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# ANALYSIS OF THE PATTERN OF RICE PRODUCTION AND FORECASTING IN BANGLADESH BY SIMPLE EXPONENTIAL SMOOTHING MODEL

**Sofi Mahmud Parvez**

***Abstract*—**This study's main focus was to forecast rice production in Bangladesh using the mathematrical model. From 1961 to 2021 (60 years), time series data on rice production in Bangladesh were used in this research work. A forecasting technique with fluctuating data is exponential smoothing. In our data set, we applied the exponential smoothing method and predicted the next 50-year pattern of rice production in Bangladesh. Our analysis based on the time series data on rice production indicates that the production trend is increasing and the estimated size will reach 333.8148863 per capita (kg) in 2071. In this study, an attempt was made to compare the original and predicted series, which behave statistically well when predicting rice production in Bangladesh. Policymakers, researchers, traders, and producers will be able to forecast future prices using the findings of this study

***Keywords*—** Exponential smoothing model, rice production, forecasting.

## I. INTRODUCTION

A developing nation with an agricultural economy, Bangladesh is actively pursuing rapid development. Approximately 16.3% of Bangladesh's GDP is produced by agriculture, which is the foundation of the nation's economy[1].The primary food crop in Bangladesh is rice, which uses about 75% of the country's agricultural land and accounts for 28% of its GDP. Bangladesh was the fourth-largest rice producer in the world in the middle of the 1980s, but its productivity lagged behind that of other Asian nations like Malaysia and Indonesia. It ranks as the sixth-largest producer of rice in the world right now[2].

Furthermore, the rice industry in Bangladesh contributes one-sixth of the national income and half of the agricultural GDP as well as 48% of rural jobs are provided by the rice industry. Additionally, it meets one-third of an average person's daily caloric requirements. 75% of the cultivated land and 80% of the total irrigated area are used for rice farming[3]. As a result, rice is the main source of income for the people of Bangladesh.

Bangladesh produced 56.9 million tonnes of paddy and rice in 2021. Bangladesh's rice and paddy production increased by 2.89% per year from 15.1 million tonnes in 1972 to 56.9 million tonnes in 2021 [6]. Nevertheless, Bangladesh's rice production is unstable until natural disasters strike again. Because rice production in Vietnam was insufficient in 2017, Vietnam exported rice to Bangladesh [7]. Because of this, the outlook for rice production. To meet the needs of the citizens of our nation is absolutely necessary.

According to the aforementioned explanation, the researchers are enthusiastic about using the exponential smoothing model to analyse the results of rice paddy production. The goal of this study is to forecast Bangladesh's local rice production results over the course of the next few years and determine which of the two models is most accurate at doing so. I therefore hope that the government can develop a more detailed plan for the rice paddy food system and turn Bangladesh into a Centre for the export of rice.

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## II. METHODOLOGY

The process entails comparing secondary source data to existing simple exponential model models.

### A. *Data Information*

The information was obtained from the Bangladesh Bureau of Statistics' Agricultural Yearbook, which covers 60 years of major crop statistics and is one of BBS's yearbooks. For an empirical analysis, annual secondary time series data were gathered from 1961 to 2021

### B. *Simple Exponential Smoothing Model*

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The analytical time series model of exponential smoothing is quite useful and practical but less user-friendly. By calculating a smoothed average of previous values from time series data and progressively lowering the smoothing factor, the exponential smoothing model enhances forecasting[4, 5].The single, double, and triple exponential smoothing models are the most common subsets of the exponential smoothing model. The single exponential smoothing is the main topic of this study.

Gives a weight based on the single exponential smoothing level (α). A single exponential smoothing method satisfies the equation (1).

$$S_t = \alpha x_t + (1 - \alpha)S_{t-1} = S_{t-1} + \alpha(x_t - S_{t-1}) \quad (1)$$

Here,

$S_t$ = smoothed statistic, the straightforward weighted average of the most recent observation $x_t$.

$S_{t-1}$ = an earlier smoothed statistic

$\alpha$ = factor for data smoothing $0 < \alpha < 1$

$t$ = time frame.

Smoothing will be reduced in level if the smoothing factor's $\alpha$ value is high. While values of closer to zero have a greater smoothing effect and are less sensitive to recent changes, values of closer to 1 have less of a smoothing effect and give more weight to recent changes in the data.

## III. Result

Time series data for this study on rice production in Bangladesh are from the Agricultural Yearbook of Bangladesh Bureau of Statistics, which covers 60 years of major crop statistics and is one of the yearbooks of BBS. For the empirical analysis, annual secondary time series data from 1961 to 2021 were collected. According to our selective Exponential smoothing model from table-1 we get that the value of alpha (level smoothing) 0.679445362 which is less than 1 and for that reason we applied Simple exponential smoothing. Table-2 represents the necessary information for model identification such as seasonal frequency 1, Model selection Criteria AIC and Box-Cox Transformation was Rounded Lambda. From Table-3, represents all statistical information like Number of observation (61), standard deviation (0.060511), Variance (0.003662), Akaike's Information Criterion (AIC) (-87.4723) and Bayesian Information Criterion (BIC) (-81.1396). In our analysis to find accuracy of forecast we calculate the following metric term, Root Mean Square Error (RMSE) (15.32839279), Mean Absolute Error (MAE) (1.32086539), Mean Absolute Percentage Error (MAPE) (4.316415825), Mean Absolute Scaled Error (MASE) (0.9356408) which is represent in table-4.

In Figure-1 we represent the difference between observation data and forecast value which help us to identify the accuracy of our analysis and we see that the residuals are -0.2 to 0.2 From this figure we can easily except that our assumed value will be equal to the actual value. Similarly, in figure-2 we represent the residuals of our forecasted value according to Lower 95.0% PI and Upper 95.0% PI.

Rice production per capita (kg) in Bangladesh increased from 278 to 336 between 1961 and 2021, indicating a positive trend. Based on this trend, we estimate that rice production in Bangladesh will increase from 336 to a maximum of 573 per capita (kg) between 2022 and 2070. The trend graph and prediction value chart of our estimate by annual period are shown an upturn and downturn pattern in Figures 3 and 4 and Table 5.

## IV. Graphs

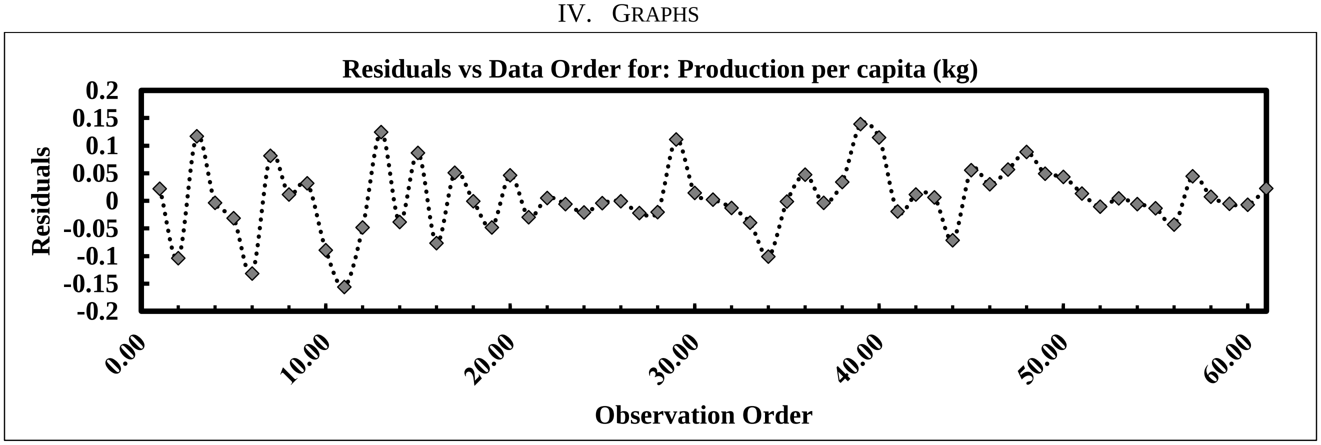


Figure1-: Graphical representation of Residuals Vs Data Order for (Production per capita kg)

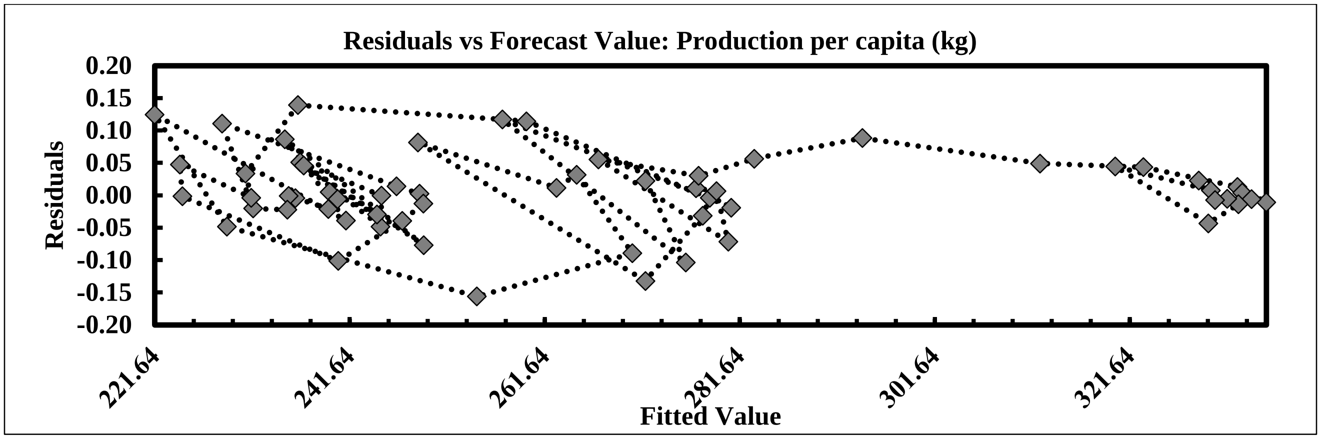


Figure-2: Graphical representation of Residuals Vs Forecast value (Production per capita kg)

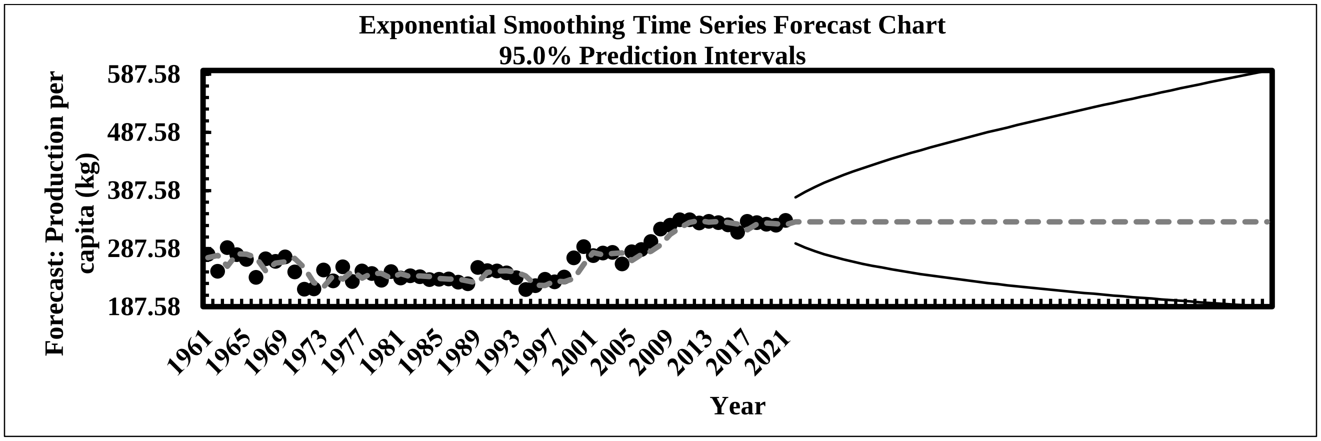


Figure-3: Graphical representation of Exponential smoothing time series data and Forecast Chart.

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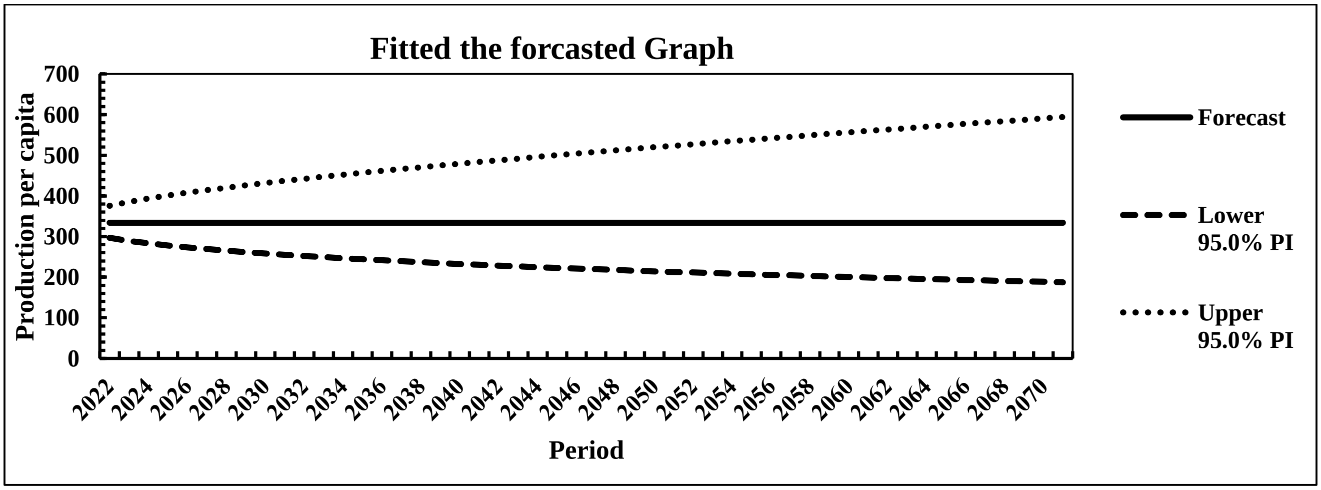


Figure-4: Fitted graph of Predicted value according to Exponential Smoothing Time Series Forecast Chart 95.0% Prediction Intervals

## V. TABLES

Table-1: Parameter Estimation for Simple exponential smoothing.

| Parameter Estimates | |
|---|---|
| Term | Coefficient |
| alpha (level smoothing) | 0.679445362 |
| l (initial level) | 5.605739657 |

Table-2: Model information of Simple exponential smoothing

| Exponential Smoothing Model Information | |
|---|---|
| Seasonal Frequency | 1 |
| Model Selection Criterion | AIC |
| Box-Cox Transformation | Rounded Lambda |
| Lambda | 0 |
| Threshold | 0 |

Table-3: Statistical information for Exponential Smoothing model.

| Exponential Smoothing Model Statistics | |
|---|---|
| No. of Observations | 61 |
| DF | 59 |
| StDev | 0.060511 |
| Variance | 0.003662 |
| Log-Likelihood | 46.73613 |
| AICc | -87.0512 |
| AIC | -87.4723 |
| BIC | -81.1396 |

Table-4: Forecast Accuracy in-Sample (Estimation) One-Step-Ahead Forecast for Simple Exponential Smoothing.

| Metric | In-Sample (Estimation) One-Step-Ahead Forecast |
|---|---|
| N | 61 |
| RMSE | 15.32839279 |
| MAE | 11.32086539 |
| MAPE | 4.316415825 |
| MASE | 0.9356408 |

Table-5: Exponential Smoothing Time Series Forecast Chart 95.0% Prediction Intervals

| Forecast Table | | | |
|---|---|---|---|
| Period | Forecast | Lower 95.0% PI | Upper 95.0% PI |
| 2022 | 333.8148863 | 296.4823798 | 375.8482321 |
| 2023 | 333.8148863 | 289.2242541 | 385.2801993 |
| 2024 | 333.8148863 | 283.1878453 | 393.4928004 |
| 2025 | 333.8148863 | 277.9473072 | 400.9118829 |
| 2026 | 333.8148863 | 273.2777795 | 407.7623088 |
| 2027 | 333.8148863 | 269.0433904 | 414.1799512 |
| 2028 | 333.8148863 | 265.1546244 | 420.2543272 |
| 2029 | 333.8148863 | 261.5488229 | 426.0480971 |

| | | | |
|---|---|---|---|
| 2030 | 333.8148863 | 258.1801093 | 431.6071388 |
| 2031 | 333.8148863 | 255.0137069 | 436.9662308 |
| 2032 | 333.8148863 | 252.0225125 | 442.1524775 |
| 2033 | 333.8148863 | 249.1849209 | 447.1874859 |
| 2034 | 333.8148863 | 246.4833823 | 452.0888072 |
| 2035 | 333.8148863 | 243.9034129 | 456.8709268 |
| 2036 | 333.8148863 | 241.4328953 | 461.5459635 |
| 2037 | 333.8148863 | 239.0615716 | 466.124177 |
| 2038 | 333.8148863 | 236.7806678 | 470.6143425 |
| 2039 | 333.8148863 | 234.5826108 | 475.0240349 |
| 2040 | 333.8148863 | 232.4608106 | 479.3598456 |
| 2041 | 333.8148863 | 230.4094914 | 483.627552 |
| 2042 | 333.8148863 | 228.4235574 | 487.8322514 |
| 2043 | 333.8148863 | 226.4984866 | 491.9784674 |
| 2044 | 333.8148863 | 224.6302441 | 496.0702363 |
| 2045 | 333.8148863 | 222.8152127 | 500.111177 |
| 2046 | 333.8148863 | 221.0501343 | 504.1045491 |
| 2047 | 333.8148863 | 219.3320626 | 508.0533004 |
| 2048 | 333.8148863 | 217.6583228 | 511.9601072 |
| 2049 | 333.8148863 | 216.0264782 | 515.8274078 |
| 2050 | 333.8148863 | 214.4343016 | 519.6574311 |
| 2051 | 333.8148863 | 212.8797509 | 523.4522205 |
| 2052 | 333.8148863 | 211.3609487 | 527.2136549 |
| 2053 | 333.8148863 | 209.8761643 | 530.9434668 |
| 2054 | 333.8148863 | 208.423798 | 534.6432573 |
| 2055 | 333.8148863 | 207.0023681 | 538.3145098 |
| 2056 | 333.8148863 | 205.6104986 | 541.9586016 |
| 2057 | 333.8148863 | 204.2469097 | 545.5768142 |
| 2058 | 333.8148863 | 202.9104081 | 549.1703423 |
| 2059 | 333.8148863 | 201.5998795 | 552.740302 |
| 2060 | 333.8148863 | 200.3142813 | 556.2877373 |
| 2061 | 333.8148863 | 199.0526363 | 559.813627 |
| 2062 | 333.8148863 | 197.8140274 | 563.3188896 |
| 2063 | 333.8148863 | 196.5975925 | 566.804389 |
| 2064 | 333.8148863 | 195.4025197 | 570.2709385 |
| 2065 | 333.8148863 | 194.2280438 | 573.7193049 |
| 2066 | 333.8148863 | 193.0734425 | 577.150212 |
| 2067 | 333.8148863 | 191.9380331 | 580.5643441 |
| 2068 | 333.8148863 | 190.8211693 | 583.962349 |
| 2069 | 333.8148863 | 189.7222392 | 587.3448403 |
| 2070 | 333.8148863 | 188.6406621 | 590.7124002 |
| 2071 | 333.8148863 | 187.5758869 | 594.0655812 |

## VI. Conclusion

According to studies, the simple exponential smoothing model was suitable for predicting the future of rice production in Bangladesh because it had the lowest values of forecasting error. The production of rice showed an increasing trend according to the forecast values. The government and policymakers will be able to make wise decisions to increase rice production in Bangladesh with the help of timely forecasts of this crop, and as a result, the increase in rice production will unquestionably help Bangladesh meet its domestic demand for this crop.

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