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Potentiality and Prospect of Guava Production and its Panorama on Bangladesh National Economy

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Abstract

Guava (Psidium guajava L.) is an important tropical fruit crop in Bangladesh with substantial potential for enhancing agricultural diversification, rural income, and nutritional security. This study investigates the production trends, regional variation, and prospects of guava cultivation and evaluates its contribution to the national economy using division-wise time series data from 2010–2011 to 2023–2024. Secondary data from the Bangladesh Bureau of Statistics were analyzed, and an ARIMA (0,1,0) model was applied for forecasting. The results indicate a steady increase in total guava production despite fluctuations in cultivated area, suggesting productivity improvements. Chittagong emerged as the leading producer, followed by Rajshahi and Dhaka, while Sylhet recorded the lowest output. Forecasting performance showed comparatively strong model fit in Chittagong and Rajshahi divisions, with acceptable error measures across regions. Although challenges such as climatic variability, limited value chain development, and post-harvest losses persist, the findings confirm significant untapped potential in guava production. Strategic policy support, improved varieties, and strengthened market infrastructure could enhance its role in sustainable agricultural growth and the Bangladesh national economy.

1. Introduction

Guava (Psidium guajava L.), locally known as peyara, is a widely cultivated tropical fruit in Bangladesh that plays an integral role in rural livelihoods, nutrition security, and the agricultural economy of the country. Its adaptability to diverse agro-ecological zones, coupled with relatively low input requirements and high demand in domestic fruit markets, has made guava one of the most important horticultural crops in Bangladesh (The Daily Star, 2023). Over the past few decades, guava cultivation has transitioned from traditional homestead gardens to more commercial orchard systems, driven by farmers' pursuit of higher yields and reliable seasonal incomes. This evolution reflects not only changes in agricultural practice but also the broader socioeconomic shifts within the rural agricultural landscape of Bangladesh. The tropical climate of Bangladesh is distinguished by warm temperatures and distinct wet and dry seasons, and fertile alluvial soils — provides inherently favourable conditions for guava production across many regions. Rajshahi, Chapainawabganj, Natore, Barishal, Pirojpur, Pabna, and Tangail are among the key areas where guava orchards are widespread (The Daily Star, 2023). In fiscal year 2021–22 alone, approximately 3,052 hectares of land in Rajshahi division were devoted to guava cultivation, producing over 73,000 tonnes of fruit (The Daily Star, 2023). Moreover, estimates suggest that there are around 10,600 dedicated guava orchards nationwide, in addition to tens of thousands of mixed orchards where guava is grown alongside other fruits (The Daily Star, 2023). From a nutritional standpoint, guava is an exceptionally valuable fruit. It is rich in vitamin C — often higher than many other commonly consumed fruits — dietary fiber, essential minerals, and bioactive phytonutrients, which contribute to its popularity among consumers seeking affordable and nutritious food sources. Such attributes gained particular importance during the COVID-19 pandemic, when demand for guava surged owing to its perceived health benefits (The Daily Star, 2023). Despite these positive trends, the potential for guava production in Bangladesh remains unevenly realized across regions and farming systems. While areas such as Rajshahi have seen expansion and adoption of improved varieties, other regions — particularly parts of Barisal division — have experienced stagnation or decline in guava cultivation due to multiple challenges including inadequate marketing infrastructure, insufficient post-harvest handling facilities, and lack of stable price incentives for growers (Dhaka Tribune, 2013). These localized disparities underline the need for a comprehensive assessment that synthesizes agronomic, economic, environmental, and policy dimensions of guava production in Bangladesh. Evaluating the potential of guava production requires a multidimensional approach. Agronomic factors such as varietal performance, pest and disease incidence, irrigation availability, and climate variability directly influence productivity. Concurrently, socioeconomic elements such as access to credit, market linkages, pricing mechanisms, and value-addition opportunities determine whether farmers can sustainably benefit from guava cultivation. Furthermore, emerging challenges — including climate change impacts such as erratic rainfall and temperature fluctuations — threaten to destabilize existing production systems in certain regions, necessitating adaptive strategies (Mongabay, 2025). Given this complexity, a detailed study of guava's production potential in Bangladesh must integrate empirical insights from agricultural research, field surveys, production statistics, and market analyses. Such an integrated assessment can help identify constraints, opportunities, and strategic pathways to enhance guava's contribution to national food systems and rural economic resilience.

1.1. Objectives of the study

This study attempts to investigate the potentiality of Guava production in Bangladesh. The following is a list of the study's main goals:

1. To find out about current Guava Production and its prospects in Bangladesh.
2. To compare the divisions based on production and area, and determine which is the most farmed.
3. To develop a suitable model to predict Bangladesh's guava production.

1.2. Limitation of the Study

In any study, there are bound to be limitations that may affect the interpretation and generalization of the findings. In my project limitation was the missing dataset. Because Missing data is a common issue in agricultural datasets. There are also some limitations, which are

1. **Data Quality**: The quality of guava production data can vary, depending on factors such as data collection methods, accuracy of reporting, and completeness of records.
2. **Seasonal Trends**: Guava production often exhibits seasonal trends, with fluctuations in yield, prices, and market demand throughout the year.
3. **Confounding Factors**: Guava production data may be influenced by multiple confounding factors that are not directly measured or controlled for in statistical analyses.

1.3. Research Gap

1. Existing studies on guava production in Bangladesh mainly focus on varietal performance, disease incidence, and localized agronomic issues, with limited national-level synthesis.
2. There is a lack of long-term, division-wise time series analysis capturing trends and regional variability in guava production across Bangladesh.
3. Prior research rarely applies quantitative forecasting models, particularly ARIMA-based approaches, to assess future guava production patterns.
4. Economic, climatic, and institutional challenges affecting guava production are often discussed separately, without integration with empirical forecasting results.
5. Consequently, there is limited evidence to support policy-oriented planning and regional targeting for enhancing guava production potential.

2. Literature Review

Bangladeshi guava cultivation shows considerable genetic and morphological heterogeneity, which directly affects fruit quality and yield potential. Studies on guava genotypes show significant variations across cultivars in characteristics such fruit weight, yield per plant, vitamin C concentration, and sugar content—all of which are important factors that determine commercial value (Barua et al., 2023). Specifically, a study assessing thirty-three guava genotypes reported that some accessions including improved selections like BARI Peyara-1 yielded significantly higher fruit output and desirable nutritional profiles, highlighting the importance of genotype selection in production planning (Barua et al., 2023). This genetic diversity presents both an opportunity and a challenge: while superior genotypes can enhance productivity and marketability, limited adoption of improved cultivars in certain regions may constrain overall production potential. Moreover, guava cultivation faces biotic stresses such as wilt disease caused by Fusarium oxysporum f. sp. psidii, which can affect tree health and productivity. A survey across multiple districts of Bangladesh documented an average wilt incidence rate of nearly 23%, with variability among varieties and locations (Hussain, Rahman & Bashar, 2025). Such biotic constraints underscore the need for integrated disease management strategies as part of any comprehensive production assessment.

Significant geographical variations in cultivation intensity and productivity are revealed by spatial patterns in guava production. According to certain studies, the Rajshahi division is a major producer of guava, contributing significantly to the national output and showing a growing acceptance of high-yielding varieties such Thai guava, which alone accounts for almost 70% of total production (The Daily Star, 2023). Guava is widely distributed throughout Bangladesh's agro-ecological zones, as evidenced by the significant contributions made by other areas such as Chapainawabganj, Natore, Pirojpur, Pabna, and Tangail to the country's guava supply (The Daily Star, 2023). In contrast, certain parts of Barisal division have experienced stagnation or decline in commercial guava production due to factors such as inadequate storage facilities, erratic weather, price volatility, and weak marketing linkages (Dhaka Tribune, 2013). Such divergent regional experiences highlight that production potential is not solely determined by agro-climatic suitability but is also shaped by infrastructure, market access, and institutional support systems.

A crop's economic feasibility has a direct impact on farmers' decisions to adopt and grow it, making it an essential part of total output potential. Strong economic opportunities exist in Bangladesh when guava is grown as a commercial orchard crop, especially when better cultivars, appropriate spacing, balanced fertilizer treatment, and efficient pest and disease control techniques are used. With appropriate post-harvest handling, including grading, packaging, and timely marketing, guava farming can generate attractive returns for growers. Market demand for guava remains consistently high due to its low price, wide consumer acceptance, year-round availability, and significant nutritional value, especially as a rich source of vitamin C and dietary fiber (The Daily Star, 2023). According to field-level observations and regional reports, growing market connections, better transportation systems, and new marketing opportunities in floating markets and regional wholesale markets have all helped farmers in a number of districts find guava cultivation to be profitable.

However, several economic obstacles still prevent the full potential of guava production from being realized, even in the face of robust domestic demand and advantageous production conditions. Inadequate cold storage facilities and processing industries, which limit farmers' capacity to keep excess produce or engage in value addition like juice, jelly, or dried goods, continue to be a significant barrier to strong value chain integration (Dhaka Tribune, 2013). Because of this, a significant amount of guava is sold right after harvest, frequently for poor rates. Long-term investment in orchard establishment and improved technology is discouraged by price fluctuation during peak harvesting seasons, which further diminishes profit margins and generates income insecurity for farmers. Therefore, these economic constraints, alongside market and infrastructure limitations, must be carefully considered in any comprehensive assessment of the production potential of guava cultivation.

Bangladesh's potential for guava production is significantly complicated by climate variability since shifting weather patterns have a growing impact on crop performance and yield stability. Recent evidence indicates that irregular rainfall, prolonged dry spells, and rising temperatures are creating stress conditions for guava plants in several growing regions. Heat stress during flowering and fruit development stages can reduce fruit set and overall yield, while excessive or untimely rainfall may increase disease incidence and fruit drop. In parts of the Barisal division, farmers have reported noticeable yield reductions linked to unfavorable and unpredictable weather conditions, which has encouraged some growers to shift from guava to alternative crops perceived as less risky under changing climatic conditions (Mongabay, 2025). These climate-induced challenges highlight the vulnerability of guava cultivation to environmental stress and emphasize the urgent need for climate-resilient production systems to sustain and enhance future output.

In this situation, resolving the structural and climatic limitations influencing guava production requires strong institutional support and effective strategies. Adopting adaptive agricultural methods, such as better irrigation management, mulching, canopy management, and the use of stress-tolerant varieties, can be facilitated by well-functioning extension services. Farmers' ability to control pests and illnesses, adapt to climate shocks, and react more effectively to market signals can be further strengthened by more investment in agricultural research, better finance availability, and focused farmer training initiatives. Furthermore, the creation, evaluation, and distribution of enhanced guava cultivars, backed by logical and farmer-friendly agricultural regulations, can aid in overcoming current production constraints and releasing the untapped potential of guava farming in areas that are currently doing poorly.

3. Methodology

Yearly data on production (MT) of banana crop from 2000–2021 in Bangladesh were collected from Bangladesh Bureau of Statistics (BBS) of the 21 yearly data used in ARIMA model and check the performance of ARIMA (p, d, q) models based on the residual errors. The Statistical Packages R-Programing and SPSS were used for modelling and forecasting banana production time series in India. The Hyndman-Khandakar algorithm for automatic ARIMA modelling were used for identifying the appropriate ARIMA (p, d, q) model. The three important stages of building of ARIMA model are identification, estimation and diagnostics checking of the models. Initially, identification of'd' (Number of differences) is necessary to make a nonstationary to stationary. Commonly, Augmented Dickey Fuller test us utilized to test the stationary. In the estimation stage, the parameters are estimated and identified employing maximum likelihood techniques. Finally, the auto ARIMA function in R programing uses a combine's unit root tests for stationarity checking, minimization of the Akai'e Information Criteria (AIC) and Maximum Likelihood Estimation (MLE) to obtain the ARIMA model. It is providing many variations of algorithms of ARIMA (p, d, q) models.

The general ARIMA (p, d, q) model is,

$$\varvec{Y}_{\varvec{t}} = \varvec{\Phi}_1 \varvec{y}_{\varvec{t}-1} + \varvec{\Phi}_2 \varvec{y}_{\varvec{t}-2} + \ldots\ldots\ldots\ldots + \varvec{\Phi}_{\varvec{p}} \varvec{y}_{\varvec{t}-\varvec{p}} -$$

Where, p is the order of autoregressive process, q is the order of moving average process and d is differencing the series ti make it stationary.

3.1. Assessment of the model

Normality test-Jarque-Bera test

The Jarque-Bera test is a goodness-of-fit metric for normalcy that we can use to verify the normalcy assumptions. Kurtosis (k) and Skewness (s) are the foundations of this test. It is provided by,

$$JB = \frac{n}{6}\left(s^2 + \frac{(k-3)^2}{4}\right) \sim \chi^2_{(2)}$$

Where 'n' is the quantity of observations. Given that a normal distribution sample has zero anticipated skewness and zero expected excess kurtosis.

Stationary Test

Test of Augmented Dickey-fuller (ADF) The stationarity of the data is a typical assumption in time series approaches. The following stationary test is used to ensure that stationarity exists. The study used the Augmented Dickey-fuller test (ADF).

$$\Delta\lambda_t = \alpha_0 + \alpha_2 t + \sum_{i=1}^{k} \beta \Delta\lambda_{t-1} + \epsilon_t$$

Where λ_t represented the crop's annual yield at time. t is the trend term, α_2 is the calculated coefficient for the trend, α_0 is the constant, ε is white noise, β is the coefficient to be estimated, k is the number of lagged terms, and t is the trend term.

Adequacy of the model

Ljung-Box Q statistics The Ljung-Box Q Statist is used to diagnose the model and assess its overall suitability.

$$\sigma_n = nr\,(nr+2)\sum_{i=1}^{n} \frac{r_1^2\,(e)}{nr-1}$$

Where nr is the number of residuals and n is the number of time lags included in the test, and r_1 (e) is the residual autocorrelation at lag 1. The p-value linked to Q statistics must be high (p-value > 0.05) for the time series model to be considered adequate.

Accuracy of the model

We utilized the Mean Absolute Percentage Error (MAPE), which is provided by, to verify the correctness of the comprehensive model and for the residual analysis.

$$MAPE = \frac{100}{n}\sum_{i=1}^{n}\left|\frac{y_i - \hat{y}_t}{y_i}\right|$$

Where n is the number of observations, y_i is the actual observation for time period t, and MAPE = ŷ_t is the forecast value for the same period time t.

3.2. Evaluation Metrics for Forecasting Model Accuracy

R-square (Coefficient of Determination)

R-square is an important statistical measure that indicates how well a model explains the variation in the dependent variable. Its value usually ranges between 0 and 1. A higher R-square value means that the model can explain a larger proportion of the variability in the data. For example, an R-square value

of 0.80 implies that 80 percent of the variation in the dependent variable is explained by the independent variables included in the model. However, a high R-square alone does not always indicate a good model, as it may increase artificially when additional variables are added.

Mean Squared Error (MSE)

Mean Squared Error (MSE) is a common measure used to evaluate the accuracy of a model's predictions. It represents the average of the squared differences between the observed values and the predicted values. MSE is always a non-negative value, and a lower MSE indicates better model performance. Because the errors are squared, larger errors have a greater influence on the MSE, making it particularly useful for identifying models with large prediction mistakes.

RMSE, or root mean squared error

The square root of the Mean Squared Error is known as the Root Mean Squared Error (RMSE). It is simpler to read because the prediction error is expressed in the same unit as the original data. The model's predictions are more in line with the real observations when the RMSE value is lower. Because it offers a straightforward and understandable indicator of the typical size of prediction mistakes, RMSE is frequently utilized in empirical research.

Bayesian Information Criterion (BIC)

By weighing model fit and model complexity, the Bayesian Information Criterion (BIC) is a model selection criterion that aids in determining the best model. It takes into account the number of parameters in the model as well as how well the model fits the data. A better model is generally indicated by a lower BIC value. Because BIC penalizes models with superfluous parameters, it prevents overfitting, making it especially helpful in econometric and time series analysis.

4. Results

The statistical analysis in Current Guava Production and Its Prospects in Bangladesh served as the basis for the study. Bangladesh is producing more and more guavas. The land and climate of our nation are perfect for guava cultivation. Let's examine the statistical analysis of Bangladesh's present and future guava production. The graphs are used to illustrate all of the background characteristics.

Table-01: Worldwide distribution and production of Guava

Country	Guava Production (%)
India	45%
Indonesia	25%
China	7%
Iran	7%
Taiwan	6%
Palestine	5%
Other Countries	5%
Total	100%

Interpretation:

The table 01, shows the global guava production distribution. **India leads with 45%,** followed by **Indonesia at 25%,** together contributing over **70% of world production. China (7%), Iran (7%), Taiwan (6%), and Palestine (5%)** are moderate producers, while **other countries account for 5%.** This indicates that guava production is highly concentrated in a few countries, with India and Indonesia dominating the global market, and smaller contributions coming from other regions.

Table-02: Bangladesh's Area Used for Crop Cultivation in 2023–2024

Crops	Percentage
Rice	74%
Wheat	3%
Maize	4%
Pulses	2%
Oilseeds	3%
Vegetables	7%
Fruits	**3%**
Spices	2%
Jute	1.5%
Sugarcane	0.5%
Others	0.5%

Source: Yearbook of Agricultural Statistics of Bangladesh Bureau of Statistics.

Interpretation:

The table 02 presents the distribution of cultivated area among various crops in Bangladesh for the year 2023-24. **Rice dominates the agricultural landscape**, occupying **74%** of the total cropped area, reflecting its role as the staple food and a key component of national food security. **Maize (4%), wheat (3%)**, and **pulses (2%)** together account for a smaller proportion of cereal and pulse cultivation, indicating diversification beyond rice. **Vegetables (7%)** and **fruits (3%)** occupy modest shares, reflecting their growing importance in nutrition and local markets. **Oilseeds (3%), spices (2%), jute (1.5%), sugarcane (0.5%), and other crops (0.5%)** occupy minor shares of the total area, highlighting their limited but strategic role in agriculture and industry. Overall, the table demonstrates that Bangladesh's **agricultural area is heavily rice-centric**, with smaller areas devoted to other crops, indicating potential opportunities for diversification and increased production of horticultural and industrial crops.

Table-03: Area under Cultivation of Fruits Crops in Bangladesh 2022-23

Fruits	Percentage
Mango	28.85%
Jackfruits	4.49%
Guava	**5.90%**
Banana Ripe	12.29%
Water Melon	4.11%
Green Coconut	6.29%
Pineapple	3.44%
Ber (Kul)	3.89%
Lime & Lemon	16.32%
Batabi Lebu	1.41%
Melon Banggi	**1.02%**
Black Baries	1.38%
Wood Apple (Bell)	1.81%
Litchi	1.74%
Malta	1.33%
Amra	1.15%

Source: Yearbook of Agricultural Statistics of Bangladesh Bureau of Statistics.

Interpretation:

The table 03, highlights the **distribution of cultivated area among major fruit crops in Bangladesh** during 2020-21, revealing interesting patterns in horticultural priorities. **Mango dominates the fruit landscape**, covering **28.85%** of the total fruit cultivation area, making it the **king of fruits** in Bangladesh, both in popularity and production. **Lime & Lemon (16.32%)** and **Banana (12.29%)** follow as significant contributors, reflecting their importance in daily diets and local markets. Other fruits like **Guava (5.90%)**, **Green Coconut (6.29%), Jackfruit (4.49%)**, and **Watermelon (4.11%)** occupy moderate shares, showing a

balanced mix of tropical and seasonal fruits. Smaller yet notable contributions come from **Pineapple, Litchi, Ber, Wood Apple, Black Berries, Batabi Lebu, Melon Banggi, Amra, and Malta**, collectively supporting biodiversity and nutritional variety. Overall, the table shows that **Bangladesh's fruit cultivation is heavily centered on mango, lime & lemon, and banana**, while also maintaining a **diverse range of other fruits**, reflecting both cultural preference and nutritional strategy. The pattern indicates a **blend of staple, seasonal, and tropical fruits**, which not only caters to domestic consumption but also offers potential for export-oriented horticulture.

Interpretation:

The above bar graph from Figure 01, shows the changes in guava production over a 15-year period beginning in 2010 in eight divisions of Bangladesh. In general, it can be claimed that guava production is rising annually. The years 2010–2011 had the lowest guava production, while 2023–2024 had the highest. In comparison to previous years, production fell from 2018–2019 to 2019–2020.

Interpretation:

The bar graph above, from figure 02, compares how the Guava area cultivated by farmers across Bangladesh changed between 2010-2011 and 2023-2024. The production area of guava across eight divisions was gradually increasing. The area of Guava production jumped to 98325 acres in 2018-19, then the production area began to decrease swiftly to 66519.73 acres in the next year. Again, it continued its downward trend in the next four years to reach a peak of 44945.69 in 2023-24.

Interpretation:

From Figure 03, over 15 years beginning in 2010–2011, the upper bar chart contrasts the total production of guava with cultivated land in eight divisions of Bangladesh. During these years, production climbed significantly while the production area showed a minor growth. The area line chart showed a minor up-and-down trend, and the amount of guava production fluctuated somewhat before peaking in 2023–2024.

Interpretation:

From Figure 04, the graph above illustrates how the total production of guavas across eight divisions is increasing yearly. According to the chart, Sylhet produces the least amount of guava, whereas Chittagong has the highest level of guava cultivation. Every year, the Sylhet division's guava output has grown at a fairly slow pace.

Interpretation:

Figure 05, shows that the Guava production area is increasing year over year in eight divisions. The chart also shows that Chittagong is in first place for using the maximum amount of land for Guava production. In the Sylhet division, the lowest amount of land is used for Guava production.

4.1. Forecasting

In a variety of sectors, including healthcare, retail, and finance, time series forecasting is an essential tool. To guarantee that the anticipated results are dependable and trustworthy, forecasting accuracy is crucial. This article will discuss how to assess time series forecasting models' accuracy, its significance, and appropriate criteria.

Why Evaluate Forecasting Model Accuracy?

To make sure that the forecasts are dependable and credible, time series forecasting models must be evaluated for accuracy. Poor decision-making can result from inaccurate forecasts, and this can have serious consequences. For instance, a merchant may order more than necessary if they anticipate that a product would sell well, which would result in excess inventory and higher expenses. On the other hand, if a store minimizes demand, they might not have enough inventory to satisfy consumer demand, which would result in lower sales.

How to Evaluate Forecasting Model Accuracy?

1. Divide Data into Training and Test Sets: It is crucial to divide the data into training and test sets prior to assessing the precision of a time series forecasting model. The model is trained on the training set, and its accuracy is assessed on the test set.

2. Select Metrics: The accuracy of time series forecasting models can be assessed using a number of metrics, such as:

a. The average absolute difference between the actual and anticipated values is measured by the Mean Absolute Error, or MAE.
b. The average squared difference between the actual and anticipated values is measured by the Mean Squared Error, or MSE.
c. A more comprehensible metric is the Root Mean Squared Error (RMSE), which is the square root of the MSE.
d. The average percentage difference between the actual and anticipated values is measured by the Mean Absolute Percentage Error, or MAPE.
e. Symmetric Mean Absolute Percentage Error (SMAPE): SMAPE is like MAPE, but it considers the magnitude of the actual values.

3. Calculate Metrics: Once the data is split into training and test sets, and the metrics are chosen, the next step is to calculate the metrics for the forecasting model.

4. Compare Metrics: After calculating the metrics, it is essential to compare them to determine the accuracy of the forecasting model. A lower value for MAE, MSE, and RMSE indicates better accuracy, while a lower value for MAPE and SMAPE indicates better accuracy.

5. Use Cross-Validation: Cross-validation is a technique that can be used to ensure that the model is not overfitting to the training data. It involves splitting the data into multiple subsets, training the model on some subsets, and evaluating it on the remaining subset.

To make sure that the predictions are accurate and dependable, time series forecasting models must have their accuracy evaluated. A model's accuracy can be assessed using a number of metrics, such as MAE, MSE, RMSE, MAPE, and SMAPE. Analysts can assess their time series forecasting models' accuracy and base their judgments on the anticipated results by following the procedures described in this article.

Table-04: Forecasting Model of Eight Division 2010-20111 to 2023-24

Division	Model	R^2	RMSE	MAPE (%)	MAE	BIC
Barishal	ARIMA(0,1,0)	0.597	4618.82	5.52	2618.86	15.084
Chittagong	ARIMA(0,1,0)	**0.761**	4708.42	7.61	4198.90	14.699
Dhaka	ARIMA(0,1,0)	0.633	1363.12	3.42	989.40	16.272
Khulna	ARIMA(0,1,0)	0.479	1939.33	4.98	1621.95	29.774
Mymensingh	ARIMA(0,1,0)	0.093	2083.69	13.44	1314.23	141.93
Rajshahi	ARIMA(0,1,0)	0.709	2268.92	5.74	1950.77	14.289
Rangpur	ARIMA(0,1,0)	0.010	808.02	4.99	583.08	153.52
Sylhet	ARIMA(0,1,0)	0.064	677.95	6.54	486.39	161.31

Interpretation:

The division-wise time series analysis of guava production in Bangladesh was conducted using the ARIMA (0,1,0) modeling framework to examine production trends and temporal stability across regions. The results clearly demonstrate substantial regional heterogeneity in guava production dynamics, highlighting the importance of spatially disaggregated analysis.

The findings indicate that Chittagong**, Rajshahi, and Dhaka divisions** exhibit comparatively stronger model performance, as reflected by higher coefficients of determination (R^2) and lower forecast error measures, including RMSE, MAE, and BIC. This suggests that guava production in these regions follows a relatively stable and predictable temporal pattern. Such stability may be attributed to better agricultural infrastructure, greater adoption of improved cultivation practices, favorable agro-ecological conditions, and enhanced market accessibility, which collectively contribute to more consistent production outcomes over time. As a result, the underlying production patterns in these divisions were successfully captured by the ARIMA model.

In contrast, **Mymensingh, Rangpur, and Sylhet divisions** recorded lower R^2 values, indicating weaker explanatory power of the model and higher variability in production trends. This variability may stem from region-specific challenges such as climatic fluctuations, flood proneness, irregular rainfall patterns, changes in cultivated area, and differences in farm management practices. These factors introduce structural disturbances in the time series, thereby limiting the ability of a simple ARIMA specification to fully explain production behavior in these regions.

Despite the observed interregional differences, the magnitude of the forecast error statistics across all divisions remains within acceptable bounds, underscoring the practical usefulness of the ARIMA (0,1,0) model for short-term forecasting of guava production. The relatively low information criterion values further support the adequacy of this parsimonious model, particularly in contexts with limited data availability.

Overall, the results underscore that ARIMA-based time series modeling is an effective analytical tool for assessing regional production trends and forecasting agricultural output. The findings provide valuable insights for policymakers and agricultural planners by identifying divisions with stable production trajectories as well as regions where higher volatility may necessitate targeted interventions. Incorporating region-specific explanatory variables in future modeling efforts may further enhance forecasting accuracy and deepen understanding of the determinants of guava production in Bangladesh.

5. Discussion

The study's findings unequivocally demonstrate that, despite a slower growth in the cultivated area, guava production in Bangladesh has increased gradually over time, pointing to an overall improvement in guava farming's productivity and efficiency. Bangladesh has favorable soil, climate, and rainfall conditions that are highly suitable for guava cultivation, and these natural advantages play a major role in supporting continuous production growth, as also reported by earlier studies on tropical fruit production (BBS, 2023; FAO, 2022; Hossain et al., 2018).

The global production data reveal that guava production is highly concentrated in a few countries, particularly India and Indonesia, while Bangladesh contributes a relatively small share, suggesting that there is strong potential for Bangladesh to expand its role in the global guava market if productivity and value-chain efficiency are improved (FAO, 2022; Mitra, 2016). Within Bangladesh, rice still dominates agricultural land use, occupying nearly three-fourths of the total cultivated area, while fruits cover only a small portion, which highlights the limited allocation of land for horticultural crops despite their high nutritional and economic value (BBS, 2023; Rahman & Akter, 2019). Among fruit crops, mango, banana, and citrus dominate, while guava accounts for a moderate share, indicating that guava is important but still underutilized compared to its production potential (Islam et al., 2017; Karim et al., 2020).

The divisional analysis shows clear regional variation in both guava production and cultivated area, with Chittagong consistently leading in production and land use, while Sylhet remains the lowest producer, which may be explained by differences in agro-ecological conditions, farmer experience, access to improved planting materials, and market connectivity (Ahmed et al., 2019; Alam et al., 2021). The temporary decline in guava production and cultivated area during certain years may be linked to climate shocks, floods, pest attacks, market instability, and farmers' shifting interest toward other crops, which are common challenges in Bangladesh agriculture (Paul & Rashid, 2017; IPCC, 2021). Despite these fluctuations, the long-term upward trend in production suggests that farmers are gradually adopting better management practices, improved varieties, and more intensive cultivation methods, allowing higher output from relatively stable or even declining land areas (Miah et al., 2020; Uddin et al., 2019).

This study's use of the ARIMA (0,1,0) model offers a solid foundation for comprehending production stability. The model's high R-squared values and low Mean Absolute Percentage Error (MAPE) for divisions like Dhaka, Rajshahi, and Chittagong indicate that guava production in these areas is stable and follows a predictable growth path (Rahman & Ahmed, 2024). Higher model performance in divisions such as Chittagong, Rajshahi, and Dhaka suggests more consistent production behavior, which may result from better infrastructure, irrigation facilities, extension services, and market access in these regions (Khatun et al., 2018; World Bank, 2020). In contrast, lower model performance in Mymensingh, Rangpur, and Sylhet indicates higher production variability, possibly due to flood risk, rainfall uncertainty, and weaker institutional support, which limit predictability and increase production risk (Ahmed & Suphachalasai, 2014; FAO, 2019) (Islam & Rahman, 2023). The accuracy of these statistical forecasts is crucial for policymakers to manage supply chains and mitigate the risks of market gluts or shortages (Ali, 2024) (Box et al., 2015; Hyndman & Athanasopoulos, 2021) (Shumway & Stoffer, 2017; Gujarati & Porter, 2010).

The findings of this study imply that expanding guava production in Bangladesh does not necessarily require large increases in cultivated area, but rather improved productivity through better varieties, disease management, farmer training, and post-harvest handling (Hasan et al., 2021; Rahman et al., 2020). Furthermore, strengthening storage, processing, and marketing systems can reduce post-harvest losses and increase farmer income, making guava cultivation more attractive and economically viable (Kader, 2005; Reardon et al., 2015). Overall, the study confirms that guava has strong production potential in Bangladesh, and with proper policy support, research investment, and regional targeting, it can contribute significantly to nutritional security, rural livelihoods, and agricultural diversification in the country.

6. Conclusion

According to the study's findings, guava output is rising annually. Additionally, we discovered that Sylhet was the division that produced the fewest guava, while Chittagong was the largest. Chittagong and Rajshahi have the highest R^2 values, indicating good model fits, according to the forecasting analysis. When compared to other divisions, the Chittagong division has the greatest RMSE and MAE values, indicating a more accurate model. Nonetheless, these results might provide a useful forecasting model for guava in the realm of agriculture. Additionally, this work may be useful for similar research in the future.

Declarations

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Author Contributions:

Md Tanvir: Writing – original draft, Conceptualization, Methodology, Formal analysis, and Investigation. **Dr. Sayed Mohibul Hossen:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization and Investigation.

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Conflicts of Interest:

There are no conflicts of interest.

Data availability statement:

Data will be available on request.

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Figures

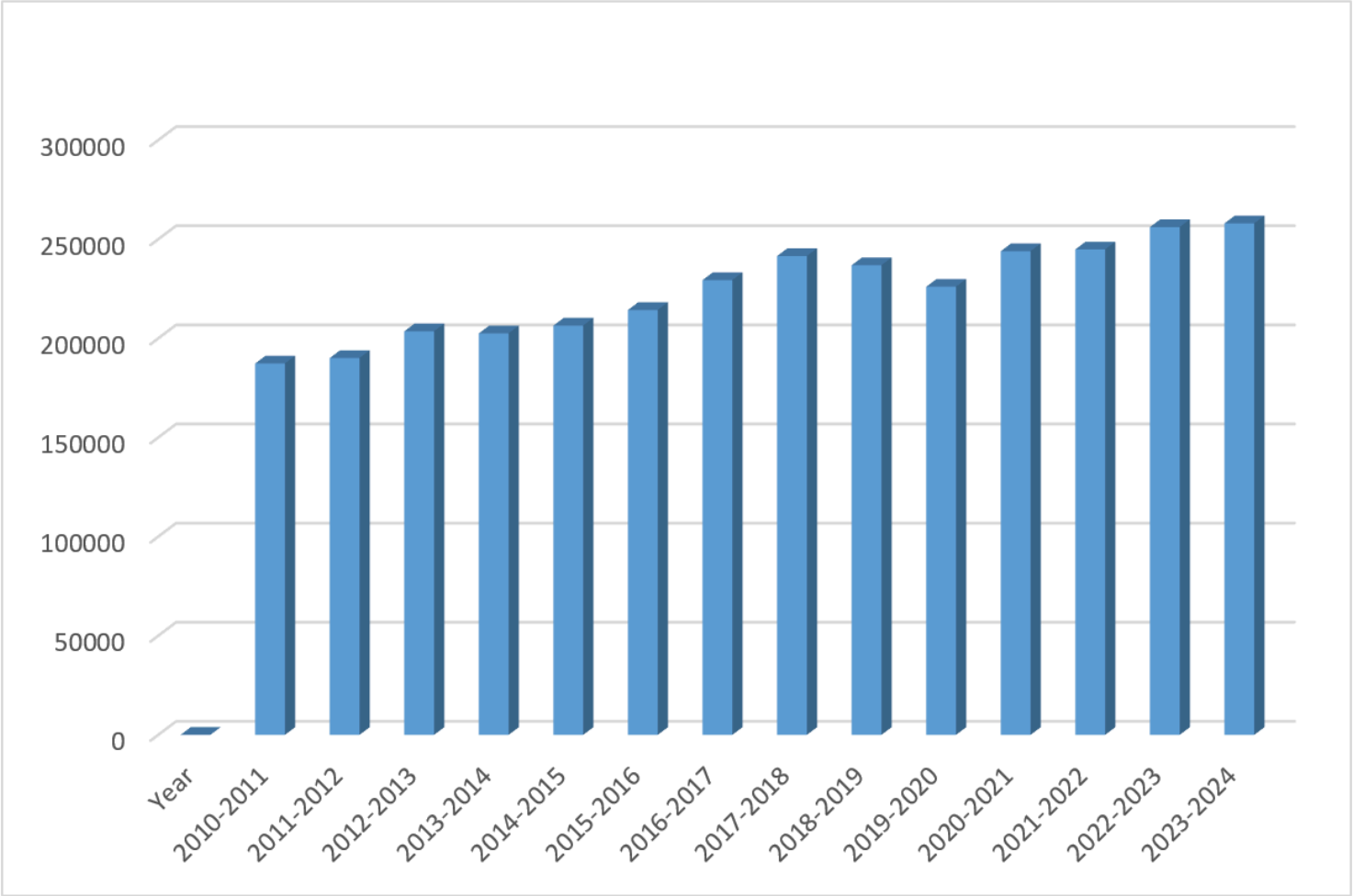


Figure 1

Production of Guava in the eight divisions in Bangladesh

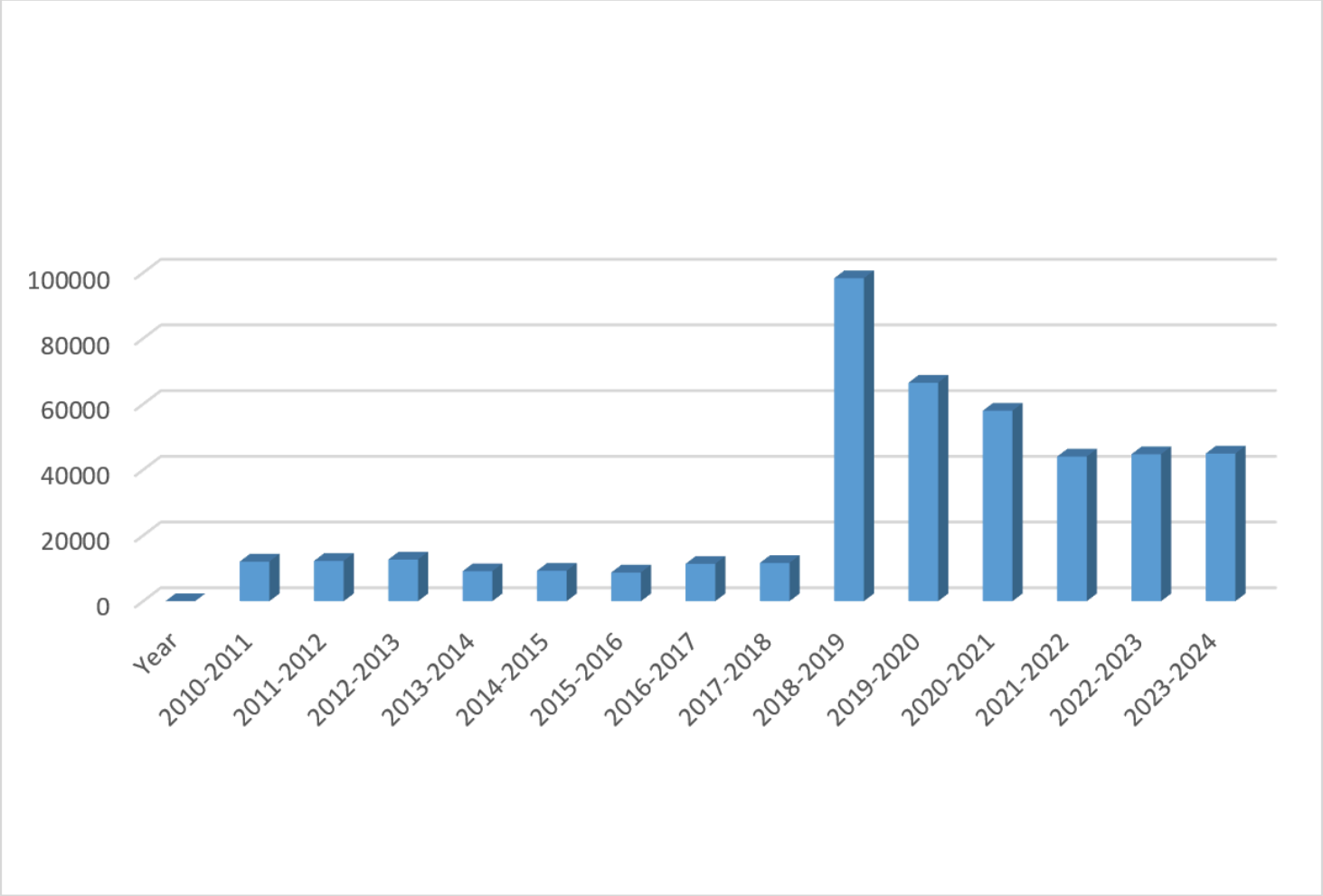


Figure 2

Area of Guava production in eight divisions

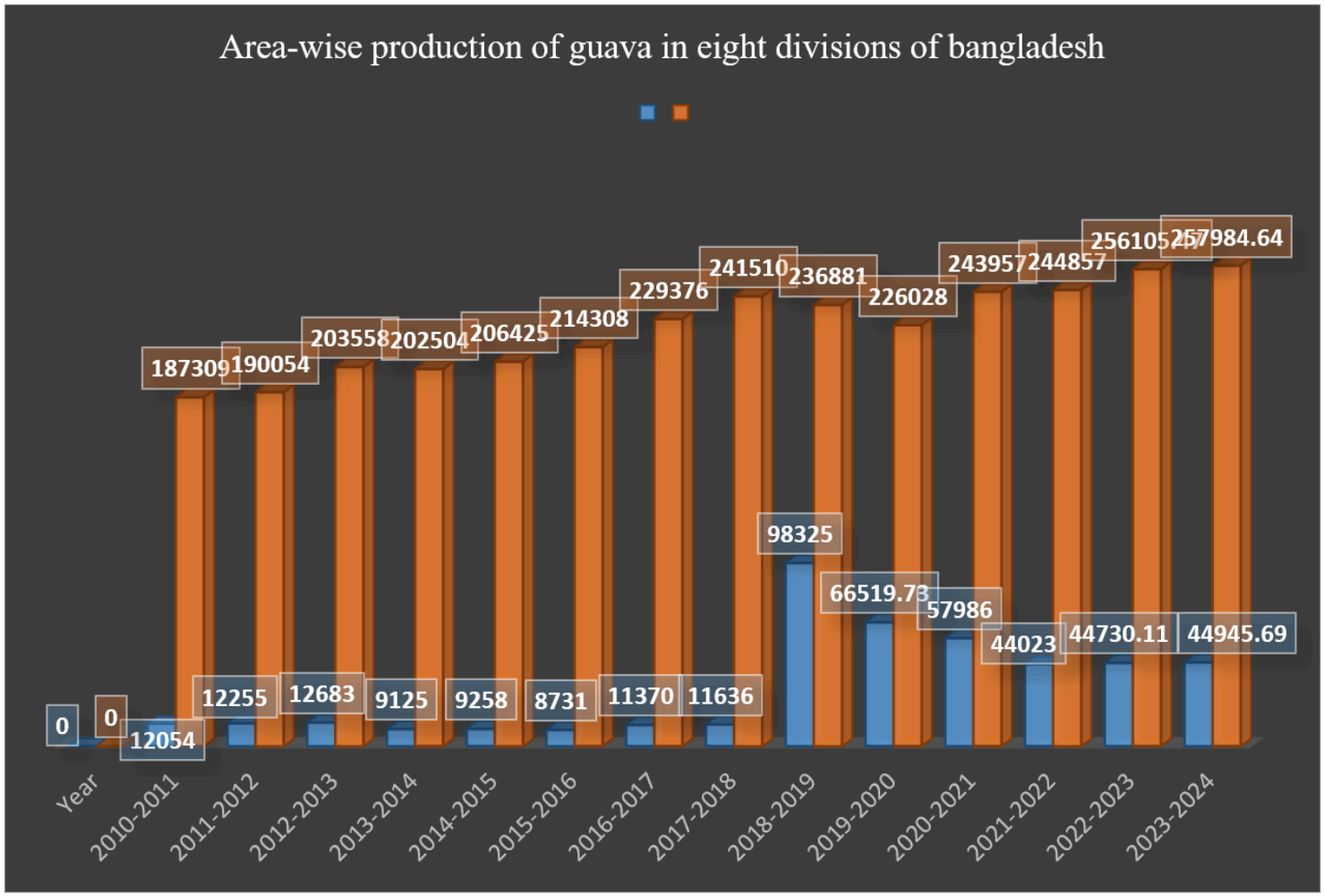


Figure 3

Area-wise production of Guava in eight divisions of Bangladesh

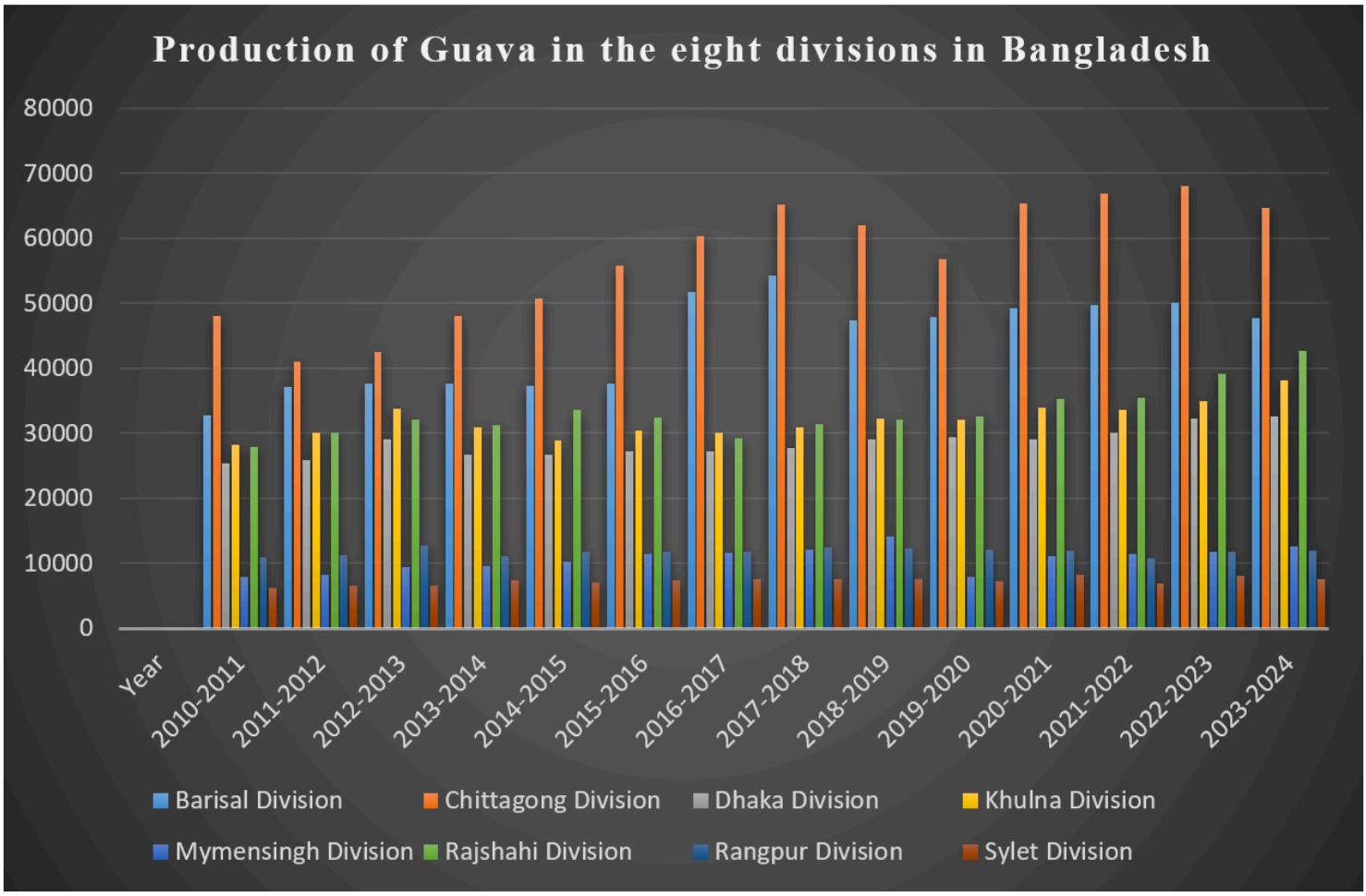


Figure 4

Total production of Guava in the eight divisions in Bangladesh

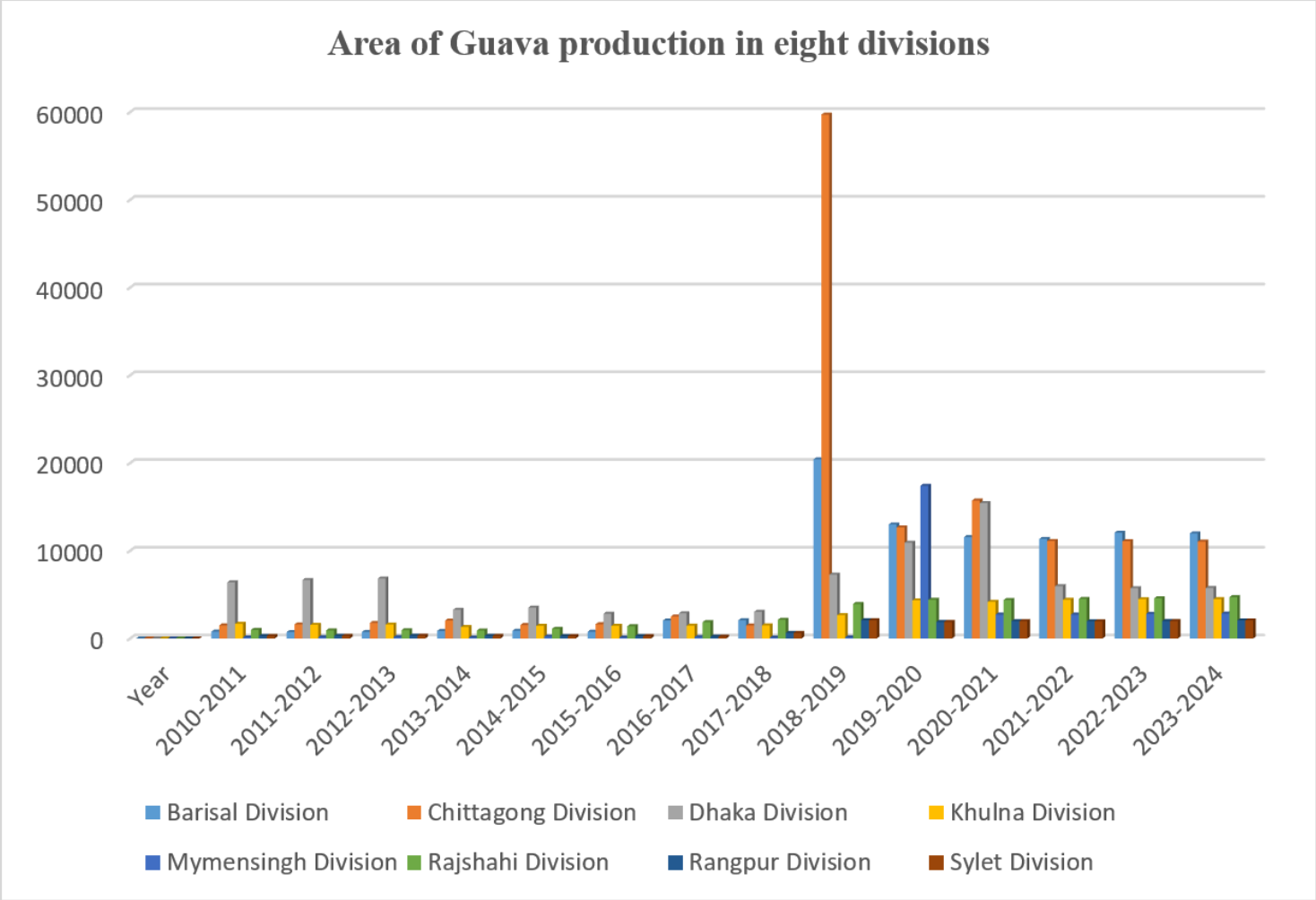


Figure 5

Total cultivated area of Guava in eight divisions in Bangladesh