival, Forecasting

Horticulture is the science and art of production, utilisation and improvement of horticultural crops, such as fruits and vegetables, spices and condiments, ornamental, plantation, medicinal and aromatic plants. Horticulture crops perform a vital role in the Indian economy by generating employment, providing raw materials to various food processing industries, and higher farm

profitability due to higher production and export earnings from foreign exchange.

India is the second largest producer of fruits and vegetables in the world after China and is recognized

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as the fruit basket of the world (Choudhary and Kundal, 2015; Saxena *et al.* 2015). In India, about 55–60 per cent of the total population depends on agriculture and allied activities. Horticultural crops constitute a significant portion of the total agricultural produce in India. They cover a wide cultivation area and contribute about 28 per cent of the Gross Domestic Product (GDP). These crops account for 37 per cent of the total exports of agricultural commodities from India. Total Horticulture production in 2021-22 is estimated to be 341.63 million tonnes, an increase of about 7.03 Million tonnes (an increase of 2.10%) over 2020-21. According to (Second Advanced Estimate) 2021--22, the fruit production is estimated to be 107.10 million tonnes compared to 102.48 Million tonnes in 2020-21.

The apple (*Malus pumila*), which ranks fourth among fruits produced worldwide behind the banana, orange, and grape, is the most significant temperate fruit commercially. India is a growing market for apples, sustained by economic growth and improved per capita incomes. As the commodity has entered the worldwide trade, apples are becoming increasingly significant in the global fruit economy.

The area under apple cultivation in India increased by 24% from 1.95 lakh ha. in 1991-92 to 2.42 lakh ha. in 2001-02 although production increased by less than 1% (i.e., from 11 to 12 lakh tones) (NHB). The area under the Second advanced estimate (2021-22) of apple was 313 thousand hectares which were the same as the previous financial year and its production was 2437 thousand million tonnes respectively. It is mostly grown in the states of Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Arunachal Pradesh and Nagaland. Out of these states, Jammu and Kashmir alone contribute 70.54% with the production of 1719.4 thousand tonnes followed by Himachal Pradesh which shares 26.42% with the production of 643.85 thousand tonnes. (NHB, 2021-22 (1st Adv. Estimate). While apple farming provides livelihood to over 45 lakh people in Kashmir and produces around 2 million metric tonnes of apples every year, its apple industry is estimated to be worth ₹ 10,000 crore. Cultivated over 1.45 lakh hectares of land, apple produce contributes about 8.2 per cent to the J&K GDP.

Apple is exported to over 75 countries. The top 5 countries that import apples from India are United

Arab Emirates (0.37 USD Million), the United Kingdom (0.32 USD Million), Nepal (0.26 USD Million), Thailand (0.24 USD Million), Vietnam (0.22 USD Million). The total export value of apple fruit in these countries is 1.41 USD million. These top 5 countries account for over 61.3% of the total apple fruit export from India.

Therefore, the following research was carried out to bridge the research gap pertaining to apples and find answers to the unsettled queries concerning the direction of the apple market of J&K, the following research was carried out. This research would not only provide an idea about the seasonality in apples but also predict the expected prices for the next eight years, thereby, giving a better prospect of trading in the commodity.

METHODOLOGY

The secondary data required for this study were collected from National Agriculture Market (eNAM) and Agricultural Marketing (AGMARK) to perform price analysis and forecasting of apples. Following statistical and analytical tools were used to meet the desired ends of the research.

Seasonal index

To evaluate seasonal trends in the prices of apple or its services/ arrivals, the seasonal index as an analytical tool was used. A seasonal index explains the relationship of a particular season's cycle with its average. So, to assess the seasonal trends in the arrival and prices of apples, subsequent steps were used

1. Arrangement of data in months and years.
2. Average $\bar{X}_i$, ($i = 1, 2, \dots, 12$) for the i^{th} month for all the years. [i^{th} month, $i = 1, 2, \dots, 12$ representing months as January, February..., December respectively].
3. Average $\bar{X}$ of the monthly averages, i.e.,

$$\bar{X} = \frac{1}{12} \sum_{i=1}^{12} \bar{X}_i$$
4. Seasonal indices for different months are obtained by expressing monthly averages as a percentage of $\bar{X}$. Thus, Seasonal index for i^{th} month $(\bar{X}_i | \bar{X}) \times 100$; $i = 1, 2, \dots, 12$.

Similar procedure was followed to evaluate the seasonal index on a quarterly basis.

Generally, Seasonal indices have an average value of 1. A value of more than 1, for example, 1.3 means that the season had 30% more than the seasonal average and a value of less than 1, for example, 0.6 means 40% less than the seasonal average.

Compound annual growth rate

To assess the growth rate of minimum, maximum and modal prices of the apple from the year 2003 to 2022, the compound annual growth rate was used as an analytical tool, having an exponential function of the form,

$$Y = ab_t U_t$$

where Y = Area / Yield / Production /Productivity/ Export

a = constant

U_t = Disturbance term in year ' t '

The compound growth rate will be calculated from the fitted exponential regression parameter b .

Average annual compound growth rate will be calculated by using the following formula;

$$CAGR = [(Antilog (\log b - 1))] \times 100$$

Polynomial regression model

For the best approximation of the relationship between the dependent and independent variable in the trend analysis of the time series data on prices and arrivals, a broad range of function as the polynomial regression model of the form $y = \alpha x^2 + \beta x + \gamma + e^0$ was used.

Where,

x = time in number of years

y = modal price of apple in ₹ Per quintal

α = regression coefficients of x^2 (slope)

β = regression coefficient of x (slope)

γ = constant

e_0 = error term

Simple Moving Average

To predict the future course of the market, a simple moving average was used. A moving average is a frequently used indicator in technical analysis that

helps in disentangling the price data by fabricating an average price. The purpose of calculating the moving average is to attenuate the effect of all the random, short-term alterations or variations occurring in the commodity prices over a certain time span.

We know that, the longer the period for the moving average, the greater the lag. A rising moving average indicates that the market is in an uptrend, while a sinking moving average indicates that it is in a downtrend. Therefore, an upsurge in the moving average illustrates an upswing in the price of the commodity whereas a downslide would be seen as a sign of decline.

The formula for calculating the simple moving average is as;

$$SMA = A1 + A2 + \dots \dots \dots An/n$$

Where SMA = Simple moving average

A = Average in period n

n = No. of time periods

RESULTS AND DISCUSSION

A seasonal index was used for the short-term forecast of the time series data to predict future scores. In general terms, seasonality refers to variations in business cycles over a period of time that occurs constantly on a particular seasonal basis.

Table 1 depicts that the seasonal index for prices was the highest at 2.25 in the month of June and lowest at 0.61 in the month of September. Similarly, on a quarterly basis, it was the highest during the second quarter i.e., Q2 with 1.63 and the lowest in Q4 with 0.72. On the other hand, for arrivals, the seasonal index was highest in the month of October at 5.39 and lowest at 0.01 in July and for the quarters it was maximum during the fourth quarter with 2.91 and a minimum of 0.02 in the second quarter.

From the above observations, it is very evident that prices and arrivals share an inverse relationship between them, i.e., when the arrivals are more/high, the prices are low and *vice-versa*.

Fig. 1 clearly shows that the seasonal index of apple prices almost remains stagnant from July to December whereas the arrivals keep fluctuating during the same period. The reason governing this

scenario is that, during this period, the demand for apples in the market is more or less the same.

Table 1: Seasonal Index of Apple (Price and Arrival)

Months	Seasonal index (Price)	Seasonal index (Arrival)
January	0.70	0.22
February	0.96	0.32
March	0.98	0.08
April	1.39	0.04
May	1.78	0.04
June	2.25	0.03
July	0.70	0.01
August	0.65	0.29
September	0.61	2.38
October	0.64	5.39
November	0.66	2.43
December	0.68	0.77
Quarters		
Q1	0.91	0.17
Q2	1.63	0.02
Q3	0.74	0.89
Q4	0.72	2.91

*Source: Agriculture Marketing (AGMARK)

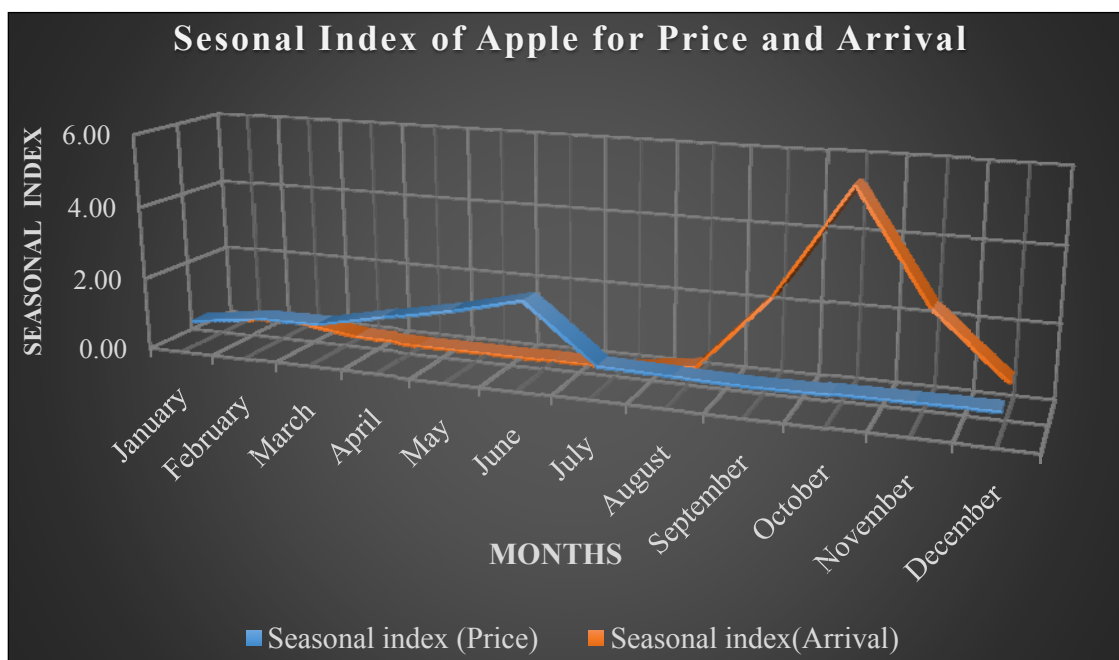
However, if we take a look at the year-on fluctuations for prices, they begin to increase slowly from

January and reach their maximum during the month of June and from then on, they fall by the month of July after which they remain stagnant. For arrivals, there are hardly any fluctuations from January to July after which there is a slight uplift and it keeps on increasing till it reaches its peak during the month of October and then slowly continues to decline till December.

Table 2 summarizes the CAGR results for the average of minimum, maximum and modal prices of apple (₹/quintal) in Narwal Mandi of Jammu, which were taken from the period of study i.e., 2003 to 2022, where we see that the minimum prices during the study period showed a growth rate of 7.71%. For the maximum prices of apple in the market, a growth of 9.52% was observed and regarding the modal prices, the computed CAGR was 8.75%.

Table 2: Average prices of Apple (Minimum, Maximum and Modal)

Years	Average of Min Price (₹/Quintal)	Average of Max Price (₹/Quintal)	Average of Modal Price (₹/Quintal)
2003	1046.84	1248.73	1149.53
2004	1103.29	1451.60	1277.44
2005	1525.15	1777.84	1651.20



*Source: Table 2. Seasonal Index of Apple (Price and Arrival)

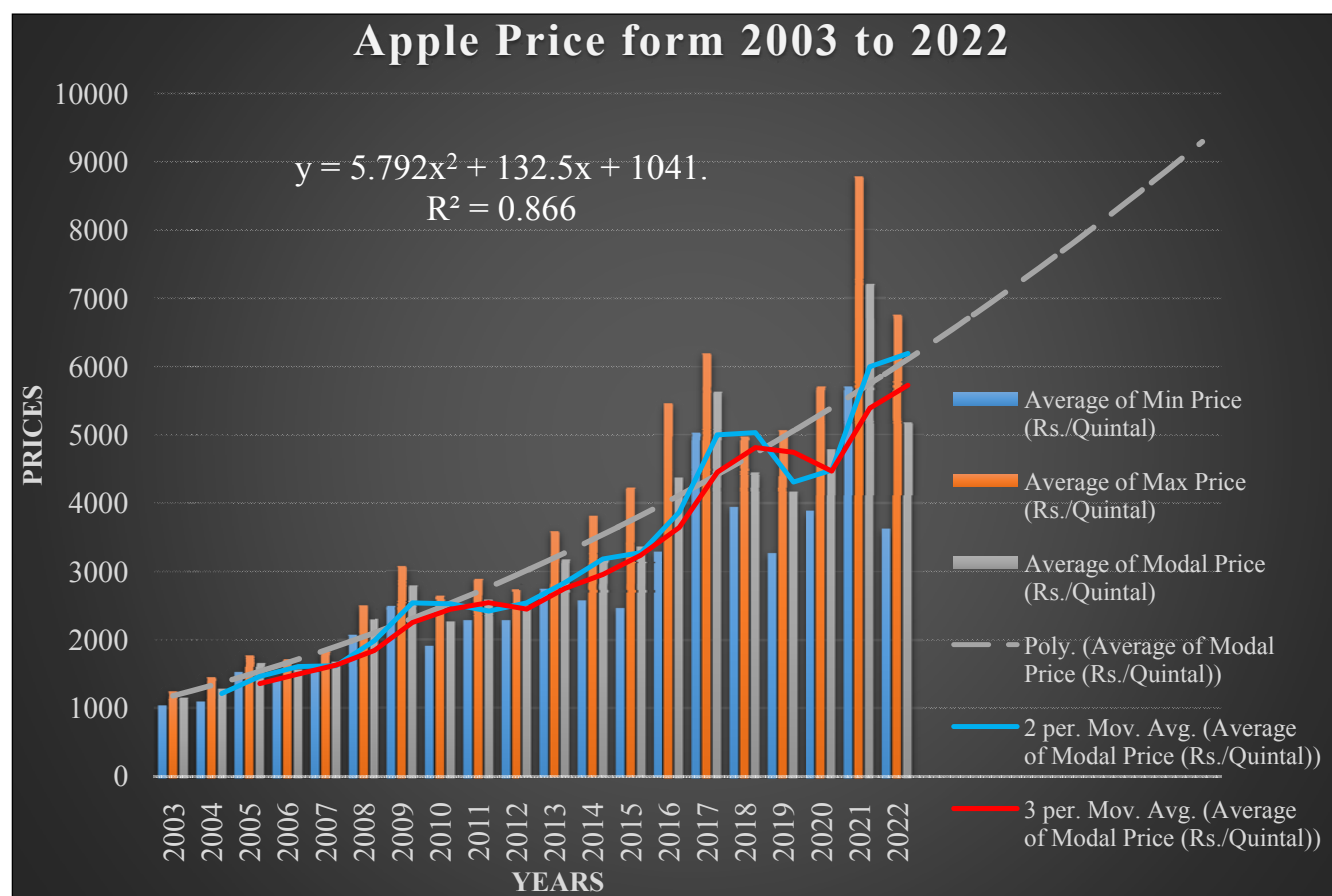
Fig. 1: Seasonal Index of Apple for price and arrival

2006	1404.71	1722.20	1563.68
2007	1532.29	1825.35	1679.17
2008	2079.29	2507.63	2291.14
2009	2489.81	3064.81	2789.49
2010	1899.65	2626.86	2263.43
2011	2283.91	2879.57	2581.74
2012	2272.89	2733.33	2503.32
2013	2746.34	3598.17	3172.13
2014	2570.59	3821.90	3196.73
2015	2468.61	4233.63	3356.28
2016	3297.78	5459.44	4382.78
2017	5030.66	6197.21	5622.47
2018	3947.51	4970.61	4444.44
2019	3275.71	5070.06	4175.42
2020	3888.81	5705.59	4796.85
2021	5705.02	8779.57	7203.76
2022	3617.32	6752.68	5183.54
CAGR	7.71%	9.52%	8.75%

*Source: Agriculture Marketing (AGMARK).

Table 3 encapsulates the actual modal prices of apples (₹/quintal) from 2003 to 2022 and the predicted modal prices of the same period along with the forecasted prices from the year 2023 to 2030. The prices of apples are estimated to be ₹ 6379.21, ₹ 7154.02 and ₹ 9293.78 per quintal for the years 2023, 2025 and 2030 respectively.

Graph 2 demonstrates the trend analysis actualized by means of the polynomial regression model, further used to predict Apple prices for the next 8 years and the 2-period–3-period moving averages to notice the price signals being positive or negative. Here, we may infer that the slower moving average (2-period moving average) intersects the upper moving average (3-period moving average) from below, proposing uptrends in the market prices which is the same as recommended by the polynomial regression model. The calculated value of R^2 was found to be 0.8667, being statistically significant.



*Source: Table 4 Average prices of Apple (Minimum, Maximum and Modal)

Fig. 2: Apple prices from 2003 to 2022

Table 3: Model and Predicted Price of Apple

Years	Model Price (₹/Quintal)	Predicted Model Price (₹/Quintal)
2003	1149.53	1179.64
2005	1651.20	1491.08
2006	1563.68	1664.18
2007	1679.17	1848.86
2008	2291.14	2045.12
2009	2789.49	2252.97
2010	2263.43	2472.40
2011	2581.74	2703.42
2012	2503.32	2946.02
2013	3172.13	3200.21
2014	3196.73	3465.98
2015	3356.28	3743.33
2016	4382.78	4032.27
2017	5622.47	4332.80
2018	4444.44	4644.90
2019	4175.42	4968.60
2020	4796.85	5303.87
2021	7203.76	5650.73
2022	5183.54	6009.18
2023		6379.21
2024		6760.82
2025		7154.02
2026		7558.81
2027		7975.18
2028		8403.13
2029		8842.66
2030		9293.78

*Source: Agriculture Marketing (AGMARK).

CONCLUSION

Contemplating the findings of the study, we may conclude that the prime period to fetch the best prices for apple is the second quarter i.e., April, May and June with June being the leading month. Whereas, for the arrivals, the fourth quarter is the choicest of all as it is during the month of October that the apples are harvested, thereby flooding the market with the produce. However, there were times when there was almost negligible availability of apples in the market during the off-season, as we see the seasonal index for arrivals generally being lower during Q2, due to the perishable nature of the commodity and inadequate storage facilities but there has been substantial change overtime from

limited to a year-round supply of the product now. The reason is better to market intelligence among the farmers and improved logistics, using which they store some of the produce in the cold storage facilities throughout the peak season to earn higher prices during the off-season, clearly justifying the inverse relationship between the prices and arrivals.

Although, the results depict a positive growth rate for minimum, maximum and modal prices of apples, the growth rate for maximum prices is higher than the minimum prices. This understandably suggests that every year when the prices are predicted for apple, the maximum price is quoted much higher than the minimum price indicating greater upside movement in the market prices of apple in future. Besides, the regression model and moving average so applied also indicate an upsurge in apple prices for the coming years. As predicted by the modal, the range of the prices will vary from around ₹ 6000/quintal in 2023 to around ₹ 9000/quintal in 2030 which illustrates a growth rate of approximately 60% for prices of apple and consequently a huge market potential.

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