REVIEW OF RESEARCH
ISSN: 2249-894X
IMPACT FACTOR : 5.7631(UIF)
VOLUME - 12 | ISSUE - 12 | SEPTEMBER - 2023

# A STATISTICAL VIEW OF INDIAN RICE EXPORT

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## ABSTRACT

*This work basically focuses on three major factors affecting the Export of Rice namely Production of Rice, Consumption of Rice, exchange rate of Rice and International Prices. It is one of the important food crops in India. This study has analyzed the trends and variability of Rice Export.*

*The study is fully based on secondary data taken mainly from the website of Agricultural & Processed Food Products Export Development Authority (APEDA). Using statistical tools like Regression Analysis, Time Series Analysis and Forecasting we have studied the interrelation between the mentioned factors and prepared an appropriate model and forecasted the future production and Export of Rice.*

*Techniques like Simple Regression Analysis have been used to study the factors responsible for variation in export of rice every year. Time Series analysis also used to do further forecasting. Rice is the major crop exported on large amount from India. This work mainly aims to do statistical study of effect of Export of Rice on our Economy and the major factors responsible for its export.*

**KEY WORDS :** *Production of Rice, Consumption of Rice, exchange rate of Rice and International Prices.*

## INTRODUCTION

As we all know, India is among those top leading countries who have delightful legacy in Agriculture realm. Right from harvesting the top-class varieties of Wheat, Rice and cotton, to exporting them outside the country, Indian Agri-Economic sector ruling the world over the decades. Indian farmers and their traditional, scientific and technocracy modus-operandi in farming is now referred by many Agri- Scientists worldwide.

This Scenario was totally different during the period from 1947 to late 1960s. Indian food sector was going through a rigorous scarcity of quality food. In those days the food availability was only 417gram/day/person. This was the time, when Green Revolution was launched under the superintendence of a geneticist Dr. M.S Swaminathan. That inclusion of High Yielding Varieties (HYVs) gave the higher productivity causing increase in farmer's income so to overcome scarcity of food and malnutrition. Since then, the Indian Agriculture is continuously progressing, as a result, the export of cereals, mainly of Rice, have shown continuous increment over the years. Actually, India initiated exporting substantial quantity of rice to all over the world since 1980-81. Since then, the continuous increasing trend has been observed in Export of Rice. In 1990-91, India was able to export only 505 thousand tonnes of rice, but this figure has now increased up to 18 million tonnes. Such international

trade plays a crucial role in economic development of country. 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 last couple of years have led huge spike in Rice Export.

As we all are aware about the fact that, Import and Export of commodities directly impact on G.D.P (Gross Domestic Product) of our country. Also, it gives a Foreign Exchange Reserves, so to boost intra-country trade. From last many years, it has been observed that the Indian Rice Export is continuously in trade surplus zone which is initializing the foreign flow of funds into the country which eventually stimulating the consumer expenditure as well.

Here, in our project, we have also shown how the export of rice is giving significant impact on Gross Value Added (GVA) and Gross National Income (GNI) of our country. As the GVA is absolute value of goods produced in an area, rice production gives superior contribution in it. On similar basis, GNP is total value of all final products turned out in given periods by country's residents.

At a glance, even if this concept of rice export looks quite simple, but via this analysis, we have realized it well that it has very deep-rooted connection with Indian Socio-economic sector.

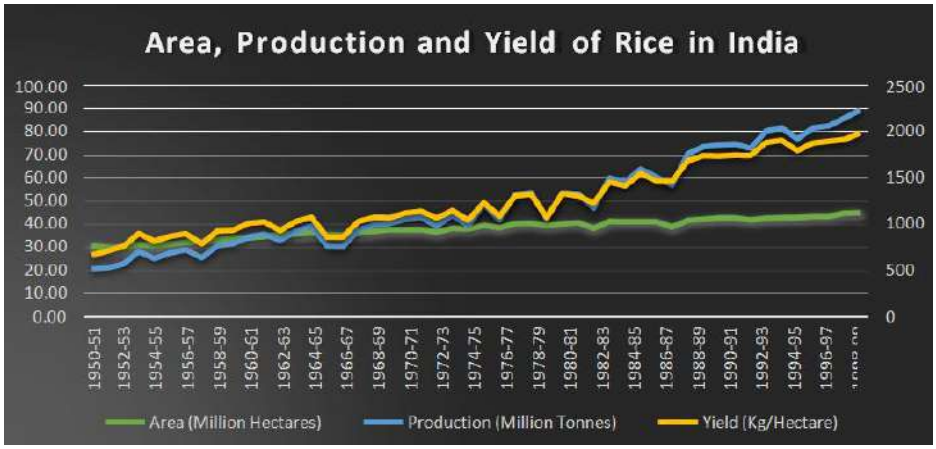
## OBJECTIVES

1) To study the effect of production of Rice, Consumption of the Rice, Exchange Rate, International prices on Export of Rice from India.
2) To study effect of Export of Rice on Indian Economy (GDP, GNI, GVA).
3) To forecast Export of the Rice and production of Rice.

## Tools used

1) Linear Regression
2) Time series

## EXPLORATORY DATA ANALYSIS

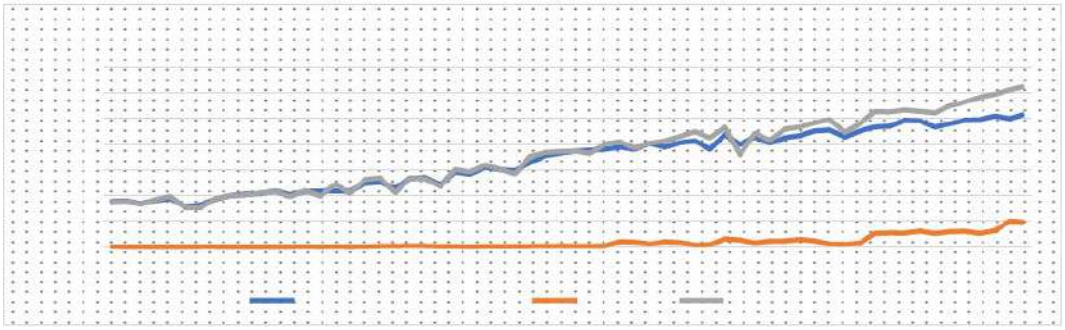



Area in (million hectares) is same throughout all the years as the production of rice highly depends on availability of water and rainfall, the area under rainfall has not seen major change. Slight increase in area is due to improvement in irrigation facilities.

Production (in million tonnes) shown a sudden increase from 1966 onwards as it was the beginning of green revolution period. In the initial phase, it was implemented in Punjab and Haryana in North and Tamil Nadu and Andhra Pradesh in south. Wheat and Rice were the major crops. High Yielding Variety (HYVs) of seeds was provided to all farmers, appropriate measures

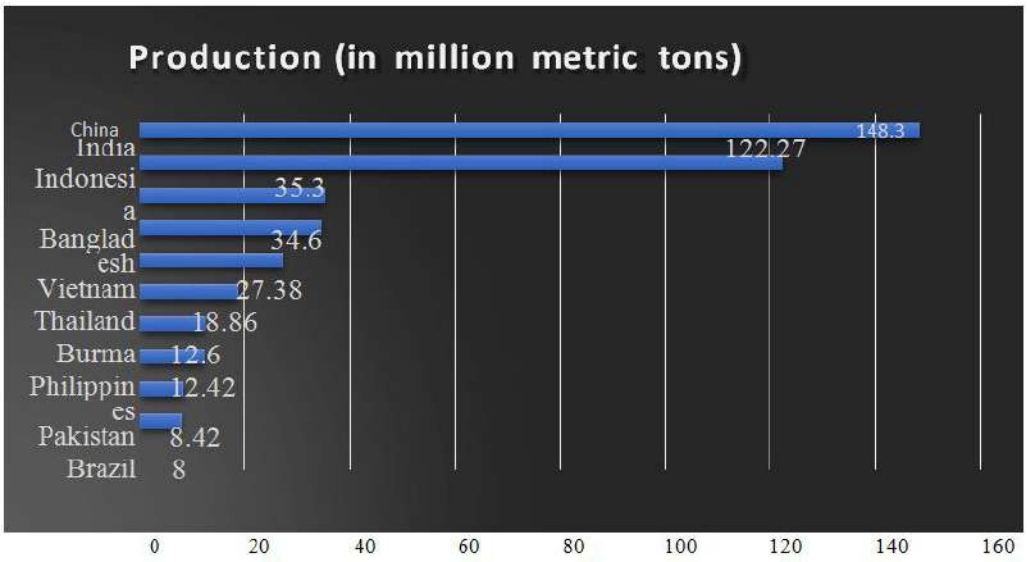
were taken to increase irrigation in those areas and subsidy on fertilizers , pesticides was given . It led to tremendous increase in production of rice.

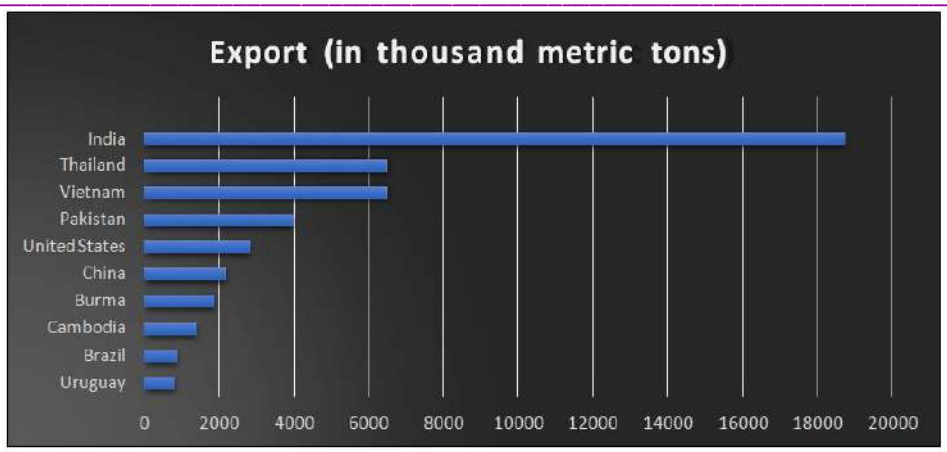
As production kept on increasing, yield continued to grow.



**National program for family planning** was brought in 1952 to implement policies for population control. Till 1980 those policies were not so effective. But after 1990, the changes were made in family planning policies and it brought the rise of population in control. As the population did not increase, domestic consumption also remained constant.

Main focus of fourth and fifth five-year plan was to become **self-dependent in agricultural production**. Fifth five-year plan also focused on export which brought new export policies. Thus, after 1980, graph shows rise in Export.



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These two graphs show that, how India is among those top countries who do production of Rice and Export of Rice in tremendous quantity. The figures shown in graph have been increasing year by year.

## TERMINOLOGY

### Gross Domestic Product (GDP):

- The total of all value added created in an economy i.e. value of goods and services produced within the border of country.
- Value added means the value of goods and services that have been produced minus the value of goods and services needed to produce them.

Foreigners coming to India and producing goods and services is included in GDP while income from outside the country is not included in GDP.

### Formula:

**GDP = C + I + G + (X - M)**

**Components of GDP:**

1. Consumption by households
2.Investment by business
3.Government spending on goods and services
4.Net export (Net export=Export-Import)

### Gross National Income:

Gross National Income (GNI) is a measurement of a country's income. It includes all the income earned by a country's residents, businesses, and earnings from foreign sources.

### Formula:

**GNI = GDP + [(A) – (B)]**

### Components:

A: Income from citizens and businesses earned abroad
B: Income remitted by foreigners living in the country back to their home countries

### Gross Value Added:

In economics, gross value added (GVA) is the measure of the value of goods and services produced in an area, industry or sector of an economy. Gross value added is the value of output minus the value of intermediate consumption.

**Formula:**

**GVA = GDP + SP − TP**

where,

SP= Subsidies on products

TP= Taxes on products

**Export:**

Goods and services that are produced domestically but then sold to customers residing in other or foreign countries is called as export.

**Import:**

Purchase of foreign products and services and bringing them to one's home country is called as import.

**Exchange Rate:**

Exchange rate between any two currencies are the rates at which they are exchanged or sold against each other i.e. price of foreign currency in terms of domestic currency.

- Exchange rates can be either fixed or floating. Fixed exchange rates are decided by central Banks of a country whereas floating exchange rates are decided by the mechanism of market

**Exchange Rate (for India) = USD /IND**

**SIMPLE LINEAR REGRESSION**

In statistical modelling, Regression Analysis is a set of statistical process for estimating relationship between dependent and independent variables.

Regression Analysis is primarily used for two conceptually distinct purposes. First, Regression Analysis is widely used for forecasting. Second, in some situations it can be used to infer the casual relationships between dependent and independent variables.

The aim in this regression analysis is to see what are the factors responsible for variation of Export of Rice every year. For this analysis I have compiled a data set which includes quantity of Rice Export over a period of 34 years (1987-2021) and the respective Production, Consumption and Exchange Rate and International Price of Rice.

**Model 1:**

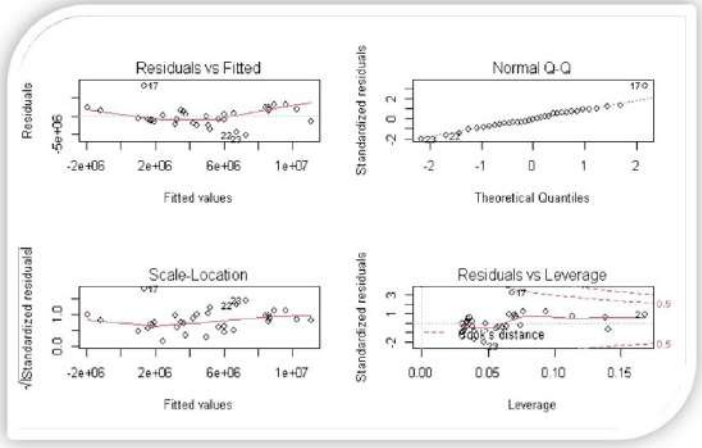
To see how the change in Production of rice affects its export.

**Y- Yearwise Export of Rice from India (in 1000MT)**

**X- Yearwise Production of Rice in India (in 1000MT)**

Here, X and Y are random variables under consideration.

## Diagnostic Plots:



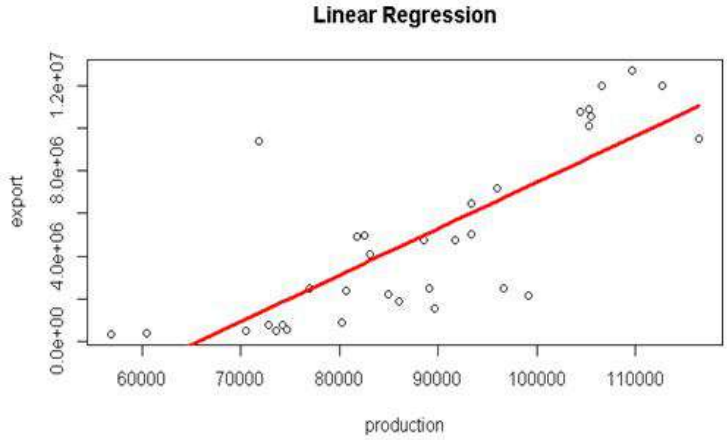

## Shapiro Test-

p-value: 0.7834

## Conclusion:

1. From Residual Vs Fitted plot we conclude that relationship between export and production is **linear.**
2. From Normal Q-Q plot and Shapiro test we conclude that the data is from **Normal Population.**

Plot-




The obtained Linear Regression Model is:

$$Y=(-1.433e+07)+ (2.179e+02)*X$$

### *Significance of regression coefficients-*

**Test statistics**: t = 7.151P-value= 4.88e-08 < 0.01
Hence, we **reject Ho** which implies that regressor X i.e
**Production is highly significant at 1% los.**
So obtained model is **significant.**

Also,
**R-squared: 0.7704**
**Adjusted R-squared: 0.7928**

Coefficient of determination is relatively high which implies that regression model capture most of the variability expressed in Y i.e. Export of Rice.

**Interpretation-**

This regression model shows us that if production of Rice increases, then it will lead to increase in Export of Rice of India linearly.

This is similar with understanding that every year production increases due to technologies and use of heavy manufacturing units. So, Export of Rice increases automatically.

**Similarly, we have done the analysis for the remaining models:**

| Model No | Variables under consideration | Model | Significance of regression coefficients | Interpretation |
|---|---|---|---|---|
| 1 | Y- Yearwise Export of Rice from India (in 1000MT)<br>X-Yearwise Consumption of Rice in India (in 1000MT) | **Y= -** 2.547e+07**+**3.551e+02***X** | **P-value** 1.5e-09 < 0.01 we **reject Ho** which implies that regressor X is significant<br>**R-squared**: 0.6878 | As consumption increases export increases |
| 2 | Y- Yearwise Export of Rice from India (in 1000MT)<br>X:Yearwise exchange rate for India | **Y=** -477800**+**239913***X** | **P-value** = 1.5e-10 < 0.01<br>Hence, we **reject Ho** which implies that regressor X is significant<br>**R-squared**: 0.7275 | As exchange rate increases export increases |
| 3 | Y- Yearwise Export of Rice from India (in 1000MT)<br>X-Yearwise International Price (in dollar per Metric ton) | **Y=** -2713463**+** 22610 ***X** | **P-value** = 0.0007 < 0.01<br>Hence, we **reject Ho** which implies that regressor X is significant<br>**R-squared**: 0.7801 | International price shows positive impact on export of Rice from India. |
| 5 | Y- Year wise Gross Value Added (in USD)<br>X- Year wise export of rice from India (in USD) | **Y= 6.740e+04 +1.097 *X** | As p-value for $\beta_1 < 0.05$.<br>Hence, we **reject Ho** which implies that regressor X is significant<br>**R-squared 0.8519** | There is almost a linear relationship between GVA and export of Rice from India. |
| 4 | Y- Year wise Gross National Income (in USD)<br>X- Year wise Export of Rice from India (in USD) | Y=1.839e+05 +3.447 *X | **Significance of Regression coefficient**-As p value for $\beta_1 < 0.05$.<br>Hence, we **reject Ho** which implies that regressor X is significant<br>**R-squared= 0.8419** | There is almost **linear relationship** between **GVA** and **Exportof Rice** from India. |

## TIME SERIES ANALYSIS

### Time Series

A time series is a series of data or observation usually collected at regular interval of time (years, months, weeks etc.) in chronological order. It can be continuous trace or discrete set of observations. Here we are dealing with observations taken at discrete time periods. By appropriate choice of origin and scale, we can take the time periods to be 1, 2…and we can denote the observations by Y1,Y2….Yt.

### Time Series analysis

- Identifying or determining the various forces or influences whose interaction produces the variation in time series.
- Isolating, studying, analyzing and measuring them independently.
- Predicting future values.

### *Checking the stationarity:*

This is the statistical test that we run to determine if a time series is stationary or not. Without going into the technicalities of the Dickey-Fuller test, it tests

Ho: Time series is not stationary.
H1: Time series is stationary.

### *Decision Rule:*

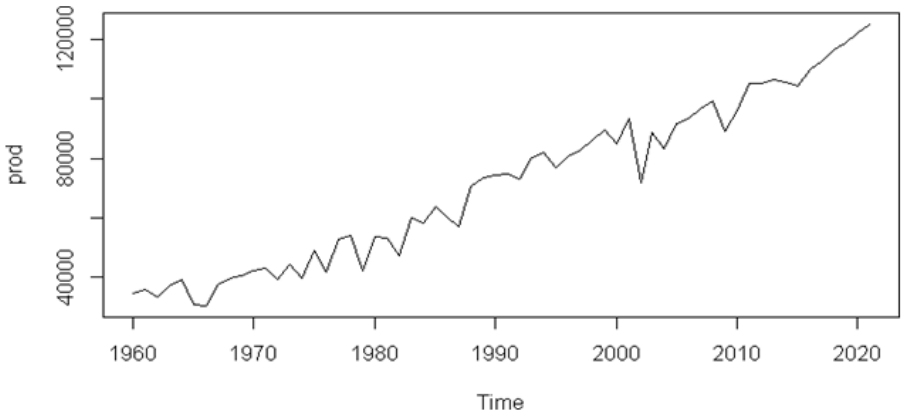
If p-value > 0.05, we may accept Ho that is the process is not stationary.

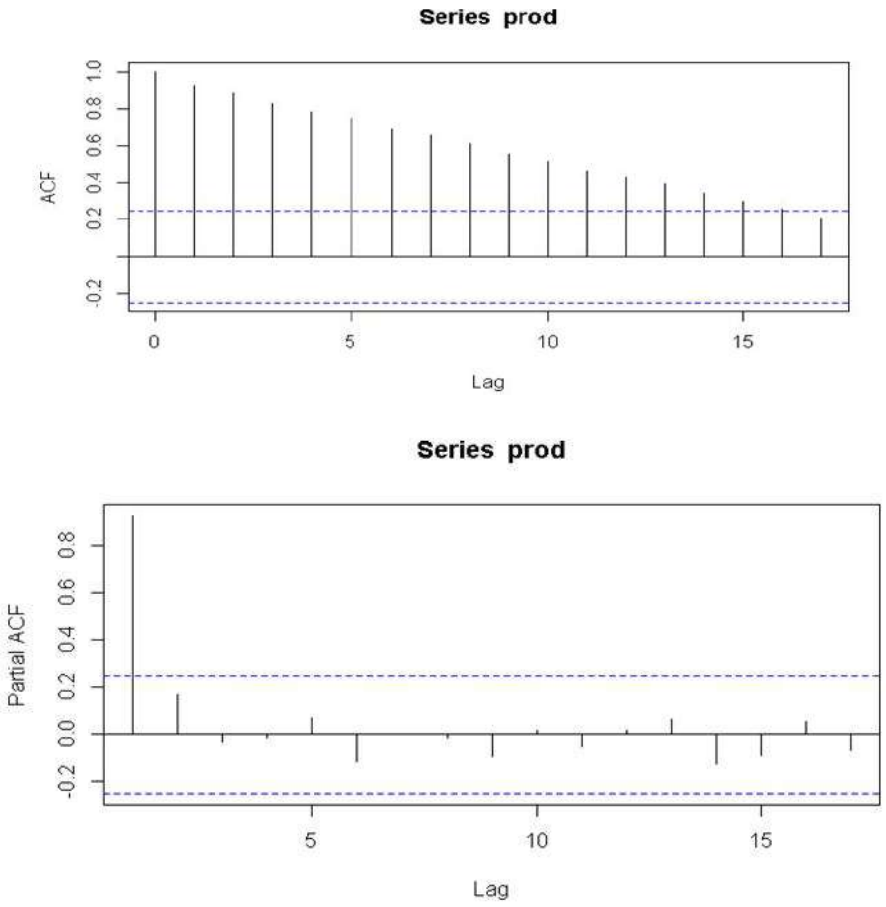
### *Differencing:*

Differencing is important and powerful tool to achieve stationarity in time series by detrending it when time series shows constant variance. In differencing single differencing removes linear trend whereas double differencing removes second degree curvilinear trend commonly observed in time-series.

## ARIMA MODELING

**Analysis 1:**
**Time series of yearly production of Rice from 1960 to 2021.**






***Checking stationarity using ADF test:***

$H_0$: The Series is not stationary.
$H_1$: The Series is Stationary.

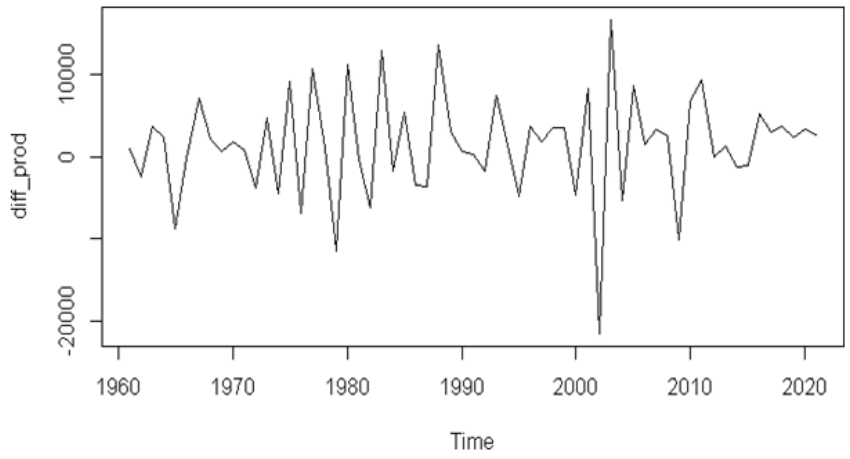
| |
|---|
| Augmented Dickey-Fuller Test |
| data: prod |
| Dickey-Fuller = -3.0549, Lag order = 3, p-value = 0.148 |
| alternative hypothesis: stationary |

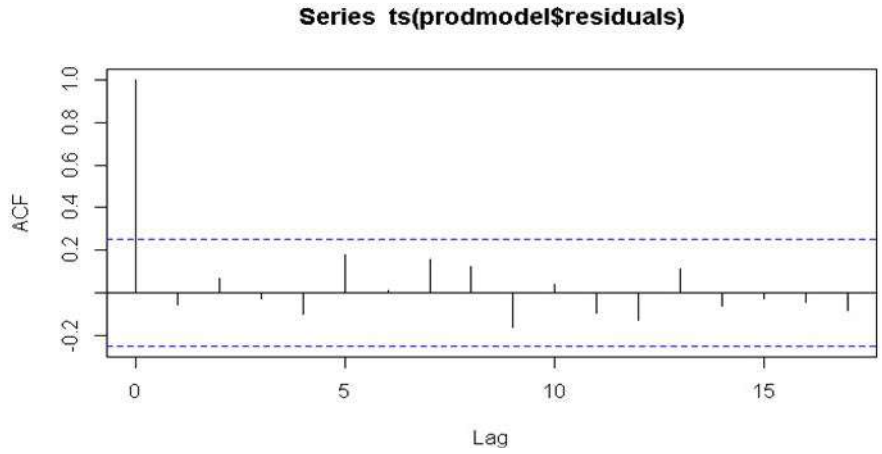
**Decision:**

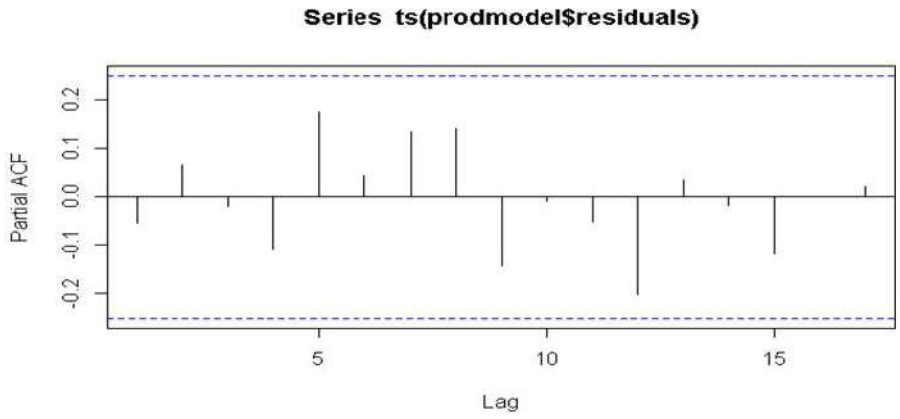
Since P-value > 0.05 we accept $H_0$. The Time Series is Not-Stationary.

**To obtain stationarity in time series** :

We convert given time series by differencing and check stationarity again.




## CONCLUSION:

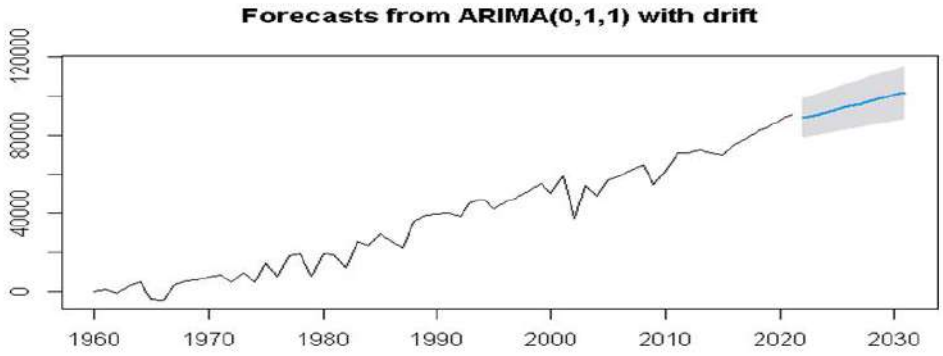
As in the acf correlogram the only one spike is beyond the limits hence we can say that sample acf are uncorrelated also in pacf all spikes are within limits.

As the necessary condition for modelling i.e Stationarity is satisfied we proceed for Modelling. By fitting a differenced time series using auto.arima() function, We get, **ARIMA (0, 1, 1)** with zero mean.

```
Coefficients:
          ma1    drift
      -0.7006 1475.005
s.e.   0.0932  202.376
sigma^2 = 26606007: log likelihood = -607.32
AIC=1220.65  AICc=1221.07  BIC=1226.98
```

**Forecasting:**

Fitting ARIMA (0,1,1) next 10 values are forecasted. Since these are the forecasted values of differenced series. Inverse- differencing of previous forecast is done.




To check the model adequacy of the fitted data **L-Jung's Box test** is used:

**$H_0$ :** The residuals follow sequence of i.i.d random variables.
**$H_1$ :** The residuals have significant serial auto-correlation**.**

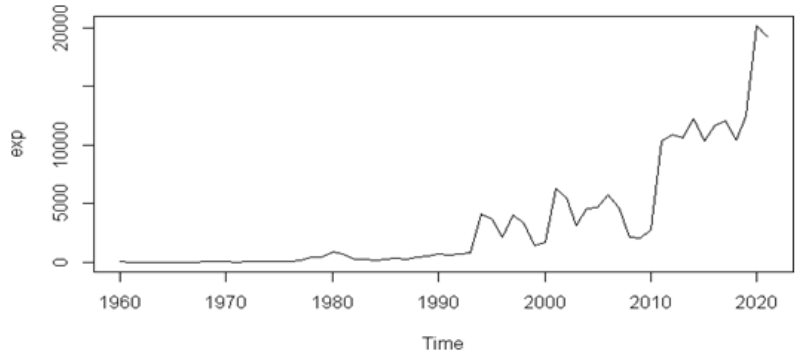
```
        Box-Ljung test
data:  forecast$resid
X-squared = 35.729, df = 40, p-value = 0.6629
```

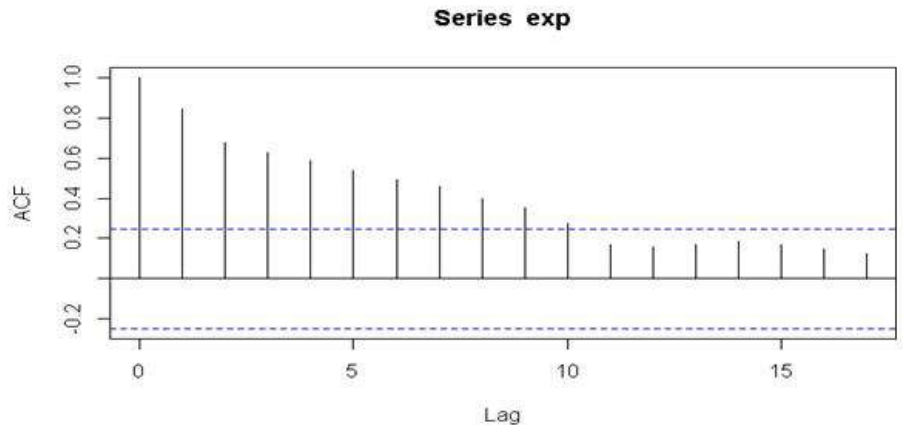
**Decision:**

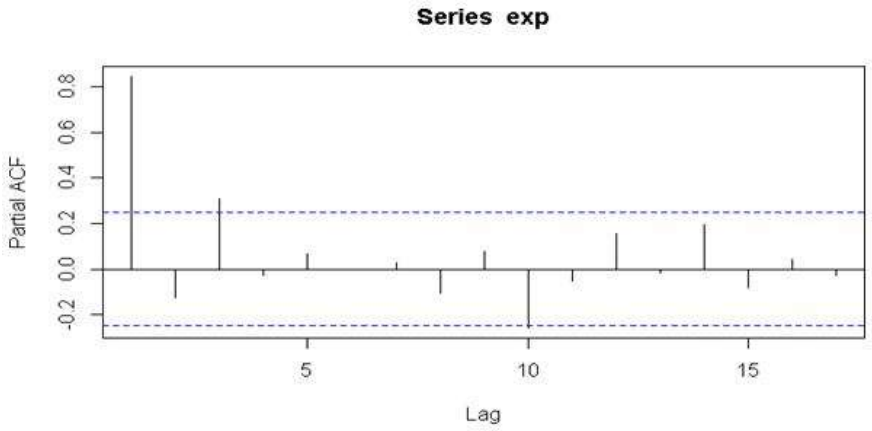
Here **p-value is 0.6629** which is greater than 0.05.
Therefore, we fail to reject null-hypothesis and conclude that the residuals are random.
Thus, the model fitted **(ARIMA (I)**) is adequate.

## Analysis 2:

Time series of yearly export of rice from **1960 to 2021**.




## Checking stationarity using ADF test:

$H_0$: The Series is not stationary.
$H_1$: The Series is Stationary.

Augmented Dickey-Fuller Test

data: exp

Dickey-Fuller = -0.39782, Lag order = 3, p-value = 0.9834

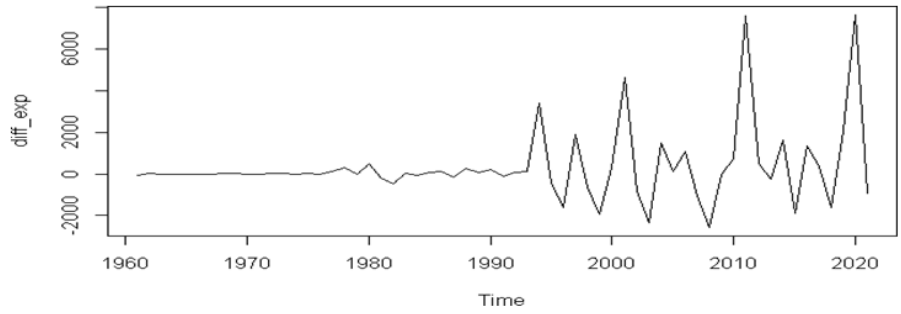
alternative hypothesis: stationary

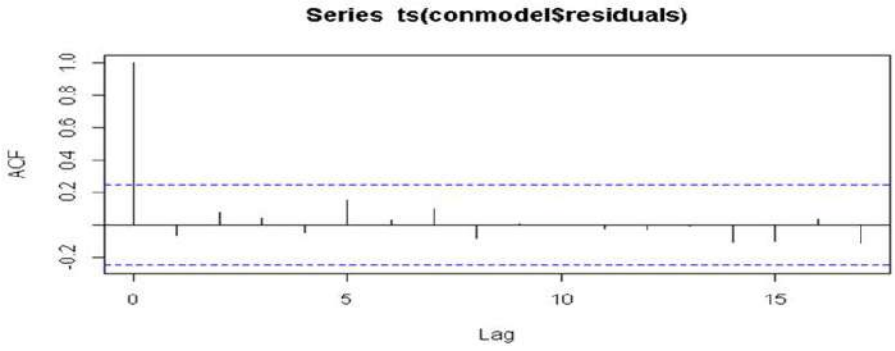
**Decision:**

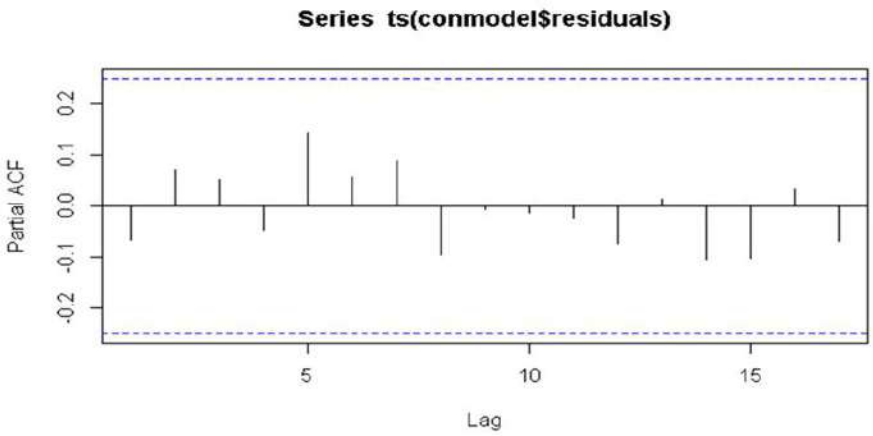
Since P-value > 0.05 we accept H0. The Series is Non-Stationary.

**To obtain stationarity in time series:**

We convert given time series by **differencing** and check stationarityagain.



## CONCLUSION:

As in the acf correlogram the only one spike is beyond the limits hencewe can say that sample acf are uncorrelated also in pacf all spikes are within limits.

```
Augmented Dickey-Fuller Test

data:  ts(expmodel$residuals)

Dickey-Fuller = -5.3152, Lag order = 3, p-value = 0.01

alternative hypothesis: stationary
```

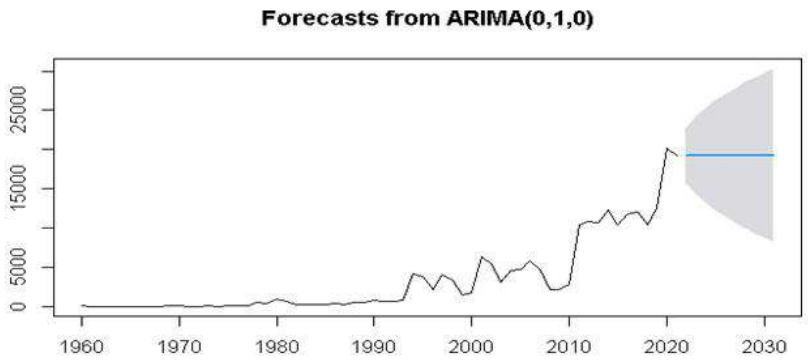
### *Decision:*

Since P-value < 0.05 we reject $H_0$. The Series is stationary.
As the necessary condition for modelling i.e Stationarity is satisfied, so we proceed for modelling.
By fitting a differenced time series using **auto.arima()** function, We get, **ARIMA (0, 1, 1)** with zero mean.

```
ARIMA(0,1,0)
sigma^2 = 3189657:  log likelihood = -543.31
AIC=1088.61   AICc=1088.68   BIC=1090.72
```

### *Forecasting:*

Fitting **ARIMA (0,1,1**) next 10 values are forecasted. Since, these are the forecasted values of differenced series. Inverse-differencing of previous forecast is done.




| | ME | RMSE | MAE | MPE | MAPE | MASE | ACF1 |
|---|---|---|---|---|---|---|---|
| Training set | 309.4043 | 1771.5 | 868.4043 | -Inf | Inf | 0.9838722 | 0.02149717 |

To check the model adequacy of the fitted data **L-Jung'sBox test** is used:

$H_0$ : The residuals follow sequence of i.i.d randomvariables (not autocorrelated).
$H_1$ : The residuals have significant serial auto-correlation (dependence).

```
        Box-Ljung test

data:  forecast$resid

X-squared = 35.729, df = 40, p-value = 0.7281
```

**Decision:**
Here **p-value is 0.7281** which is greater than 0.05.
Therefore, we fail to reject null-hypothesis and conclude that the residuals are random. Thus, the model fitted **(AR(I)) is adequate**

## CONCLUSION

1) There is a positive linear relationship between Export of Rice from India and Production of Rice,Consumption of Rice, Exchange Rate, International Prices of Rice.
2) From Multiple Regression we can say that there is positive effect of Exchange Rate and International Prices on Rice Export at once.
3) Due to Export of Rice many economy boosting activities take place such as transportation of goods, packaging, polishing the cereals, heavy manufacturing of direct consumable products, increment in foreign flow of funds. All those things eventually impact on GDP, GNI and GVA in India.

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