

# India's Basmati Rice Export Forecasting and Performance: ARIMA Model

## Abstract

Rice is the staple food in India and also in many countries of Asian continent. Indian rice is having higher demand in international market, so the Basmati and non-Basmati rice contributing a very high national income through export. The export performance and forecasting of basmati rice was carried out by using CAGR, Instability Index and ARIMA model. This study tried to understand the per cent share of rice export from the total agricultural export, growth rate from 1987 to 2022. Only secondary data was used for this study and the data was collected from APEDA. The study found that, the total export share of rice to the total agricultural export was 55.20 per cent in terms of quantity and 42.68 per cent in terms of value during the period 2020-21. This paper also predicted the next 5 years Basmati rice export from India using SPSS software. The CAGR was used to find the growth rate and it was found that 10.31 per cent and 17.37 per cent of growth with respect to quantity and value of export. The study concluded that positive growth rate of basmati and non-basmati rice was noticed in terms of quantity as well as in terms of value with higher instability. The study showed that higher instability within exports of non-Basmati rice as compared to Basmati rice during the study period. The forecasting of basmati rice exports showed increasing trends in exports over the years.

**Key words:** CAGR, ARIMA, EXPORT IN VALUE, EXPORT IN QUANTITY, BASMATI

## Introduction

Rice is one of the most important staple food crop and feeds more than 60 percent of populations of our country. India is the world's second largest in the production of rice after China and accounted for 22.12 per cent of global rice production in 2012. The production of rice increased from 53.60 million tons in during 1980 to 120 million tons during 2021 (Anup Adhikari *et. al.*, 2016). India is the second largest rice producer in the world after China. In 2020-21, India's rice exports including Basmati and Non-Basmati rose by 87 per cent to 17.72 Million Tonne (MT) from 9.49 MT achieved in 2019-20 (GOI, 2021). The major areas in India, where basmati is mainly grown are J&K, Himachal Pradesh, Punjab, Haryana, Uttarakhand, Western Uttar Pradesh and Delhi. The major destinations for the Indian Basmati rice (volume) exports in the world are Saudi Arabia, Iran, Iraq, Yemen, United Arab Emirates, United States of America, Kuwait, United Kingdom, Qatar and Oman have a share of around 80 per cent in total shipments of aromatic long grained basmati rice during 2021-22 (GOI, 2021).

India's thrust on expanding port handling infrastructure, development of value chain involving key stakeholders along with efforts to explore new opportunities in countries or markets for rice exports in the last couple of years have led to a huge spike in rice exports (GOI, 2021). India exported rice to over 150 countries in 2021-22, of which 76 countries

were sent non-basmati rice worth more than \$1 million in 2021-22 (IANS, 2022). As per the data from Director General of Commercial Intelligence and Statistics (DGCIS), Kolkata, India exported non-basmati rice worth \$2,015 million in 2019-20, which rose to \$4,799 million in 2020-21 and \$6,115 million in 2021-22 (IANS, 2022).

Hence, based on above background, the present study was undertaken with the overall objective of assessing the export performance and forecasting of basmati rice in India.

## DATA AND METHODOLOGY

The study is totally based on time series data of Basmati and non-Basmati rice on export quantity and export value. The time series data was collected from Agricultural and Processed Food Products Export Development Authority (APEDA) for the period of 34 years (1987-88 to 2021-22). For the analysis, the total data was subdivided into two periods for better understanding. The period I is from 1987-88 to 2005-06, whereas period II is from 2007-08 to 2021-22. The period was divided for better understanding by dividing the 34 years into two parts for better understanding the rice performance.

### Growth rate analysis

In order to assess the growth in export value and export quantity of rice for 34 years data from 1987-88 to 2021-22 were used. The compound growth rates were computed by using the exponential function of the form.

$$Y_t = AB^t + U_t \dots \dots \dots (1)$$

Where,

$Y_t$  = Area, production and productivity of chilli and cotton

$t$  = Year 1,2,.....n

$U_t$  = Disturbance term in year "t"

"a" and "b" are the parameters to be estimated

The equation (1) was transformed into a log linear form and written as

$$\text{Log } Y = \text{log } A + t \text{ log } B + \text{log } U_t \dots \dots \dots (2)$$

Equation (2) was estimated by using ordinary least squares (OLS) technique.

Compound growth rate (g) was then estimated by using the relationship given in equation (3).

$$\hat{g} = (b-1) * 100 \dots \dots \dots (3)$$

Where,

$\hat{g}$  = Estimated compound growth rate % per annum

$b$  = Antilog of B

The standard error of the growth rate was estimated and tested for its significance with 't' statistics.

The **Instability Index** was computed using Cuddy-Della Valle Index,  $I = CV * (1-R^2)$  0.5 (Singh and Byerlee, 1990; Jainuddin *et al.*, 2021), where in, CV is the coefficient of variation and R<sup>2</sup> is the corrected coefficient of determination of the log linear function.

Whereas, if the instability index is 0 to 15 per cent indicates less instability.

If the instability index is 15 to 30 per cent indicates moderate instability.

If the instability index is more than 30 per cent indicates high level of instability.

To study the Basmati rice export from India, ARIMA technique was used using SPSS software.

The mathematical representation of AR, MA and ARIMA processes is provided in detail in literature. For non-seasonal time series, the simplified general form of these processes is given in Nochai and Nochai (2006) as;

(a) The  $p^{th}$ -order autoregressive model, AR( $p$ ) has the general form as;

$$Y_t = \phi_0 + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + \varepsilon_t \dots \dots \dots (24)$$

Where:

$Y_t$  = the dependent variable (*i.e.* maize price) at time  $t$ .

$Y_{t-1}, Y_{t-2}, \dots, Y_{t-p}$  = dependent variable at time lags  $t-1, t-2$  and  $t-p$ , respectively.

$\phi_0, \phi_1, \phi_2, \dots, \phi_p$  = coefficients to be estimated

$\varepsilon_t$  = error term at time  $t$

(b) The autoregressive moving average, MA ( $q$ ) which has the general form as;

$$Y_t = \mu + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \dots - \theta_q \varepsilon_{t-q} \dots \dots \dots (25)$$

Where:

$Y_t$  = dependent variable at time  $t$

$\mu$  = constant mean of the process

$\varepsilon_t$  = error term at time  $t$

$\theta_1, \theta_2, \dots, \theta_q$  = coefficients to be estimated

$\varepsilon_{t-1}, \varepsilon_{t-2}, \dots, \varepsilon_{t-q}$  = errors in the previous time periods that are incorporated in the dependent variable  $Y_t$ .

(c) Autoregressive Moving Average model: ARIMA ( $p, q$ ) which is a combination of AR ( $p$ ) and MA ( $q$ ) processes and has the general form as;

$$Y_t = \phi_0 + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \dots - \theta_q \varepsilon_{t-q} \dots \dots \dots$$

### **The Box-Jenkins (BJ) methodology**

ARIMA technique is also popularly known as Box-Jenkins method. This method consists of four steps which are well explained in many econometrics as well as time series analysis literature (Cooray, 2008). In this study the description of the four steps for model building as adopted from Gujarati, *et al.* (2012: p. 824) namely; (a) Identification of model, (b) Estimation of parameters, (c) Diagnostic checking and (d) Forecasting, are described in detail below.

#### **(a) Identification of model**

This step refers to the process of finding out the appropriate values of  $p$ ,  $d$  and  $q$ . The main statistical tools used for identification of model are the Auto-Correlation Function (ACF), the Partial Auto-Correlation Function (PACF) and the resulting correlograms, which are simply the plots of ACF and PACFs against the lag length (Cooray, 2008). Gujarati, *et al.* (2012) have provided some theoretical hints to consider while examining the ACF and PACF correlogram in order to identify appropriate model, AR( $p$ ) or MA( $q$ ) or ARMA ( $p, q$ ).

First, the ACF and PACF enable the determination of whether the series is stationary or not (Nochai and Nochai, 2006). Second, different patterns of ACF and PACF and the associated correlograms will yield several ARMA processes, such as AR(1), AR(2), MA(1), MA(2), ARMA (1,1), ARMA (1,2) and so on. Since each of these stochastic processes exhibits typical pattern of ACF and PACF, if the time series under study fits one of these patterns, one can identify the time series with that process. However, one has to apply diagnostic tests to find out if the chosen ARIMA model is reasonably accurate.

#### **(b) Estimation**

Once the appropriate values of  $p$  and  $q$  have been identified, the next step is to estimate the parameters of the autoregressive and moving average terms included in the model. Sometimes this calculation can be done by simple least squares, but sometimes one will have to resort to non linear (in parameter) estimation methods.

### **(c) Diagnostic checking**

Once the parameters have been estimated, the chosen model is checked if it fits the data reasonably well, because ARIMA models can yield several values of  $p$  and  $q$  and it is possible that another ARIMA model may yield better estimate of parameters. One easy test of the identified model is to examine if the residuals estimated from these models have white noise; if they have, one can accept the particular fit; otherwise the process has to be done all over again. An overall check of model adequacy is provided by the Ljung-Box Q statistic.

## **RESULTS AND DISCUSSIONS**

### **Share of rice export to total agricultural exports: 1987-88 to 2021-22**

India has been exporting large quantities of rice to various countries around the world since 1980-81. In 1987-88 the total agricultural export was 10,61,153.44 MT and the contribution of rice export to the total export was 36.63 per cent. The rice has also contributed 44 per cent to the total export value in the same year. It is observed (Table 1) that during 1995-96 the per cent share of rice export quantity was 65.54 and which contributed 57.96 per cent to total export value. In 2010-11 the export quantity of Basmati and Non-Basmati rice was very less i.e., 20.49 and 0.87 per cent respectively. It is due to frequent ban on non-Basmati rice. Which impacted on total rice export from India which was recorded only 21.36 per cent during the year. The total export of rice in 2015-16 was 51.33 per cent and it has increased over the period and it contributed 55.20 per cent during the period of 2020-21. It is observed that so much fluctuation in the export value and export quantities has been observed from 1987-88 to 2021-22. The fluctuation of rice export quantity as well as export value was due to fluctuation of domestic production, inconsistent export policies, frequent bans on export of non-basmati rice, currency devaluation and volatility in the international market (M. Udhayakumar and K.R.Karunakaran., 2020).

Table 1. Share of rice export to total agricultural exports: 1989-88 to 2021-22

(In per cent)

Years	Basmati Rice	Non-Basmati Rice	Total Rice
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	Percent share in total export (Quantity '000 tonnes)	Percent share in total export (Value Lakhs)	Percent share in total export (Quantity '000 tonnes)	Percent share in total export (Value Lakhs)	Percent share in total export (Quantity '000 tonnes)	Percent share in total export (Value Lakhs)
1990-91	22.03	29.91	2.13	1.56	24.15	31.46
1995-96	4.98	10.79	60.56	47.17	65.54	57.96
2000-01	17.99	23.75	14.42	8.52	32.41	32.27
2005-06	11.22	16.30	28.11	17.02	39.32	33.31
2010-11	20.49	26.76	0.87	0.55	21.36	27.30
2015-16	19.76	21.14	31.57	14.41	51.33	35.54
2020-21	14.42	19.50	40.78	23.18	55.20	42.68
2021-22	9.15	13.62	41.46	25.74	50.60	39.36

Source: APEDA, 2022

Table 2 indicated that CAGR of export of rice in terms of quantity and values of exports. The CAGR for export of basmati rice, non-basmati and total rice in terms of quantity, value and unit value during the period 1987-88 to 2021- 22 are presented in Table 2. During the period 1987-88 to 2005-06, the quantity of Basmati rice recorded positive but its lesser than non-Basmati rice. The export performance of Basmati rice in terms of quantity, value was 9.76 and 14.86 percent respectively. During that period I the export performance of non-Basmati rice was 30.64 per cent in Quantity and 32.45 per cent in value respectively. The total performance of rice export performance was positive during period I. This is because of high demand for Indian rice in international market. In the period II, the Total export performance of rice was lesser as compared to period I, this is due to frequent ban on rice export. So, the totalrice export performance in terms of quantity and value was 4.96 and 11.20 per cent respectively. When its comparison between overall performance of Basmati and non-Basmati, then its non-Basmati rice stands first in terms of quantity and as well as in value (12.43 and 18.54 per cent respectively). The performance of Basmati rice export from 1987-88 to 2021-22 in terms of quantity and value was 10.09 and 16.26 per cent respectively, which is due to higher demand of basmati rice in the international market, consistent policies for export of basmati rice, higher international price, and increased domestic production making comfortable stock of rice in the central pool (Gangwar and Rai, 1995; Shende *et al.*, 1998).

Table 2. Compound annual growth rates (CAGR) of quantity and value of Rice export from India, 1987-88 to 2021-22

Period	Basmati		Non Basmati		Total Rice	
	Quantity	Value	Quantity	Value	Quantity	Value

I (1987-88 to 2005-06)	9.76 (4.64)	14.86 (2.167)	30.64 (0.00003)**	32.458 (0.00001)**	16.76 (5.65)	20.44 (8.16)
II (2006-07 to 2021-22)	7.03 (0.001)**	10.04 (0.001)**	23.184 (0.014)	27.190 (0.004)	4.96 (0.01)*	11.20 (0.0001)**
Overall (1987-88 to 2021-22)	10.09 (3.370)	16.261 (2.50)	12.433 (0.00001)**	18.546 (7.415)	10.31 (3.26)	17.37 (2.15)
Note: Figures within the parentheses indicate standard error in respective values ** and * denote significance at 1 per cent and 5 per cent level, respectively.						

The instability of export in terms of value and quantity was presented in Table 3. The higher instability of non-Basmati rice in terms of quantity was higher in period I, whereas medium instability shown in Basmati rice during the period I. The total rice in terms of quantity has shown higher level of instability during that period. The similar result was found in period II whereas the higher instability with respect to non-Basmati and medium instability was seen in Basmati rice. But the total quantity export instability was lower in period II as compared to period I. Which may be due to the consistent export policy, international demand for and domestic production of basmati rice during period II may be the other factors (Anup Adhikari *et al.*, 2016).

With respect to value instability index during period I shown that non-Basmati rice was higher and Basmati rice shown almost less Instability which may be due to higher demand in the international market for Indian Basmati rice. However, with respect to period II, the Basmati and non-Basmati rice shown similar result and it was high instability index. In terms of total export value, the instability index (period II) was as compared to period I. The overall instability index in terms of value was shown very high instability with respect to both period I, II and total export. The export instability of rice in terms of quantity as well as value may be due to increasing domestic and international rice demand, volatility in world prices, changes in export policy of India and political situation in international markets (Anup Adhikari *et al.*, 2016).

The forecasting of basmati rice export in terms of quantity was represented in table 4. The basmati rice export from India was forecasted for the period of five years up to 2026-27. The study indicated that the export of basmati rice is going to increase over the period and expected to reach 64, 33,890.75 MT in 2026-27 from 51,96,453.74 MT in 2022-23.

Table 3. Instability index of rice export from India: 1987-88 to 2021-22

Period	Basmati Rice		Non-Basmati Rice		Total Rice	
	CV	Instability	CV	Instability	CV (%)	Instabilit

	(%)	Index	(%)	Index		y Index
Quantity						
I (1987-88 to 2005-06)	47.21	<b>19.01</b>	93.62	<b>74.73</b>	74.84	<b>36.35</b>
II (2006-07 to 2021-22)	37.21	<b>25.99</b>	61.18	<b>39.93</b>	34.07	<b>28.46</b>
Overall (1987-88 to 2021-22)	86.56	<b>36.50</b>	92.77	<b>58.01</b>	76.30	<b>32.19</b>
Value						
I (1987-88 to 2005-06)	60.95	<b>16.67</b>	95.04	<b>71.63</b>	76.06	<b>21.45</b>
II (2006-07 to 2021-22)	50.29	<b>35.11</b>	71.09	<b>37.21</b>	48.19	<b>28.78</b>
Overall (1987-88 to 2021-22)	114.02	<b>56.50</b>	124.62	<b>71.67</b>	111.18	<b>50.15</b>

Table 4. Forecasting of Basmati rice export from India (2022-23 to 2026-27)

Sl.No	Predicted Years	Predicted export quantity (in MT)
1	2022-23	51,96,453.74
2	2023-24	54,92,631.02
3	2024-25	57,97,596.28
4	2025-26	61,11,349.52
5	2026-27	64,33,890.75

## CONCLUSION

The study concluded that Basmati and non-basmati rice contributing a very high national income through export. Present study shown that the share of total rice export was more than 30 per cent towards total agriculture export during study period. The CAGR of Basmati and non-basmati rice record shown a positive growth rate, not only in terms of quantity but also value exported. This study also shown, higher instability index for both basmati and non-basmati rice, in terms of quantity and value exported was due to various restrictions on export from time to time. Study predicted that, the export quantity of Basmati rice will be performing better in future years. This is due to the higher demand for Indian Basmati rice in international market. The study suggested that, there is a scope for increasing export of Indian Basmati rice at international market through best variety of rice at competitive price and The policies should be focuses on influencing Indian farmers to grow more basmati rice to meet the international market demand.

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