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Forecast, Trend, Growth, and Instability of Potato Production in Bangladesh

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Abstract
Although Bangladesh is known as a rice-eating country, enormous amounts of potatoes are produced and consumed each year. Potato has gradually acquired popularity in Bangladesh. Potato is grown as a food crop and a vegetable by both the rich and the poor. This study attempts to measure the trend, growth, and instability of potato production. Besides, here is an attempt to forecast the potato production of the coming years. This secondary data was gathered from the website https://www.potatopro.com/bangladesh/potato-statistics. Here, different statistical tools including t-test, correlation, simple linear regression, semi-log growth model, ARIMA (0,2,1) model, simple exponential smoothing, and Holts Damped trend method were used. Potato production is increasing in Bangladesh. It seems that the production of potatoes will continue to increase in the coming years. The growth rates of potato production in the whole period, period-1 and period-2 are 6.7, 2.7, and 9.3 respectively and CV's around the trend line are 40.28, 7.43, and 10.46 respectively. Therefore, potato production in Bangladesh is showing an increasing trend. It seems that the production of potatoes will continue to increase in the coming years. Potato production in Bangladesh is increasing and it is unstable. The government and numerous non-governmental organizations (NGOs) must work together to increase potato production.
Keywords: Forecast, Trend, Growth, Instability, Potato, Production
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1 Background

1.1 Introduction of the Study: Potatoes are the world's most important non-grain food crops and global food security (Xu *et al.*, 2011). It is grown in hundreds of countries around the world (He, Larkin and Honeycutt, 2012). It originated from the Andes and developed short-life-dependent tuber formation as a vegetable propagation (Kloosterman *et al.*, 2013)**.** Potato starch and its derivatives are very important in the food industry because they control the texture and thus the taste of foods (Semeijn and Buwalda, 2018). Customers choose the place and time of planting to produce good high-quality tuber yields under site-specific atmospheric conditions (Pereira, Villa Nova and Pereira, 2009). Many crop models have been made for potatoes (Raymundo *et al.*, 2014). Yield is improved by using the most adapted cultivators and fertilizers / organic inputs in its agricultural zone (Janssens *et al.*, 2014). Heat-tolerant potato cultivation can reduce the effects of global warming in the tropics (Hijmans, 2003). Except for Punjab, the field's contribution to production is higher than that of yield (Sreepriya, Sidhu and Kumar, 2017). According to the majority of farmers potatoes are planted on more than 25% of all farms (Jane Muthoni, Shimelis and Melis, 2013),
1.2 Research Objective: The goal of this study is to determine the trend, growth, and instability of potato production. In addition, there is an attempt to forecast potato production in the coming years.
1.3 Statement of Problem: The amount of potato production in Bangladesh is not enough compared to the demand. Therefore, it is very important to see the forecast, trend, growth, and instability of potato production.
1.4 Scope of Research: Since the data on potato production of Bangladesh has been used here, so this study will cover the whole of Bangladesh.
1.5 The rationale of the Study: So far, no one has worked on the forecast, trend, growth, and instability of potato production in Bangladesh. So this study has tried to do it.
1.6 Significance of the Study: This study will help the government to make policy. As a result, the people of Bangladesh will benefit from it.

2 Methods

2.1 Data Source: Secondary data was collected from the website https://www.potatopro.com/bangladesh/potato-statistics.
2.2 Study Area: Bangladesh is a developing country. The main food of the people of Bangladesh is rice. Bangladesh produces a lot of potatoes. That is why all the poor and rich people of Bangladesh eat potatoes as a vegetable.
2.3 Outcome variable: In this study, the production of potatoes has been used as the outcome variable.
2.4 Predictor variables: The area of cultivation has been used as a predictor variable.

2.5 Statistical Analysis: First, the whole period 1975 to 2017 has been divided into two periods to compare potato production. The years 1975 to 1995 have been named period-1 and 1996 to 2017 have been named period-2. Then the t-test, correlation, simple linear regression, semi-log growth model, ARIMA (0,2,1) model, simple exponential smoothing, and Holts Damped trend method have all been used. SPSS 23, R 3.6.3, and Microsoft Excel have been used for the analysis.

3 Results

3.1 The trend of Potato Production

Figure-1 shows that potato production increased very slowly from 1975-1998. But potato production has been growing very fast since 1999. As a result, potato production is showing an increasing trend.

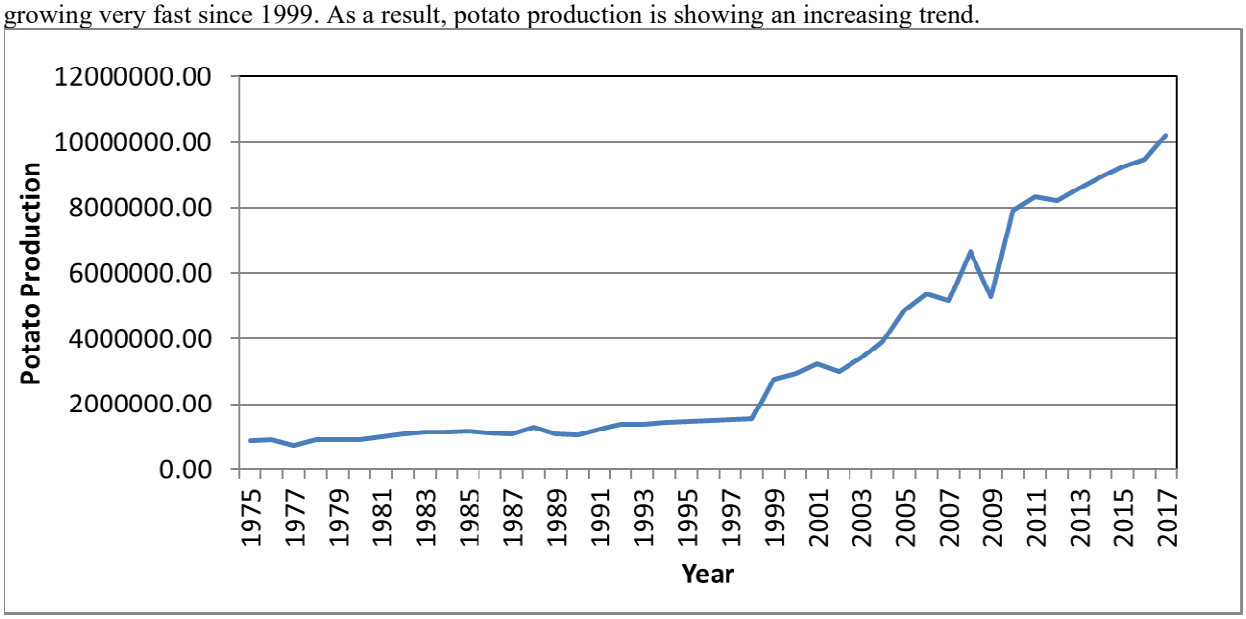

Figure-1: Trend of Potato Production

3.2 Forecasting Potato Production

The ARIMA (0,2,1) model, simple exponential smoothing, and Holts damped trend approach are used in this article to forecast potato production for the next seven years. The forecasted potato production for the year 2018-2024 is shown in **Table-1**. According to the ARIMA model, simple exponential smoothing, and Holts Damped Trend method, the forecasted potato production for 2023 is 14570739, 10117521, and 11714858 respectively. Similarly, potato production of other years can also be interpreted.

Table-1: Forecasted Potato Prediction

Year	Using ARIMA Model (95% CI)	Using Simple Exponential Smoothing (95% CI)	Using Holts Damped Trend Method (95% CI)
2018	10838795 (8181537 – 14359096)	10117521 (8917787-11317255)	10532897 (9584413-11481381)
2019	11499557 (7686190 – 17204858)	10117521 (8524917-11710125)	10778936 (9782471-11775400)
2020	12200601 (7402503 – 20108694)	10117521 (8211370-12023672)	11020054 (9925181-12114927)
2021	12944383 (7217784 – 23214473)	10117521 (7942565-12292477)	11256350 (10008396-12504304)
2022	13733507 (7091141 – 26597867)	10117521 (7703508-12531534)	11487919 (10036462-12939377)
2023	14570739 (7002774 – 30317477)	10117521 (7486080-12748962)	11714858 (10017139-13412576)
2024	15459011 (6941523 – 34427748)	10117521 (7285294-12949748)	11937257 (9958075-13916439)

3.3 Comparing Different Forecasting Methods

Table-2 shows that the forecasting errors of the ARIMA model are less than the errors of simple exponential smoothing and Holts Damped Trend method. So ARIMA model is the best forecasting method for this dataset.

Table-2: Comparing Different Methods

Methods		ARIMA	Simple Exponential Smoothing	Holt's Damped Trend Method
Error	**MAE**	290031.2	340302.4	297065.6
	MAPE	8.081	9.368	9.408
	MASE	0.862	1.012	0.883

3.4 Change in Area of Cultivation, Production, and Yield of Potato

According to the t-test, **Table-3** demonstrates that from period-1 to period-2 the area of potato cultivation, potato production, and potato yield increased by 3.073, 4.99, and 1.53 times, respectively. The increase in potato cultivation area, production, and yield have a p-value of less than 0.05. As a result, the increase in potato cultivation area, production, and yield are statistically significant. Therefore, it can be said that the area of cultivation, production, and yield of potatoes is increasing in Bangladesh.

Table-3: Change in Area of Cultivation, Production, and Yield of Potato

Field of Measurement	**Mean Value**		**t Statistic**	**p-value**
	Period –1 (1975-1995)	**Period –2 (1996-2017)**		
Area	109607.67	336930.22	-8.78	0.000
Production	1109550.33	5546211.36	-7.15	0.000
Yield	10.07	15.42	-7.51	0.000

3.5 Relationship between Area of Cultivation and Production of Potato

Table-4 states that the values of correlation in the whole period, period-1, and period-2 between the area of cultivation and potato production are 0.98, 0.97, and 0.97 respectively. Since the p-value of the correlations of each period is less than 0.05. Therefore, the correlation of each period is statistically significant. As a result, there is a high and positive correlation between the area of cultivation and potato production in Bangladesh.

Table-4: Relationship between Area of Cultivation and Production of Potato

Criteria	**Value of Correlation (r)**		**P-value**
Area of Cultivation vs Potato Production	Whole Period (1975-2017)	0.98	0.000
	Period-1 (1975-1995)	0.97	0.000
	Period-2 (1996-2017)	0.97	0.000

3.6 Dependency of Potato Production on Area of Cultivation

According to simple linear regression, **Table-5** shows that the regression coefficients of the whole period, period-1, and period-2 are 20.88, 13.13, and 23.48, respectively. It can be seen here that the p-value of the regression coefficient of period-2 is less than 0.05. So this regression coefficient is statistically significant. Here the regression coefficient of period-2 23.48 means that if the area of cultivation increases by 1 hectare, production on average will increase by 23.48 times. Similarly, other regression coefficients can also be explained.

Table-5. Dependency of Potato Production on Area of Cultivation

Period	**Constant Value**	**Reg. Coefficient**	**t Statistic**	**P-value**
Whole Period (1975-2017)	-1338425.88	20.88	35.31	0.000
Period-1 (1975-1995)	-329048.56	13.13	18.26	0.000
Period-2 (1996-2017)	-2367866.68	23.48	19.33	0.000

3.7 Growth Rate of Productions and Area of Cultivation and Yield of Potato

Table-6 declares that the growth rate of potato production in the whole period, period-1, and period-2 are 6.7, 2.7, and 9.3 respectively. The growth rate is statistically significant as the p-value of the growth rate is less than 0.05. Therefore, it can be said that the growth rate of potato production is increasing in Bangladesh. Similarly, although the growth rate of the area of cultivation and yield of potato has increased, it is less than the growth rate of potato production.

Table-6: Growth Rate of Productions and Area of Cultivation and Yield of Potato

Field of Measurement	Measurement Statistics	Growth Rate (%)	P-value
Production	Whole Period (1975-2017)	6.7	0.000
	Period-1 (1975-1995)	2.7	0.000
	Period-2 (1996-2017)	9.3	0.000
Area of Cultivation	Whole Period (1975-2017)	4.7	0.000
	Period-1 (1975-1995)	2.1	0.000
	Period-2 (1996-2017)	6.1	0.000
Yield	Whole Period (1975-2017)	1.9	0.000
	Period-1 (1975-1995)	0.6	0.001
	Period-2 (1996-2017)	3.2	0.000

3.8 Instability of Production and Area of Cultivation, and Yield of Potato

Table-7 illustrates that the CV around the trend line of potato production in the whole period, period-1, and period-2 are 40.28, 7.43, 10.46 respectively. Due to the large value of this CV around the trend line, the production of potatoes can be called unstable. In the same way, although the area of cultivation and yield are unstable, they are less than the instability of potato production.

Table-7. Instability in Area, Production, and Yield of Potato in Bangladesh.

Field of Measurement	Measurement Statistics	Whole Period (1975-2017)	Period-1 (1975-1995)	Period-2 (1996-2017)
Production	CV	90.07	18.02	52.33
	R-square	0.80	0.83	0.96
	P value	0.000	0.000	0.000
	D-W	0.18	1.43	2.09
	CV around the trend line	40.28	7.43	10.46
Area of Cultivation	CV	63	13.52	35.73
	R-square	0.86	0.87	0.94
	P value	0.000	0.000	0.000
	D-W	0.19	1.92	1.17
	CV around the trend line	23.57	4.88	8.75
Yield	CV	28.02	5.56	21.32
	R-square	0.81	0.46	0.92
	P value	0.000	0.001	0.000
	D-W	0.44	1.02	2.21
	CV around the trend line	12.21	4.09	6.03

4 Discussion

Over the previous three decades, there has been an upward trend in potato production (Sreepriya, Sidhu and Kumar, 2017). The predicted values of both area and production of potato crops illustrate the growing trend (Abid *et al.*, 2018). This study also shows the increasing trend of the area of cultivation and production. The growth rate of potato production in West Bengal was negative (-2.3) (Rana and Anwer, 2018). But the growth rate of potato production in Bangladesh is positive. The ARIMA model performed statistically well and is a good fit for forecasting Bangladeshi potato production (Hossain and Abdulla, 2016). This study also found that among the ARIMA model, simple exponential smoothing, and Holts Damped trend methods, the ARIMA model is the best forecasting method.

5 Limitation

In this study, only the cultivation area is used as the independent variable. The result will be better if more independent variables are used.

6 Conclusion

Potato production in Bangladesh is increasing very fast. The ARIMA model is the best forecasting method for this dataset. Forecasting has shown that potato production will continue to increase in the coming years. Potato production is growing faster than the area of cultivation and yield in Bangladesh. The instability of potato production is much higher than the area of cultivation and yield.

7 Recommendation

Although the production of potatoes is increasing, it is not enough compared to the demand of people. Therefore, the government and various NGOs must come forward to increase the production of potatoes at a higher rate.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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