

Major Crops Yield Prediction of Rajshahi, Dhaka, Chittagong and Khulna Districts Based On Climatic Variable: A Machine Learning Approach

Forecasting Algorithm

We have used four forecasted algorithm in this study. These are:

1. Multiple Linear Regression Model
2. Random Forest Regression Model
3. K-Nearest Neighbour Regression Model
4. Autoregressive Moving Average Model.

Software Used

We have used Microsoft Excel for the purpose of data modification. Microsoft Excel is a widely used spreadsheet application that allows users to organize, analyze, and visualize data. It is part of the Microsoft Office suite of productivity software. Excel provides a grid interface where users can enter data into cells, perform calculations, create charts, and generate reports.

On the other hand, we implemented the algorithms using Python Programming and we developed the python program by using Anaconda Software. Anaconda is a distribution of the Python and R programming languages for data science and machine learning. It is a comprehensive platform that includes a variety of tools and packages to facilitate the development, testing, and deployment of data science projects. Here are some key features of Anaconda:

1. **Package Management:**
 - Anaconda comes with a package manager called conda. Conda simplifies the process of installing, updating, and managing various Python packages and dependencies. It helps avoid compatibility issues and makes it easy to create isolated environments for different projects.
2. **Jupyter Notebooks:**
 - Anaconda includes Jupyter Notebooks, a popular interactive computing environment for creating and sharing documents that contain live code, equations, visualizations, and narrative text. Jupyter Notebooks are widely used in data analysis, machine learning, and research.
3. **Integrated Development Environments (IDEs):**
 - Anaconda can be used with different IDEs, but it comes pre-packaged with its own lightweight IDE called Anaconda Navigator. Additionally, you can use other popular IDEs like JupyterLab, Spyder, or VS Code with Anaconda.
4. **Data Science Libraries:**

- Anaconda includes a curated selection of data science libraries and frameworks, such as NumPy, pandas, SciPy, scikit-learn, TensorFlow, and PyTorch. These libraries are essential for tasks like data manipulation, statistical analysis, machine learning, and deep learning.

5. Visualization Tools:

- Anaconda includes visualization libraries like Matplotlib, Seaborn, and Plotly for creating high-quality charts and plots.

6. Distribution Management:

Anaconda makes it easy to create and manage Python environments, allowing users to have different versions of Python and packages for different projects. This helps in avoiding conflicts between project dependencies.

7. Community and Support:

- Anaconda has a large and active user community. The community support, forums, and documentation are valuable resources for users encountering issues or seeking advice.

8. Education and Training:

- Anaconda is widely used in educational settings for teaching Python and data science. It provides an easy-to-use platform for students and educators.

9. Data Integration:

- Anaconda can be integrated with various data storage and processing systems, making it suitable for handling diverse data sources and big data projects.

Result

5.1 Accuracy

The accuracy of crop yield predictions can vary depending on the methods used, the data available, and the specific crop and location being considered.

Statistical models, such as regression analysis, can be used to predict crop yields based on historical data and weather forecasts. These models can provide relatively accurate predictions, but their accuracy may be limited by the quality and availability of data.

Machine learning and artificial intelligence methods, such as neural networks and deep learning, can also be used to predict crop yields. These methods can analyze large amounts of data from a wide variety of sources and identify patterns that may not be apparent using traditional statistical methods. However, the accuracy of these predictions can depend on the quality and quantity of available data, as well as the complexity of the model used.

Table 5.1.1: Accuracy of Dhaka District

	Training Accuracy					Testing Accuracy				
	Potato	Wheat	Paddy			Potato	Wheat	Paddy		
Model			Aus	Aman	Boro			Aush	Aman	Boro
Multiple linear Regression	0.721	0.68	0.7306	0.7541	0.692	0.676	0.659	0.635	0.629	0.6058
Random Forest Regression	0.9744	0.961	0.976	0.97	0.974	0.998	0.906	0.964	0.831	0.917
KNN Regression	0.783	0.684	0.73	0.7509	0.692	0.683	0.641	0.605	0.7254	0.572

Table- 5.1.2: Accuracy of Rajshahi District

	Training Accuracy					Testing Accuracy				
	Potato	Wheat	Paddy			Potato	Wheat	Paddy		
Model			Aush	Aman	Boro			Aush	Aman	Boro
Multiple linear Regression	0.959	0.769	0.753	0.69	0.738	0.934	0.659	0.708	0.642	0.676
Random Forest Regression	0.987	0.991	0.821	0.952	0.97	0.991	0.978	0.798	0.983	0.9274
KNN Regression	0.704	0.74	0.656	0.692	0.6547	0.681	0.718	0.619	0.654	0.574

Table-5.1.3: Accuracy of Khulna District

	Training Accuracy					Testing Accuracy				
	Potato	Wheat	Paddy			Potato	Wheat	Paddy		
Model			Aush	Aman	Boro			Aush	Aman	Boro
Multiple linear Regression	0.651	0.789	0.823	0.658	0.741	0.623	0.719	0.7414	0.521	0.713
Random Forest Regression	0.972	0.961	0.975	0.982	0.912	0.936	0.945	0.957	0.917	0.848
KNN Regression	0.759	0.725	0.746	0.705	0.773	0.727	0.889	0.653	0.683	0.7123

Table-5.1.4: Accuracy of Chattogram District

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	Training Accuracy						Testing Accuracy					
	Potato	Wheat	Paddy			Potato	Wheat	Paddy				
Model			Aush	Aman	Boro			Aush	Aman	Boro		
Multiple linear Regression	0.745	0.685	0.705	0.7819	0.698	0.6571	0.652	0.685	0.681	0.609		
Random Forest Regression	0.898	0.91	0.936	0.9597	0.887	0.875	0.88	0.972	0.9265	0.843		
KNN Regression	0.647	0.687	0.552	0.8309	0.	0.625	0.573	0.635	0.814	0.665		

Table-5.1.5: Overall Accuracy

Used Model	Dhaka			Rajshahi			Khulna			Chittagong		
	Potato	Wheat	Paddy	Potato	Wheat	Paddy	Potato	Wheat	Paddy	Potato	Wheat	Paddy
MLR	0.698	0.6575	0.6828	0.691	0.648	0.942	0.714	0.730	0.67	0.707	0.637	0.748
RFR	0.986	0.9335	0.97	0.90	0.945	0.98	0.974	0.809	0.967	0.948	0.954	0.953
KNN	0.733	0.6625	0.6675	0.738	0.632	0.692	0.728	0.637	0.673	0.614	0.743	0.807

5.2. Graphical Representation

Random Forest Regression:

The Random Forest Regression model generates prediction figures that represent the predicted values for the target variable based on the input features.

- ❖ Rajshahi District
- The wheat data figures for the Rajshahi district.

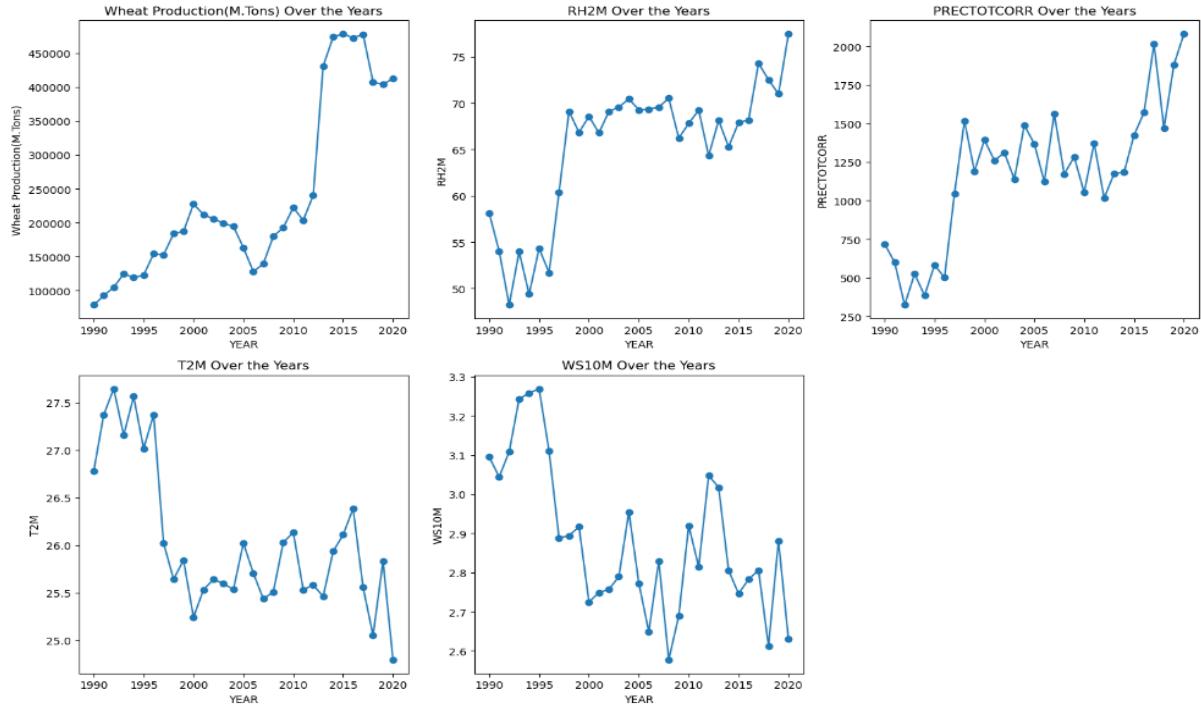


Figure-5.1: The wheat data figures for the features

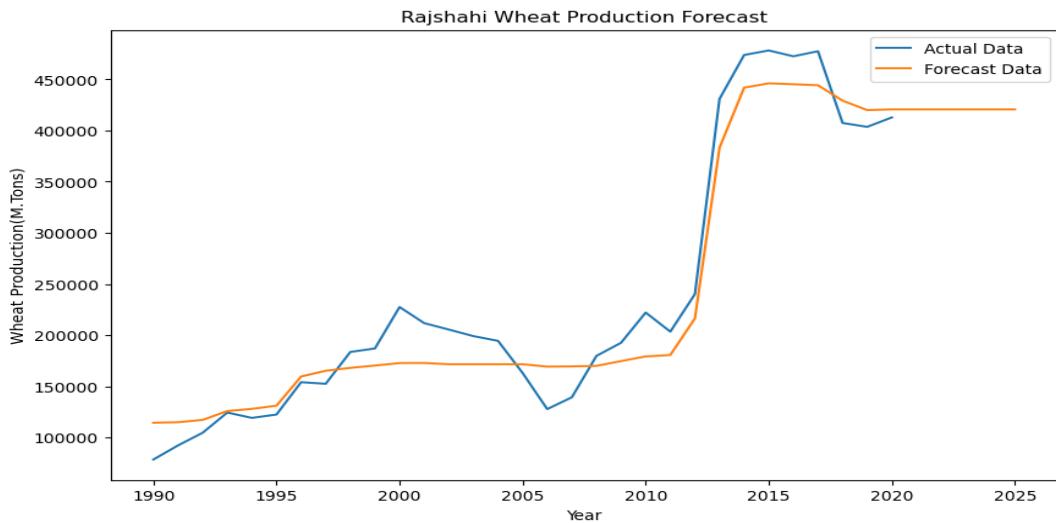


Figure- 5.2: The wheat data figures for actual and predicted production.

- The potato data figures for the Rajshahi district.

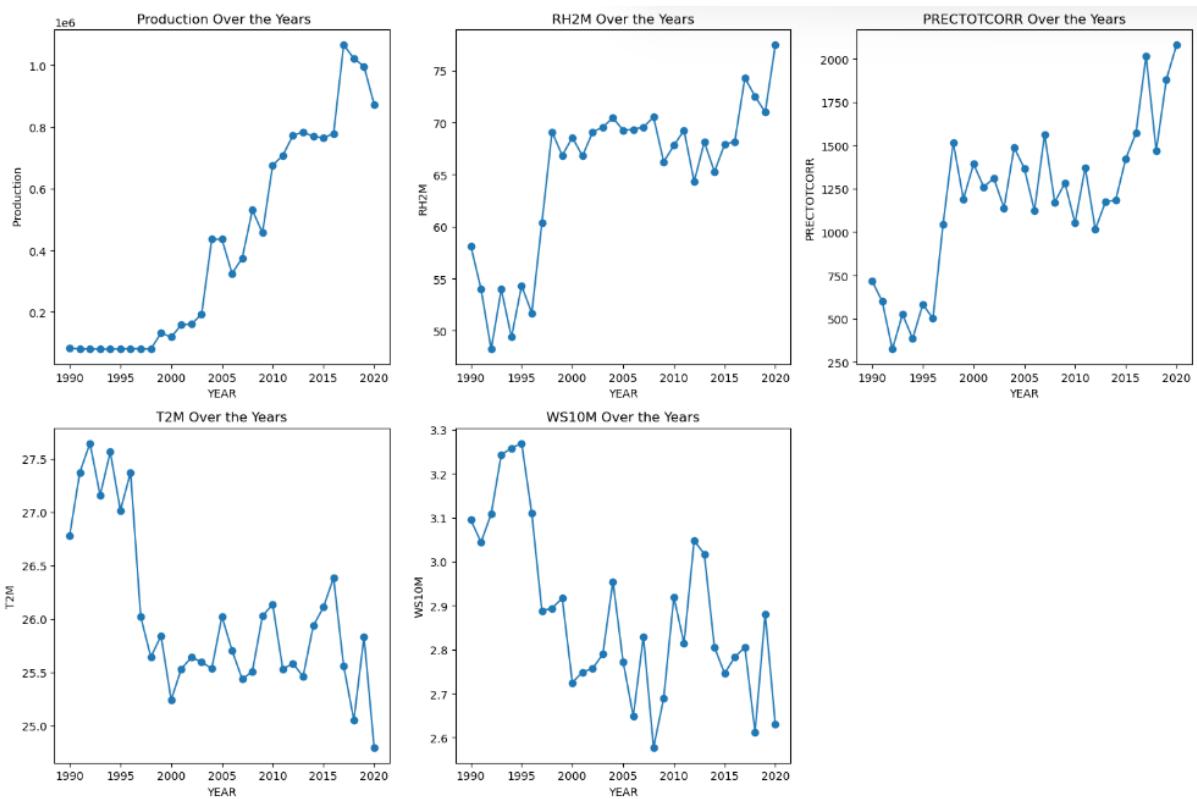


Figure:3- The Potato data figures for the features.

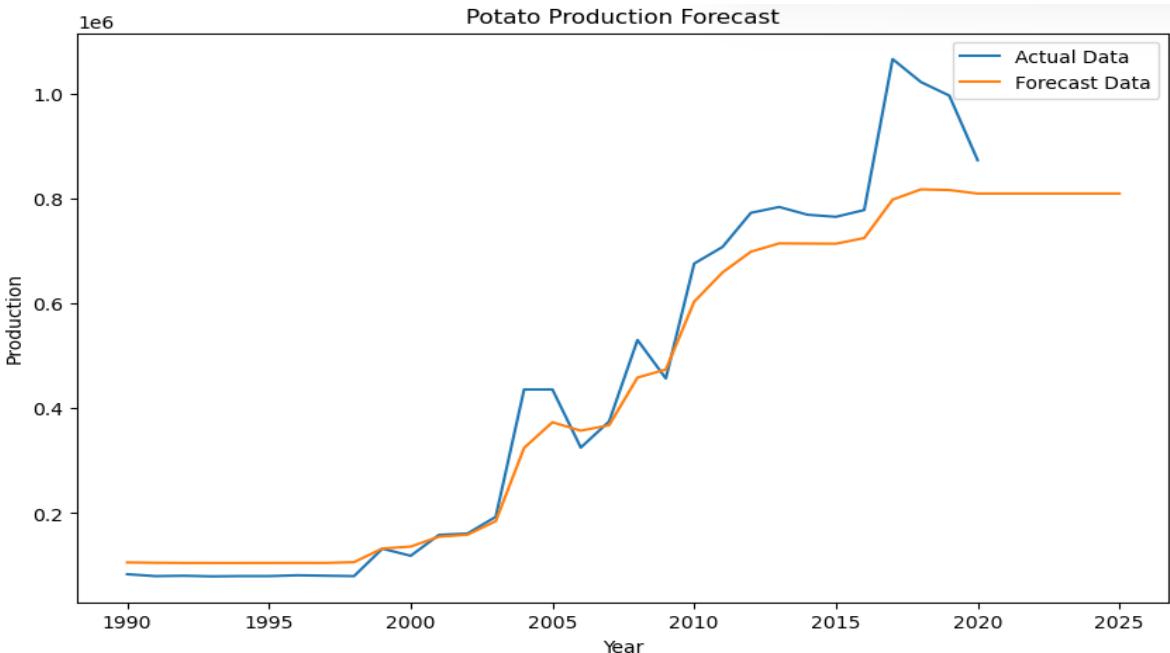


Figure -5.4: The wheat data figures for actual and predicted production.

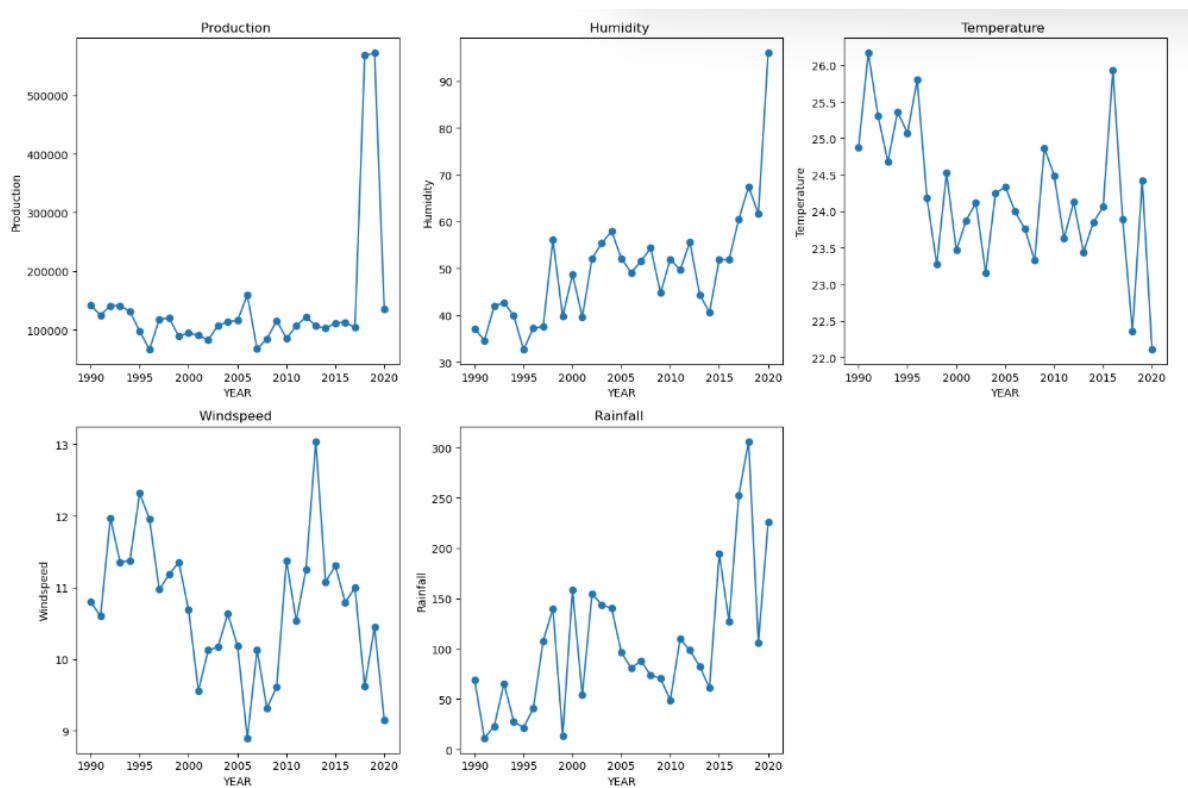


Figure-5.5: The Aush data figures for the features.

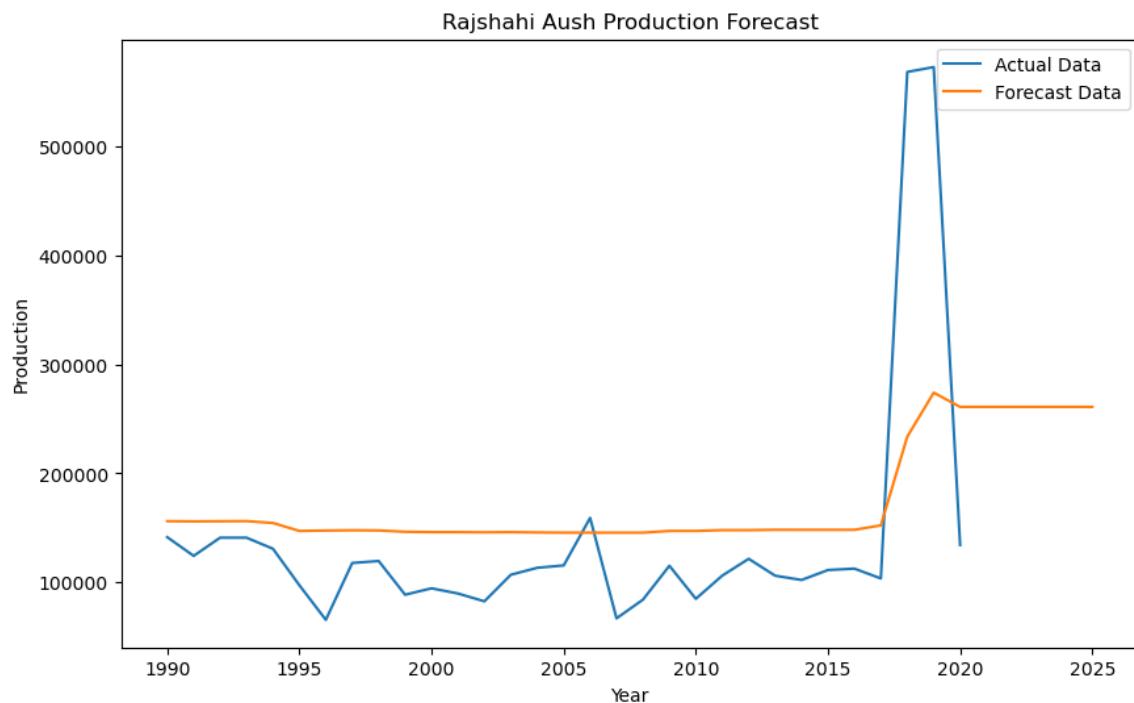


Figure-5.6: The wheat data figures for actual and predicted production.

➤ The Amon data figures for the Rajshahi district.

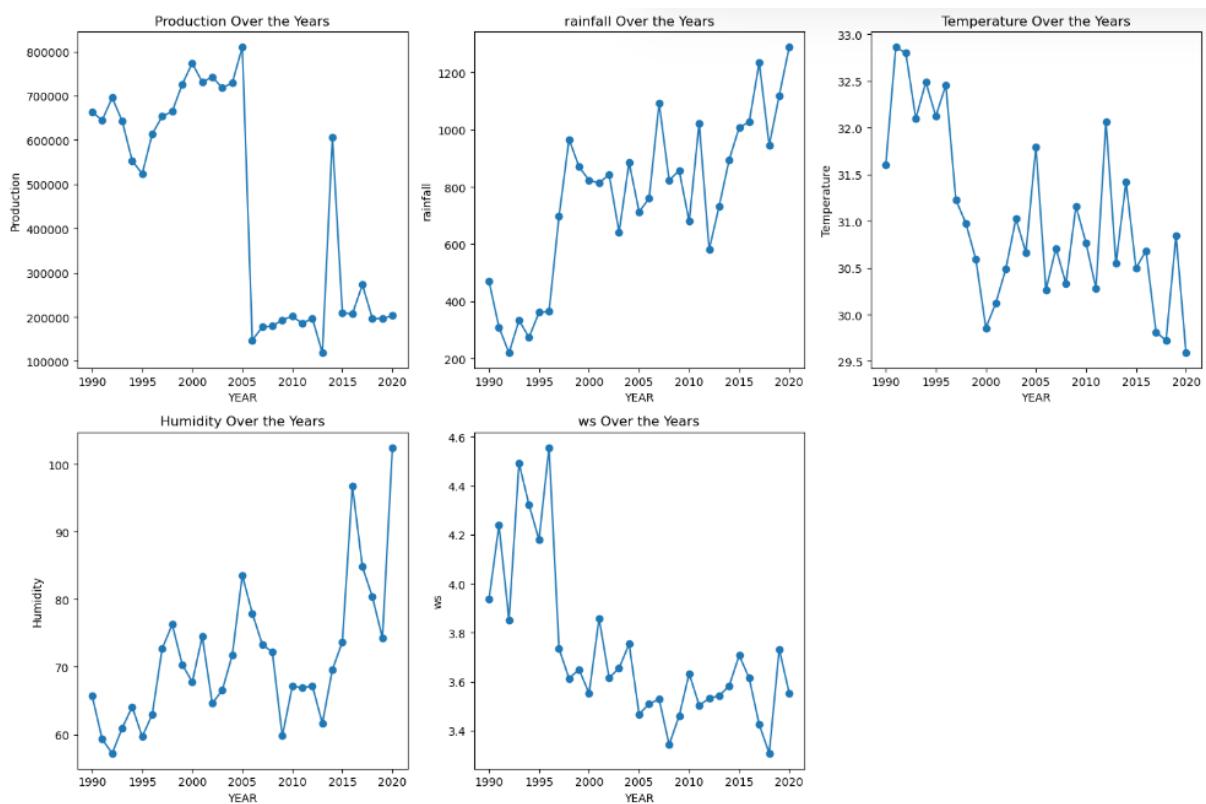


Figure-5.7: The Amon data figures for the features.

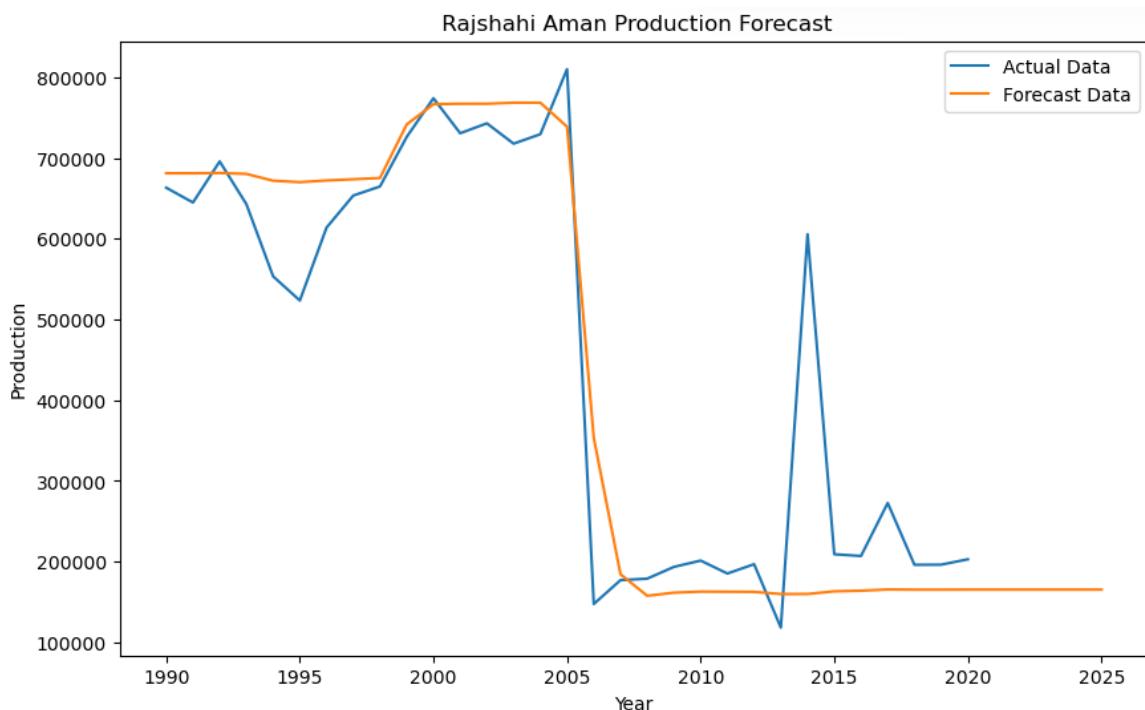


Figure- 5.8: The Amon data figures for actual and predicted production.

➤ The Boro data figures for the Rajshahi district.

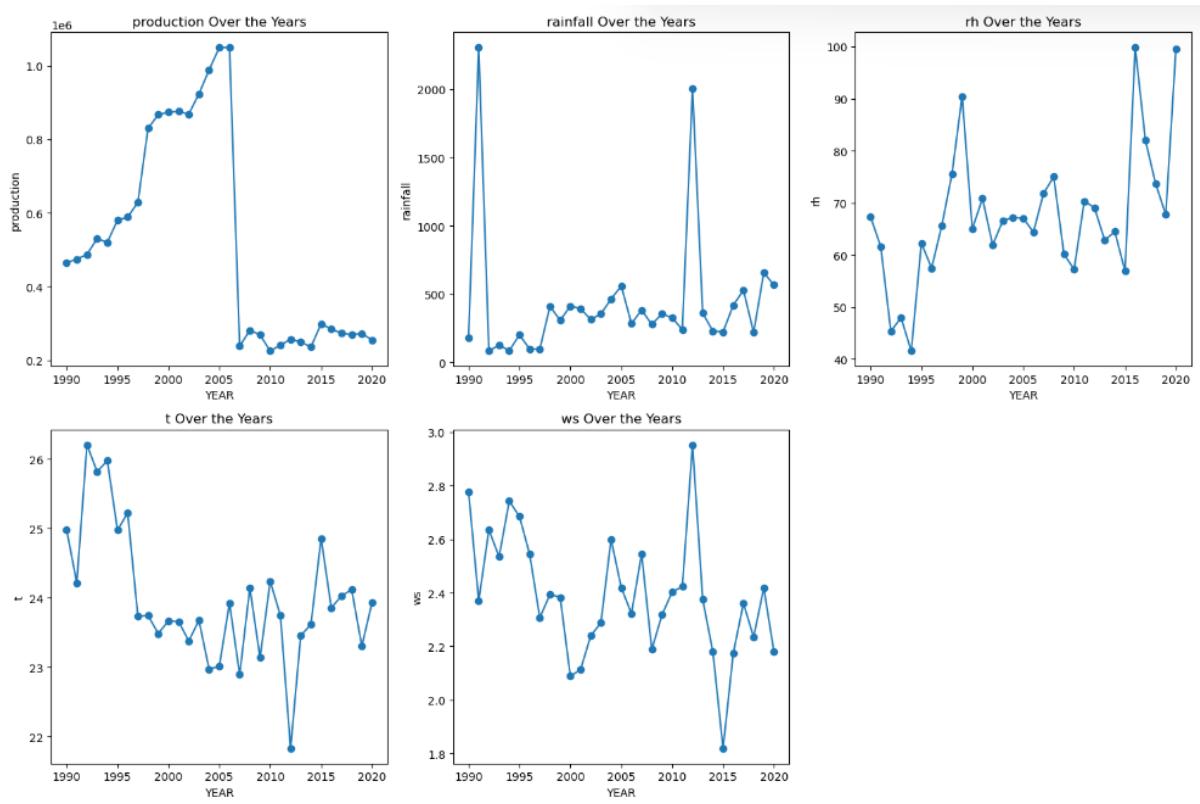


Figure-5.9: The Boro data figures for the features.

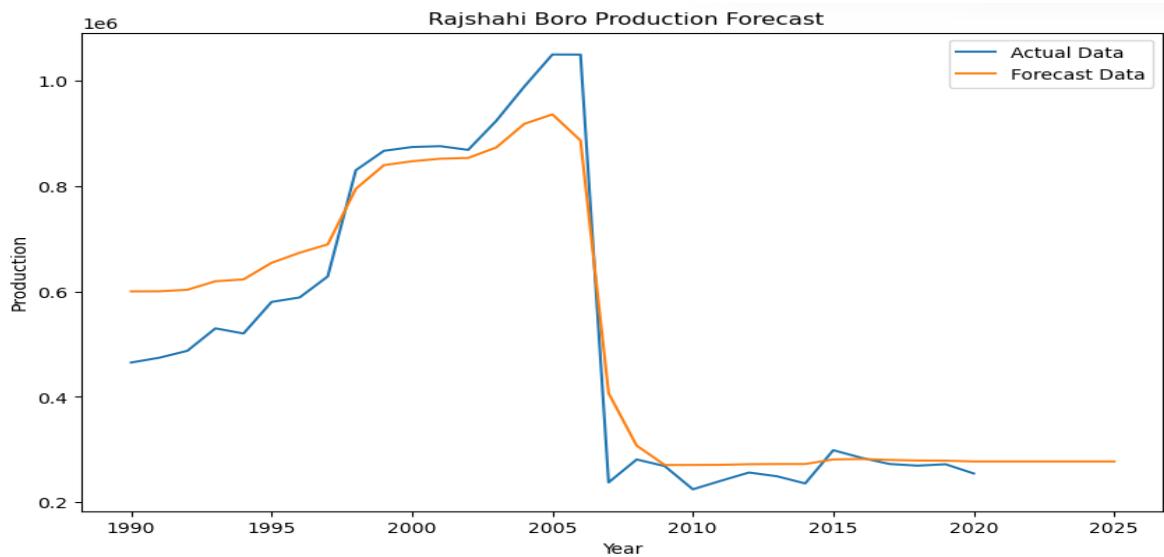


Figure-5.10: The Boro data figures for actual and predicted production.

- ❖ Dhaka district
- The wheat data figures for the Dhaka district.

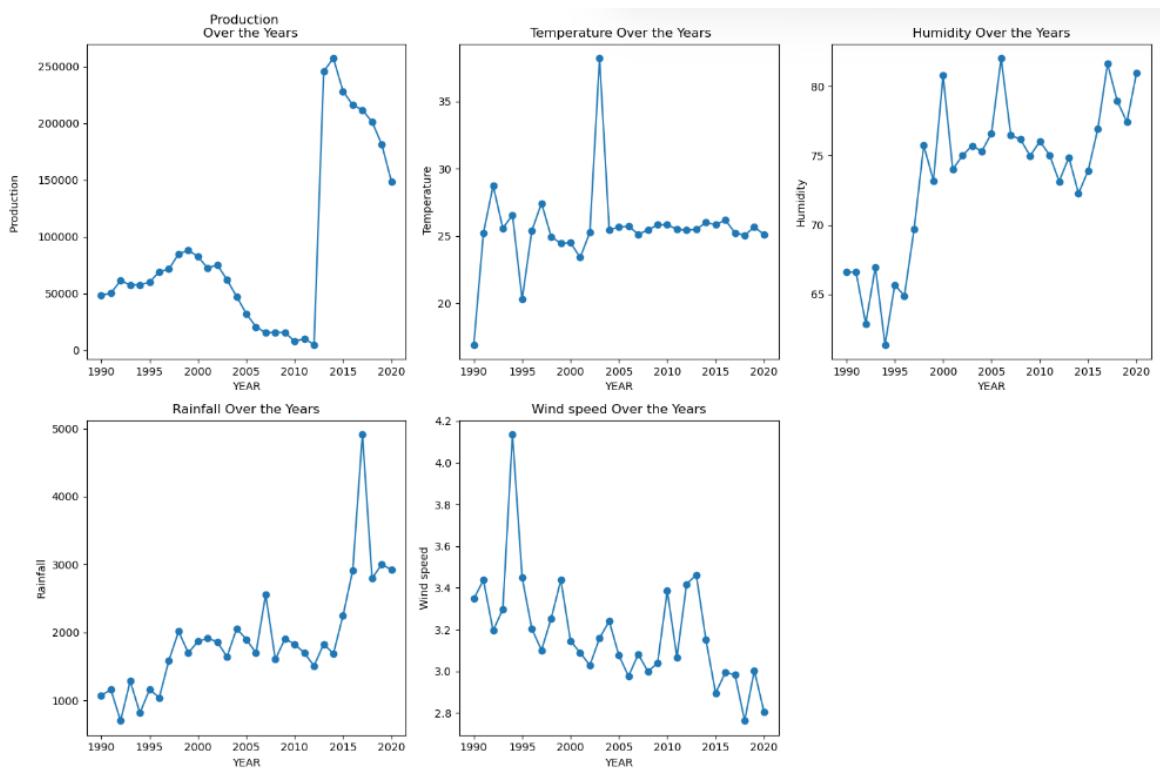


Figure-5.11: The wheat data figures for the features.

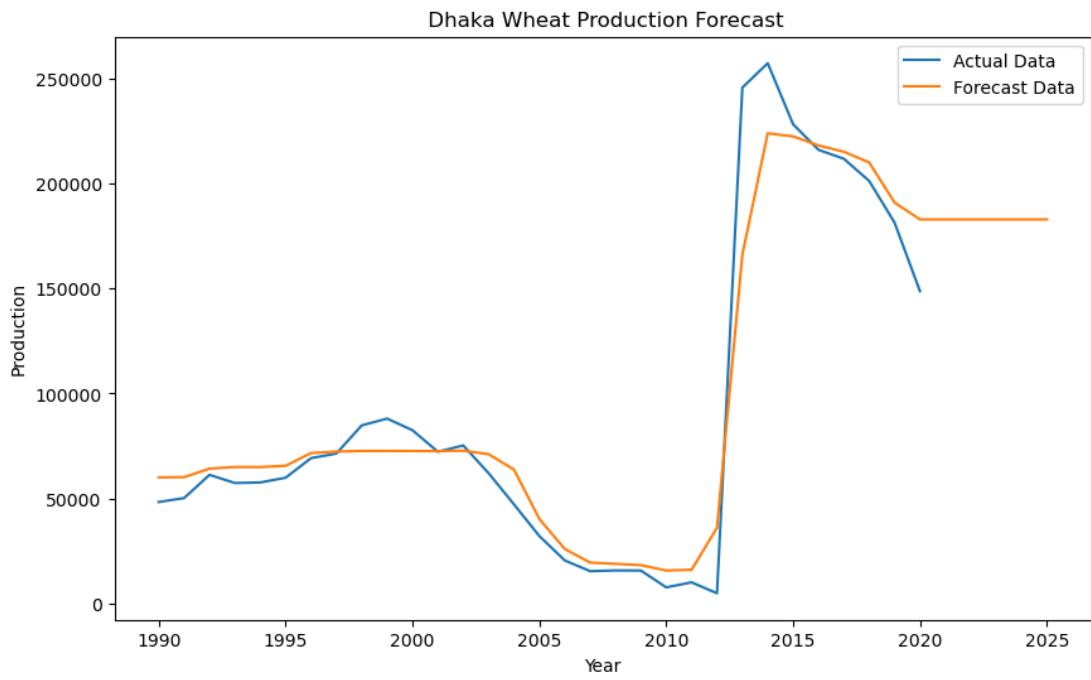


Figure-5.12: The wheat data figures for actual and predicted production.

- The potato data figures for the Dhaka district.

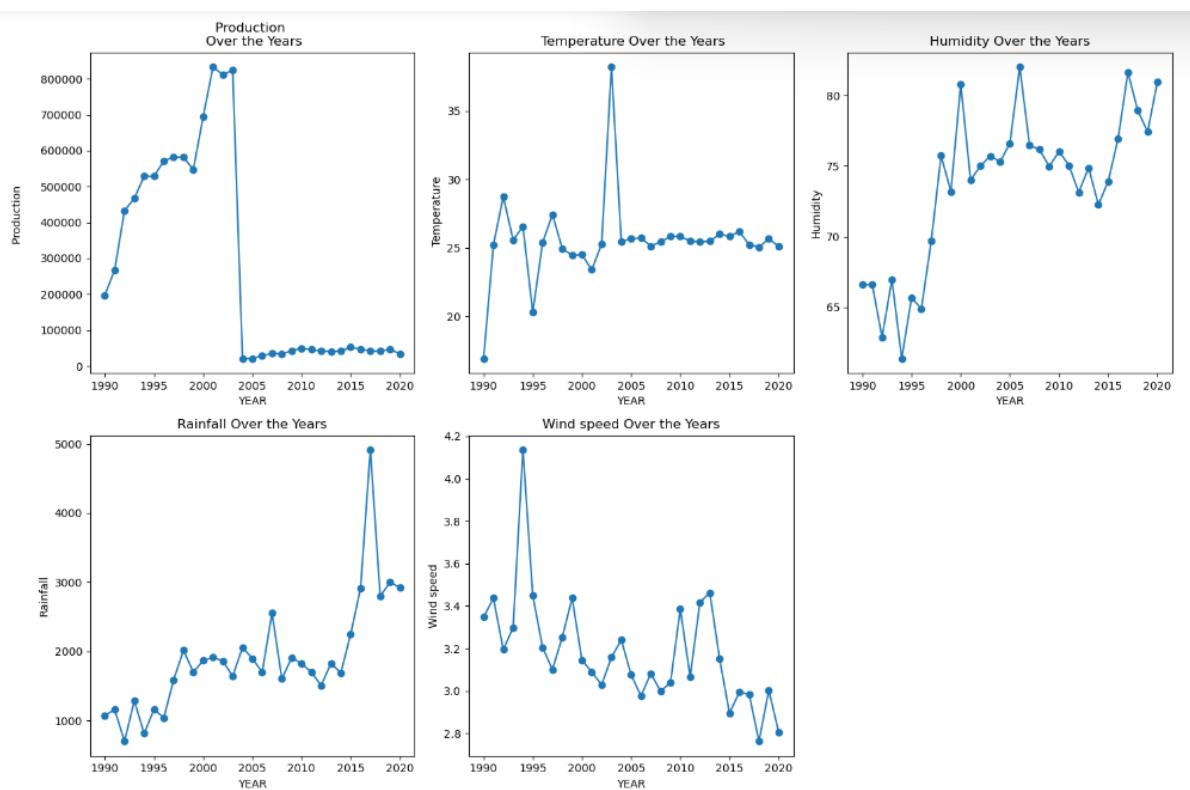


Figure- 5.13: The potato data figures for the features.

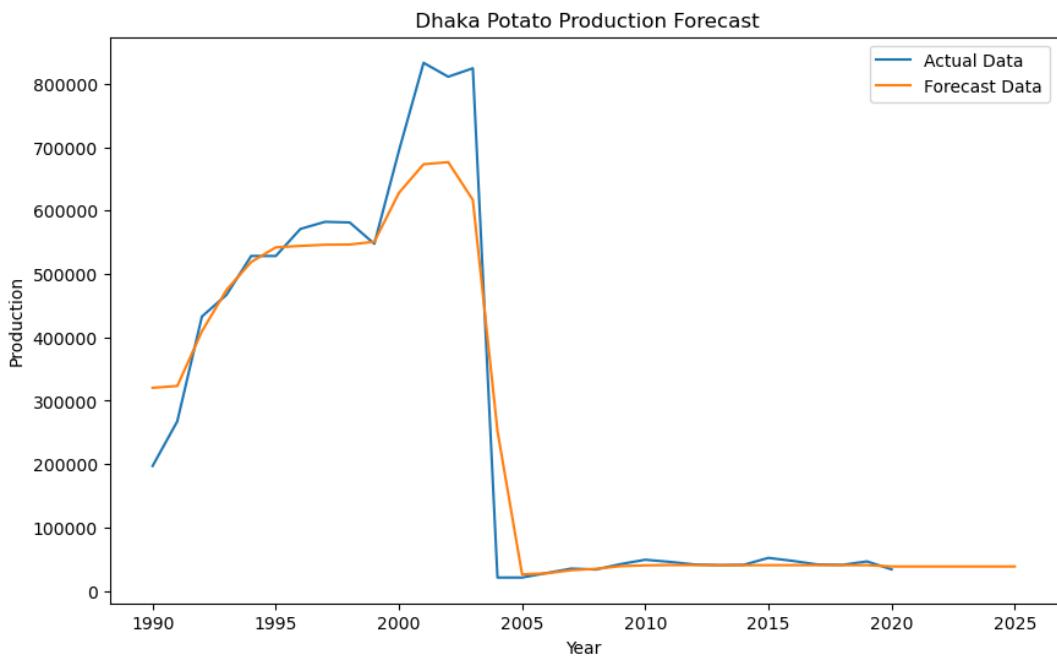


Figure-5.14: The potato data figures for actual and predicted production.

➤ The Aush data figures for the Dhaka district.

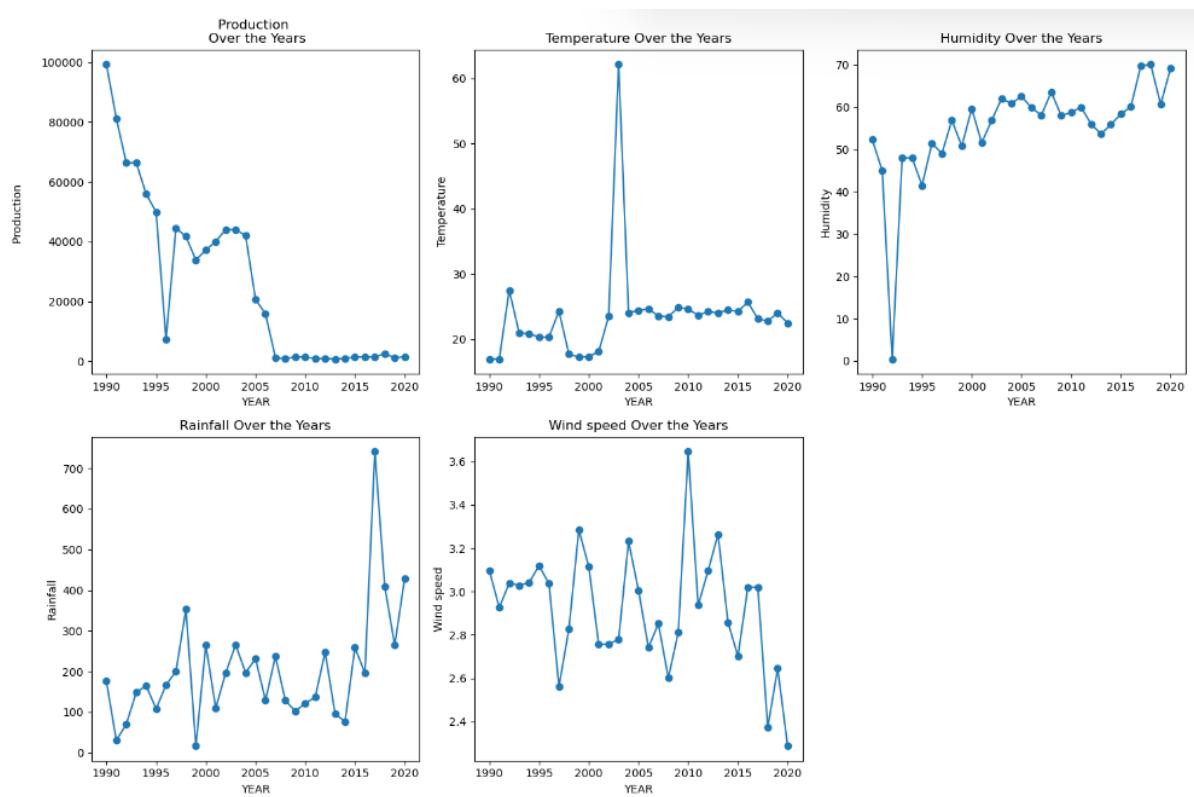


Figure-5.15: The Aus data figures for the features.

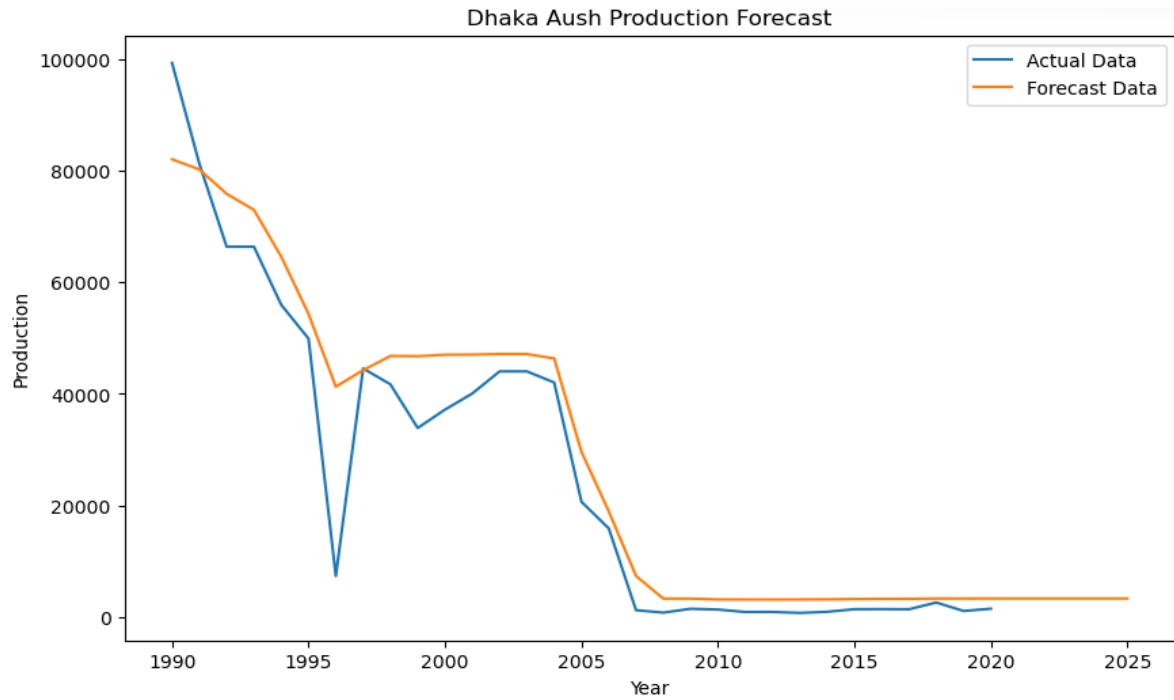


Figure-5.16: The Aush data figures for actual and predicted production.

The Amon data figures for the Dhaka District.

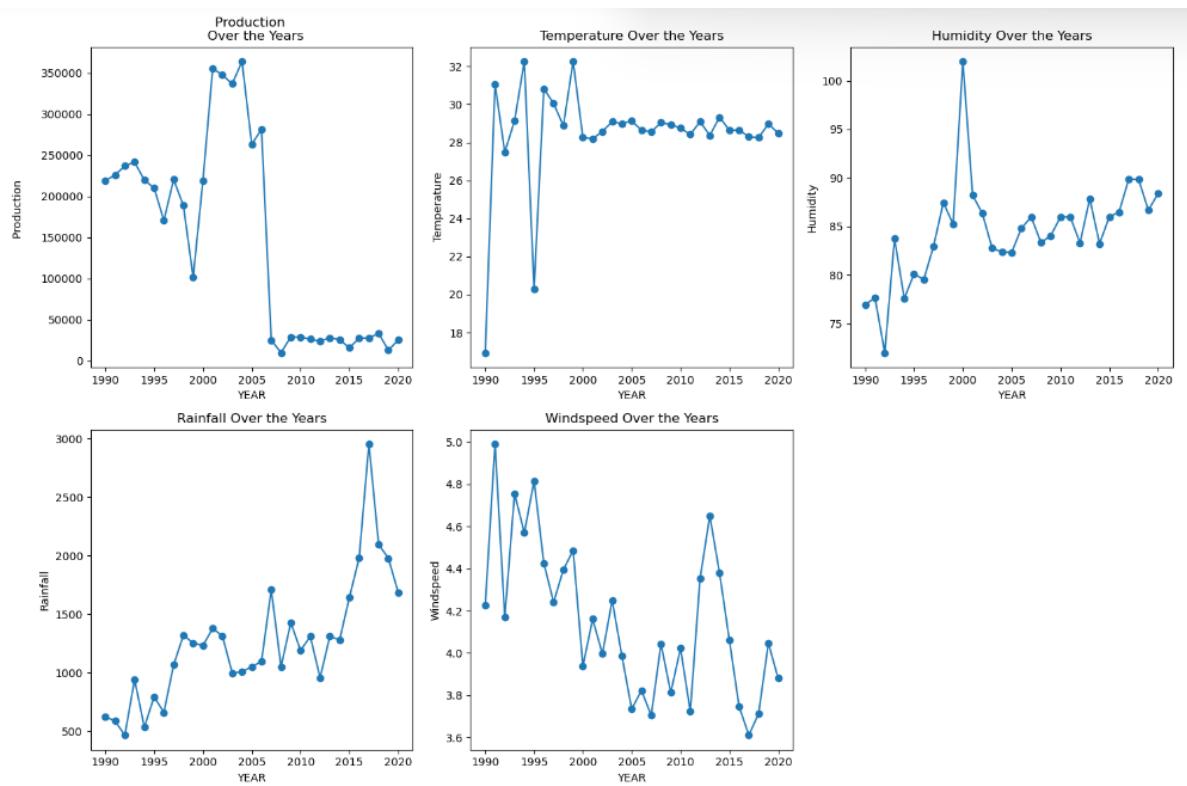


Figure- 5.17: The Amon data figures for the features.

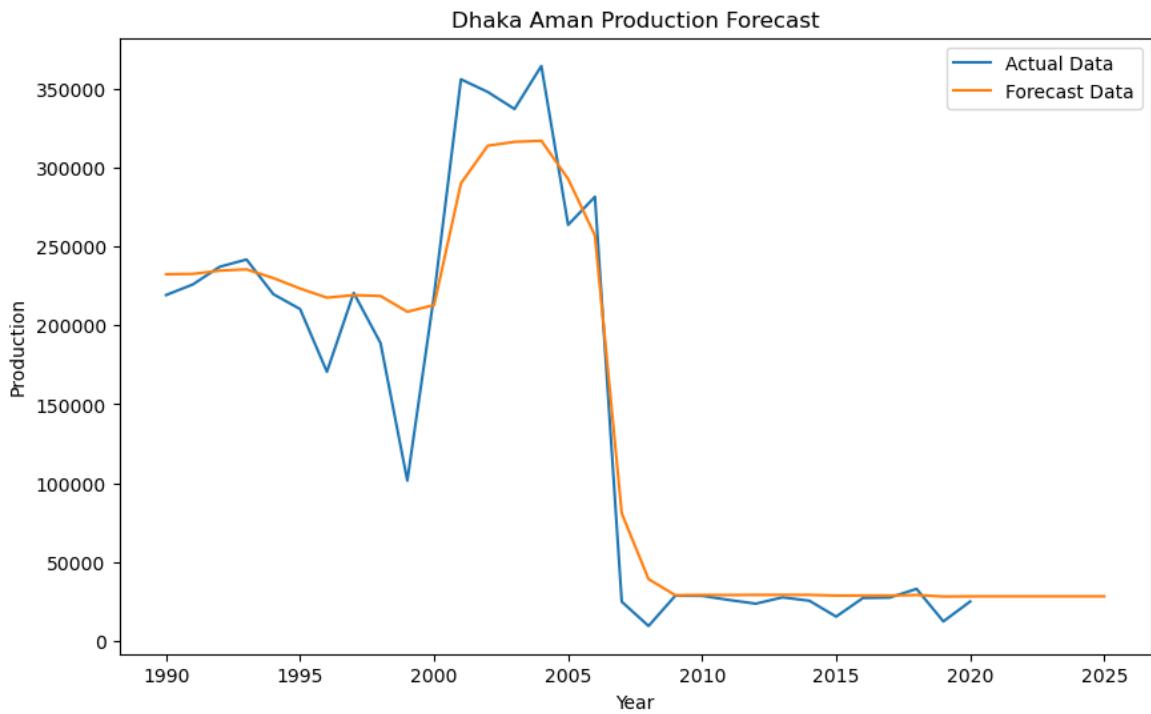


Figure-5.18: The Amon data figures for actual and predicted production.

➤ The Boro data figures for the Dhaka District.

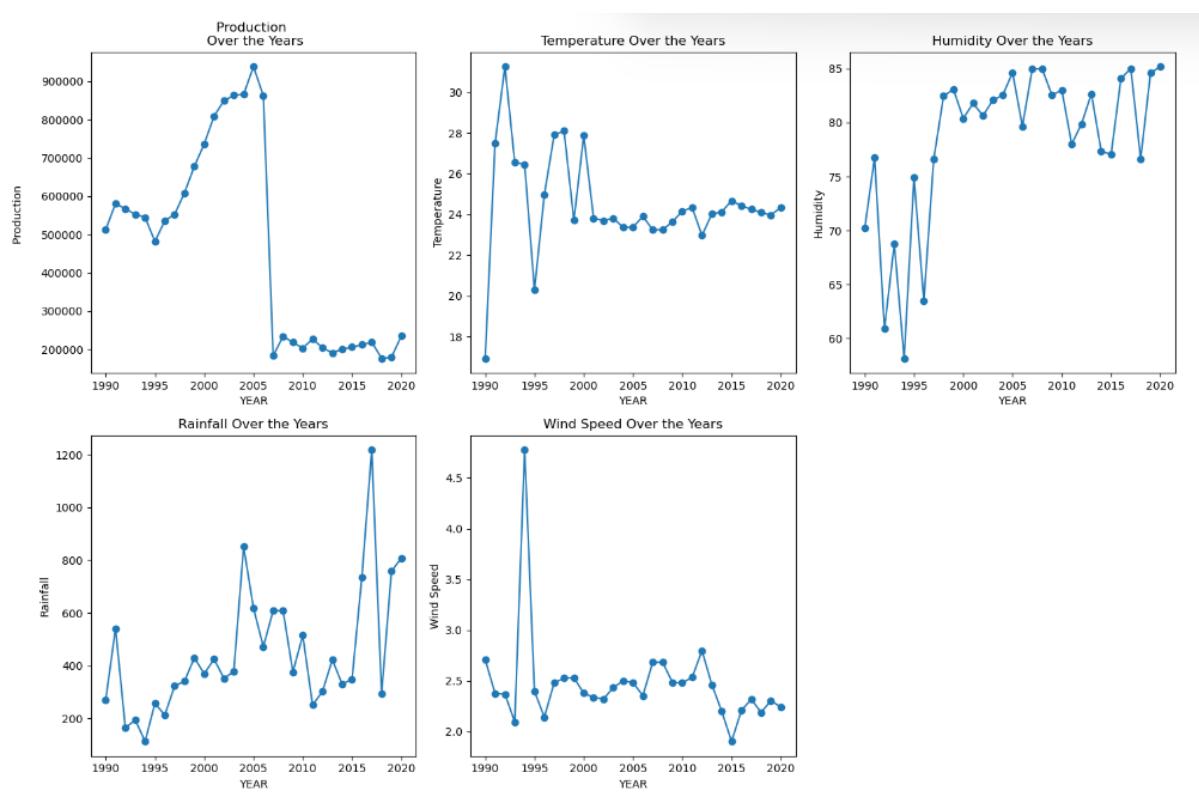


Figure-5.19: The Boro data figures for the features.

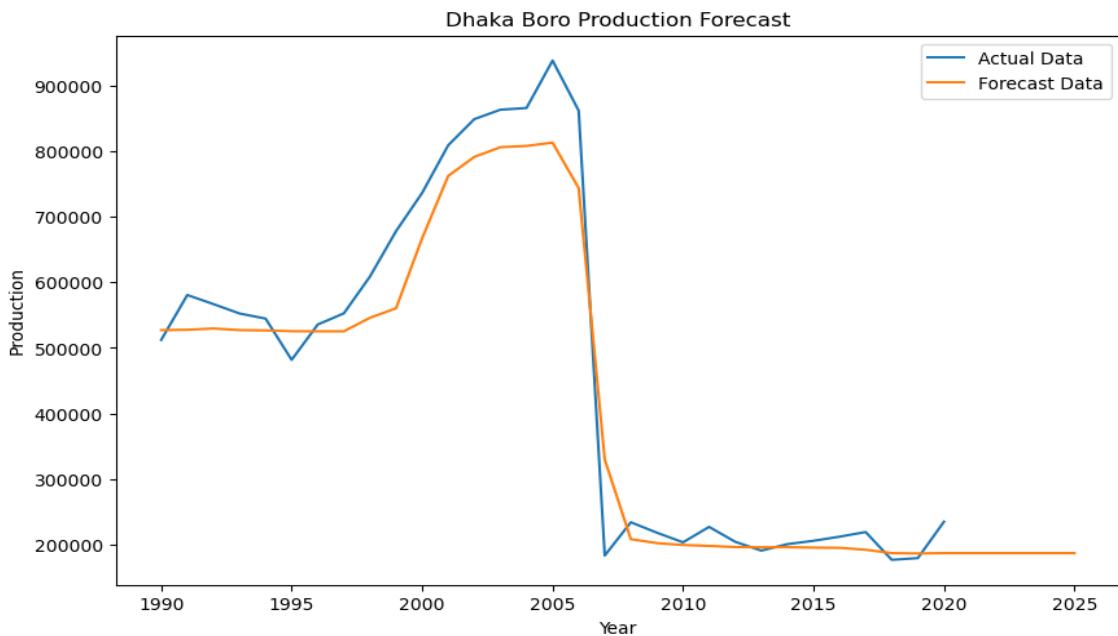


Figure-5.20: The Boro data figures for actual and predicted production.

❖ Khulna District

- The wheat data figures for the Khulna District.

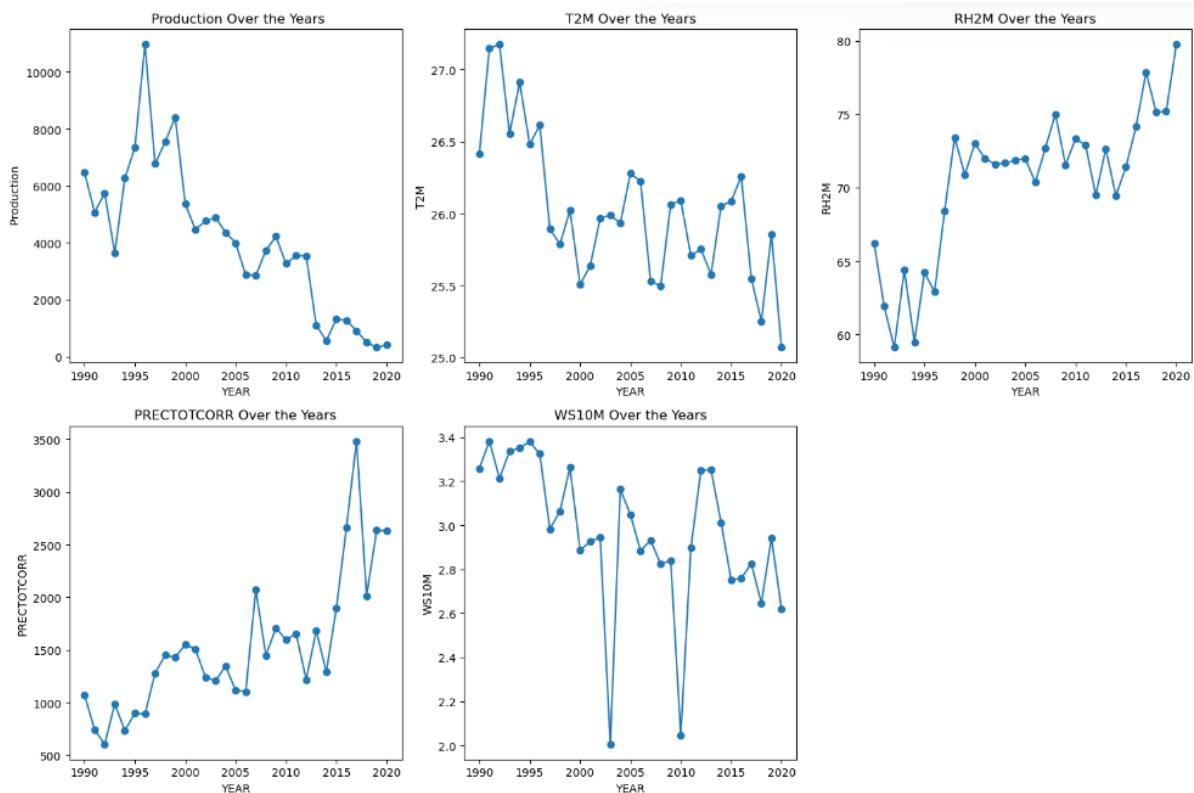


Figure-5.21: The wheat data figures for the features.

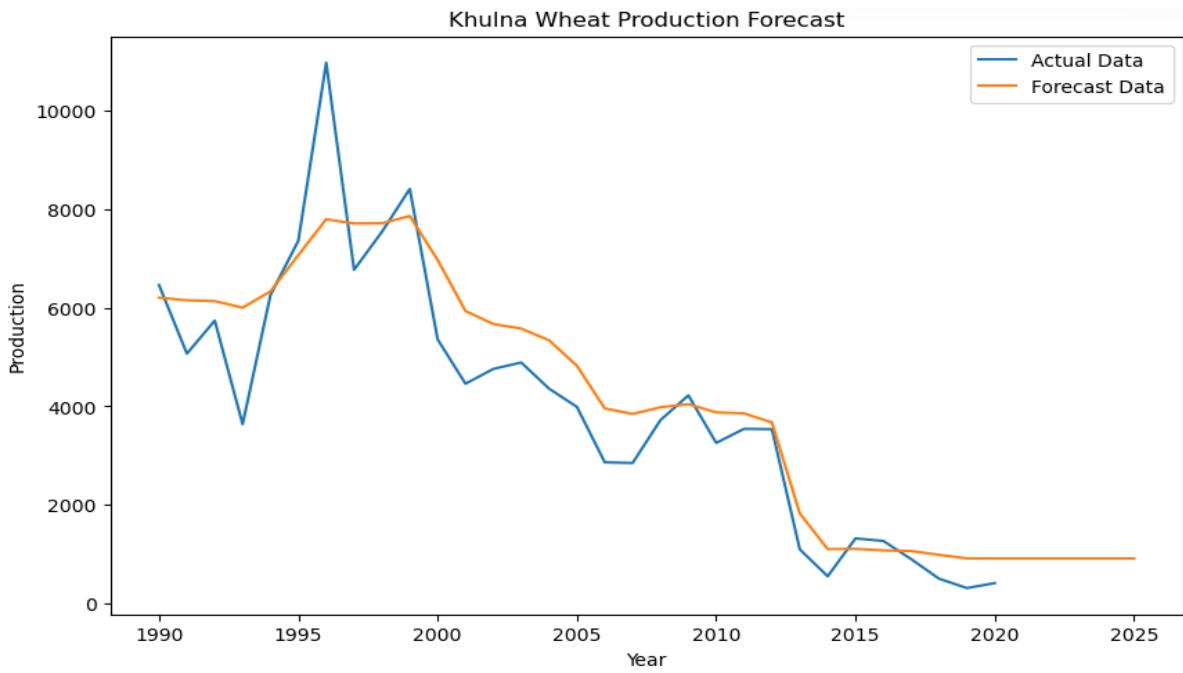


Figure-5.22: The wheat data figures for actual and predicted production.

- The potato data figures for the Khulna District.

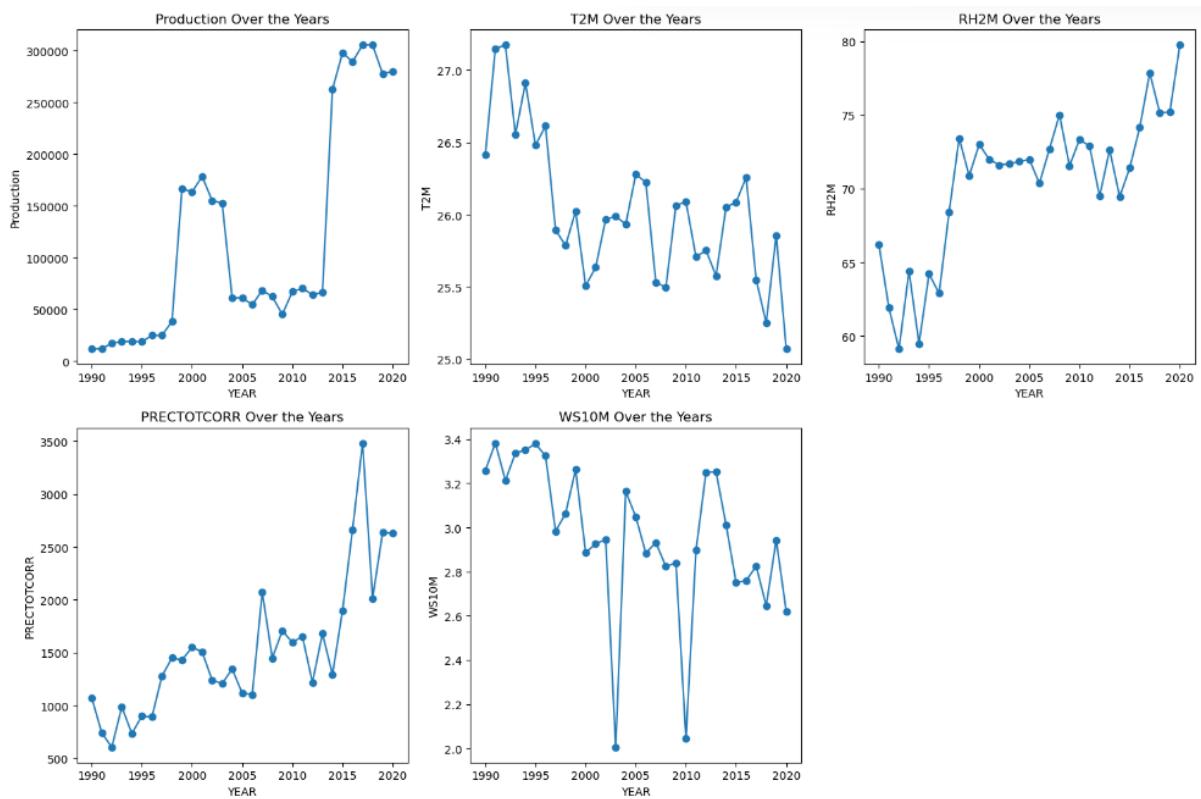


Figure-5.23: The potato data figures for the features.

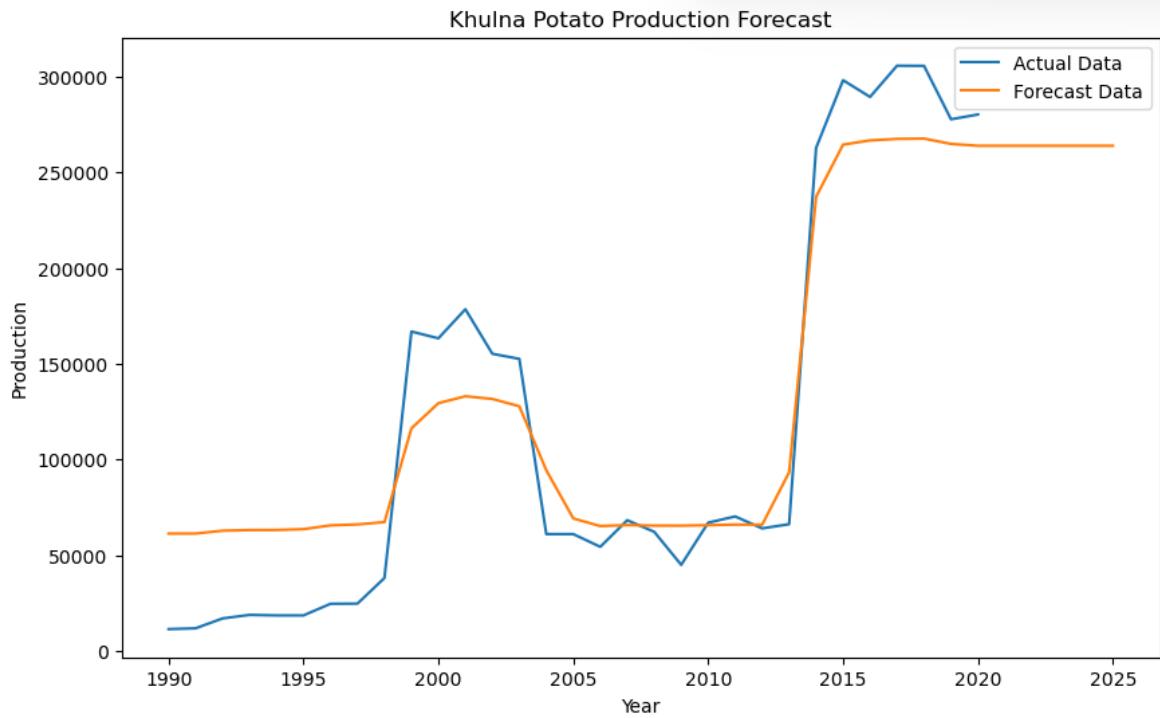


Figure-5.24: The wheat data figures for actual and predicted production.

- The Aush data figures for the Khulna District.

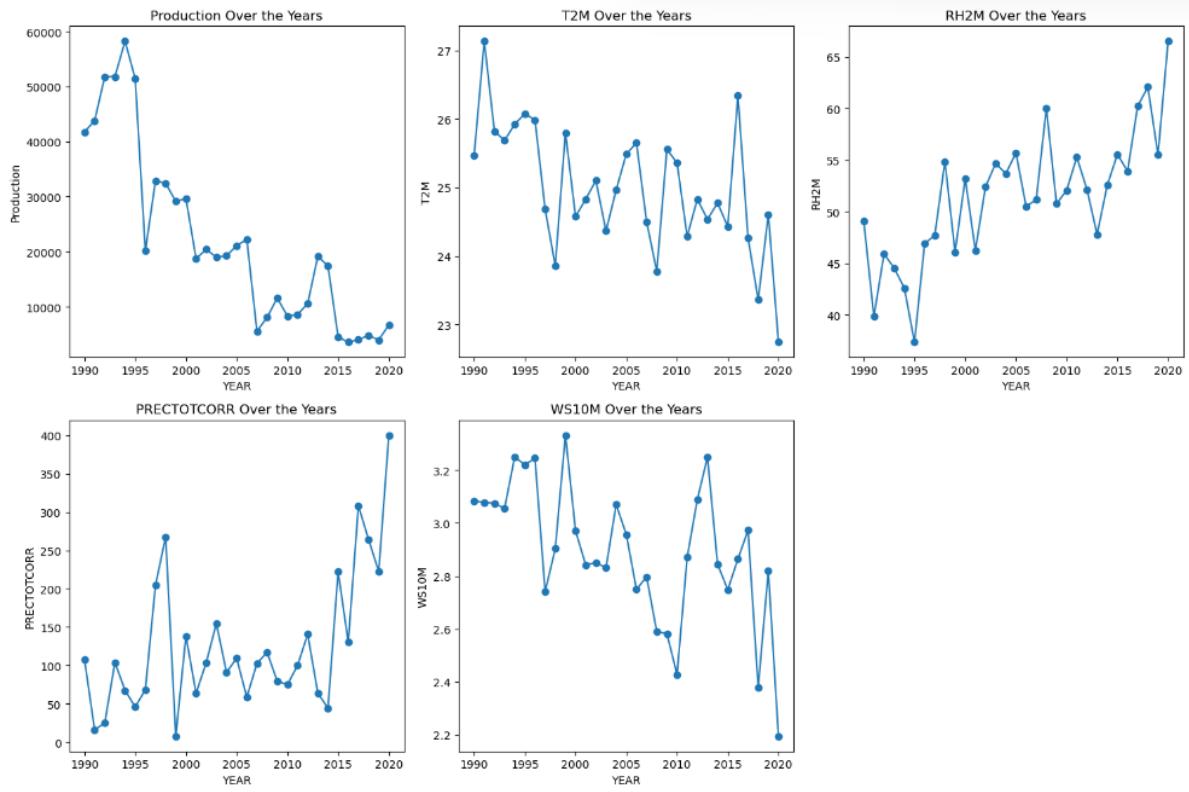


Figure-5.25: The Aush data figures for the features.

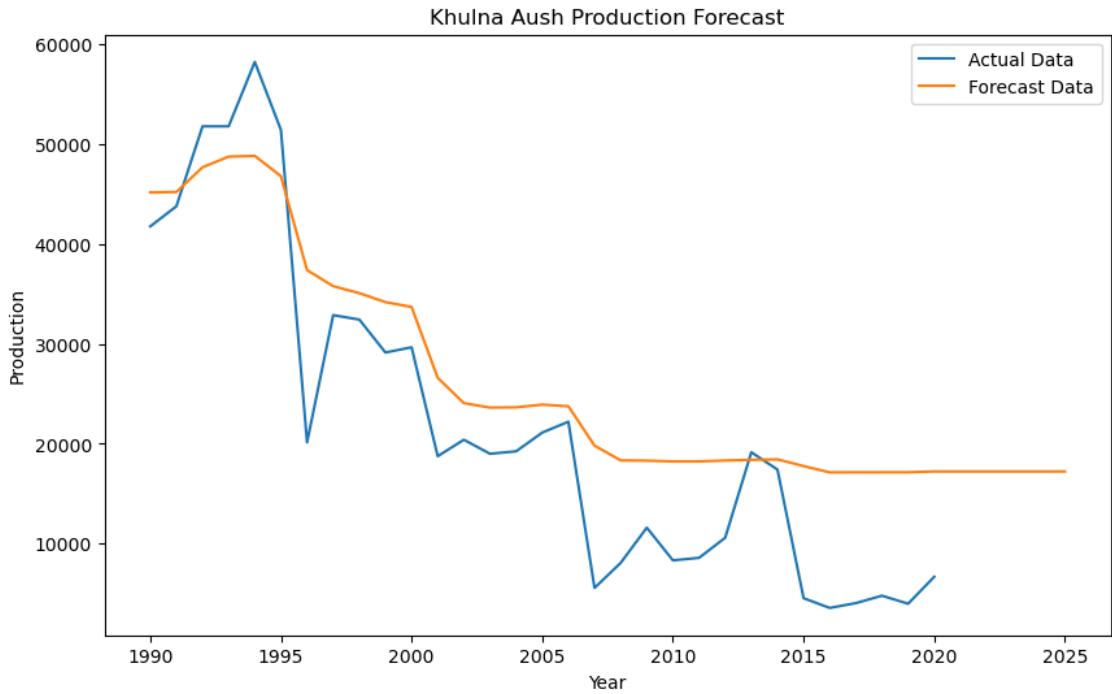


Figure-5.26: The Aush data figures for actual and predicted production.

➤ The Amon data figures for the Khulna District.

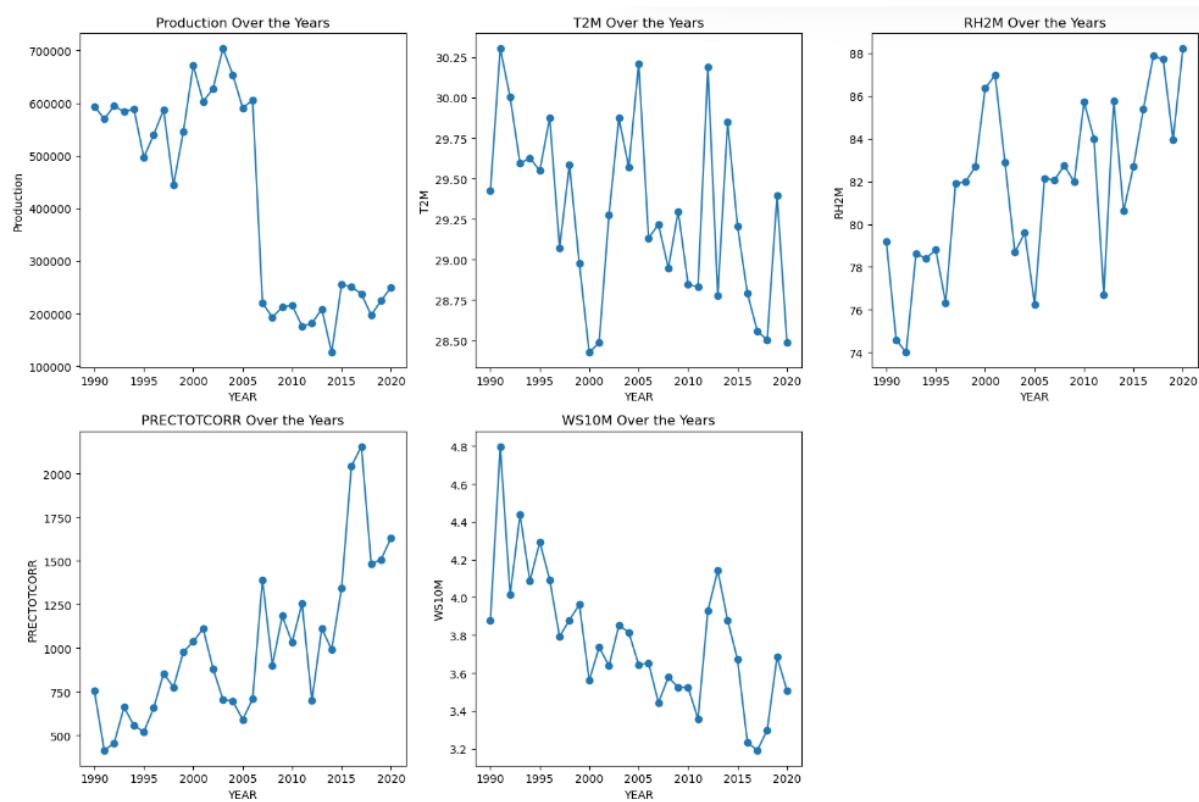


Figure-5.27: The Amon data figures for the features.

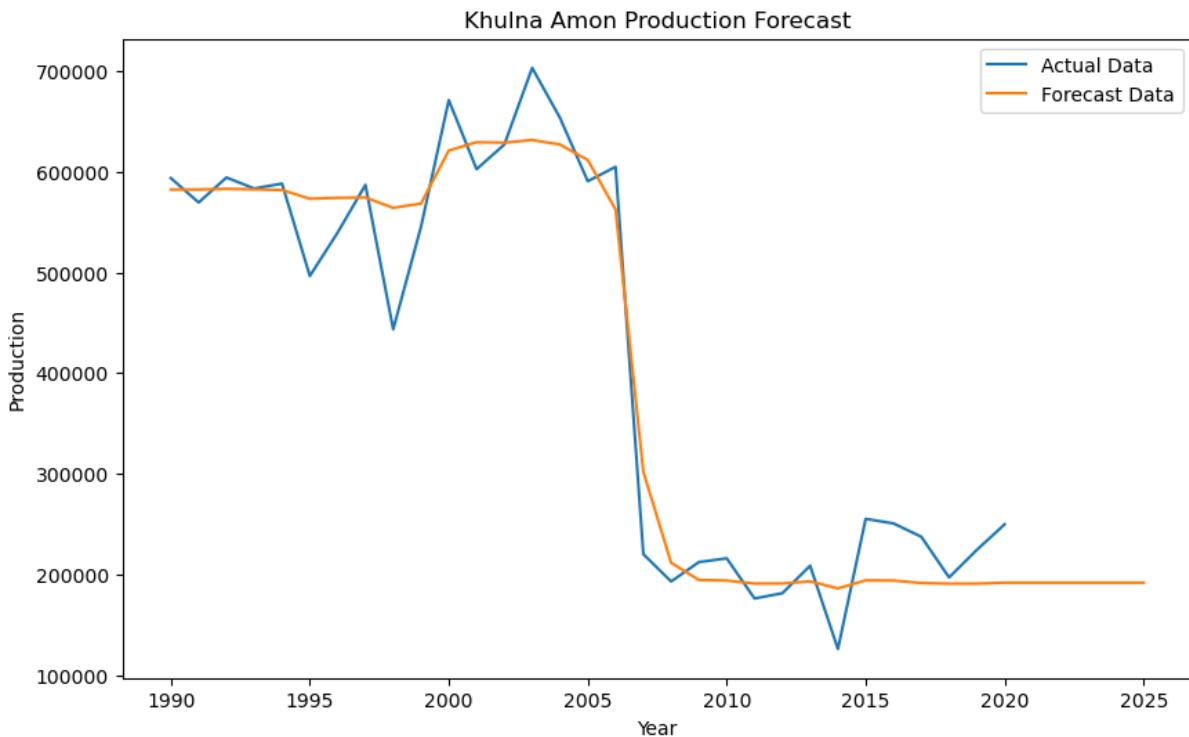


Figure-5.28: The Amon data figures for actual and predicted production.

➤ The Boro data figures for the Khulna District.

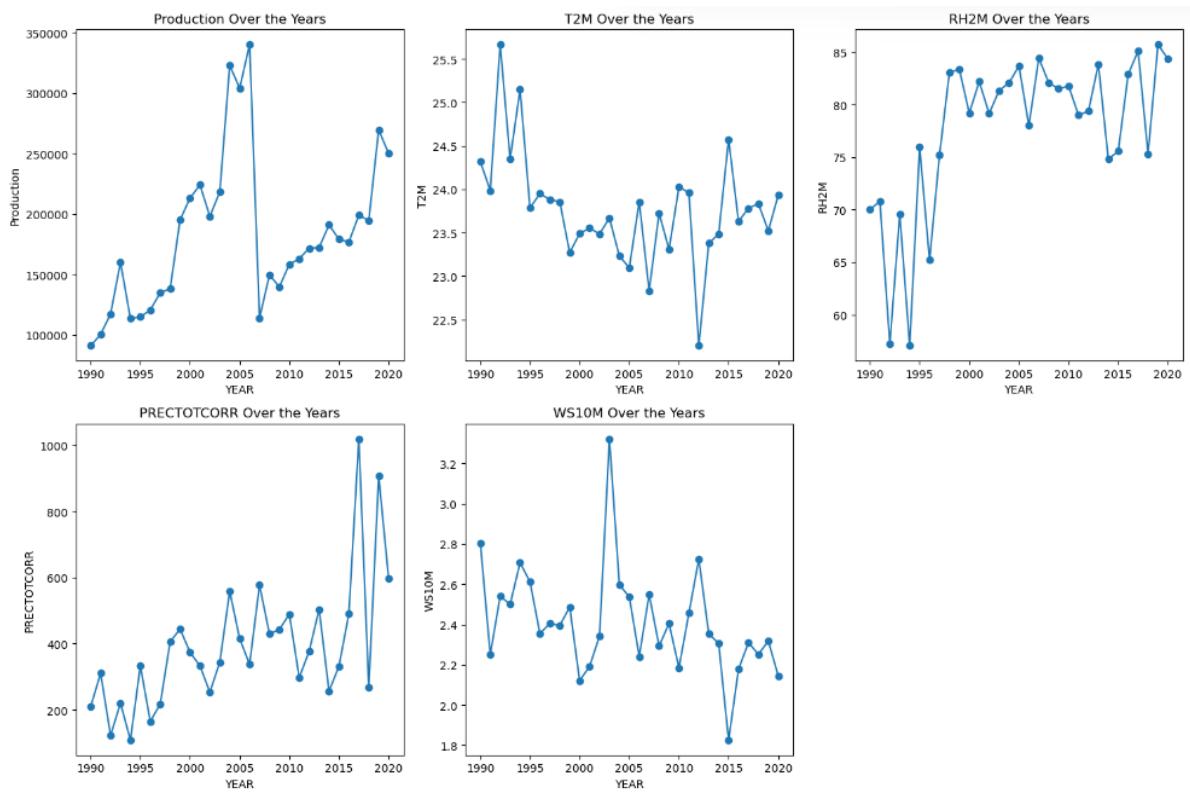


Figure-5.29: The Boro data figures for the features.

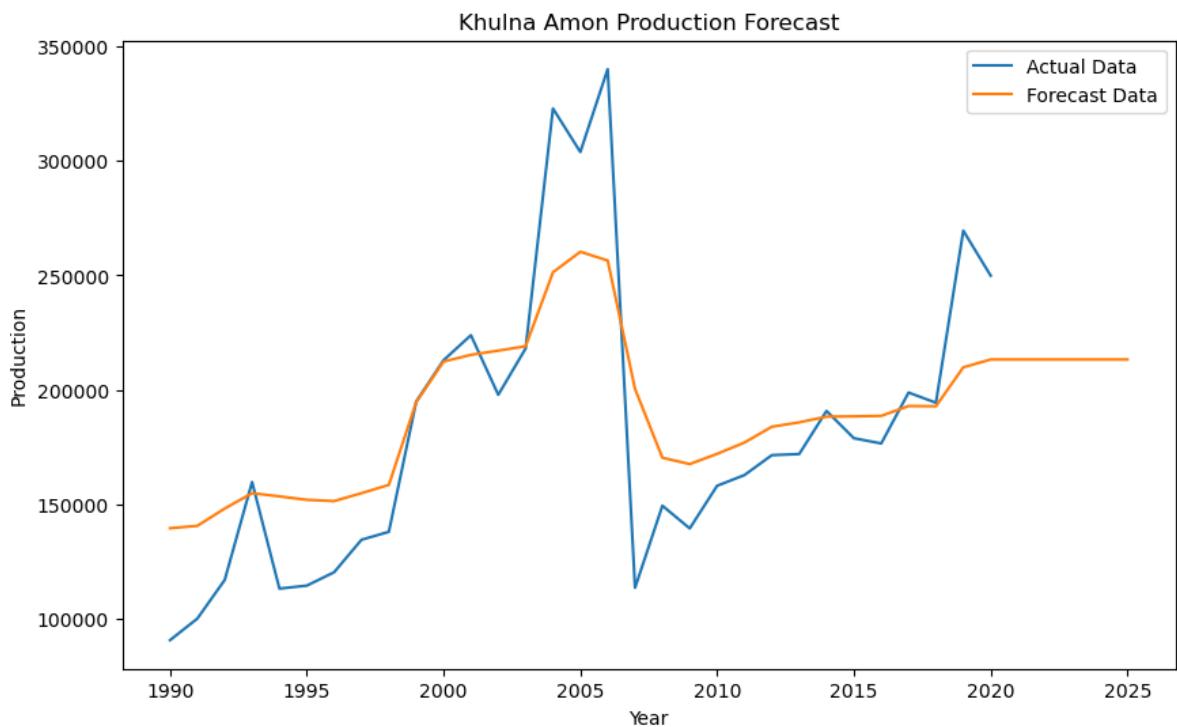


Figure-5.30: The Boro data figures for actual and predicted production.

❖ Chatogram District

➤ The wheat data figures for the Chatogram district.

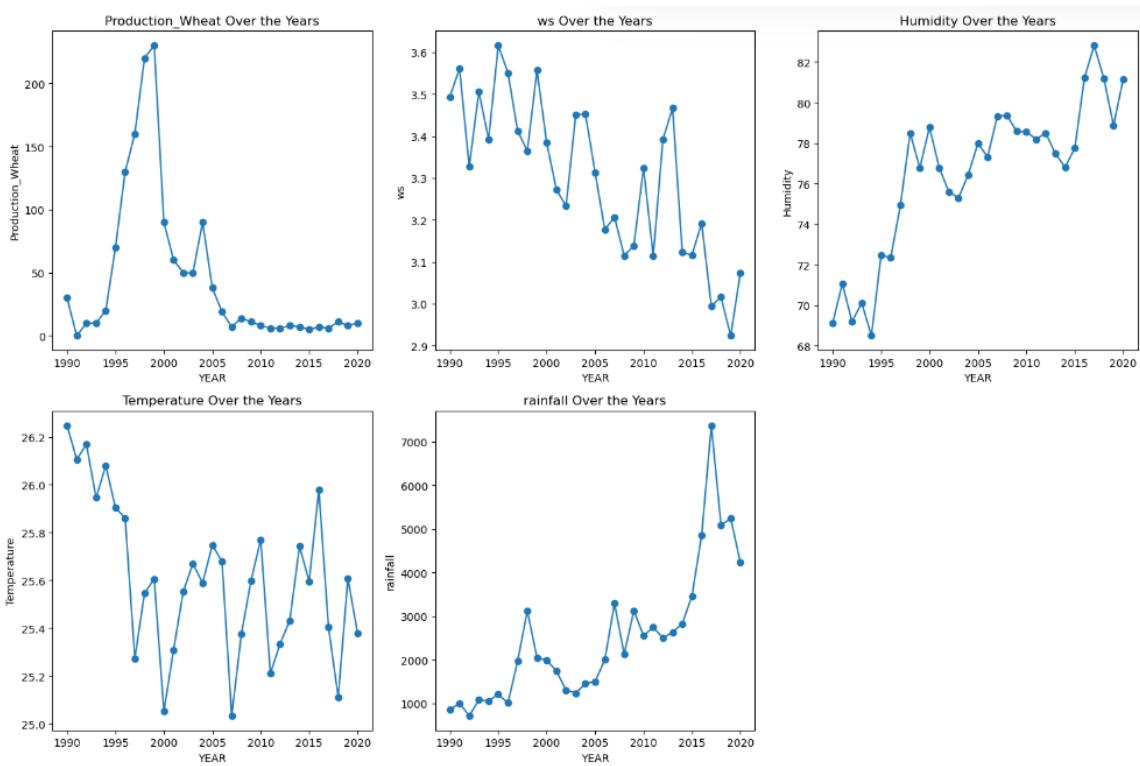


Figure- 5.31: The wheat data figures for the features.

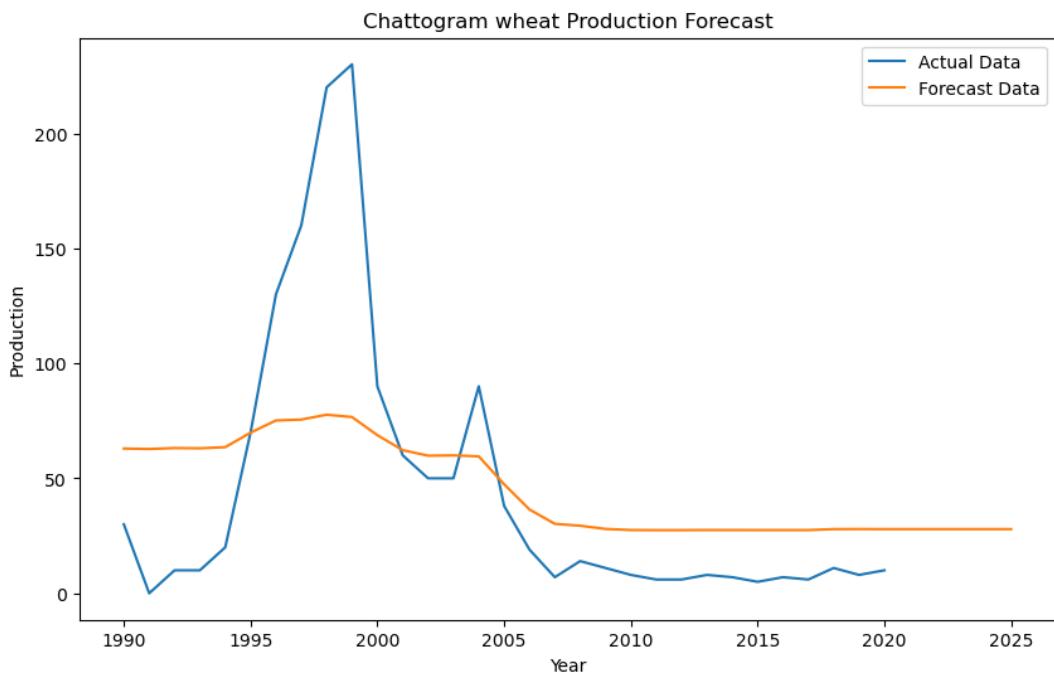


Figure-5.32: The wheat data figures for actual and predicted production.

- The potato data figures for the Chattogram district.

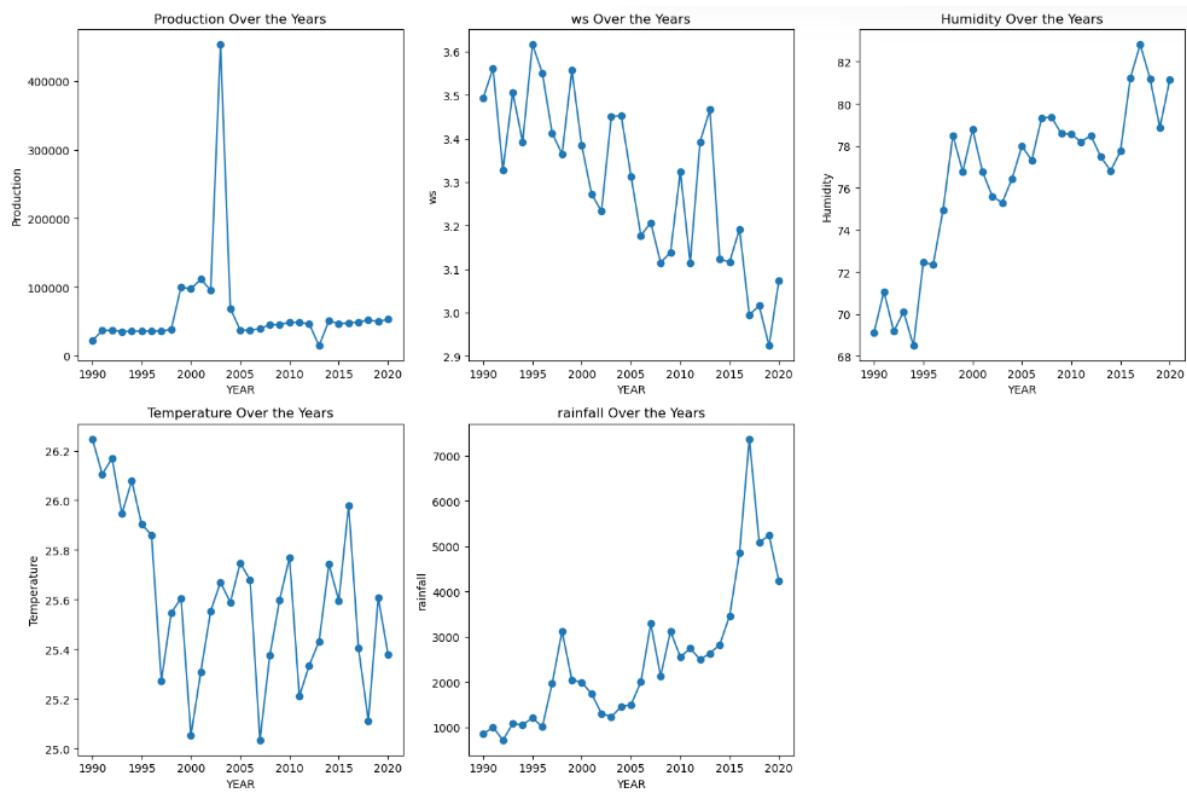


Figure-5.33: The potato data figures for the features.

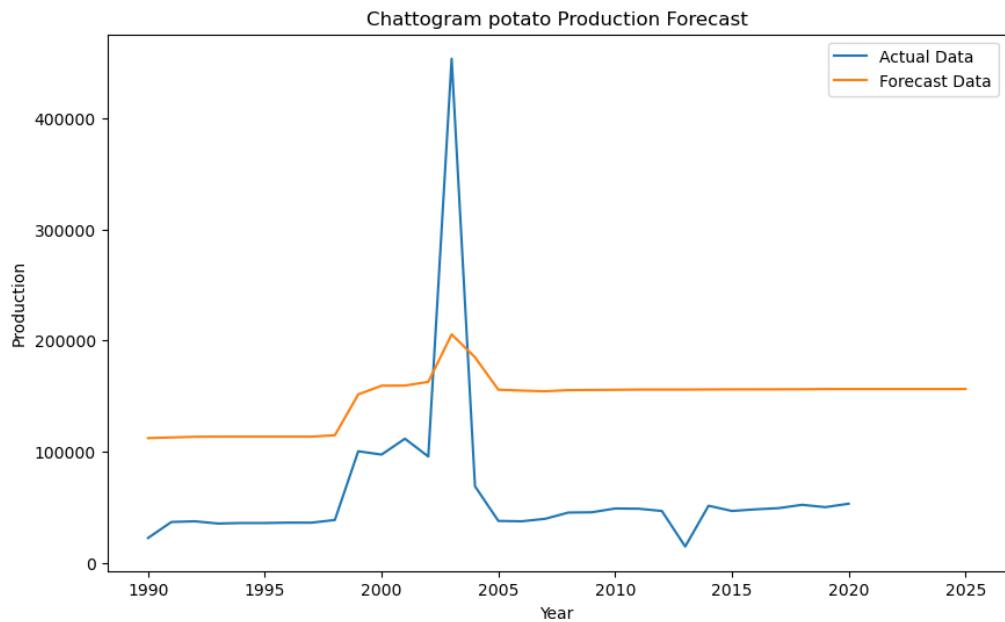


Figure- 5.34: The potato data figures for actual and predicted production.

➤ The Aush data figures for the Chattogram district.

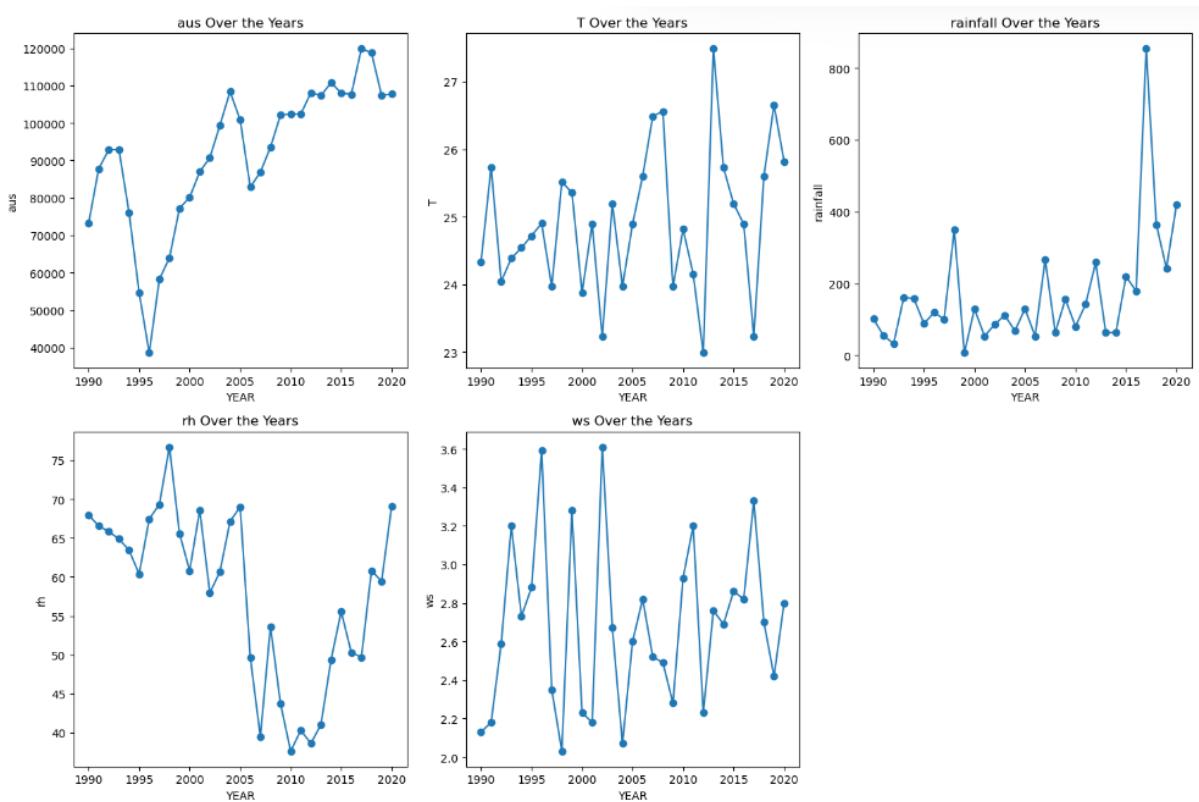


Figure-5.35: The Aush data figures for the features.

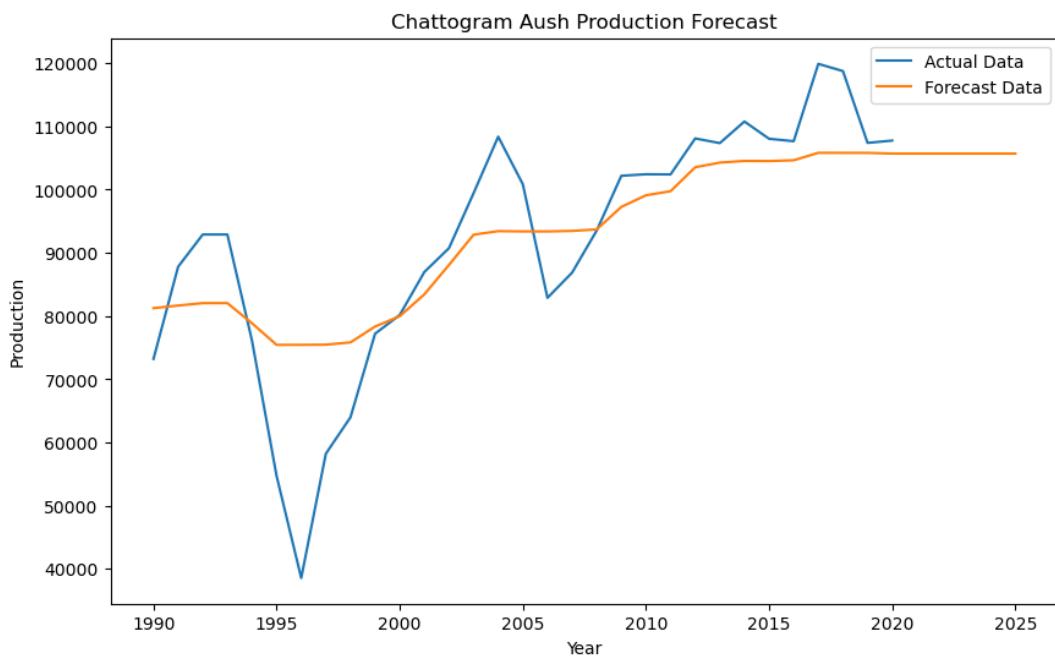


Figure-5.36: The Aush data figures for actual and predicted production.

➤ The Amon data figures for the Chattogram district.

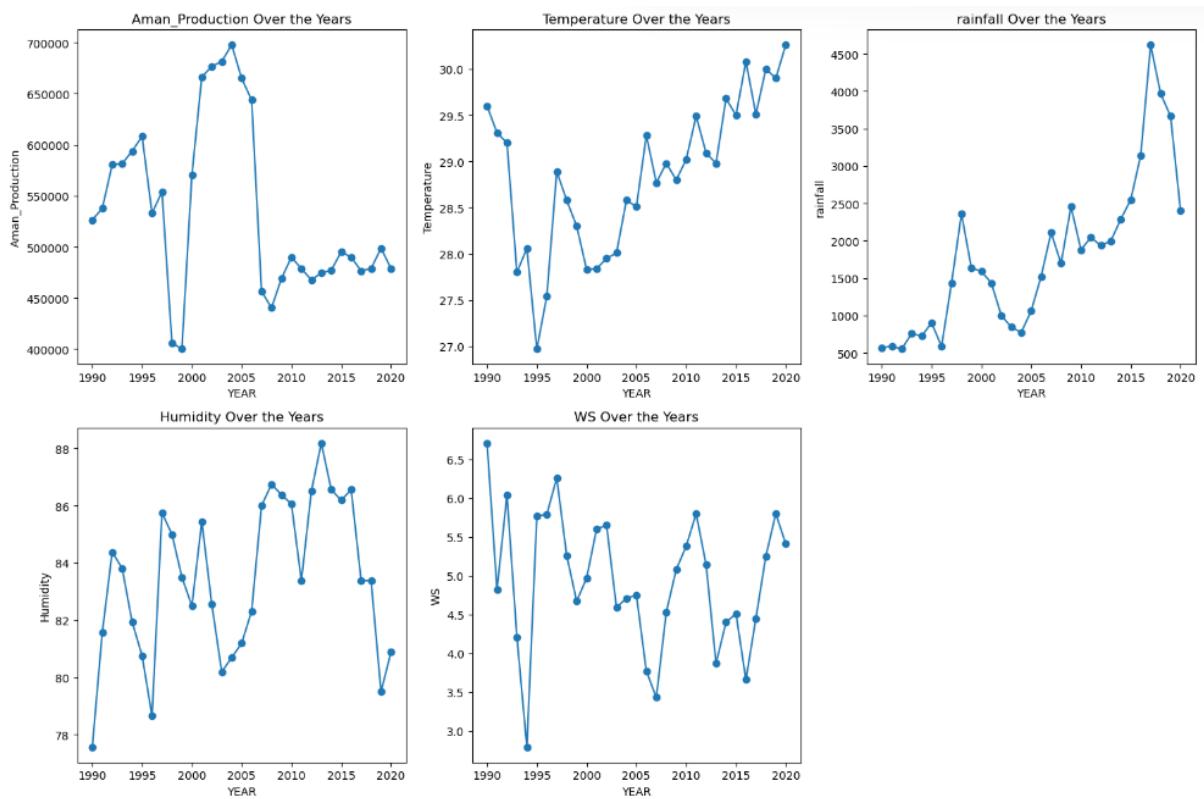


Figure5.37: The Amon data figures for the features.

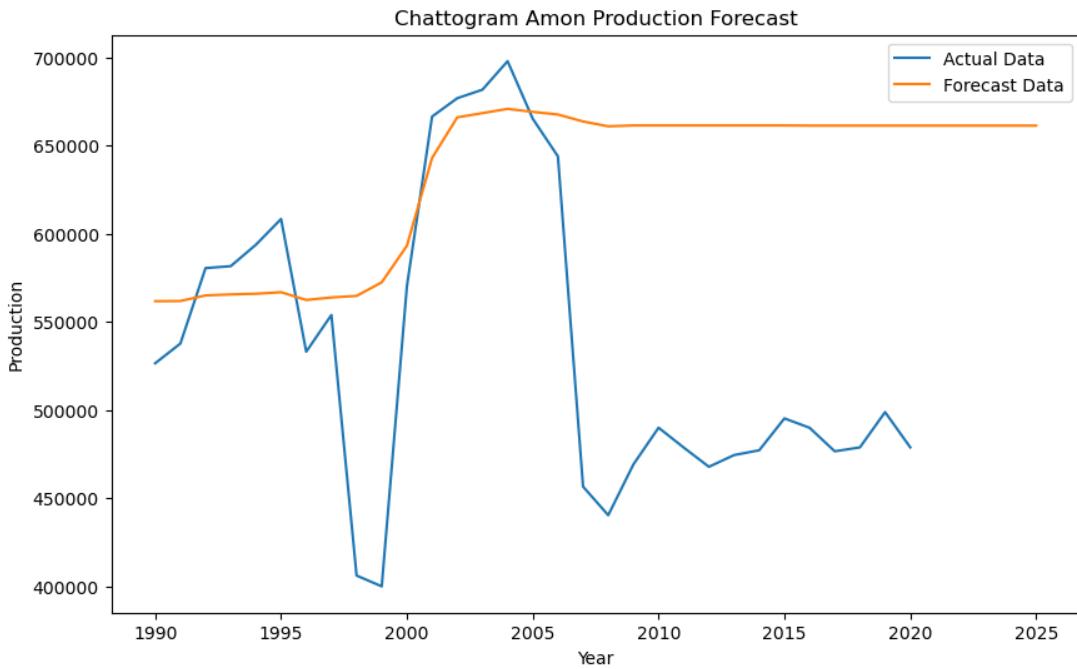


Figure-5.38: The Amon data figures for actual and predicted production.

➤ The Boro data figures for the Chattogram District.

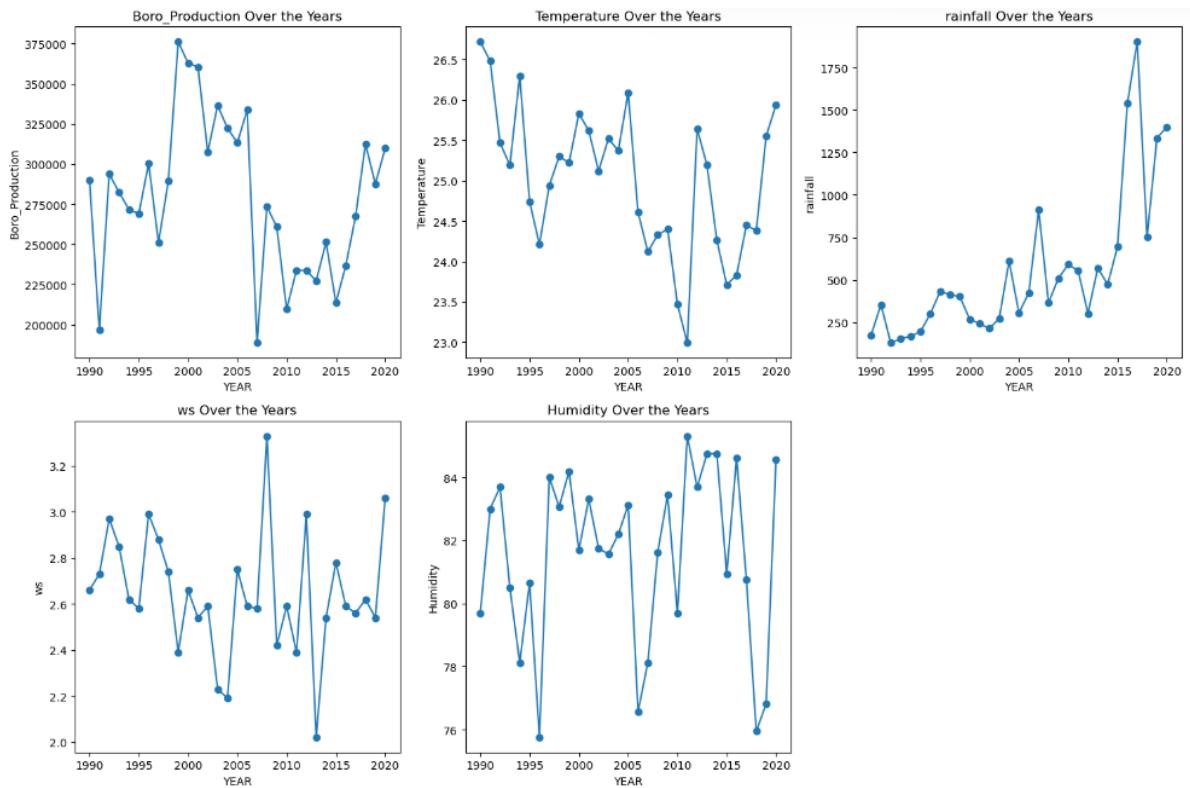


Figure-5.39: The Boro data figures for the features.

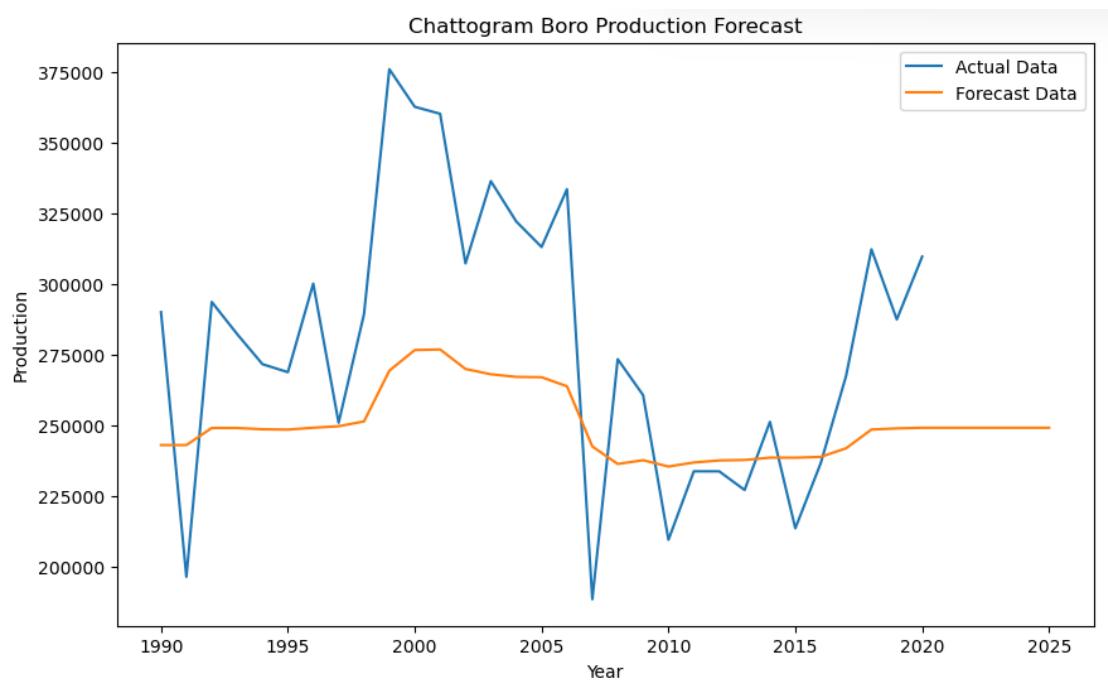


Figure-5.40: The Boro data figures for actual and predicted production.

Multiple Linear Regression

The Multiple Linear Regression model generates prediction figures that represent the predicted values for the target variable based on the input features.

❖ **Rajshahi District**

- Wheat data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.

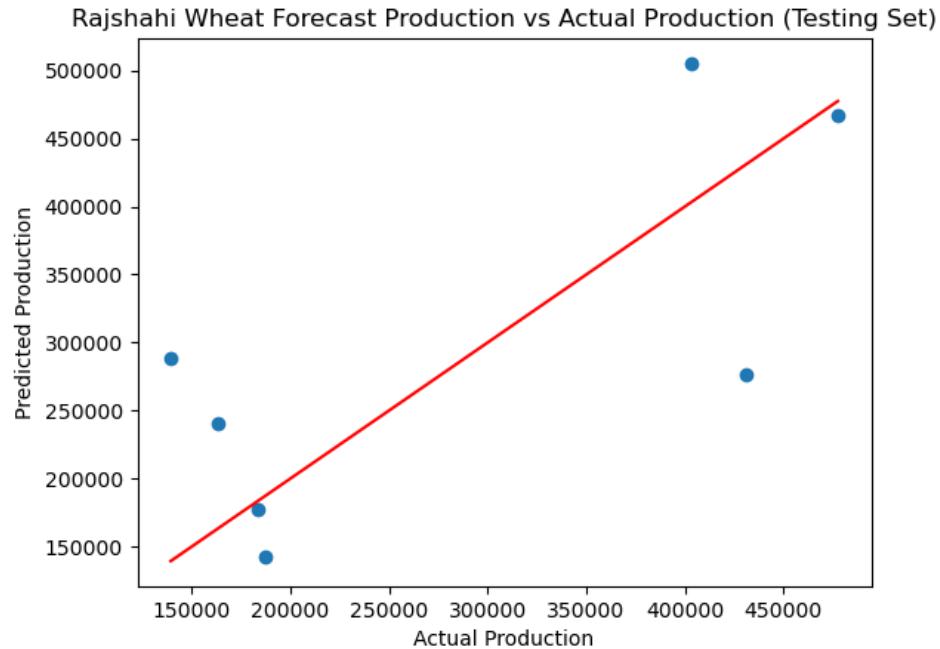


Figure-5.41: Figure of testing dataset.

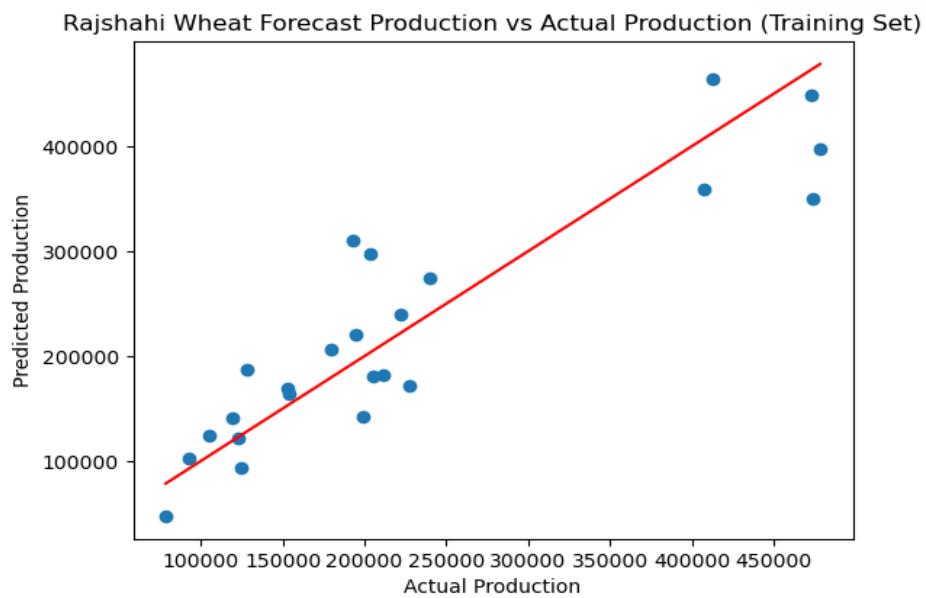


Figure-5.42: Figure of training dataset.

- Potato data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.

Rajshahi Potato Forecast Production vs Actual Production (Testing Set)

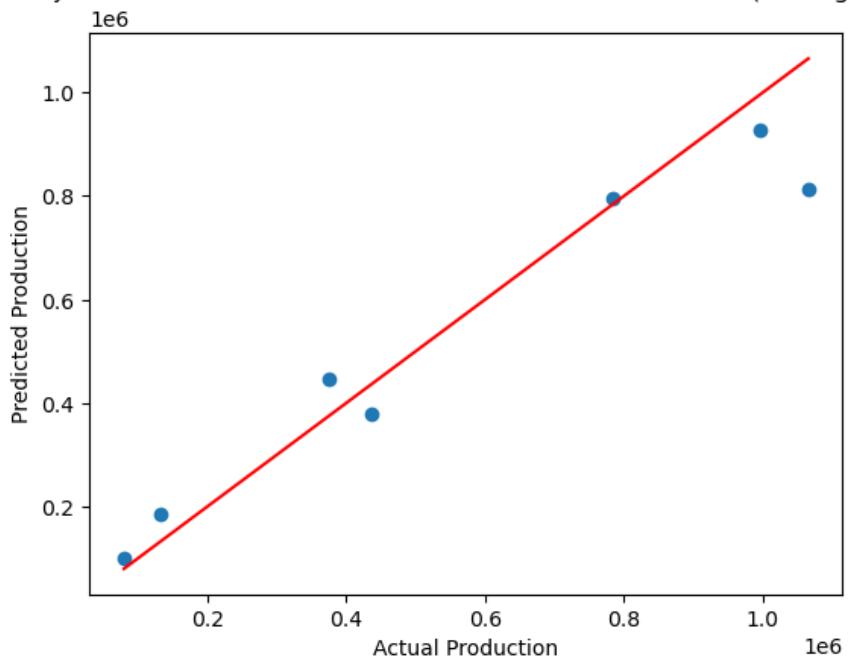


Figure-5.43: Figure of testing dataset.

Rajshahi Potato Forecast Production vs Actual Production (Training Set)

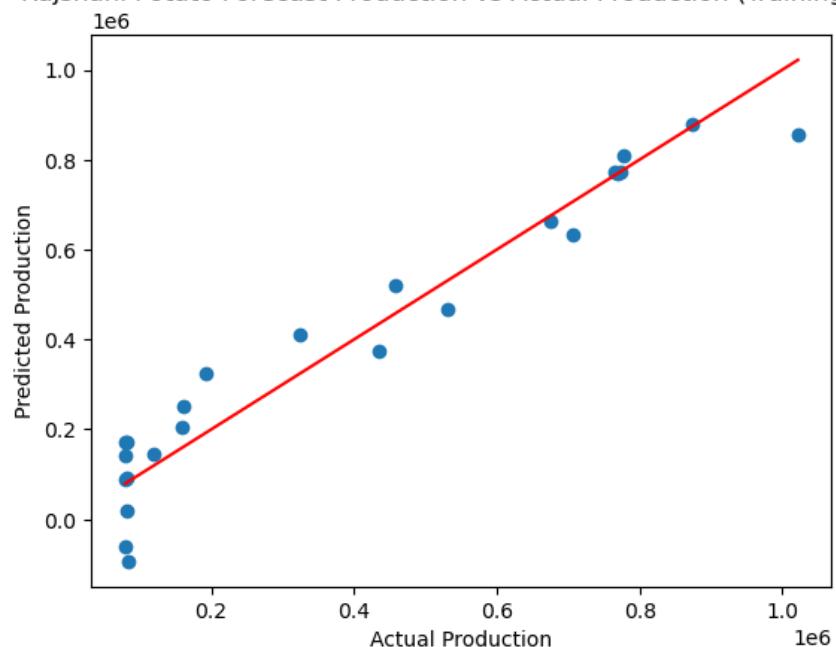


Figure-5.44: Figure of training dataset.

- Aush data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.

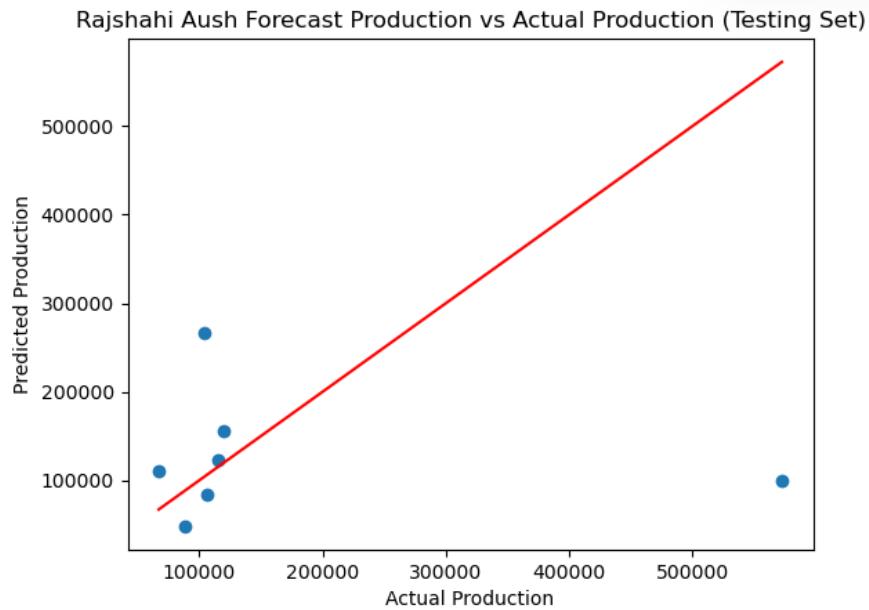


Figure-5.45: Figure of testing dataset.

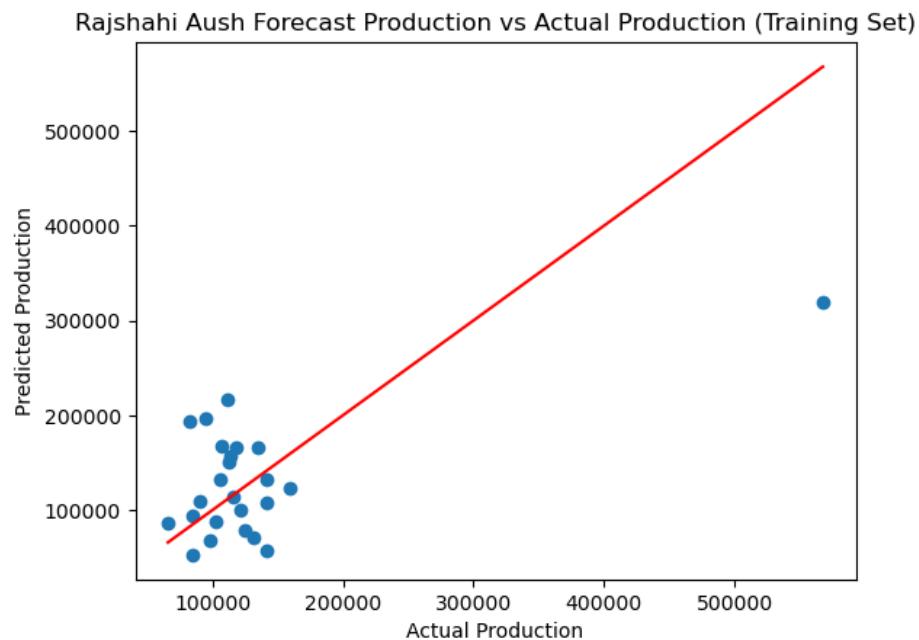


Figure-5.46: Figure of training dataset.

- Amon data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.

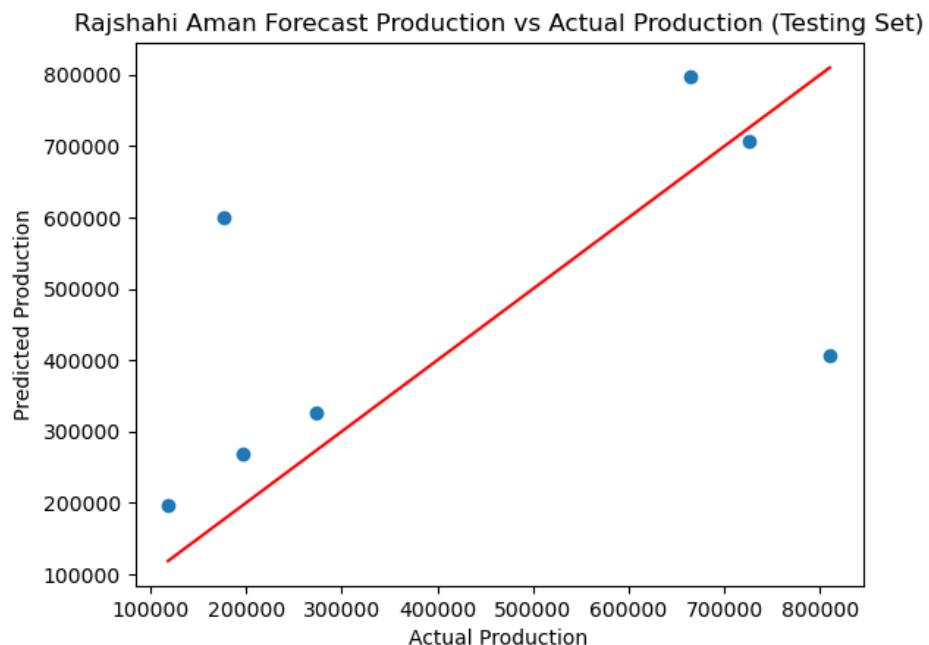


Figure-5.47: Figure of testing dataset.

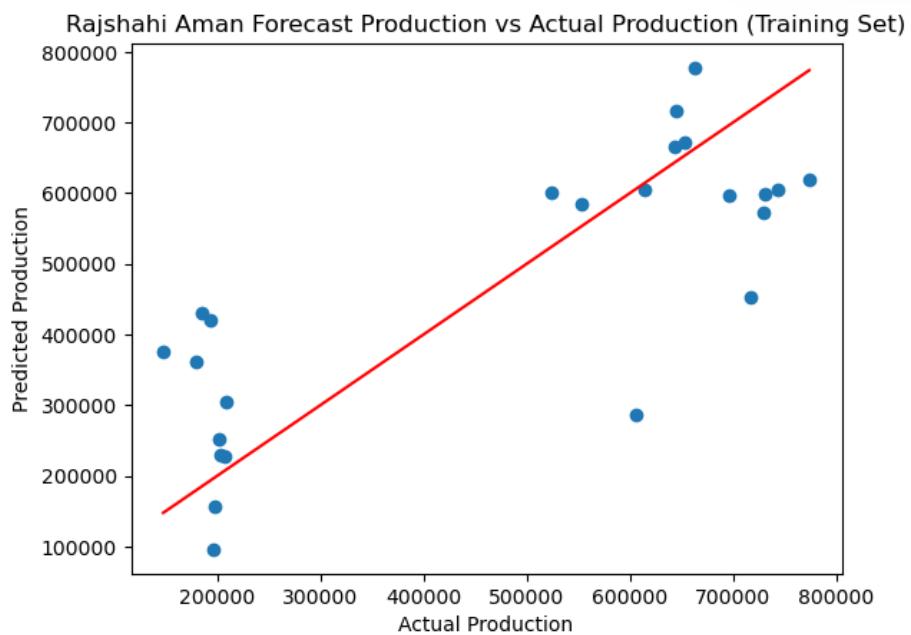


Figure-5.48: Figure of training dataset.

- Boro data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.

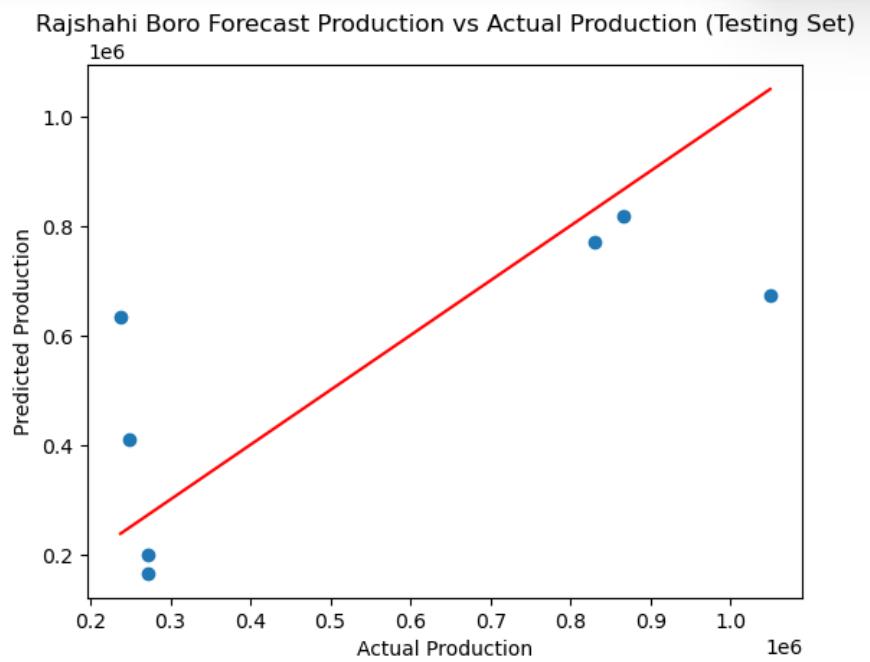


Figure-5.49: Figure of testing dataset.

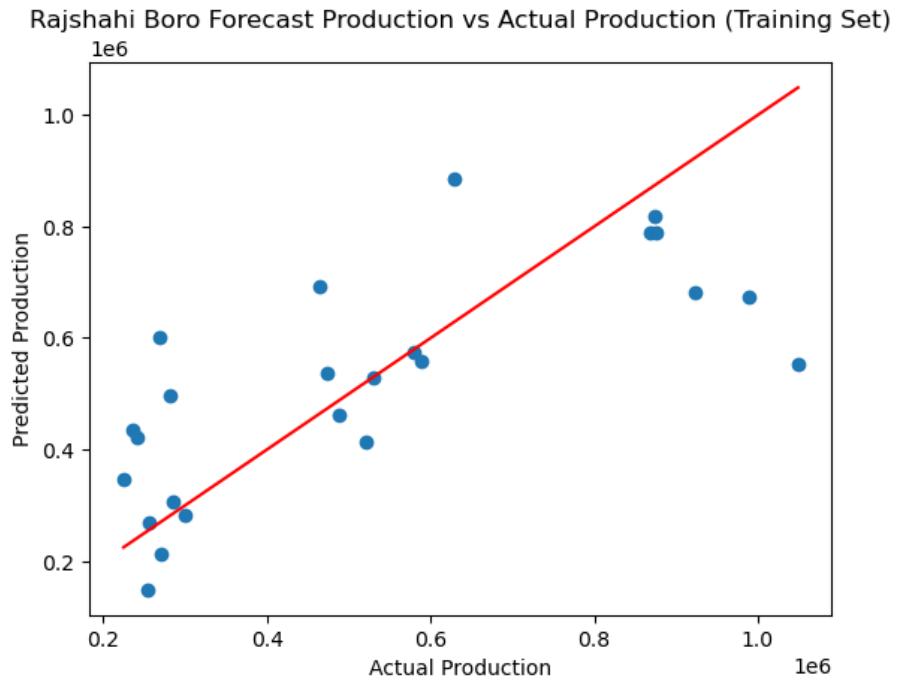


Figure-5.50: Figure of training dataset.

❖ Dhaka District

- Wheat data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

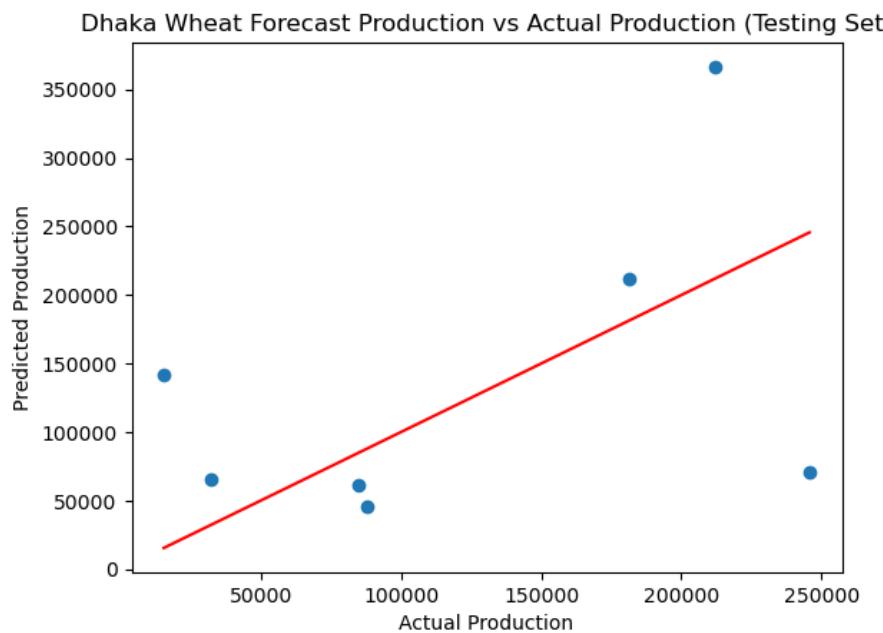


Figure-5.51: Figure of testing dataset.

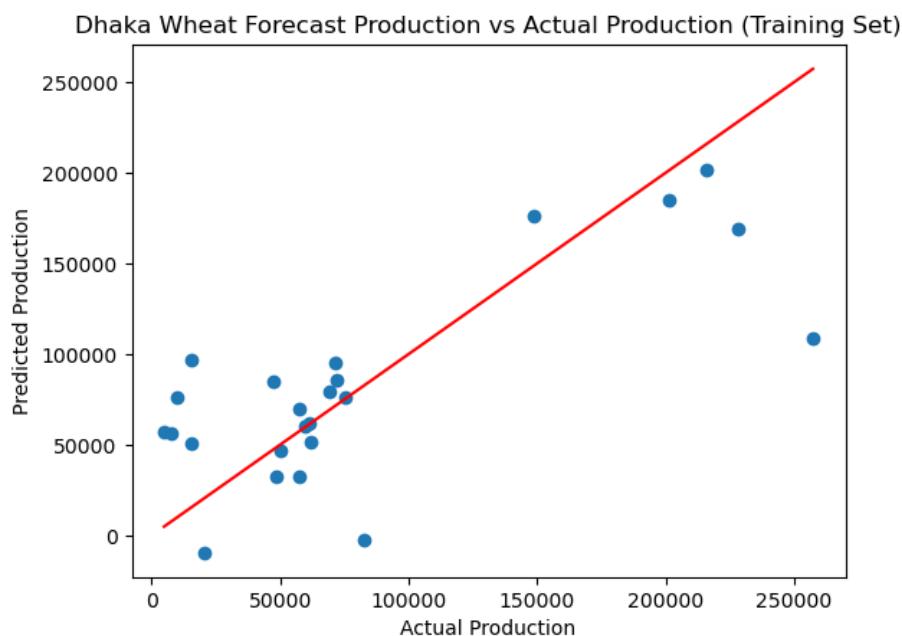


Figure-5.52: Figure of training dataset.

- Potato data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

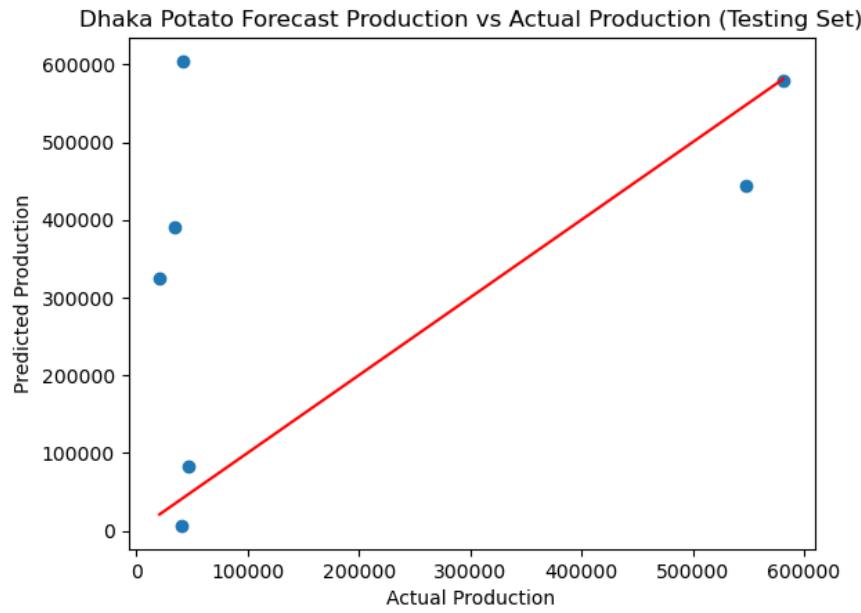


Figure-5.53: Figure of testing dataset.

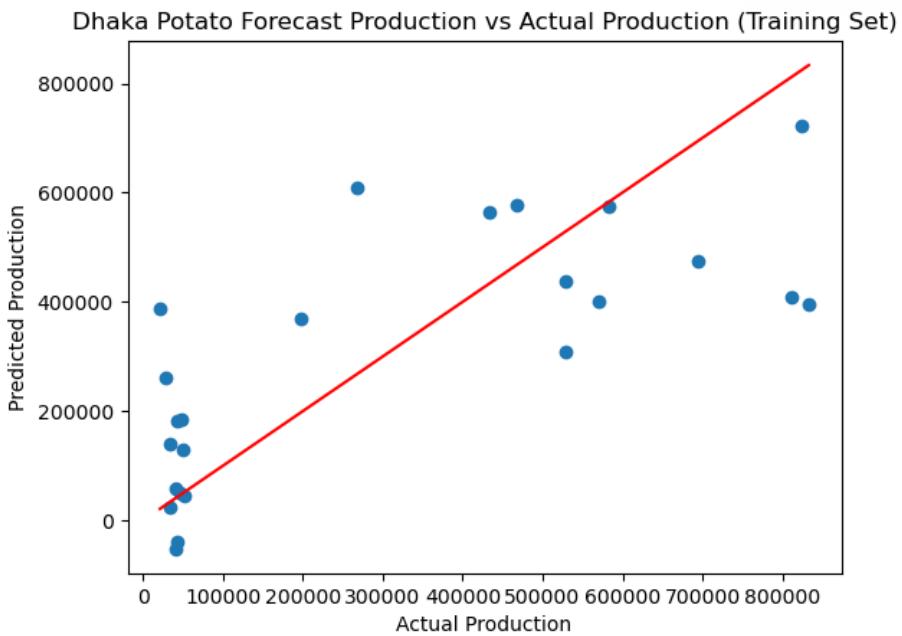


Figure-5.54: Figure of training dataset.

- Aush data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

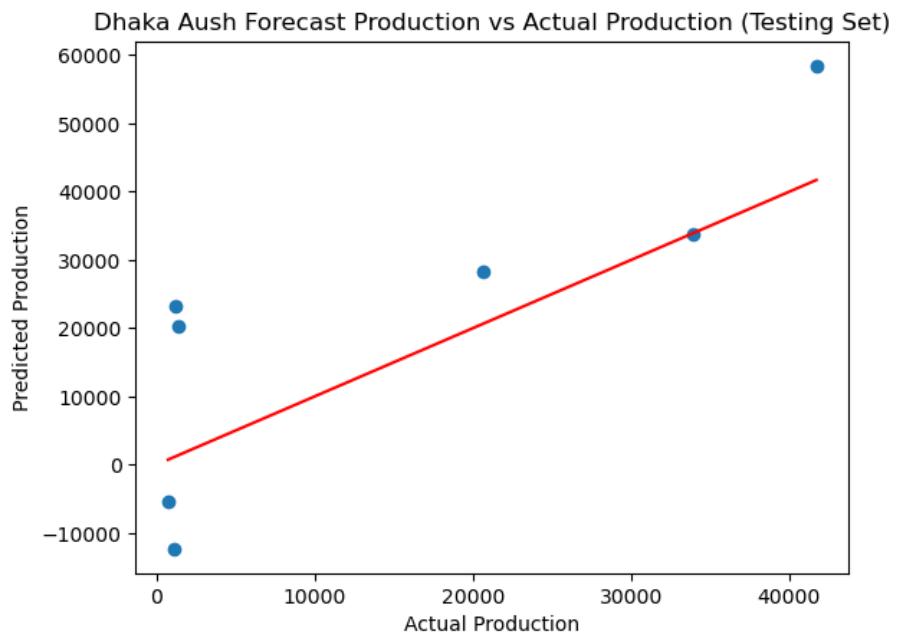


Figure-5.55: Figure of testing dataset

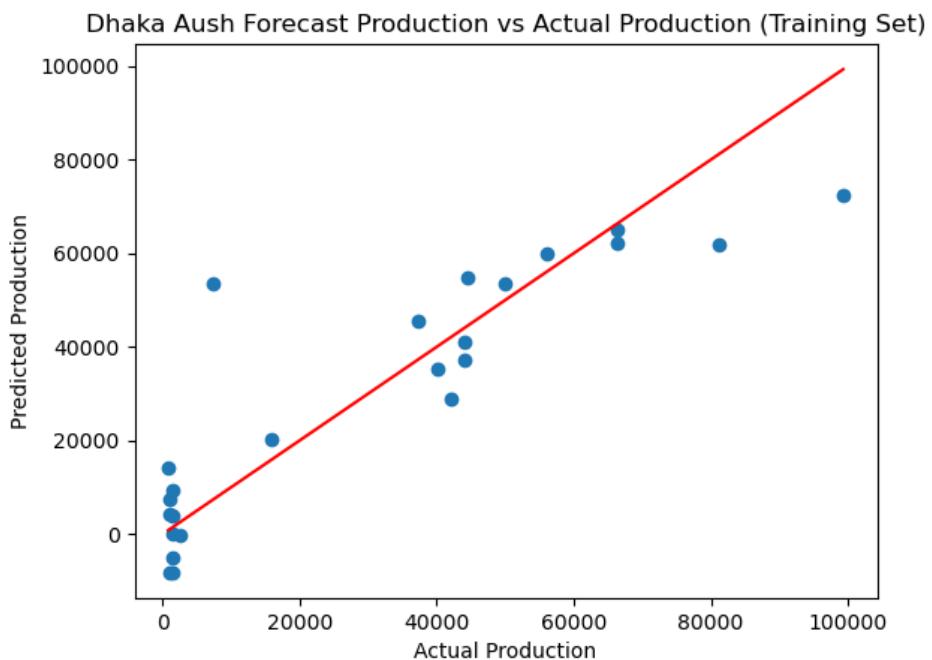


Figure-5.56: Figure of training dataset.

- Amon data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

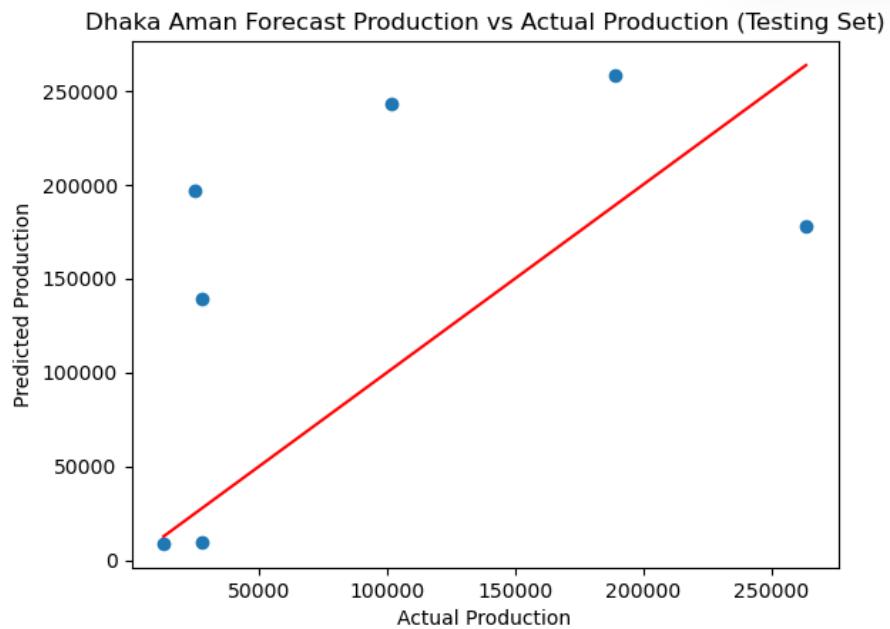


Figure-5.57: Figure of testing dataset.

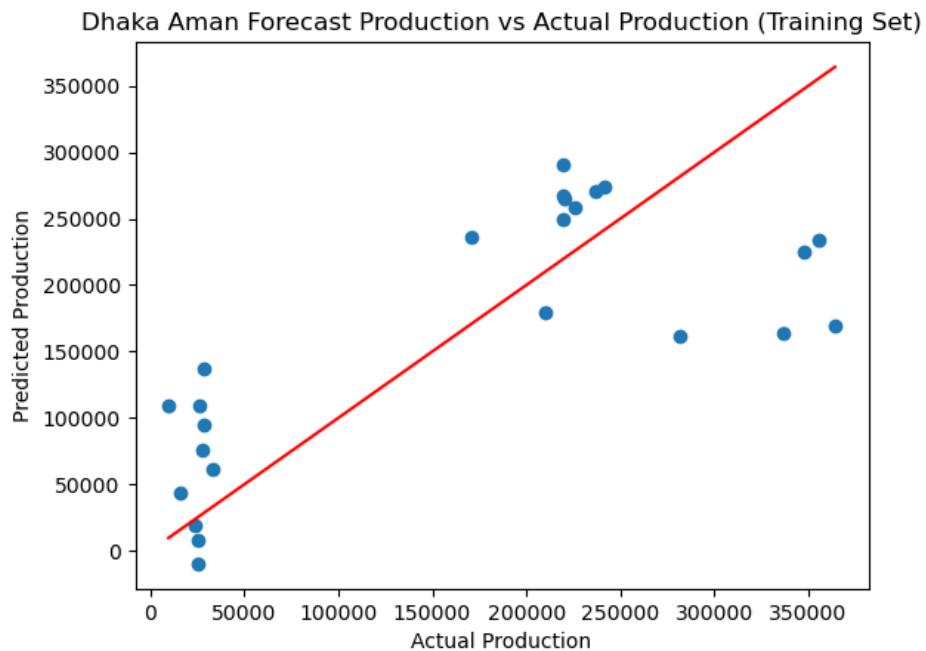


Figure-5.58: Figure of training dataset.

- Boro data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

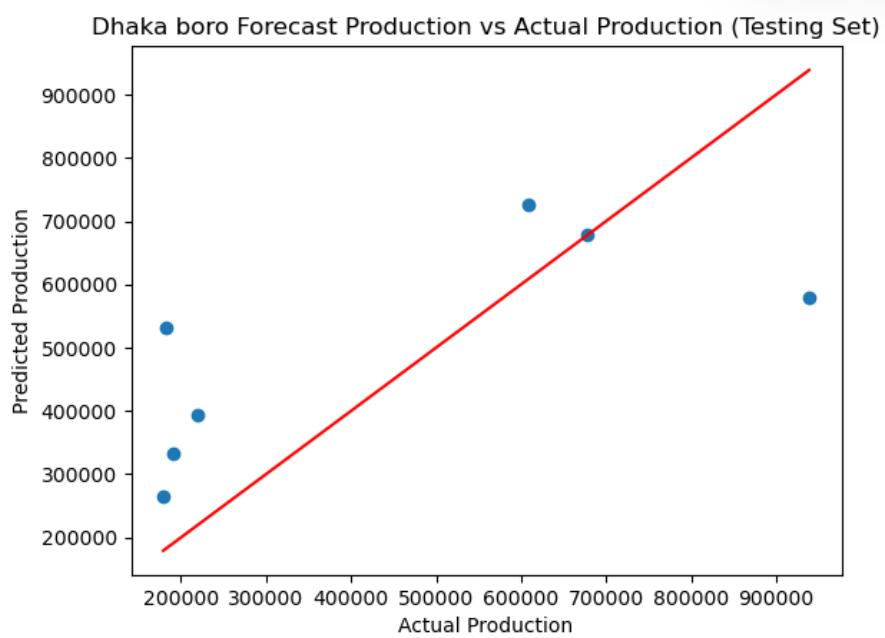


Figure-5.59: Figure of testing dataset.

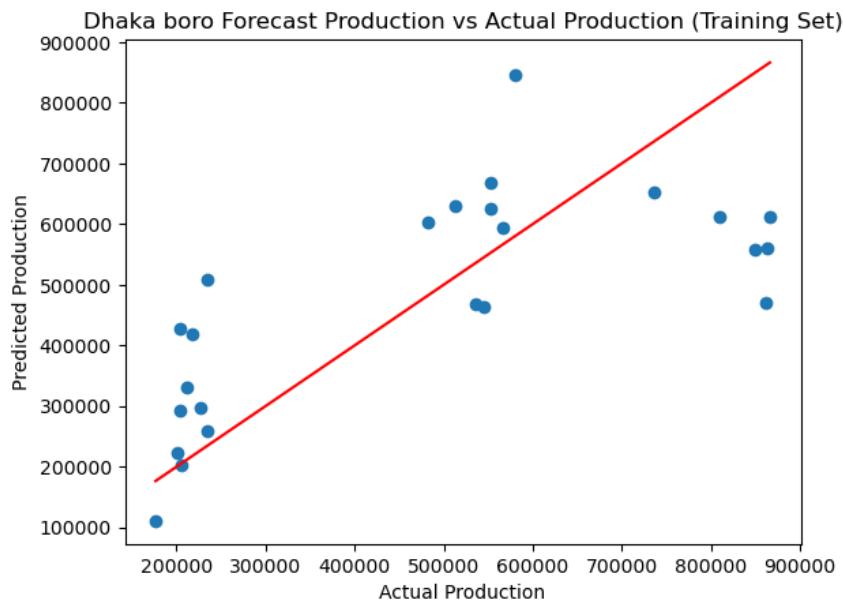


Figure-5.60: Figure of training dataset.

❖ Khulna District

- Wheat data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

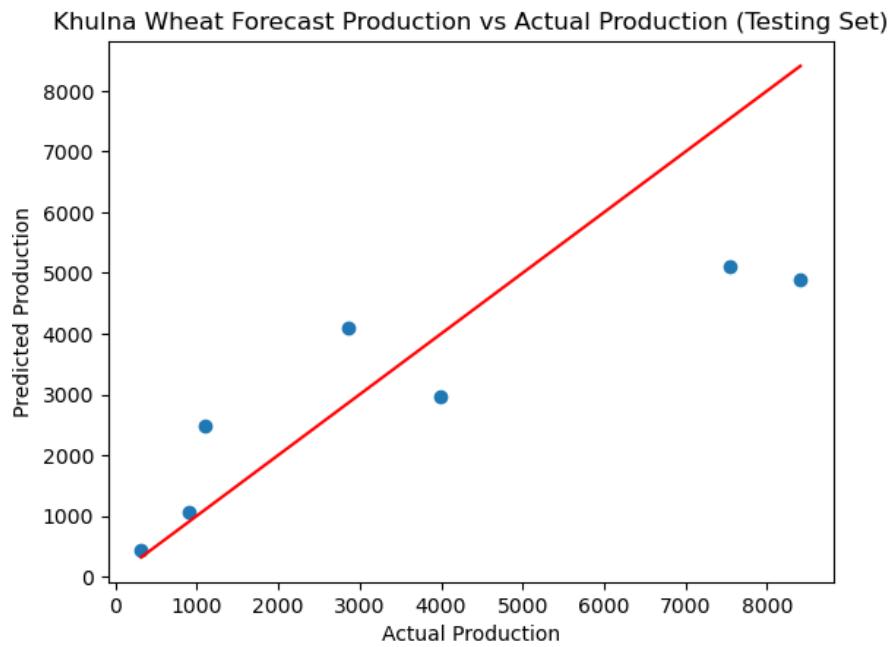


Figure-5.61: Figure of testing dataset.

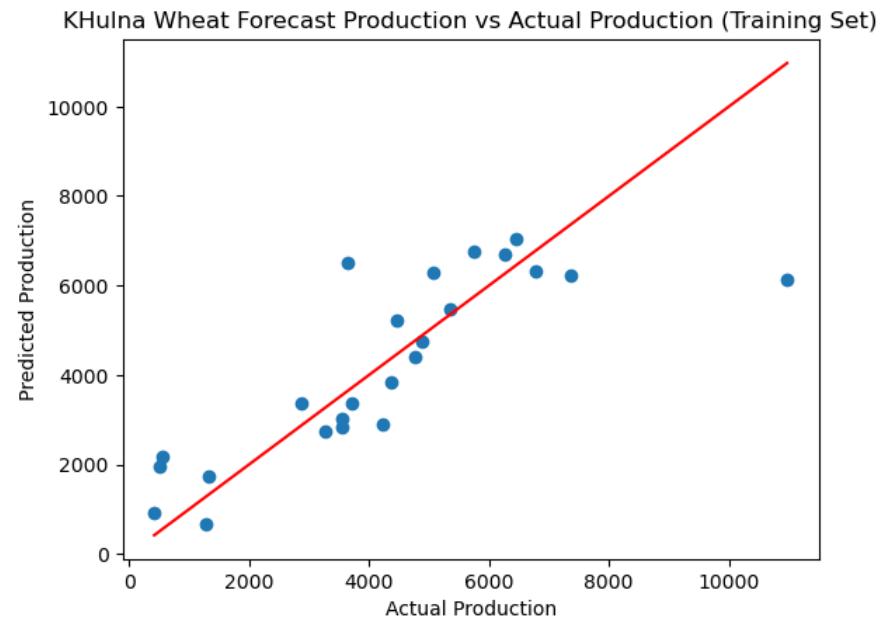


Figure-5.62: Figure of training dataset.

- Potato data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

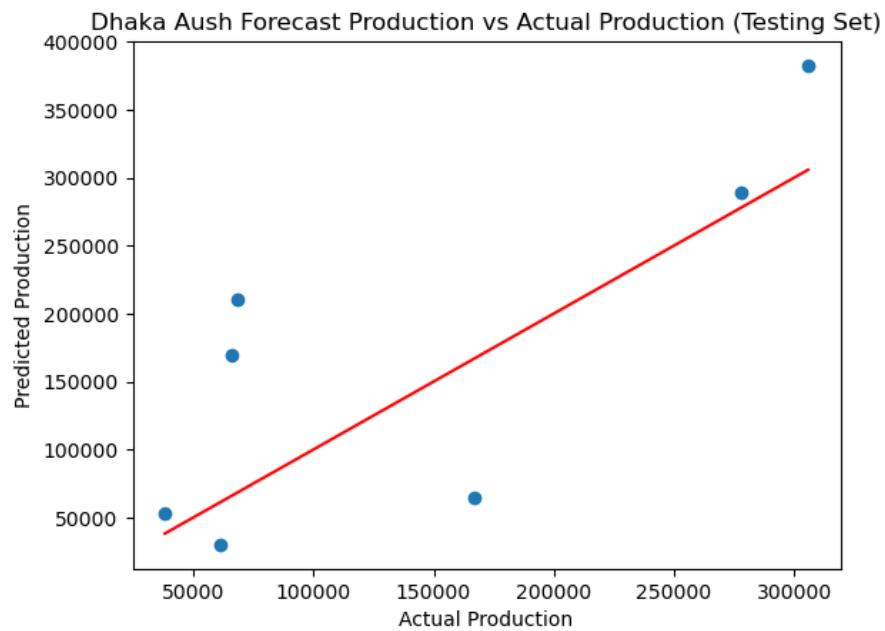


Figure-5.63: Figure of testing dataset.

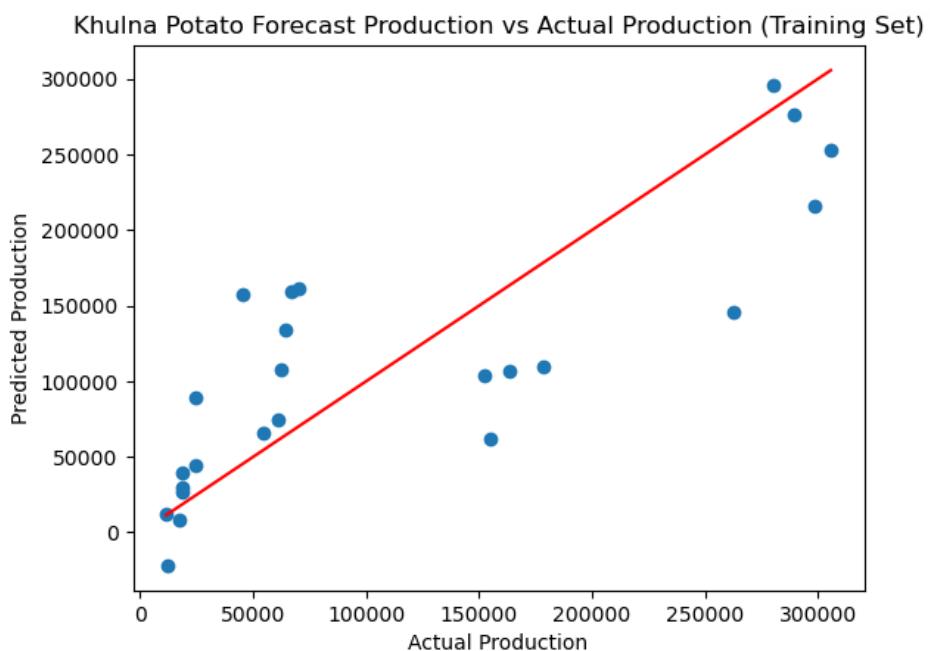


Figure-5.64: Figure of training dataset.

- Aush data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

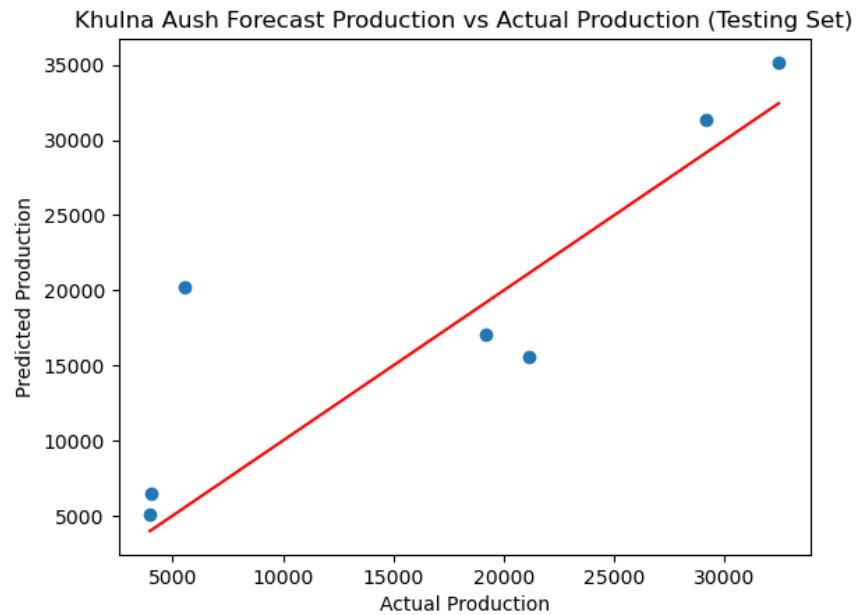


Figure-5.65: Figure of testing dataset.

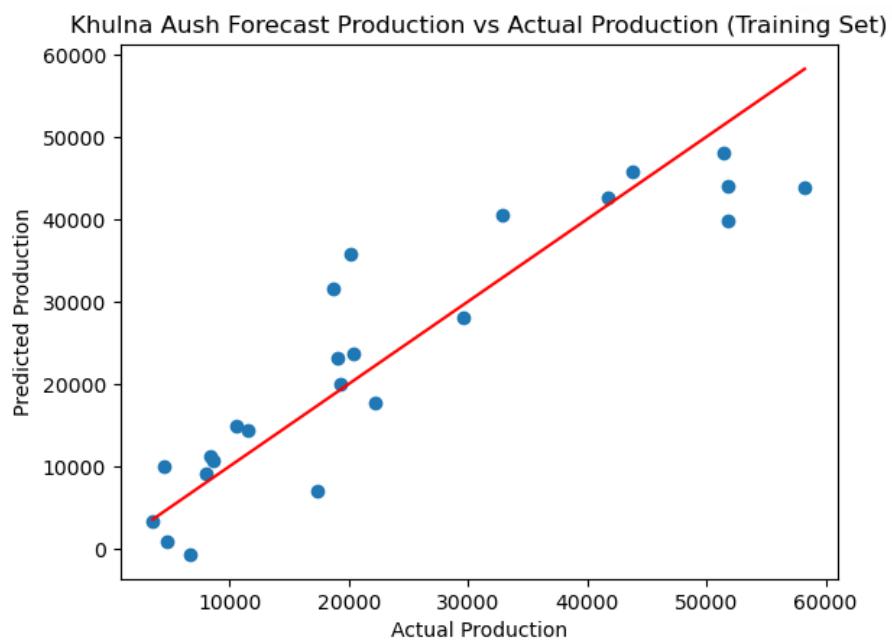


Figure-5.66: Figure of training dataset.

Amon data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

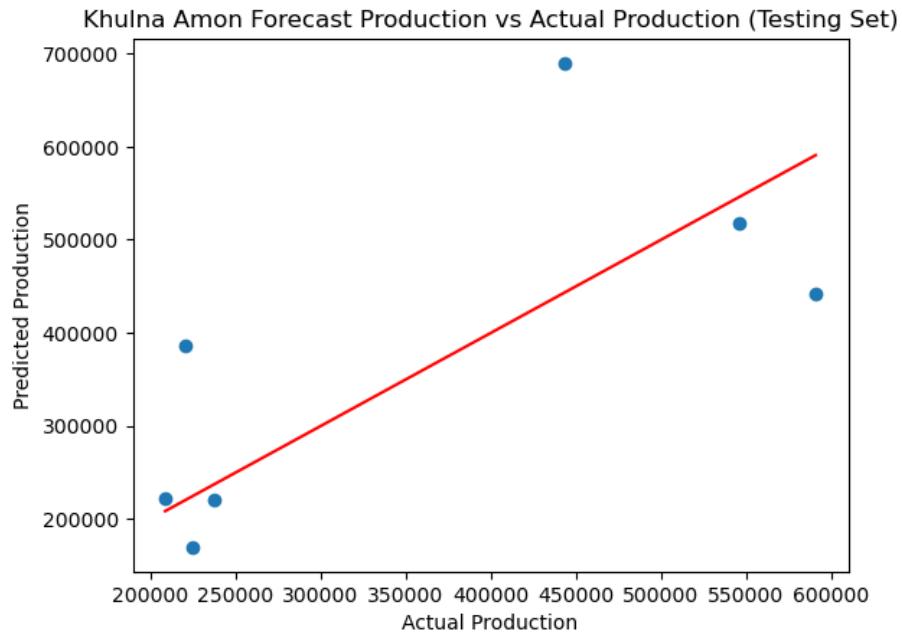


Figure-5.67: Figure of testing dataset.

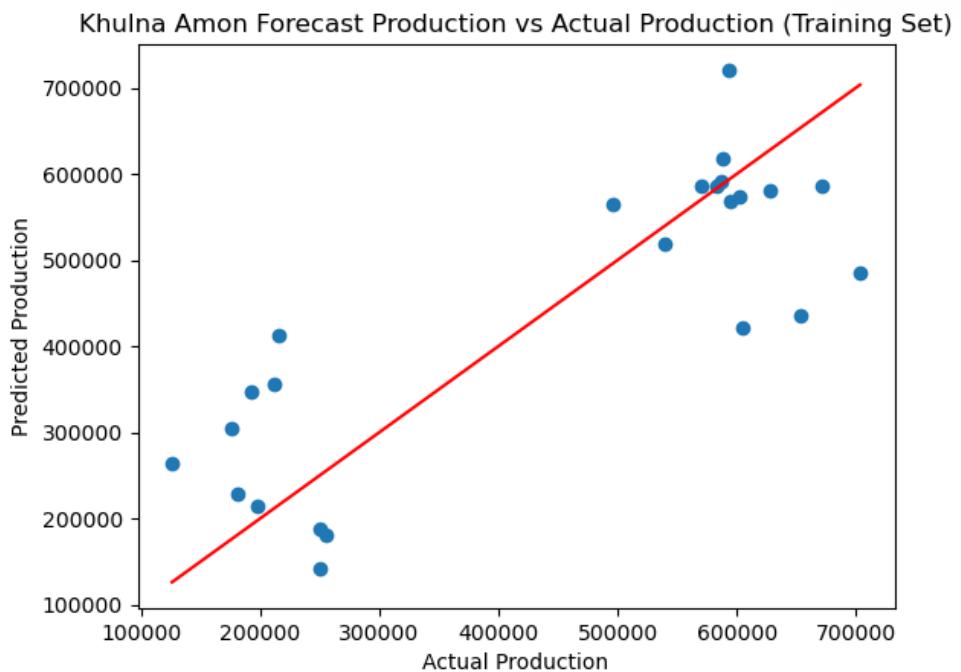


Figure-5.68: Figure of training dataset.

- Boro data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

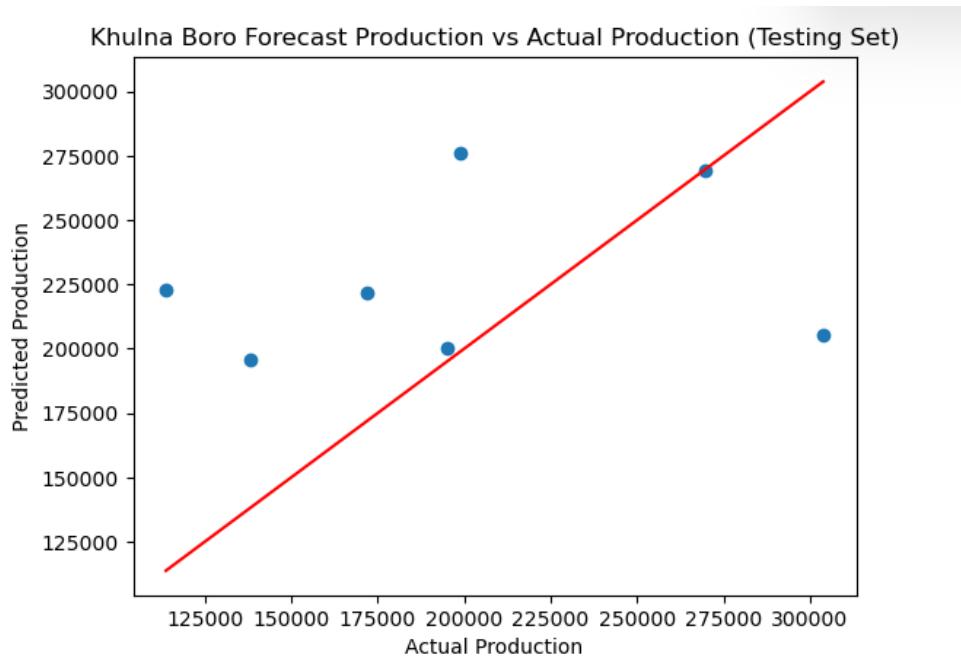


Figure-5.69: Figure of testing dataset.

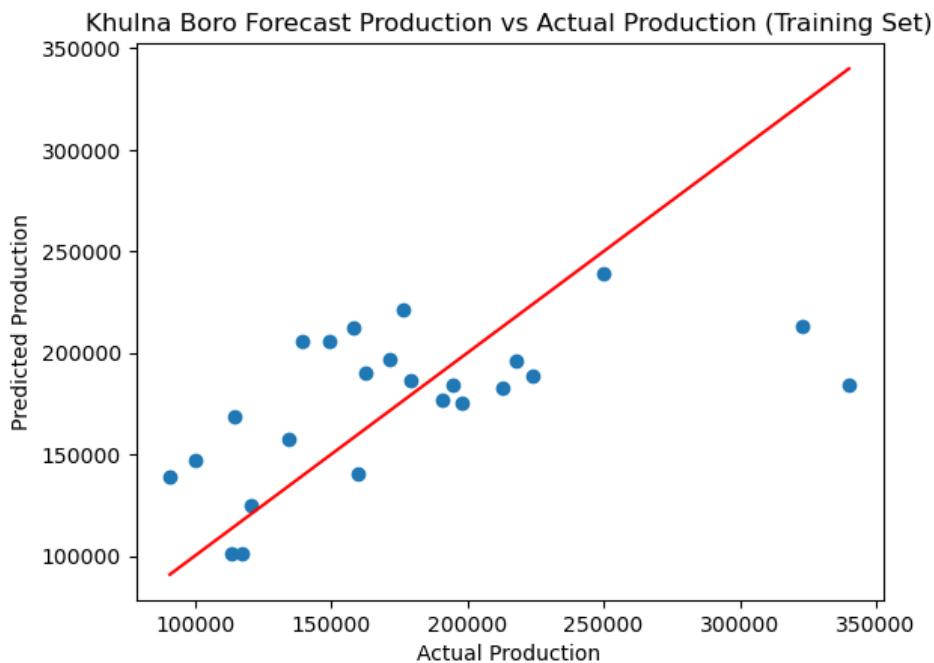


Figure-5.70: Figure of training dataset.

❖ Chatogram District

- Wheat data figures compare actual and predicted production in Chatogram, including forecasts for both training and testing sets.

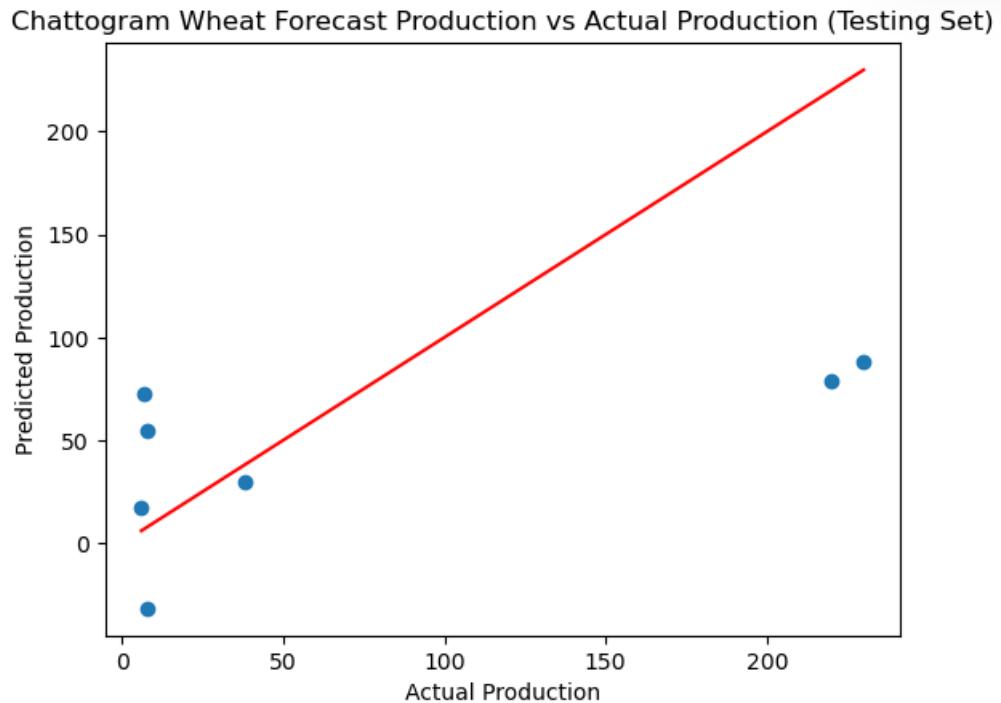


Figure-5.71: Figure of testing dataset.

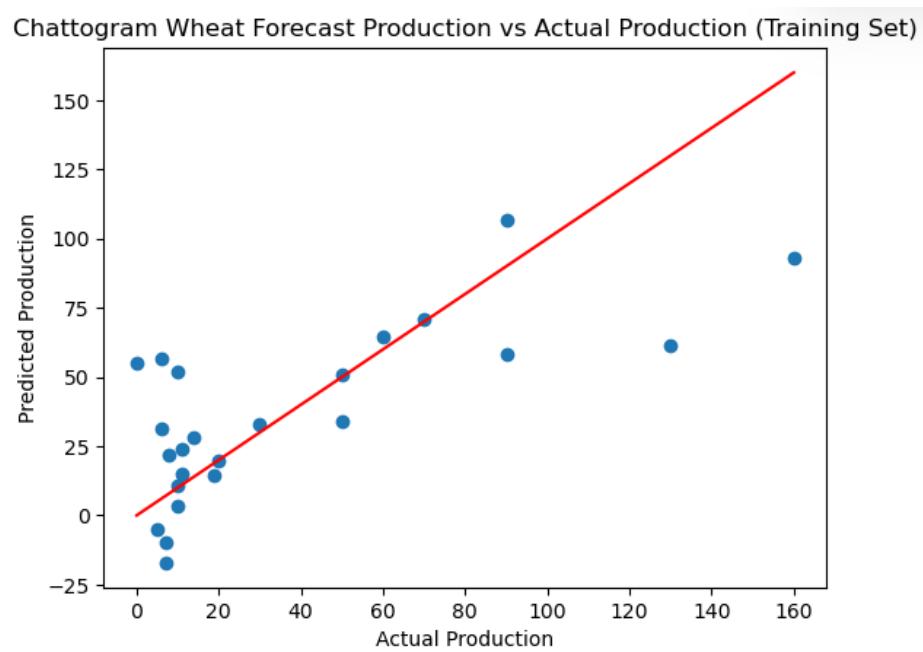


Figure-5.72: Figure of training dataset.

- Potato data figures compare actual and predicted production in Chattogram, including forecasts for both training and testing sets.

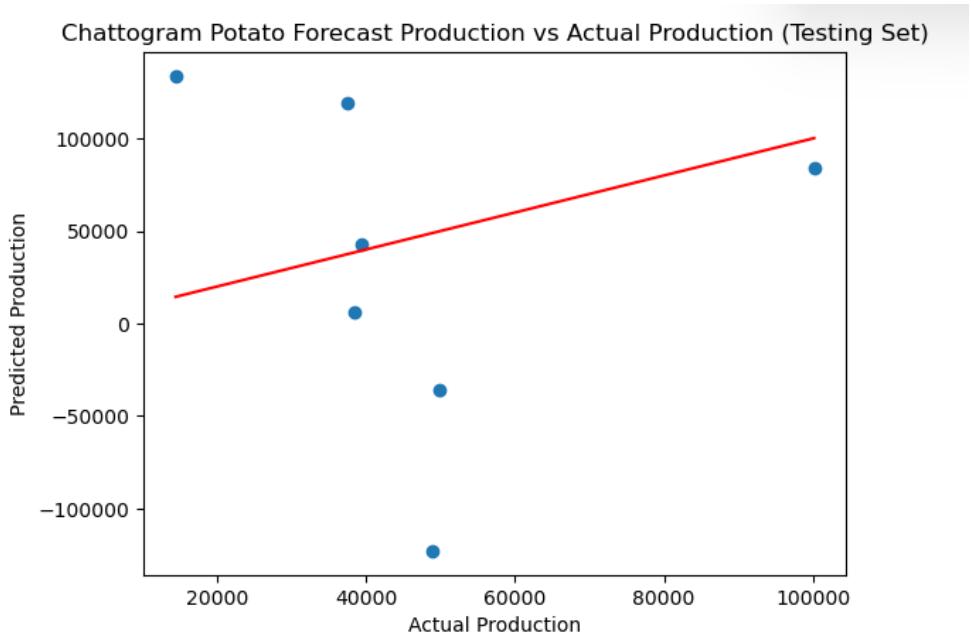


Figure-5.73: Figure of testing dataset.

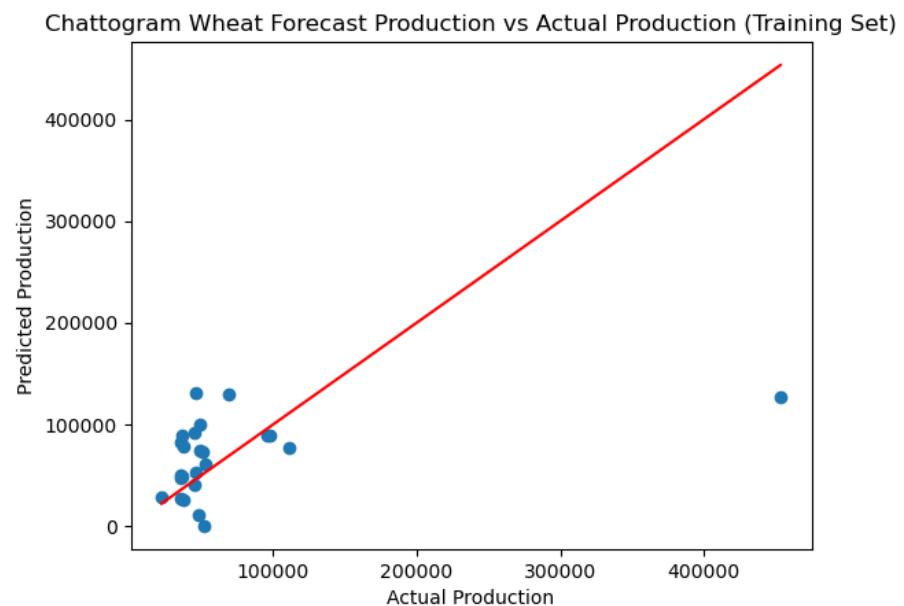


Figure-5.74: Figure of training dataset.

- Aush data figures compare actual and predicted production in Chatogram, including forecasts for both training and testing sets.

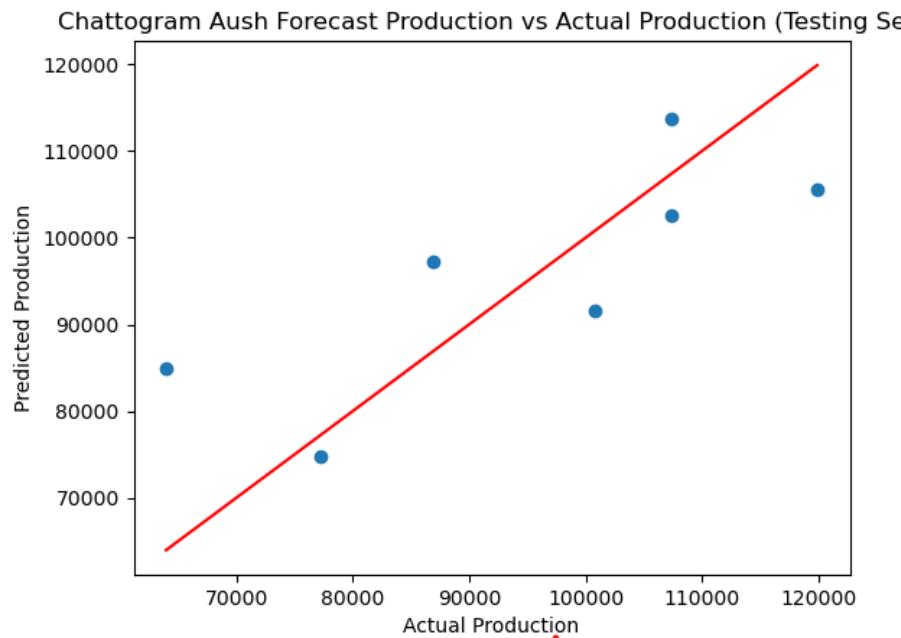


Figure-5.75: Figure of testing dataset.

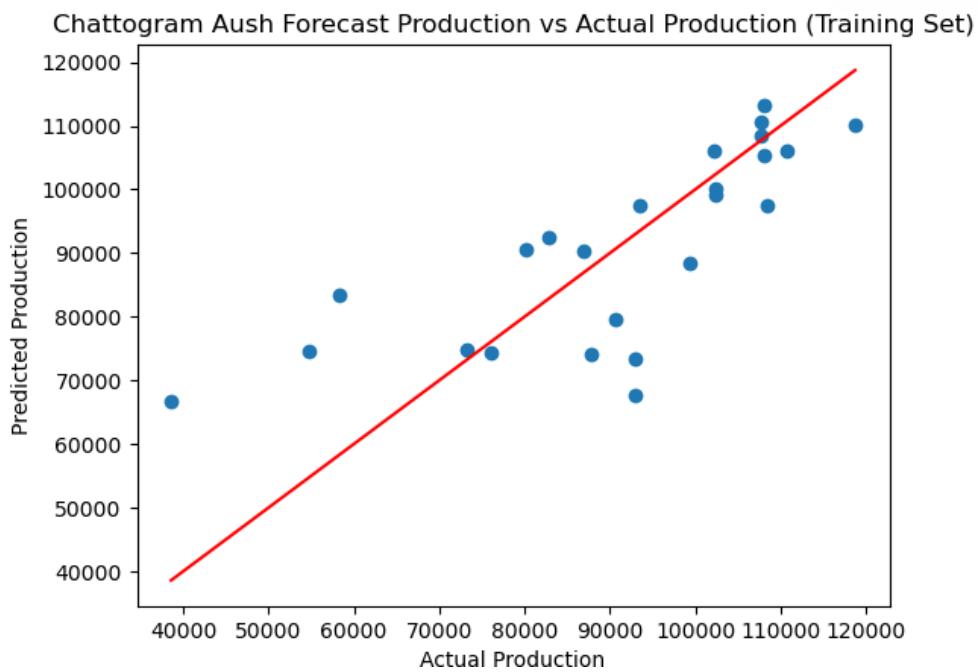


Figure-5.76: Figure of training dataset.

- Amon data figures compare actual and predicted production in Chattogram, including forecasts for both training and testing sets.

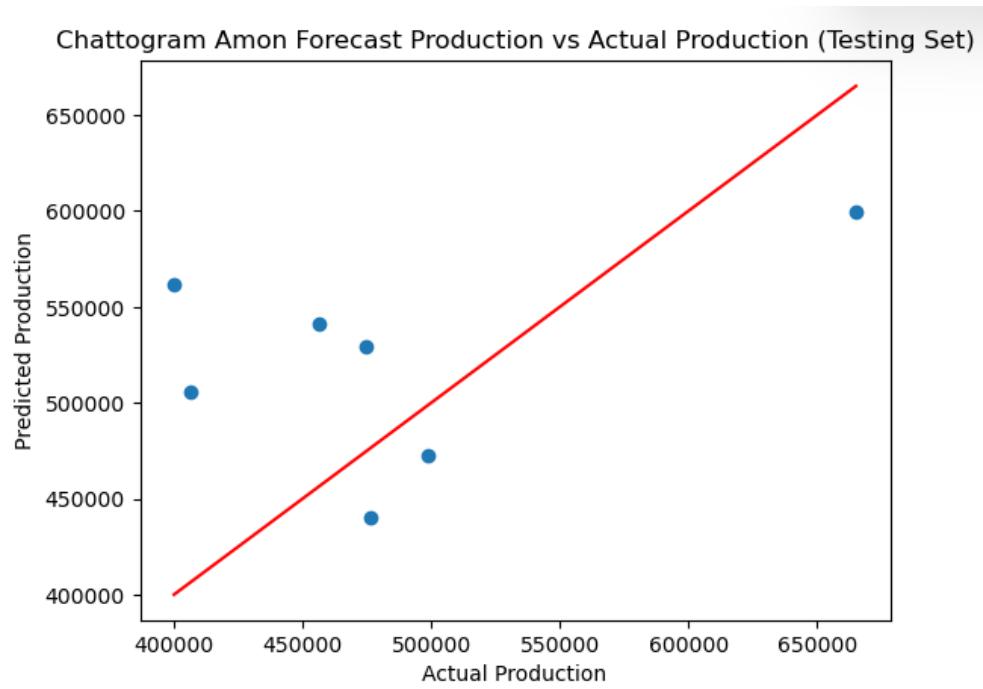


Figure-5.77: Figure of testing dataset.

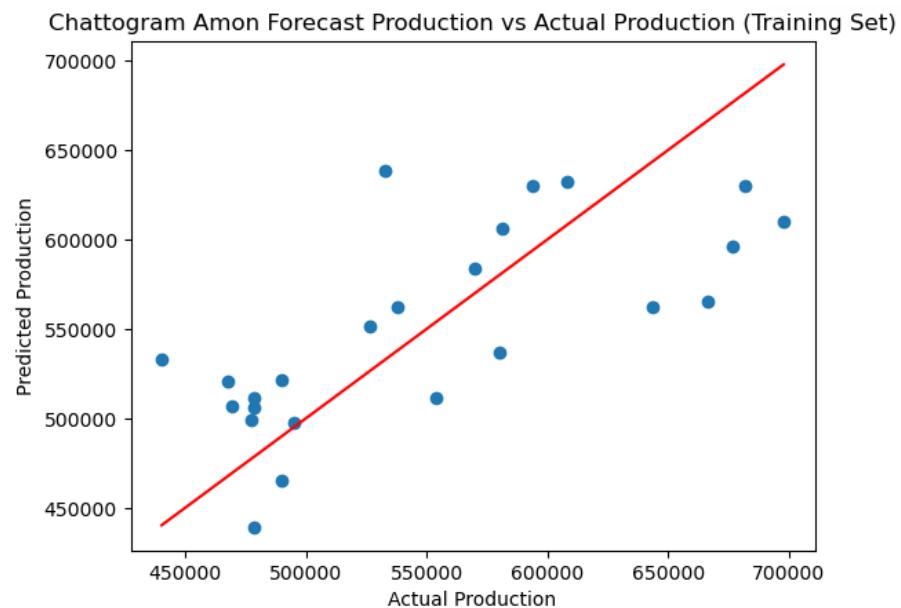


Figure-5.78: Figure of training dataset.

- Boro data figures compare actual and predicted production in Chattogram, including forecasts for both training and testing sets.

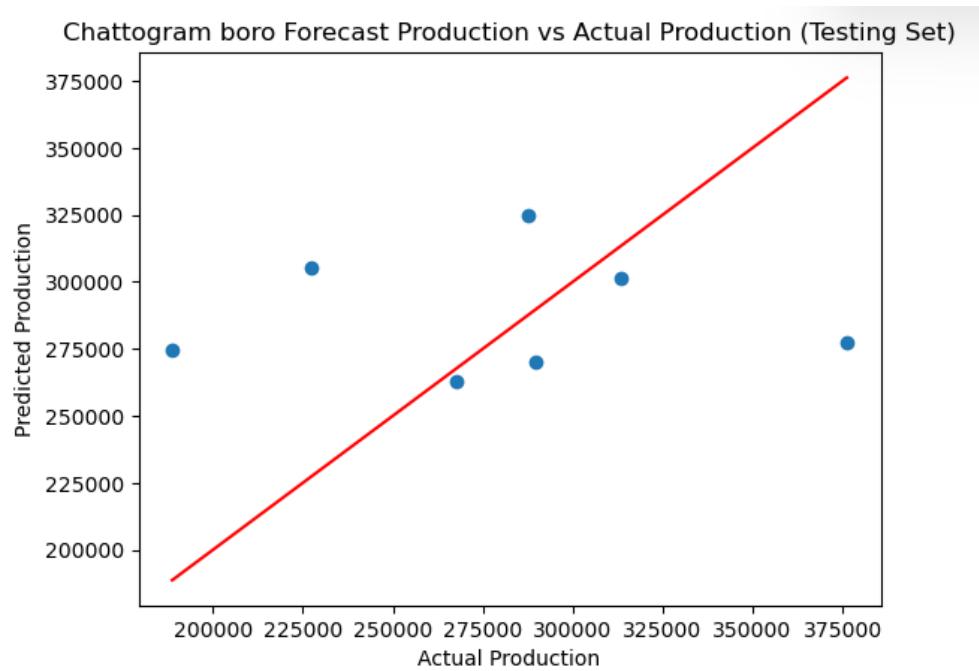


Figure-5.79: Figure of testing dataset.

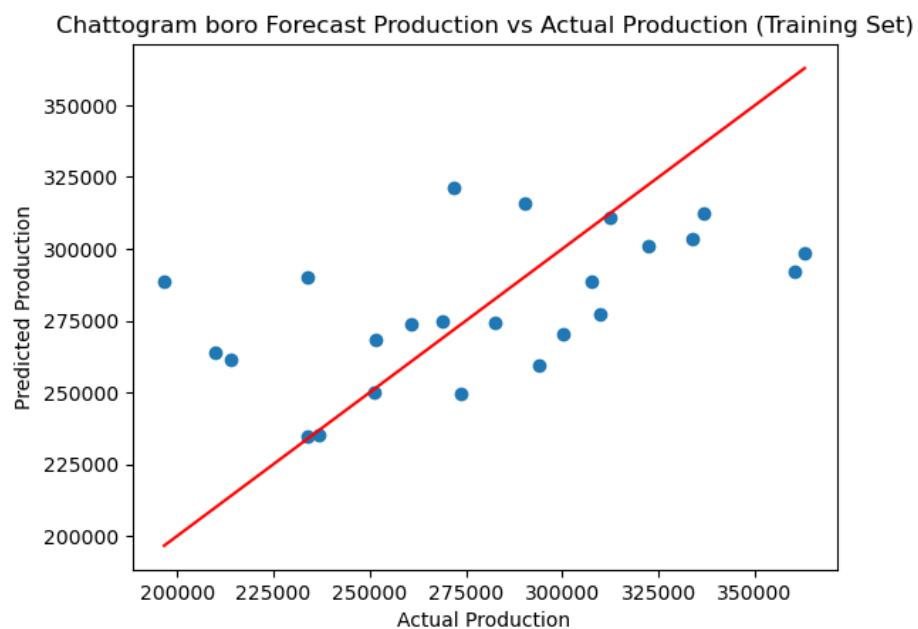


Figure-5.80: Figure of training dataset.

K-Nearest Neighbors Regression

The K-Nearest Neighbors Regression Model generates prediction figures that represent the predicted values for the target variable based on the input features.

- ❖ Rajshahi Region
- Wheat data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.

KNN Regression Rajshahi wheat Production: Actual vs Forecast Production (Training Set)

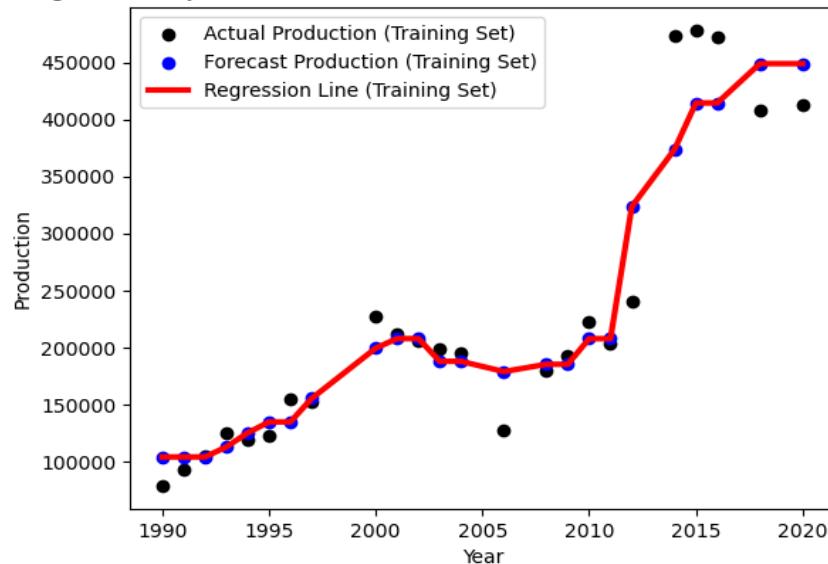


Figure-5.81: Figure of training dataset.

KNN Regression Rajshahi Wheat Production: Actual vs Forecast Production (Testing Set)

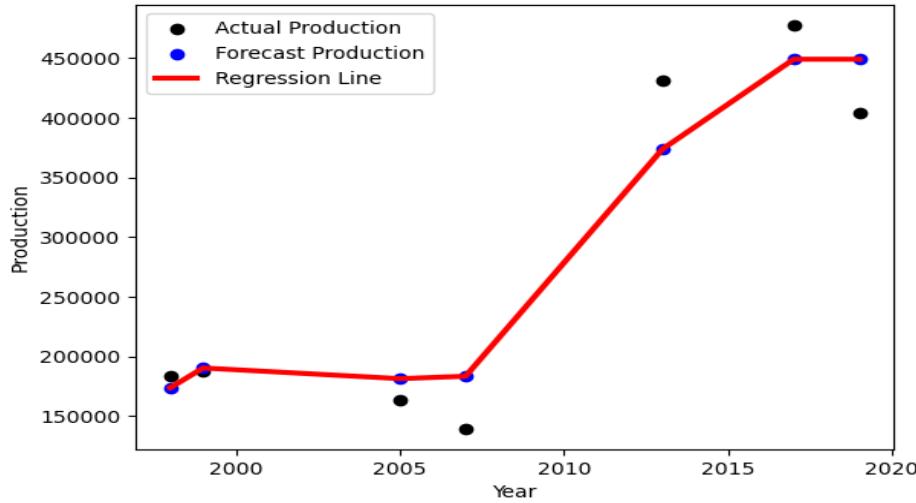


Figure-5.82: Figure of testing dataset.

- Potato data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.

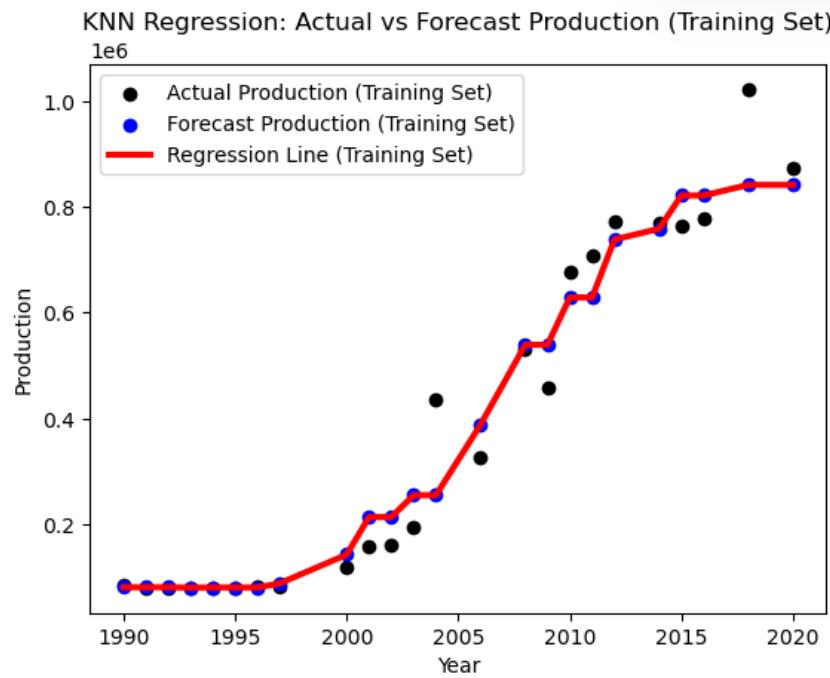


Figure-5.82: Figure of training dataset.

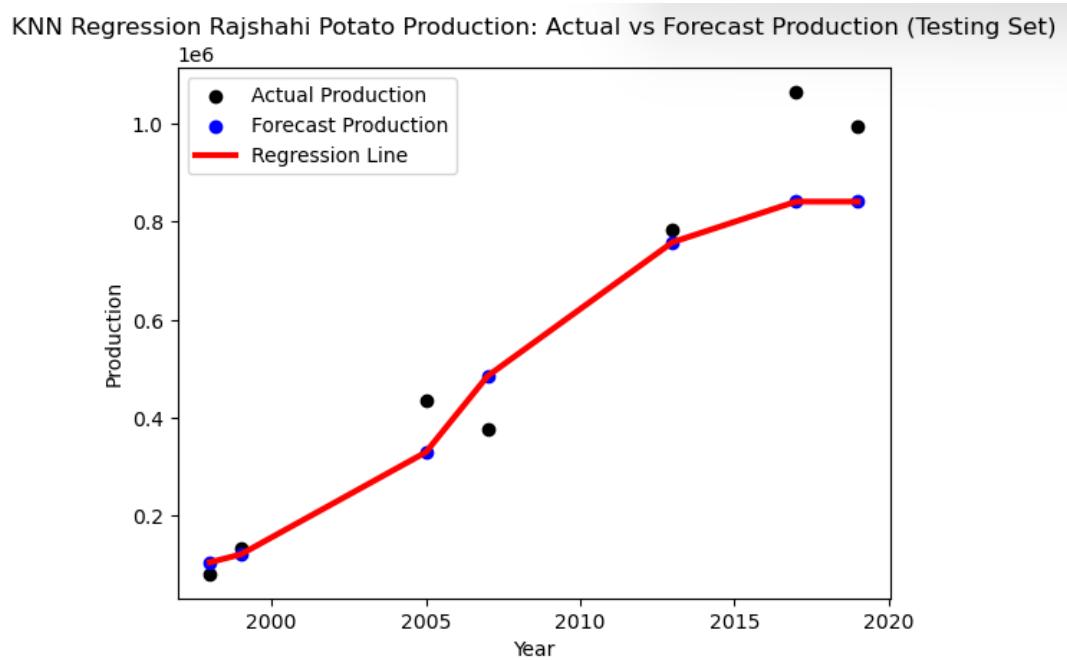


Figure-5.83: Figure of testing dataset.

- Aush data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.

KNN Regression Rajshahi Aush Production: Actual vs Forecast Production (Training Set)

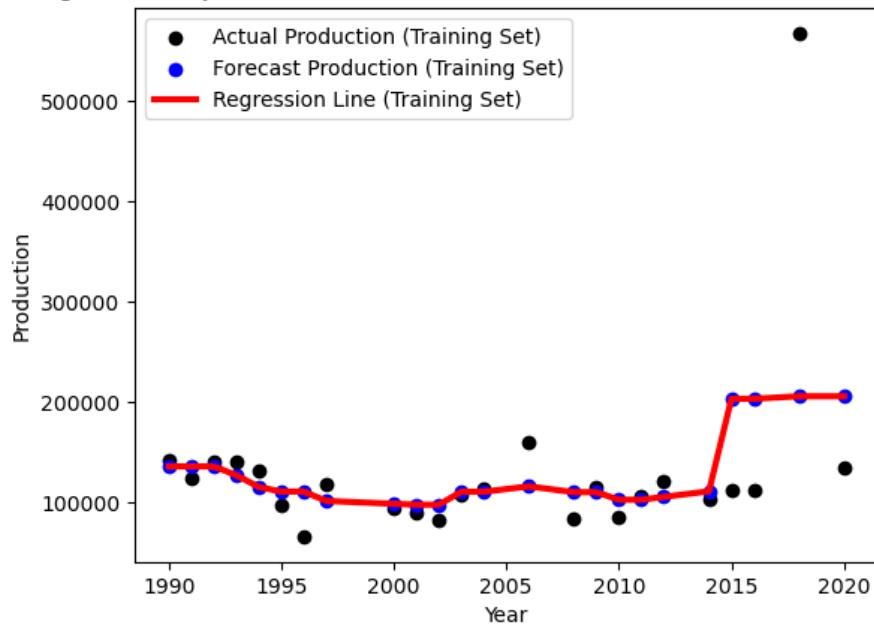


Figure-5.85: Figure of training dataset.

KNN Regression Rajshahi Aush Production : Actual vs Forecast Production (Testing Set)

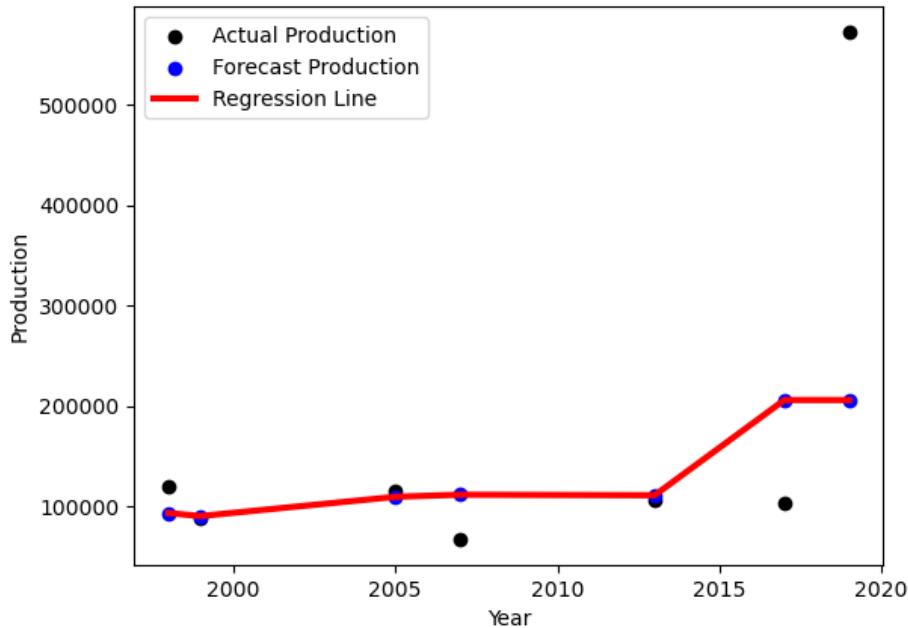


Figure-5.86: Figure of testing dataset.

- Aman data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.

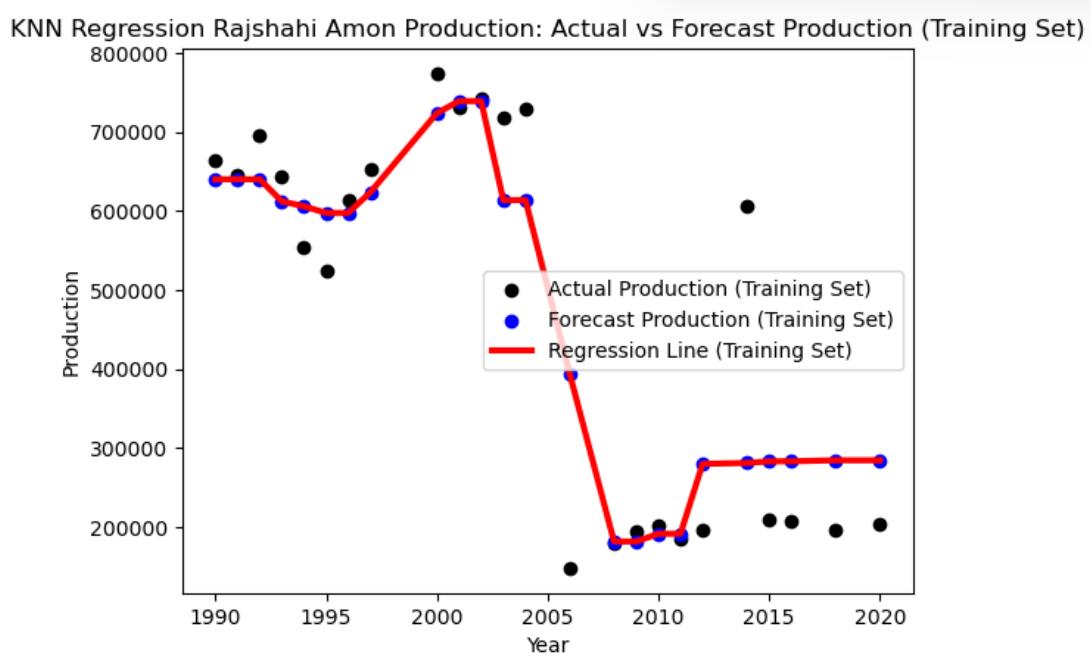


Figure-5.87: Figure of training dataset.

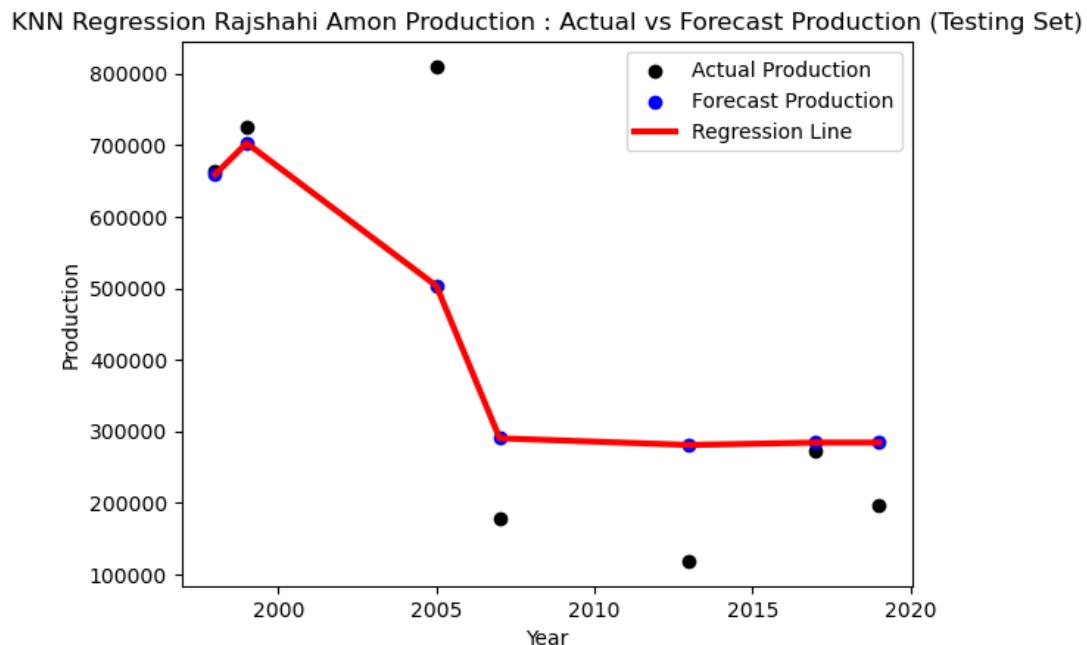


Figure-5.88: Figure of testing dataset.

- data figures compare actual and predicted production in Rajshahi, including forecasts for both training and testing sets.
-

KNN Regression Rajshahi Boro Production: Actual vs Forecast Production (Training Set)

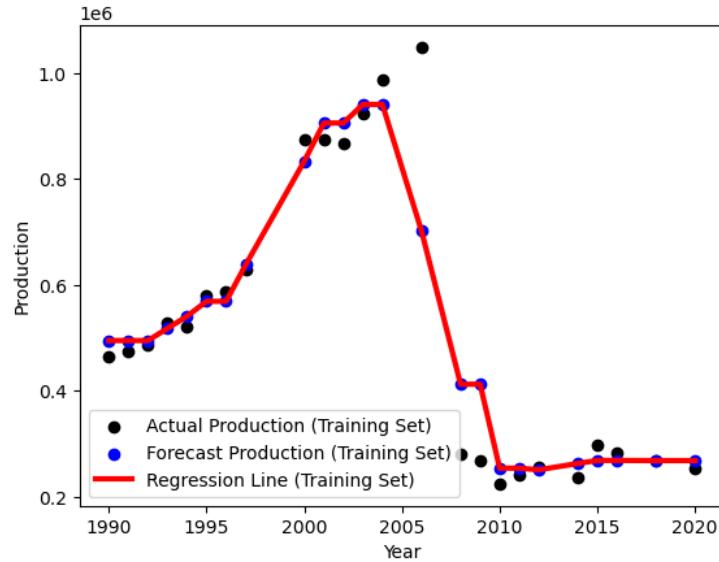


Figure-5.89: Figure of training dataset.

KNN Regression Rajshahi Boro Production: Actual vs Forecast Production (Testing Set)

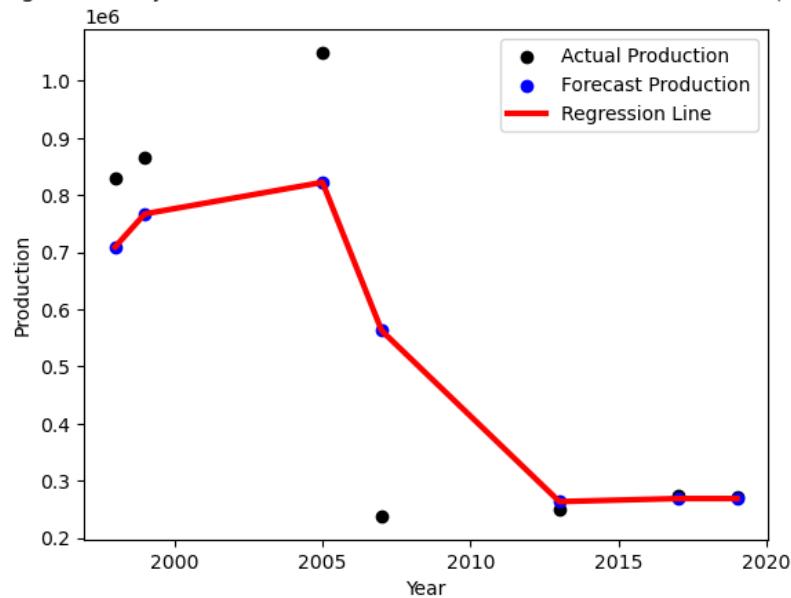


Figure-5.90: Figure of testing dataset.

❖ Dhaka Region

- Wheat data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

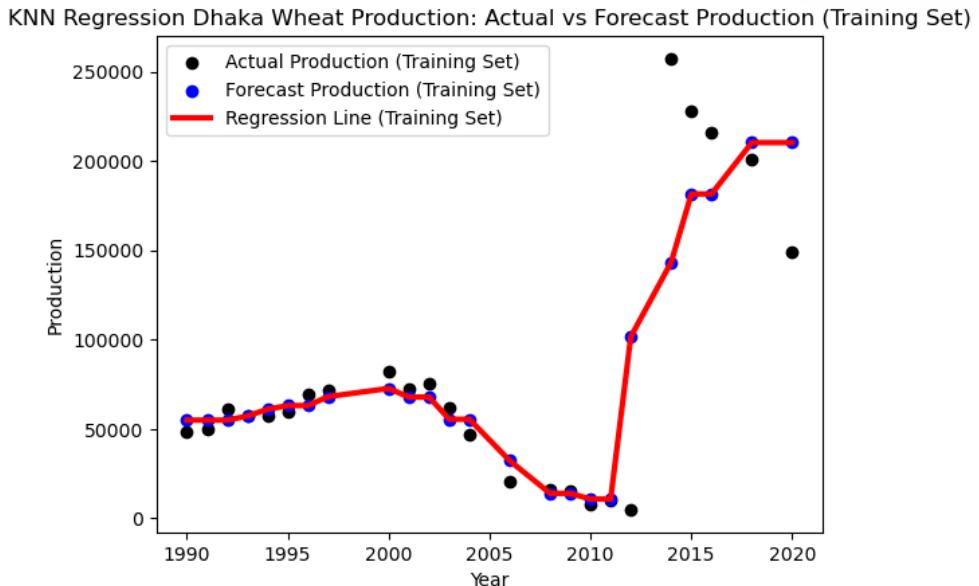


Figure-5.91: Figure of training dataset.

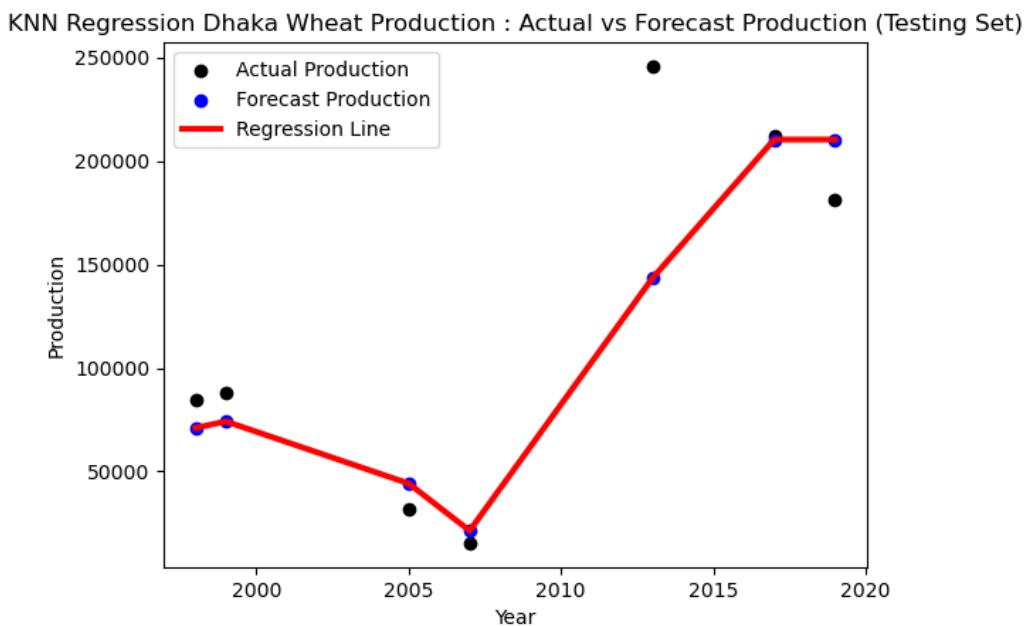


Figure-5.92: Figure of testing dataset.

- Potato data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

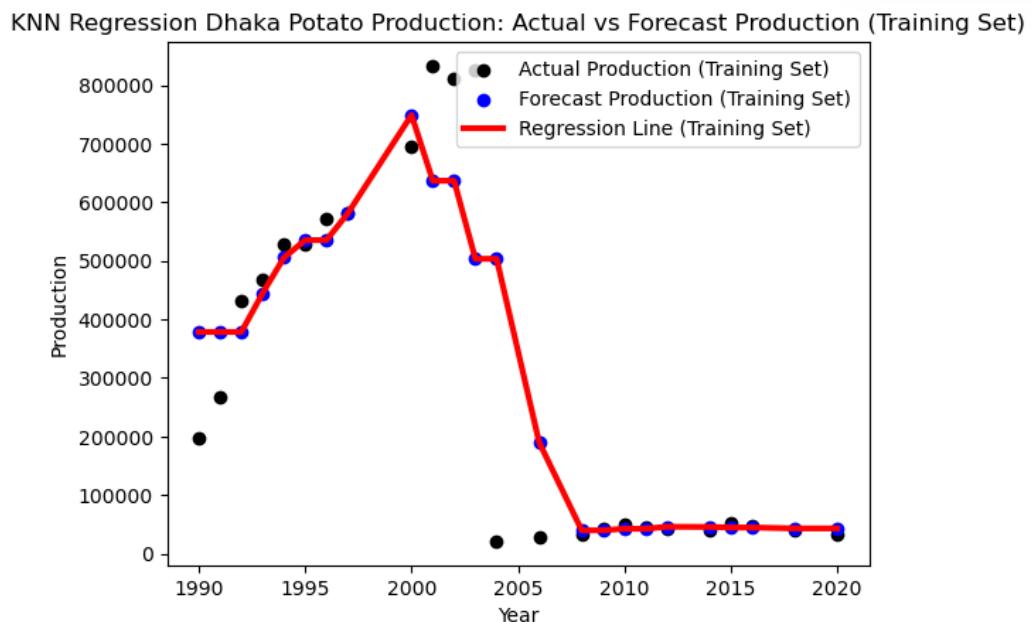


Figure-5.93: Figure of training dataset.

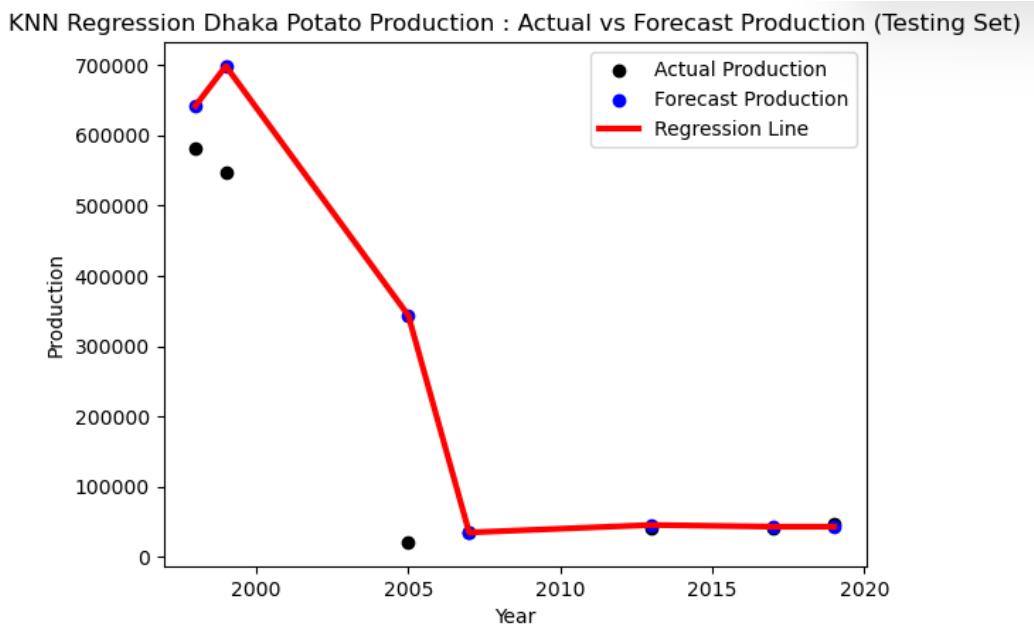


Figure-5.94: Figure of training dataset.

- Aush data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

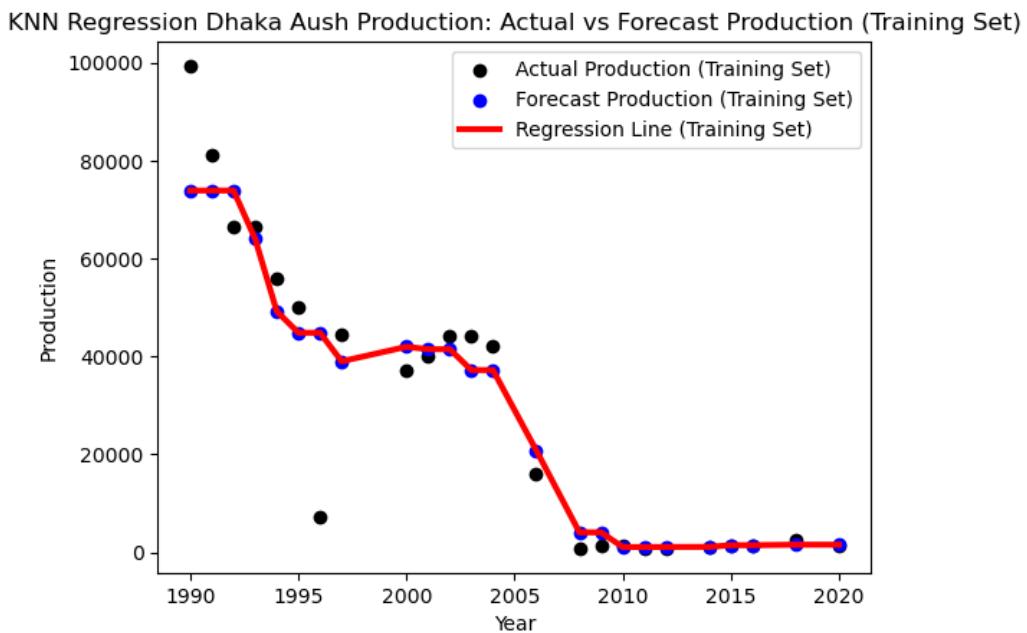


Figure-5.95: Figure of training dataset.

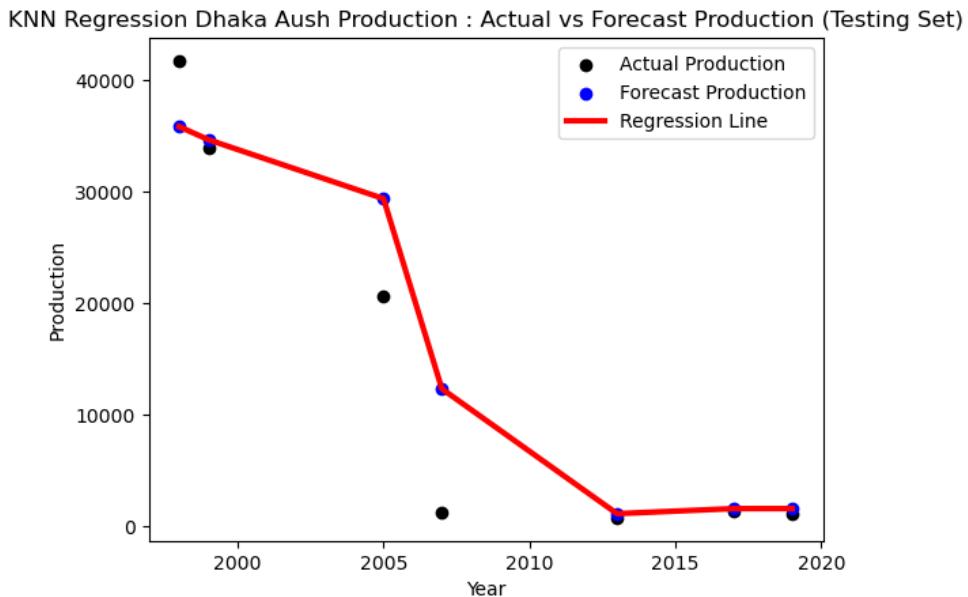


Figure-5.96: Figure of training dataset.

- Amon data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

KNN Regression Dhaka Amon Production: Actual vs Forecast Production (Training Set)

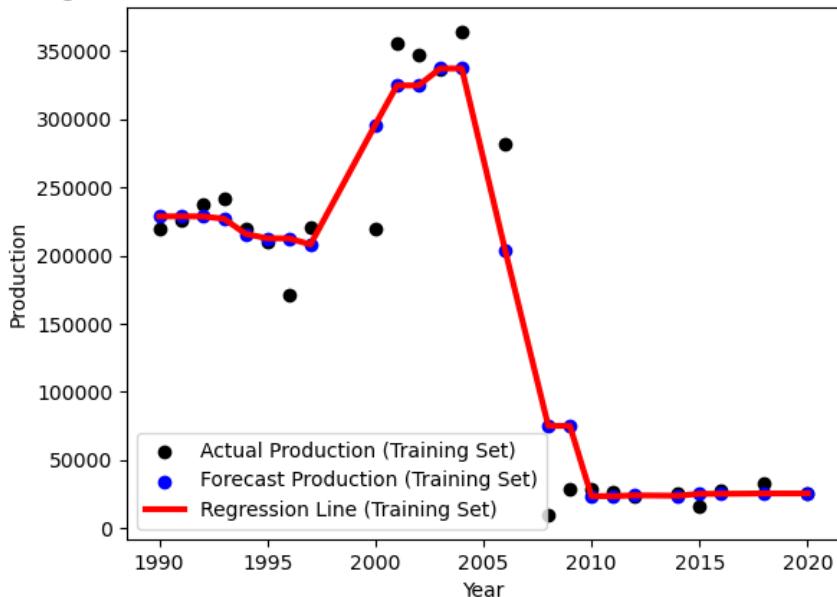


Figure-5.97: Figure of training dataset.

KNN Regression Dhaka Amon Production : Actual vs Forecast Production (Testing Set)

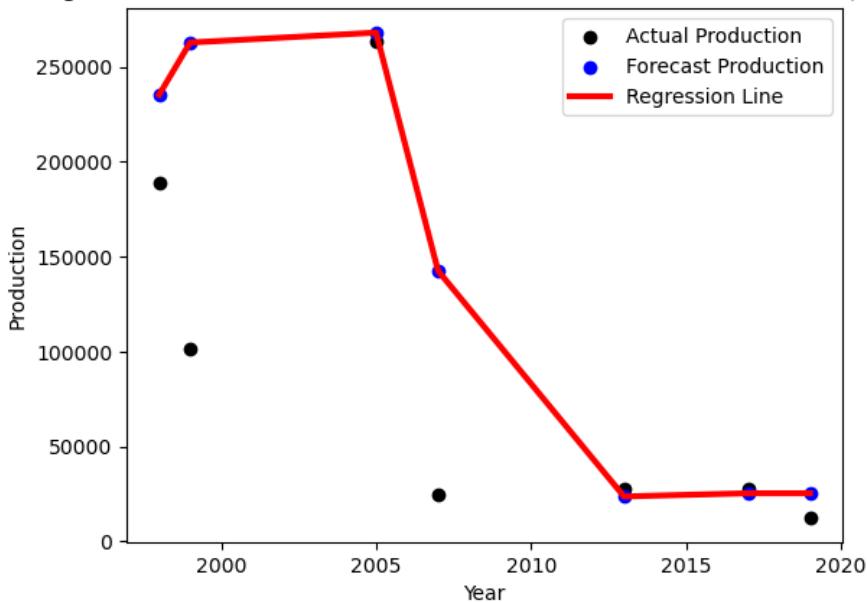


Figure-5.98: Figure of training dataset.

- Boro data figures compare actual and predicted production in Dhaka, including forecasts for both training and testing sets.

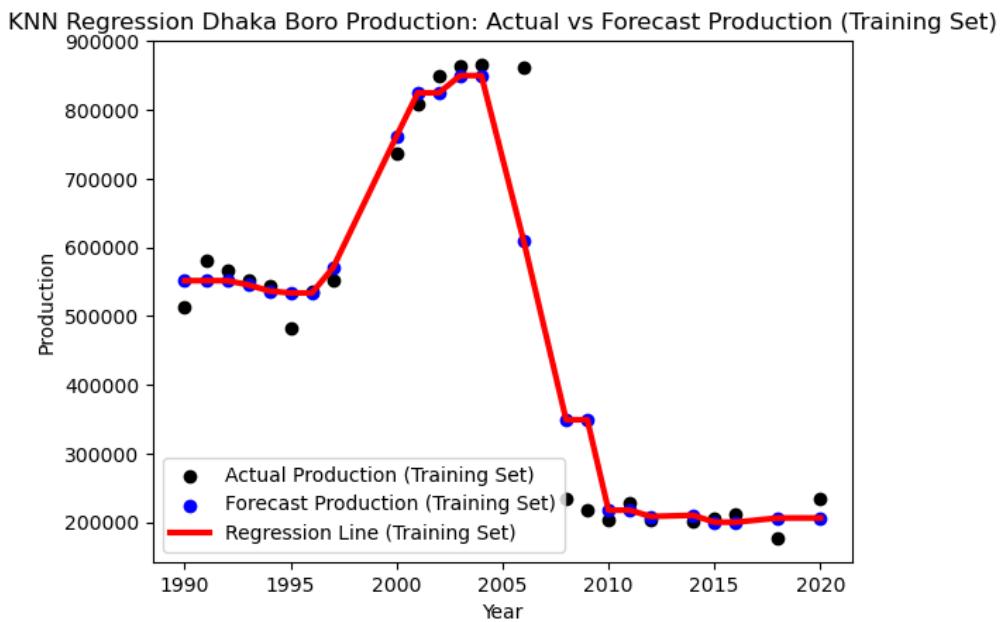


Figure-5.99: Figure of training dataset.

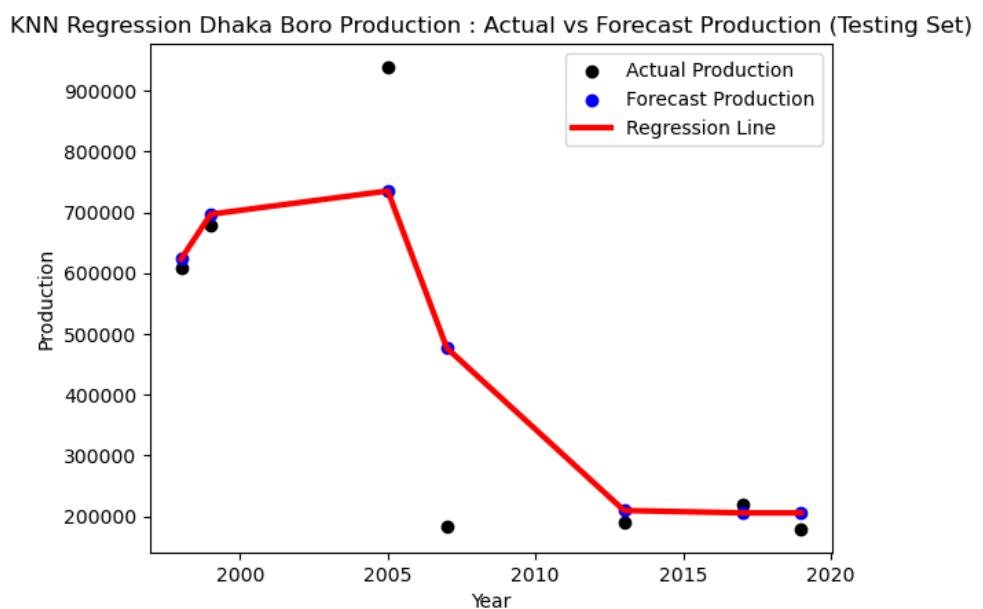


Figure-5.100: Figure of testing dataset.

❖ Khulna Region

- Wheat data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

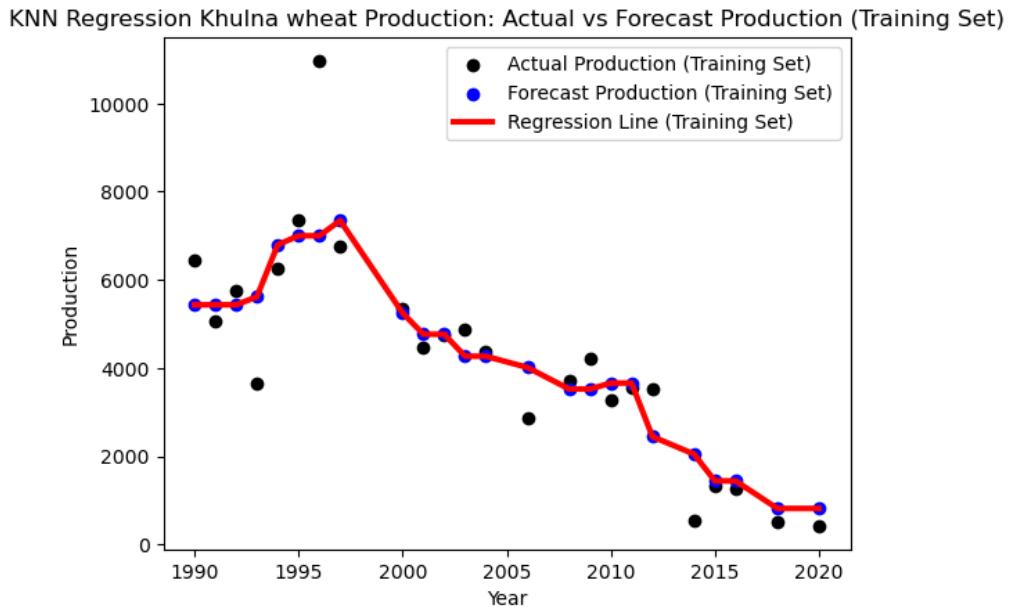


Figure-5.101: Figure of training dataset.

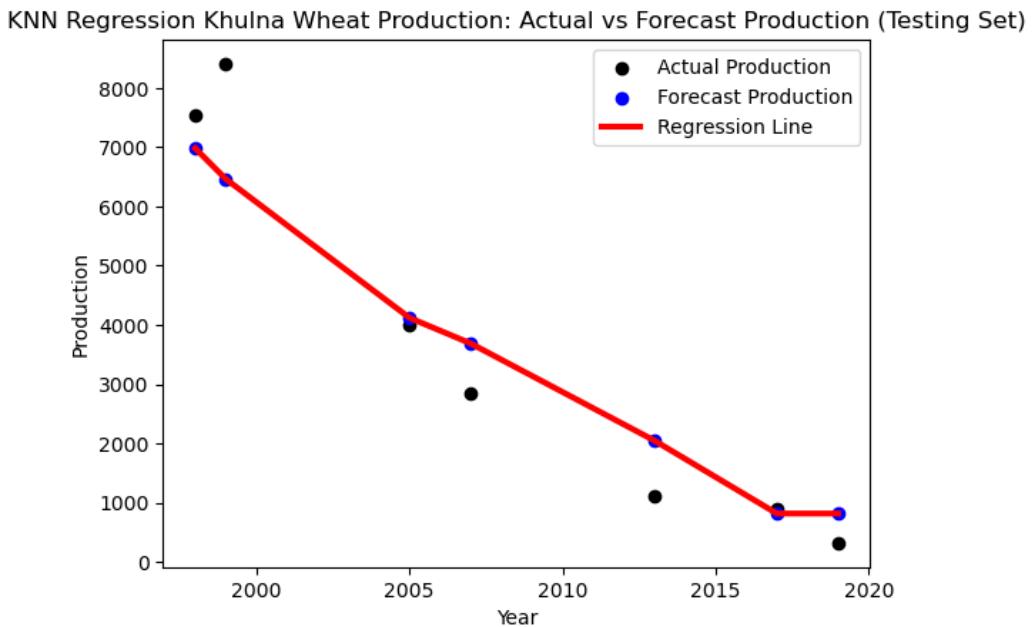


Figure-5.102: Figure of testing dataset.

- Potato data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

KNN Regression Khulna Potato Production: Actual vs Forecast Production (Training Set)

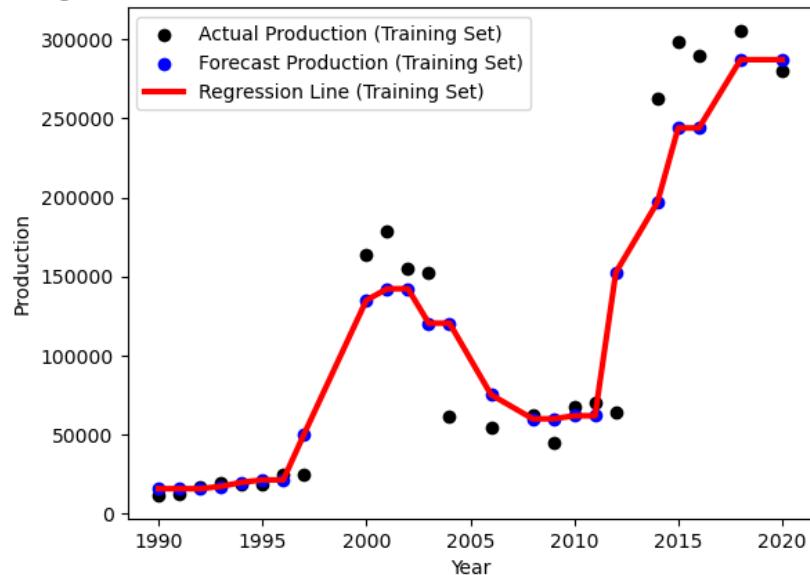


Figure-5.103: Figure of training dataset.

KNN Regression Khulna Potato Production: Actual vs Forecast Production (Testing Set)

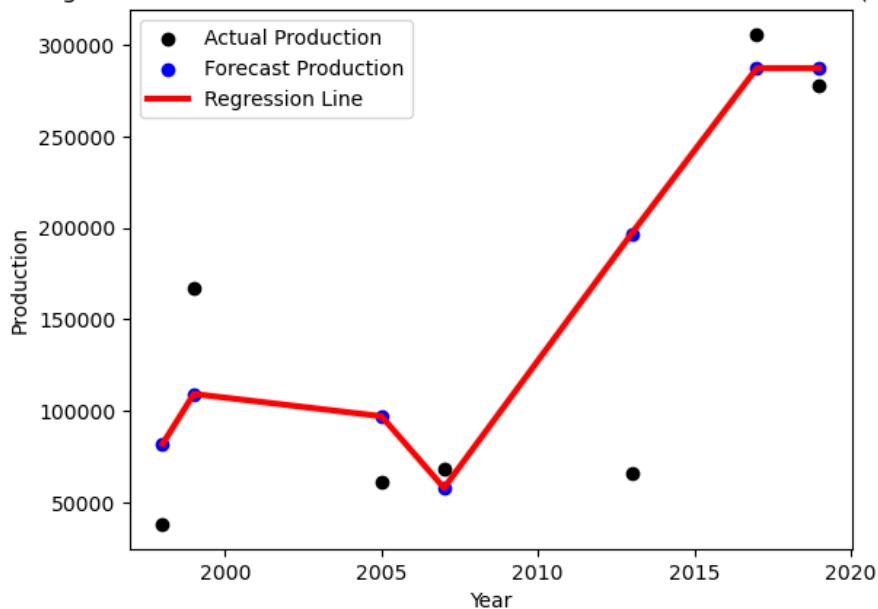


Figure-5.104: Figure of testing dataset.

- Aush data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

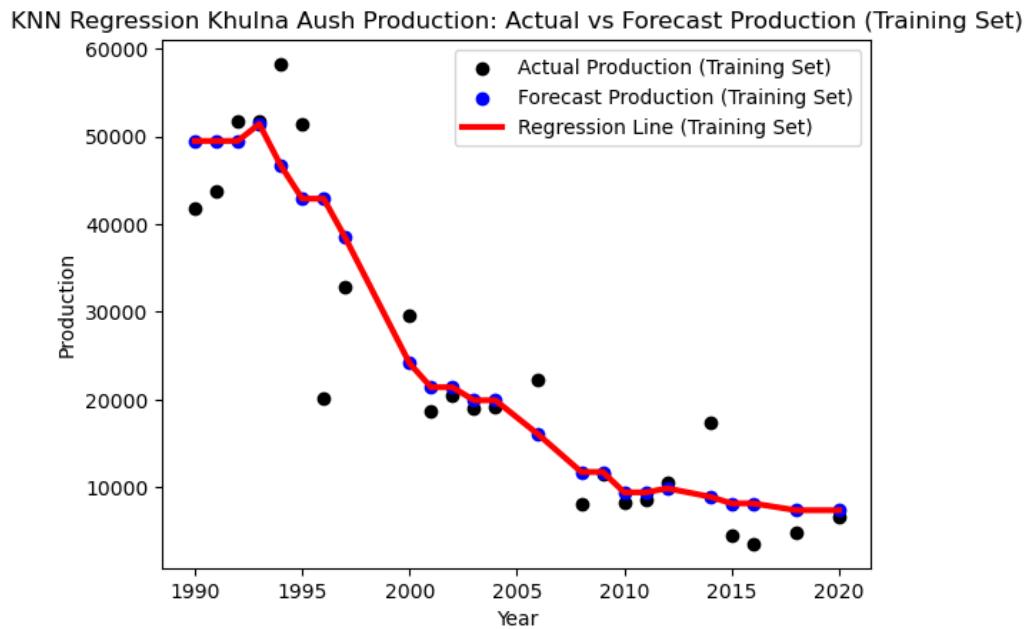


Figure-5.105: Figure of training dataset.

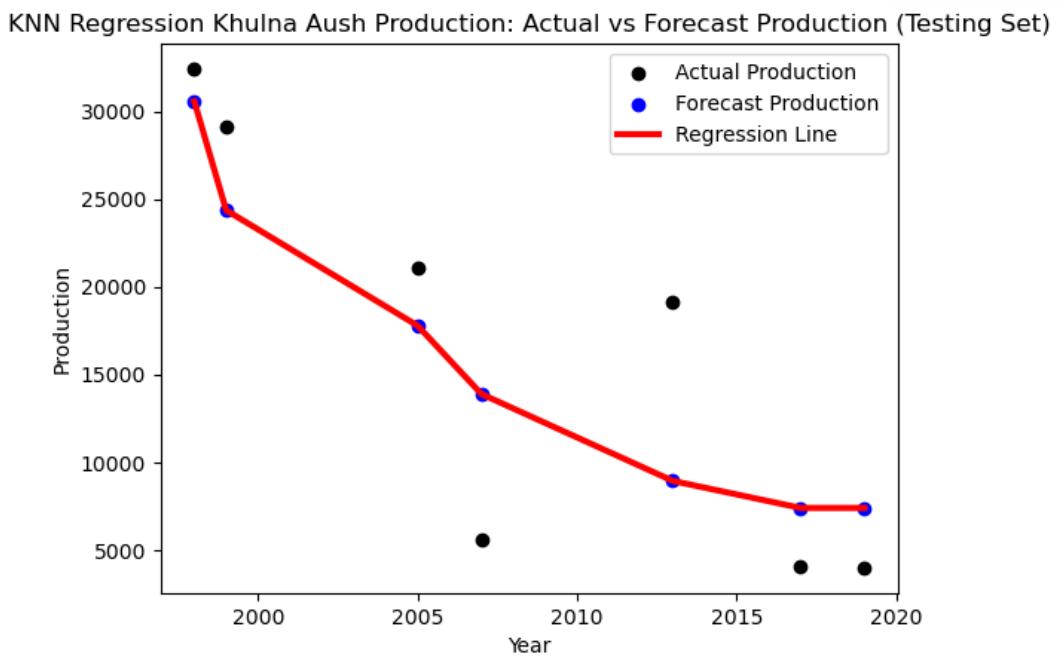


Figure-5.106: Figure of testing dataset.

- Amon data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

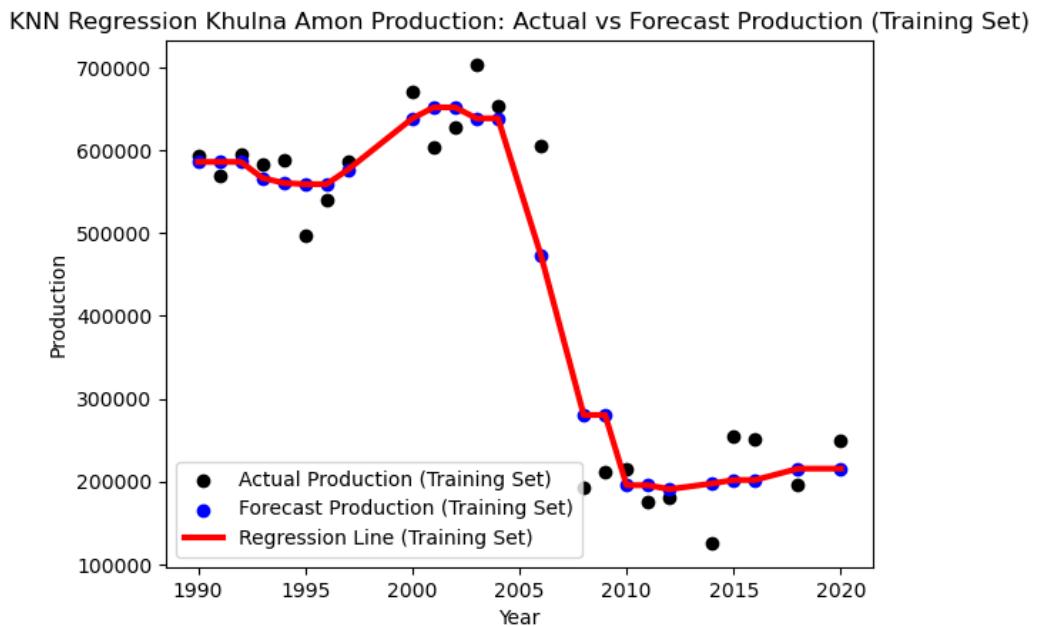


Figure-5.107: Figure of training dataset.

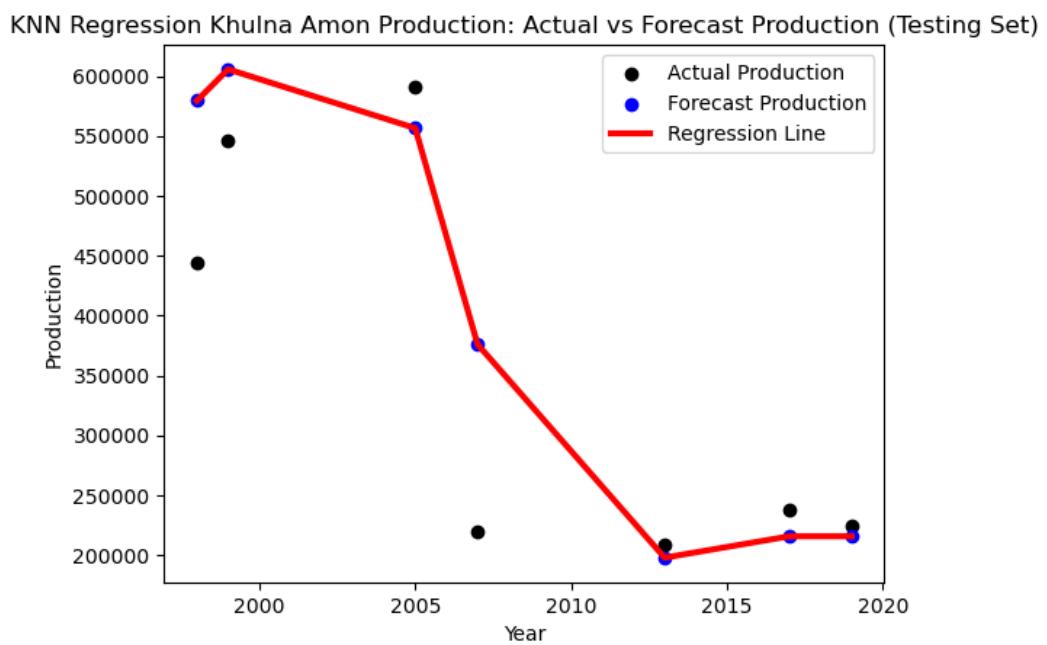


Figure-5.108: Figure of testing dataset.

- Boro data figures compare actual and predicted production in Khulna, including forecasts for both training and testing sets.

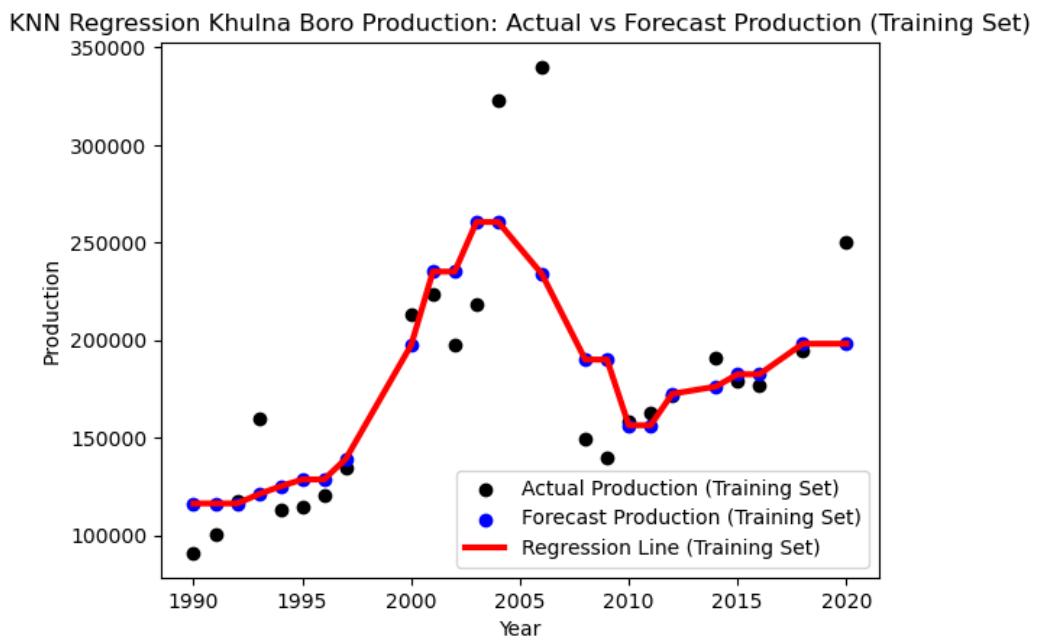


Figure-5.109: Figure of training dataset.

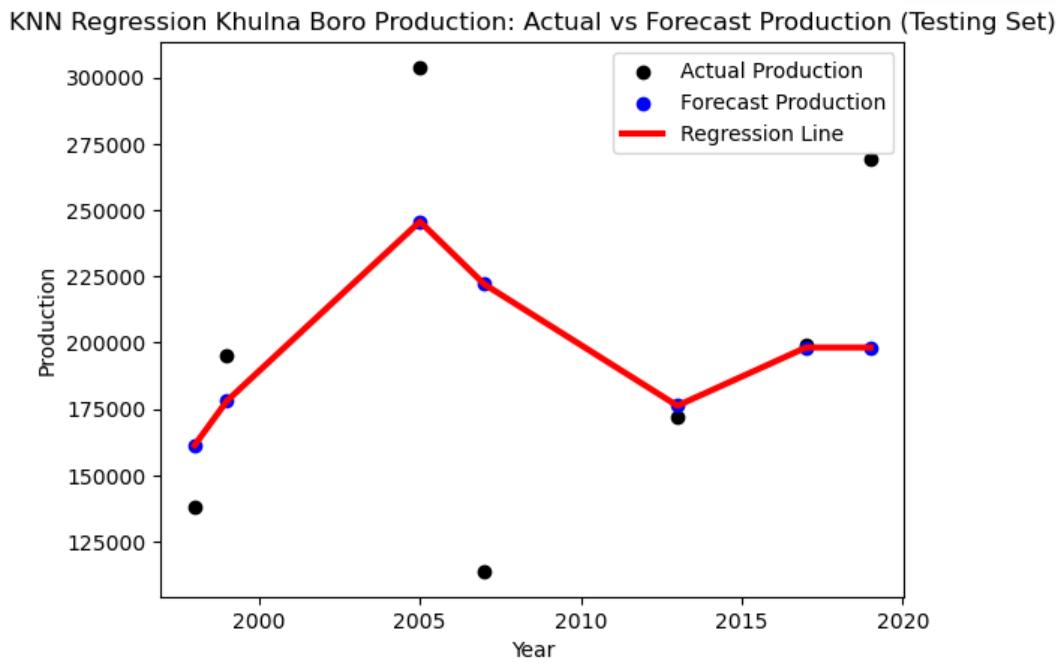


Figure-5.110: Figure of testing dataset.

❖ **Chattogram District**

- Wheat data figures compare actual and predicted production in Chattogram, including forecasts for both training and testing sets.

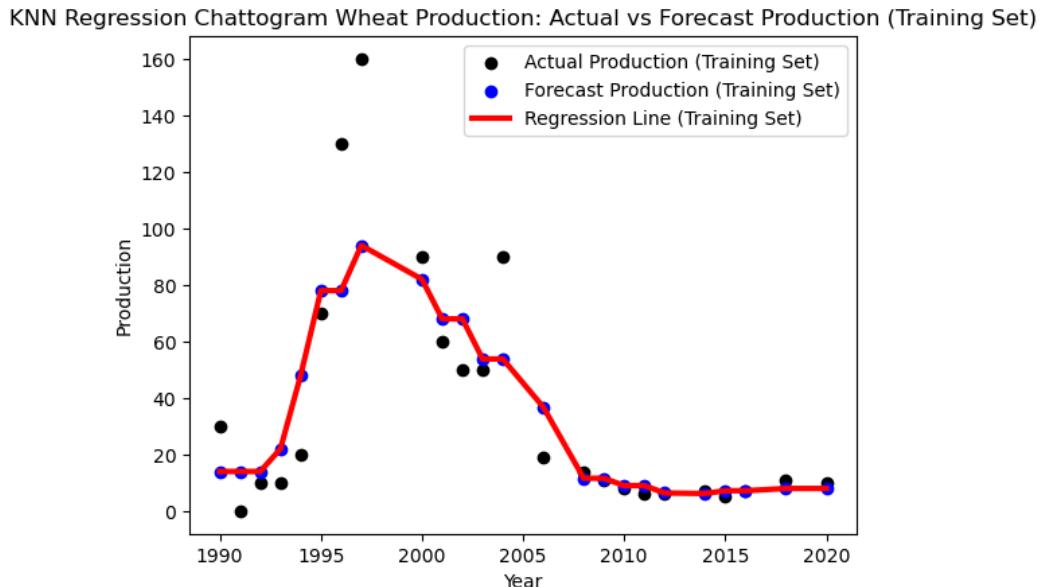


Figure-5.111: Figure of training dataset.

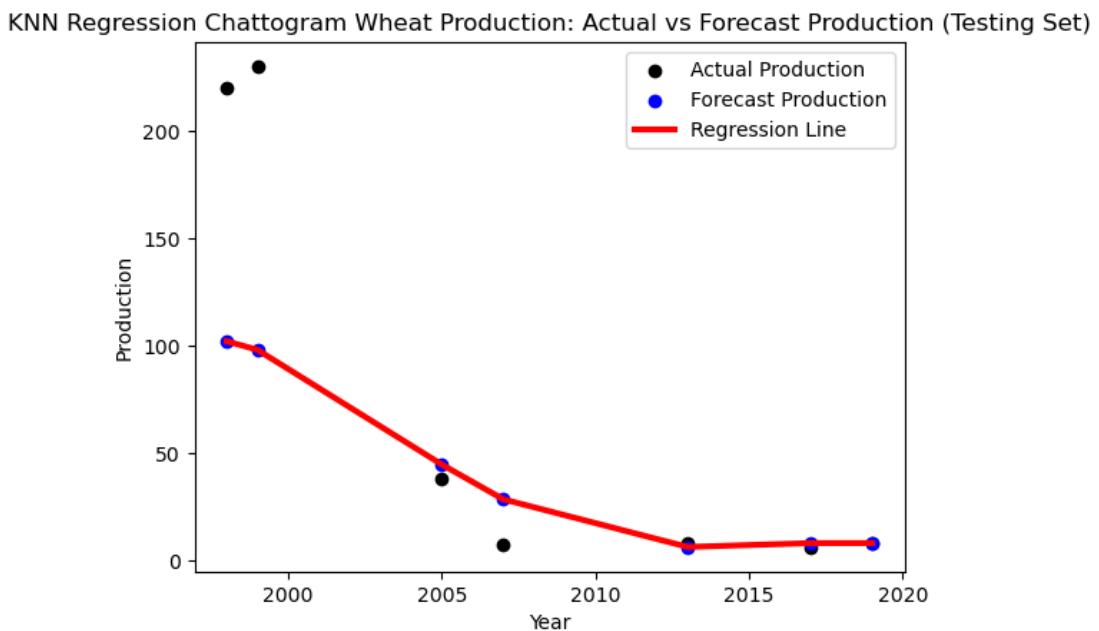


Figure-5.112: Figure of testing dataset.

- Potato data figures compare actual and predicted production in Chattogram, including forecasts for both training and testing sets.

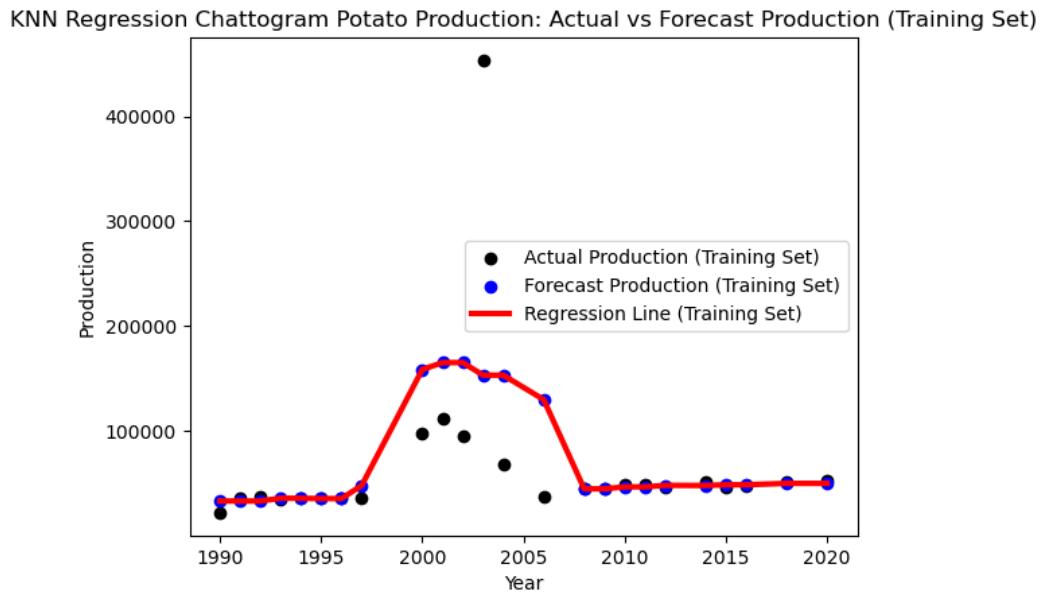


Figure-5.113: Figure of training dataset.

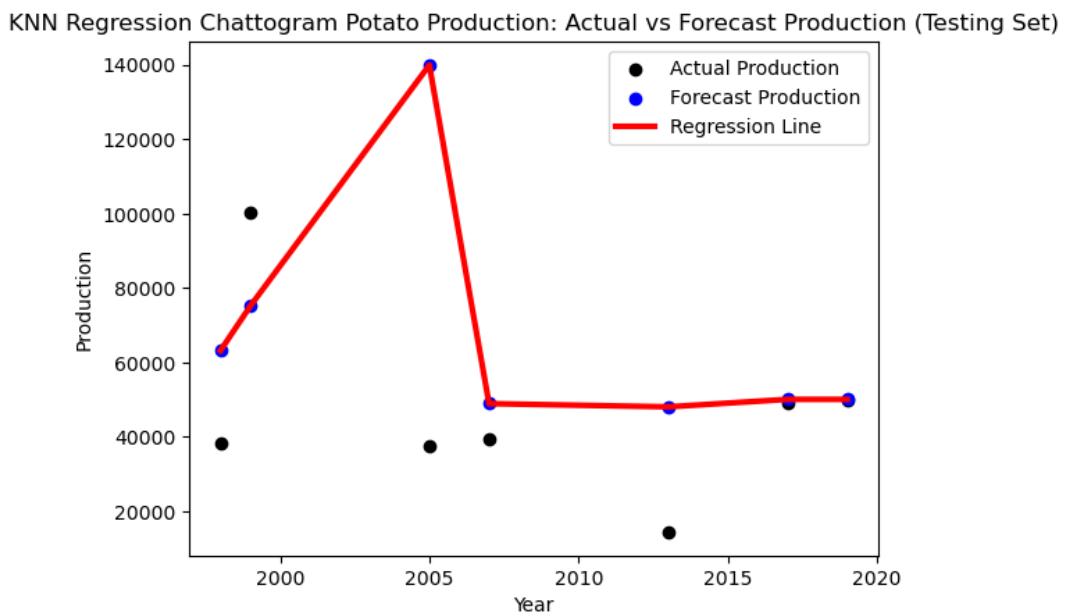


Figure-5.114: Figure of testing dataset.

- Aush data figures compare actual and predicted production in Chattogram, including forecasts for both training and testing sets.

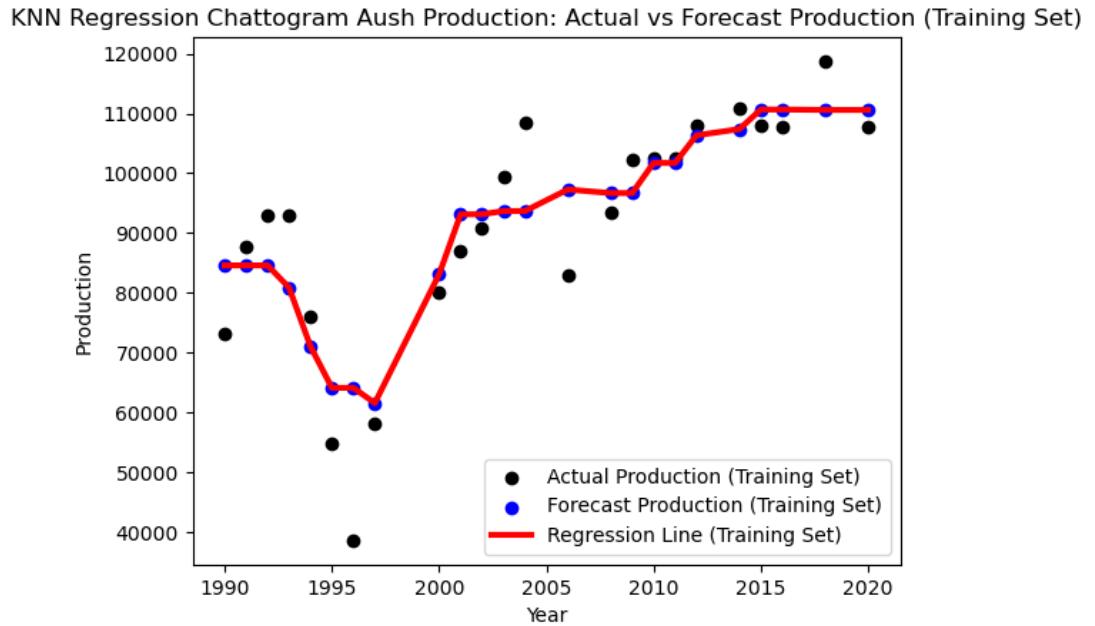


Figure-5.115: Figure of training dataset.

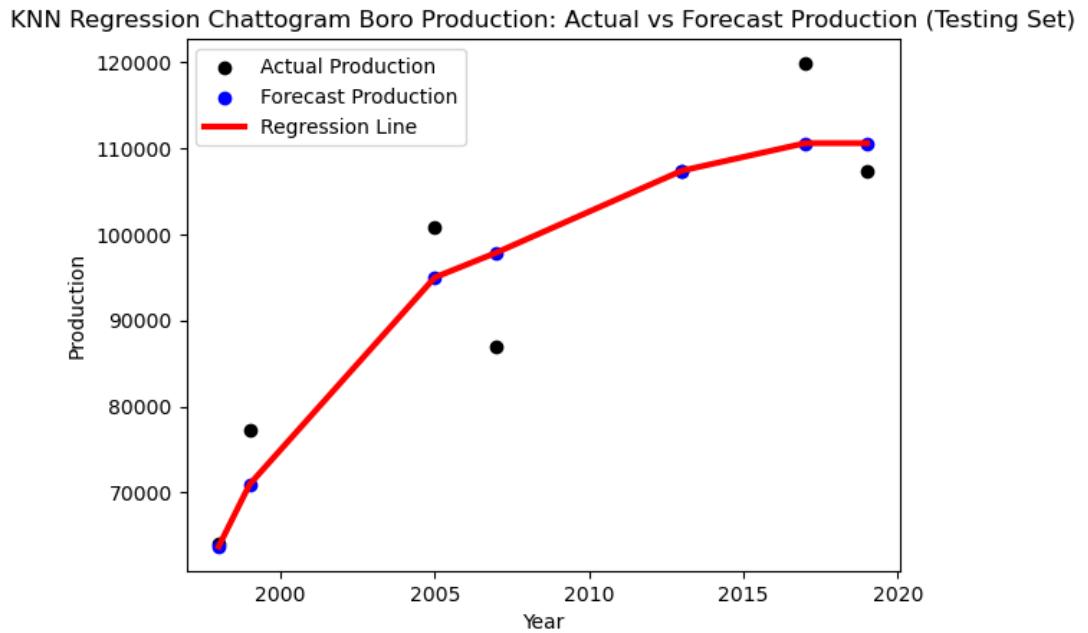


Figure-5.116: Figure of testing dataset.

- Amon data figures compare actual and predicted production in Chattogram, including forecasts for both training and testing sets.

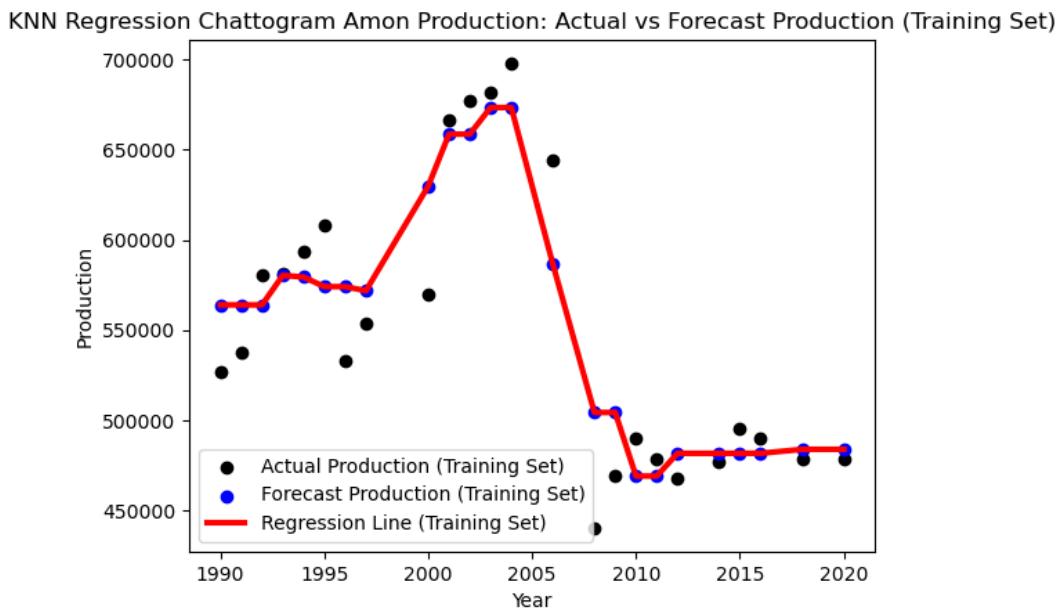


Figure-5.117: Figure of training dataset.

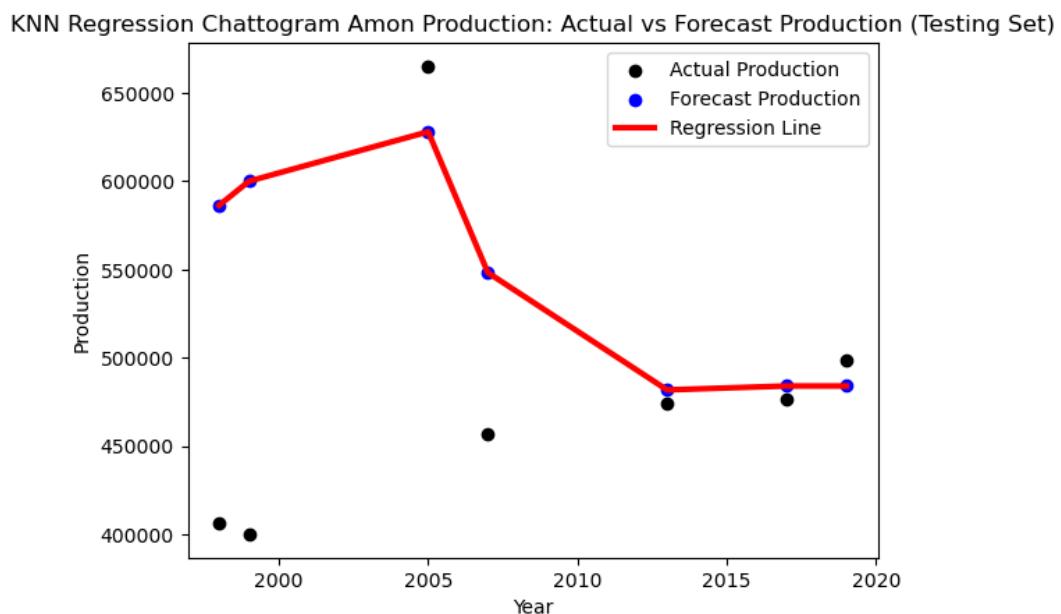


Figure-5.118: Figure of testing dataset.

- Boro data figures compare actual and predicted production in Chattogram, including forecasts for both training and testing sets.

KNN Regression Chattogram Boro Production: Actual vs Forecast Production (Training Set)

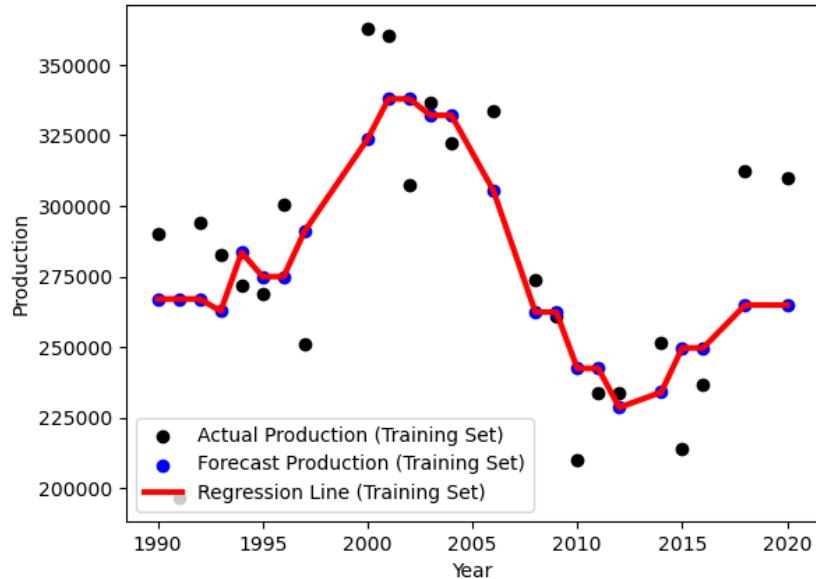


Figure-5.119: Figure of training dataset.

KNN Regression Chattogram Boro Production: Actual vs Forecast Production (Testing Set)

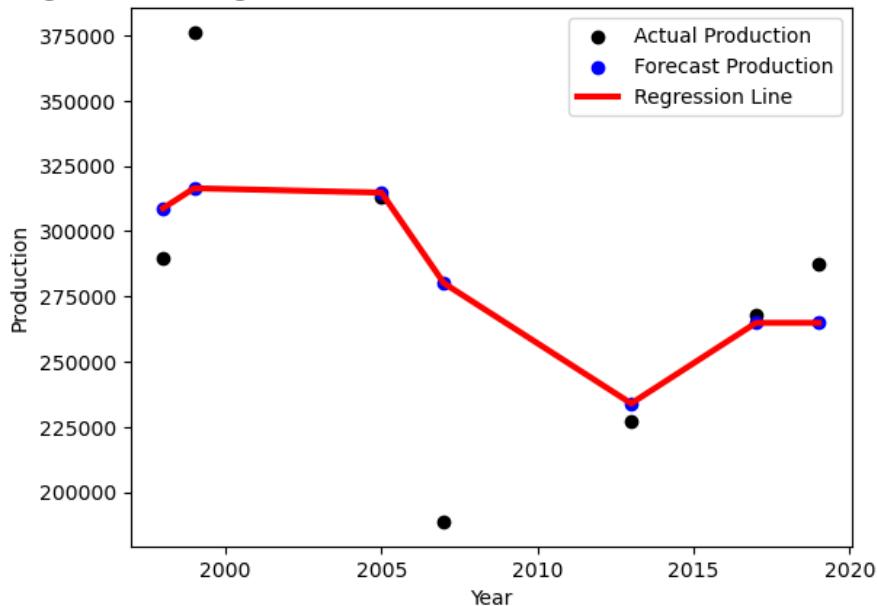


Figure-5.120: Figure of testing dataset.

ARIMA Model

- The data from the Rajshahi region

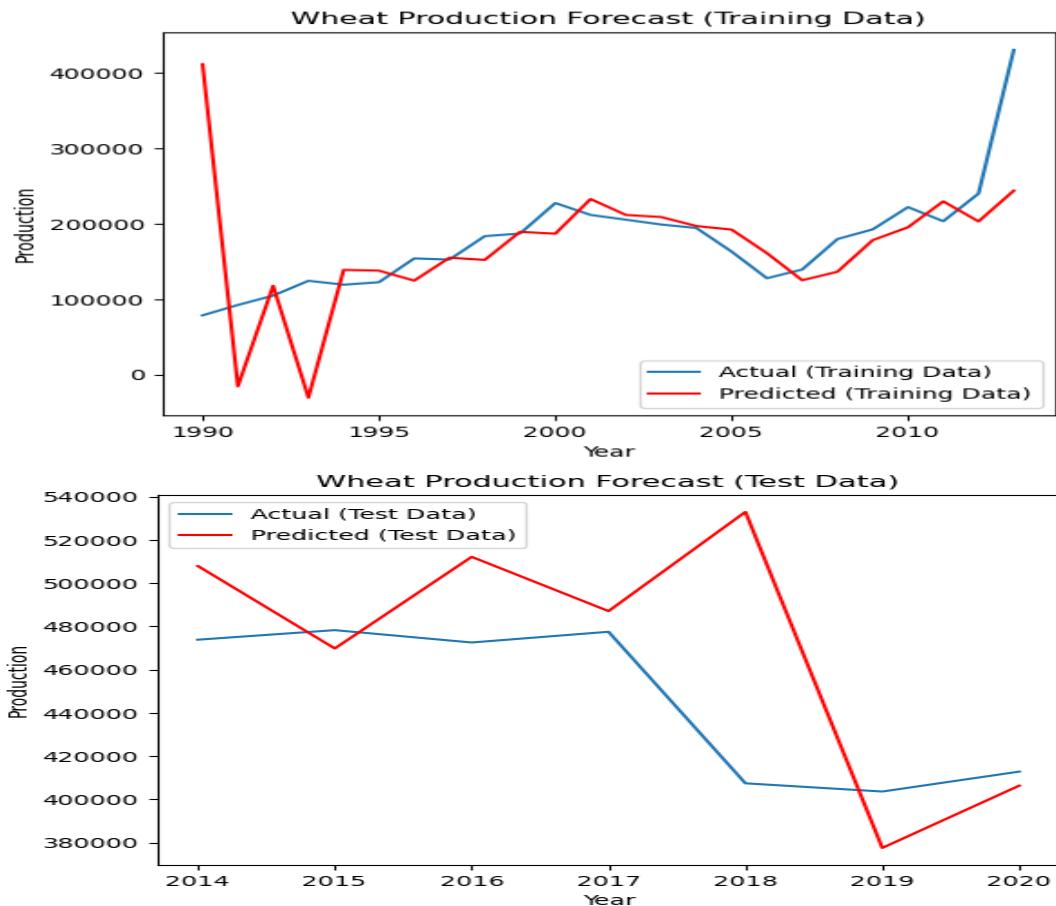


Figure-5.121: Figure of training and testing dataset.

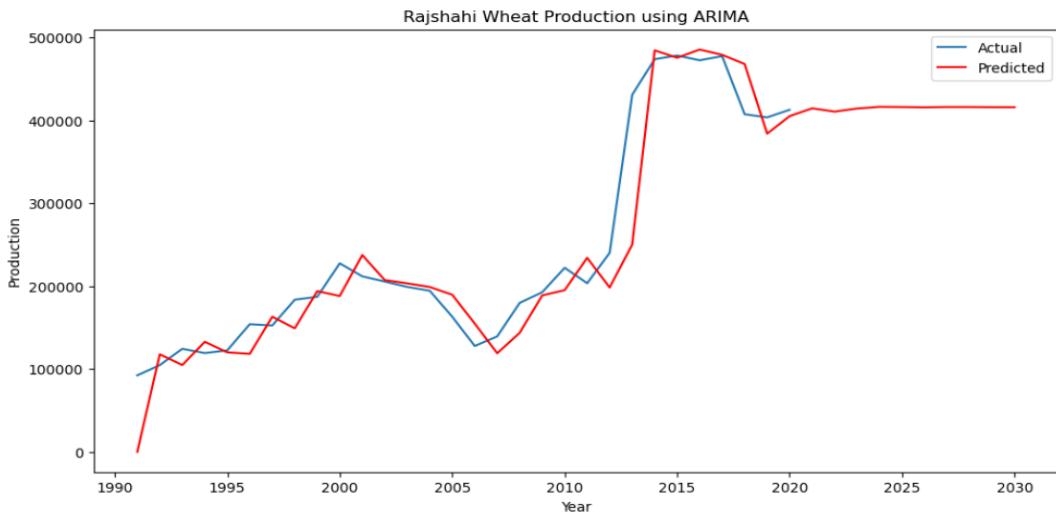


Figure-5.122: The ARIMA(1,1,1) model's actual and predicted wheat production figures are visually represented in a plot.

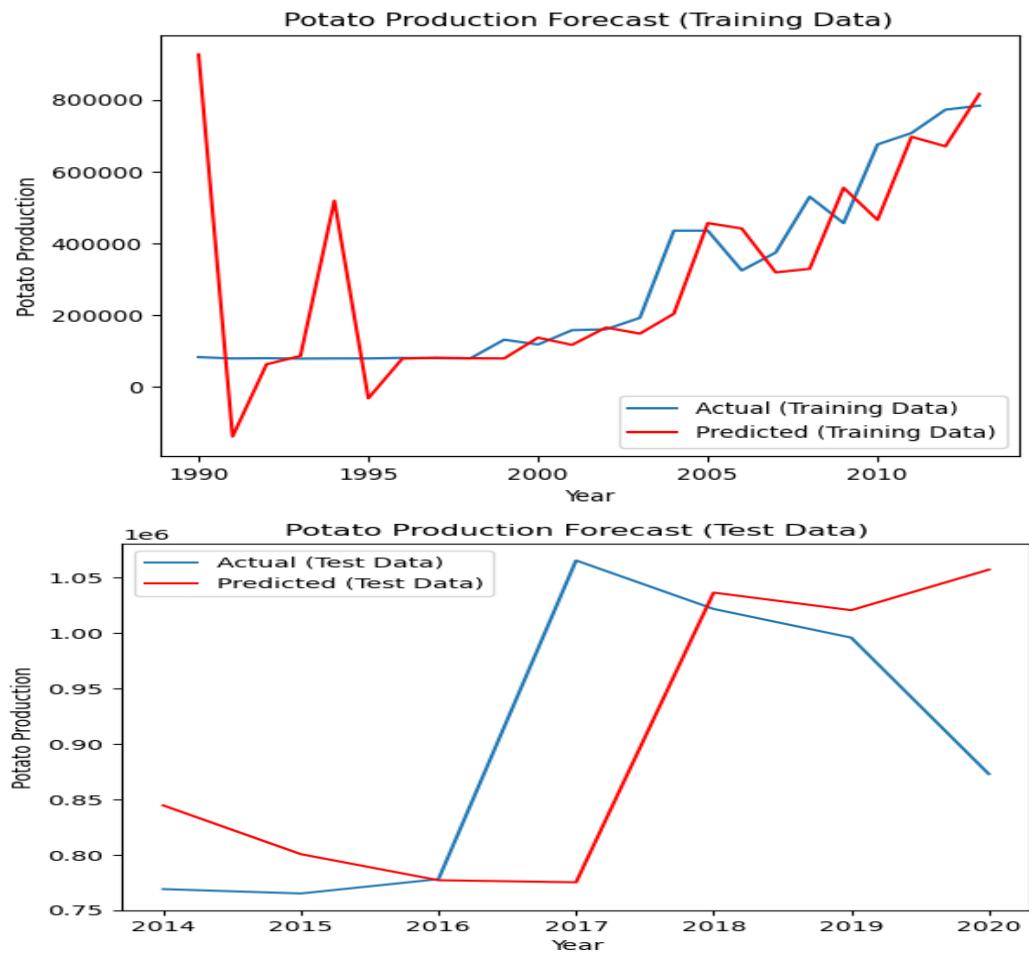


Figure-5.123: Figure of training and testing dataset.

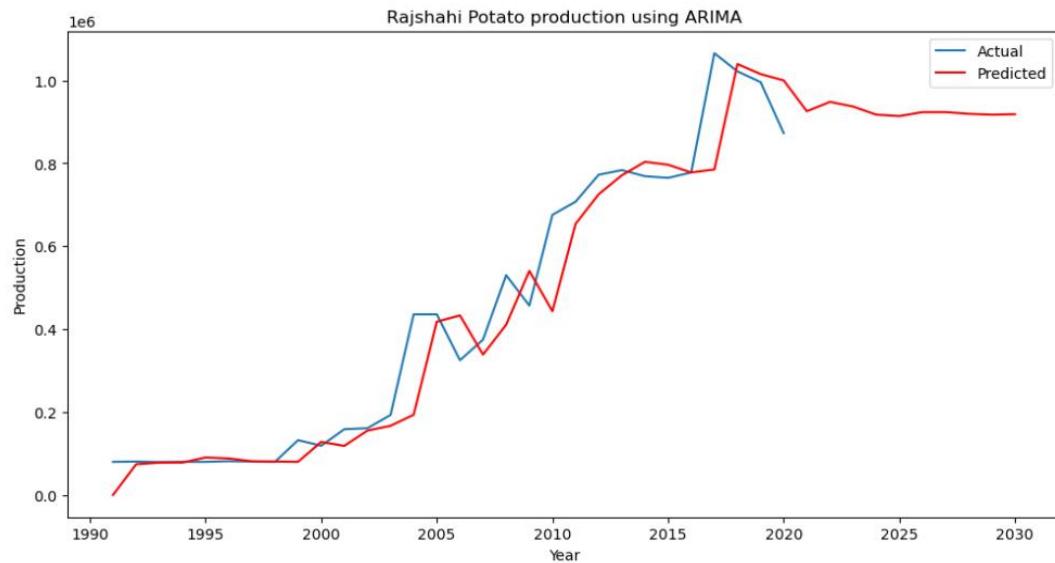


Figure-5.124: The ARIMA(5,1,1) model's actual and predicted Potato production figures are visually represented in a plot.

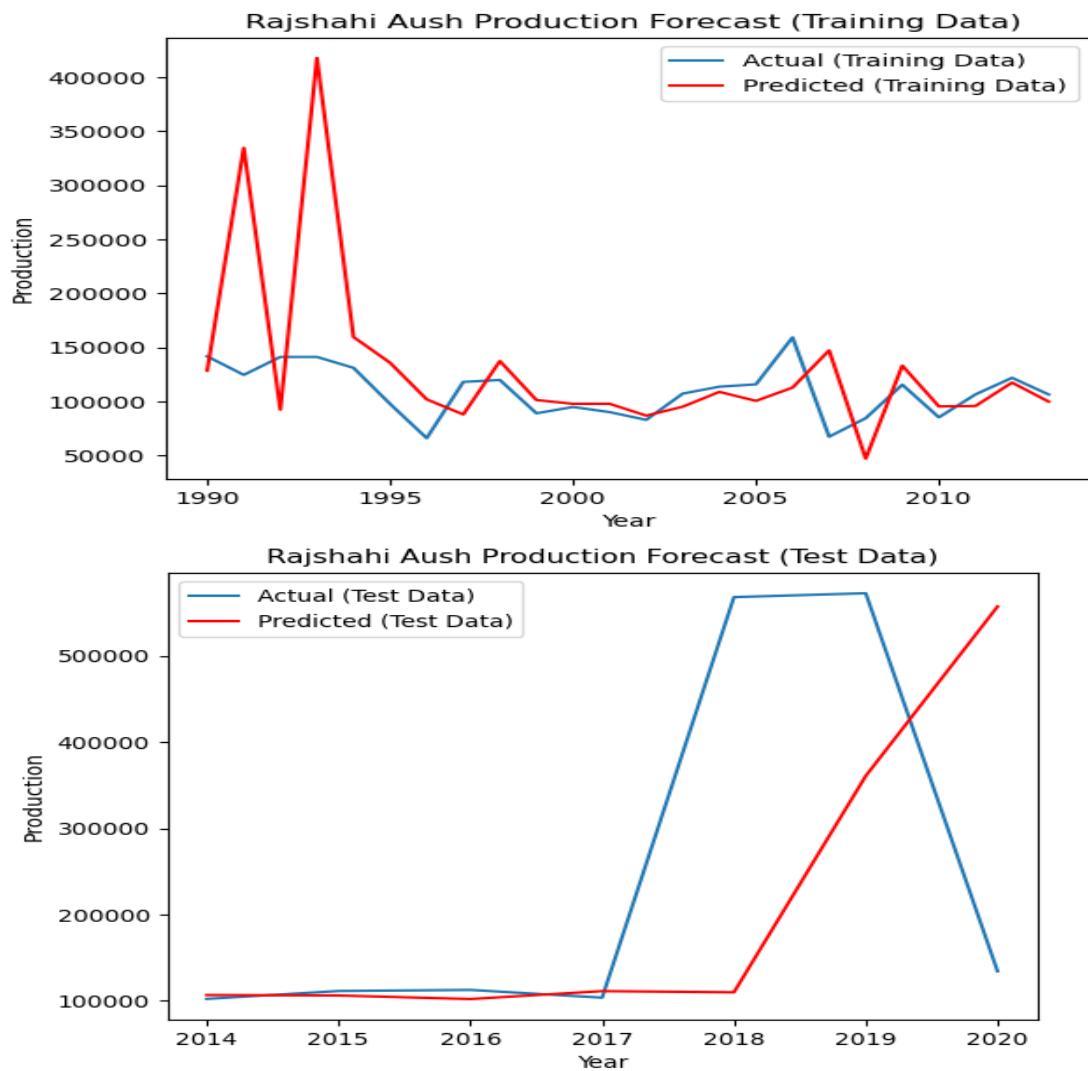


Figure-5.125: Figure of training and testing dataset.

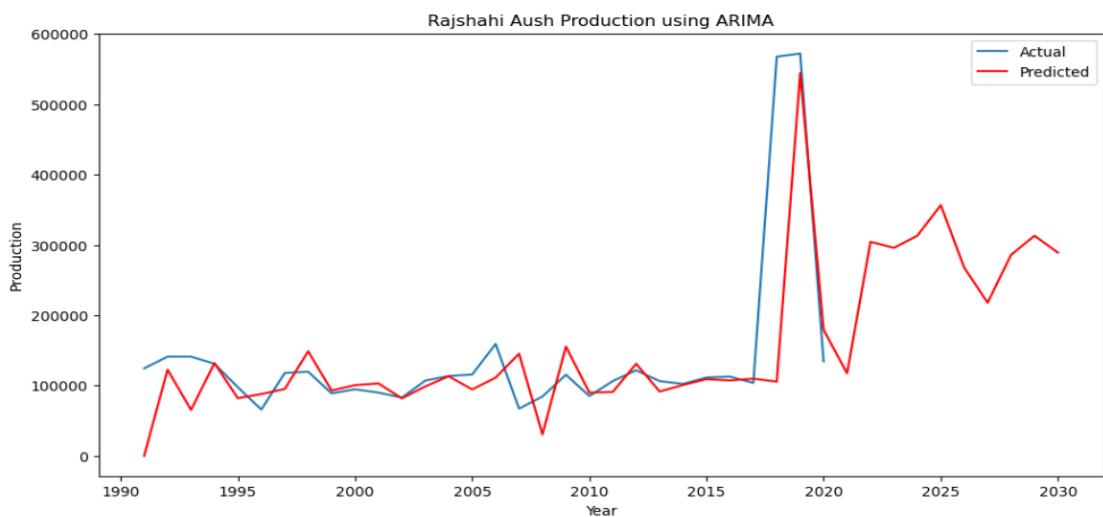


Figure-5.126: The ARIMA (5, 1, 0) model's actual and predicted Aush production figures are visually represented in a plot.

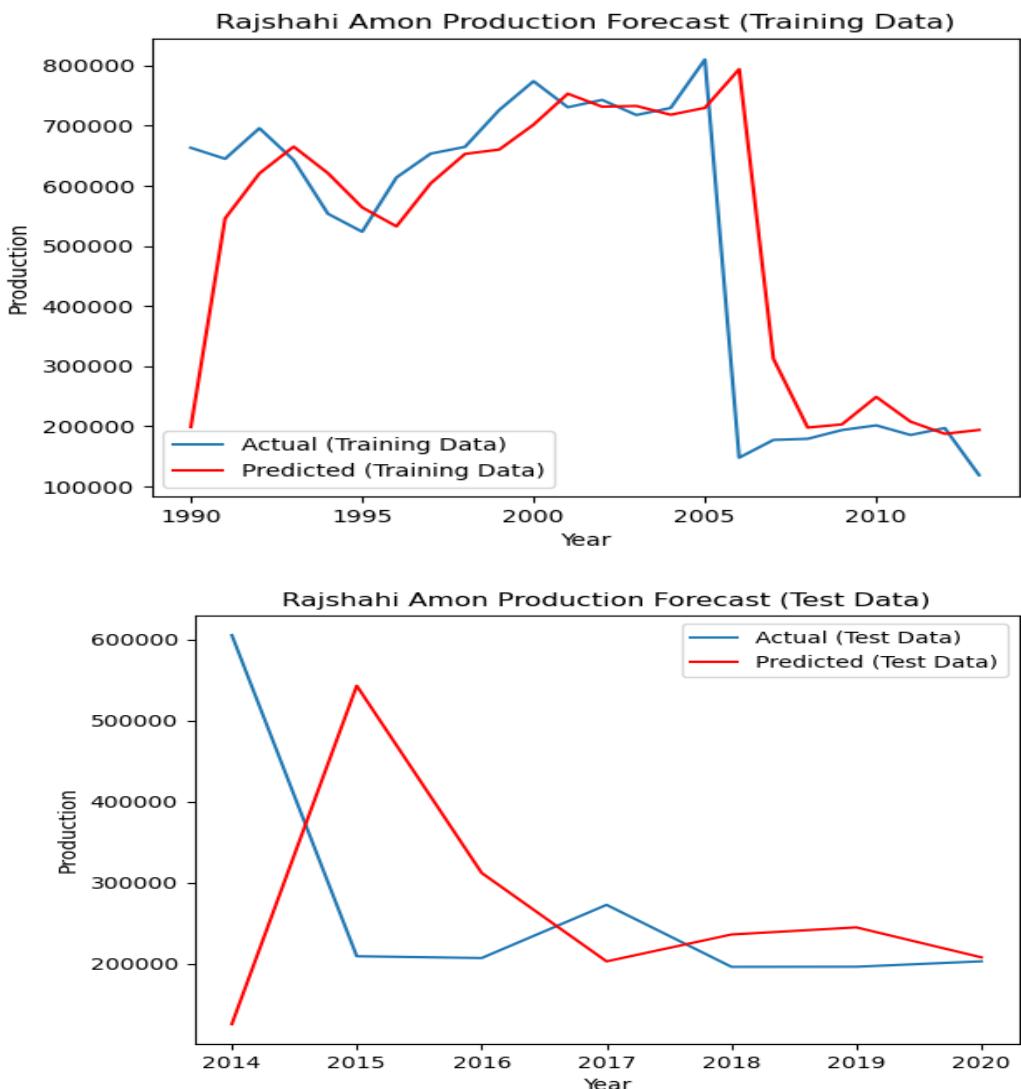


Figure-5.127: Figure of Training and testing dataset.

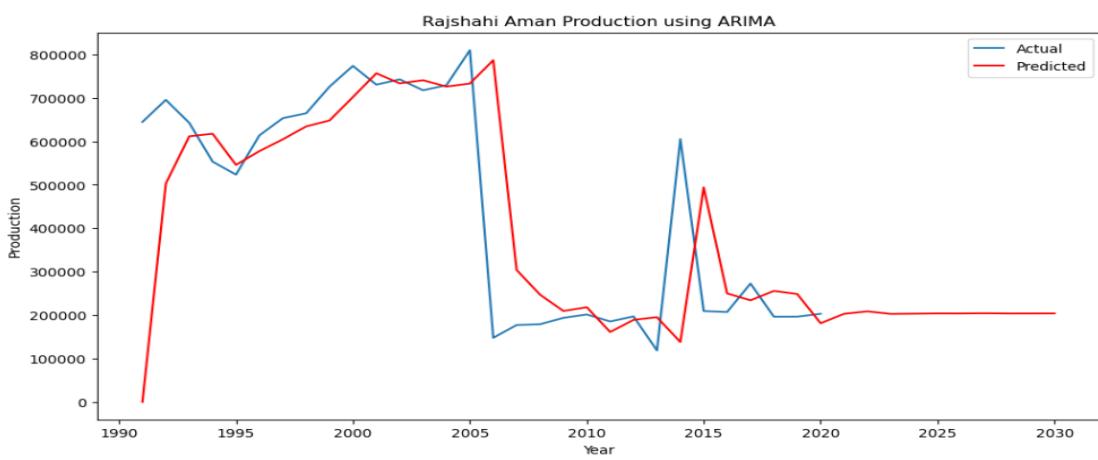


Figure-5.128: The ARIMA (5, 1, 0) model's actual and predicted Amon production figures are visually represented in a plot.

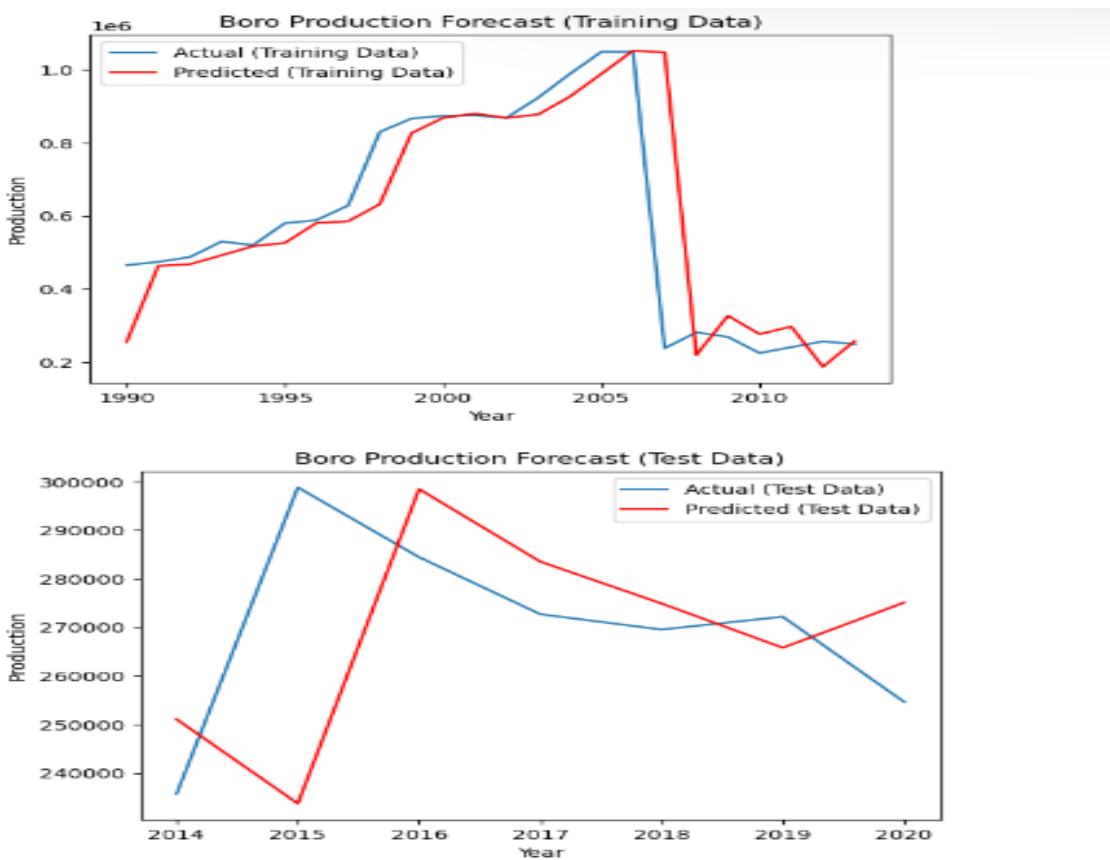


Figure-5.129: Figure of training and Testing dataset.

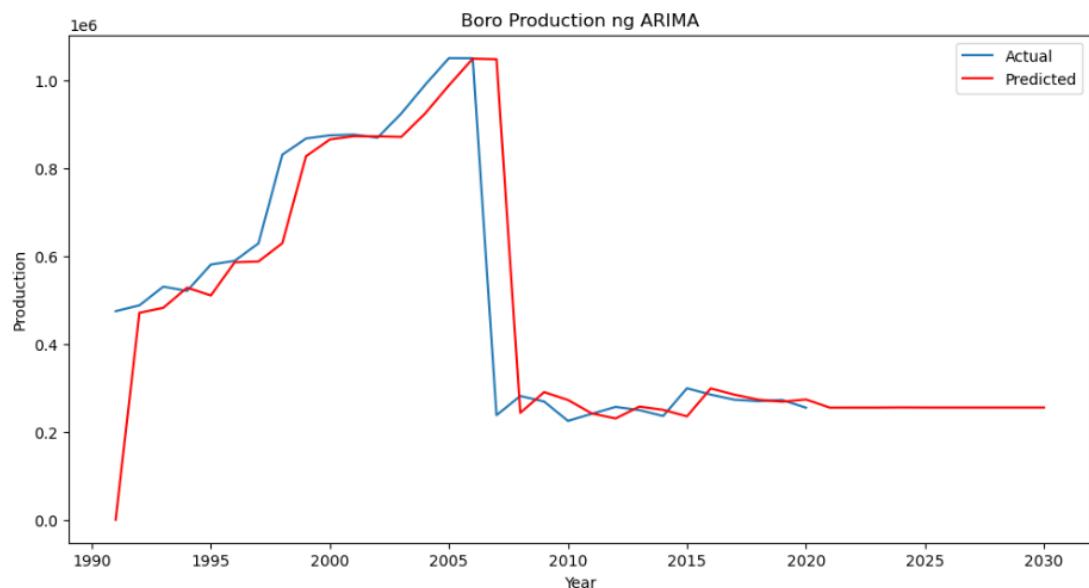


Figure-5.130: The ARIMA (5, 1, 0) model's actual and predicted Boro production figures are visually represented in a plot.

- The data from the Dhaka District

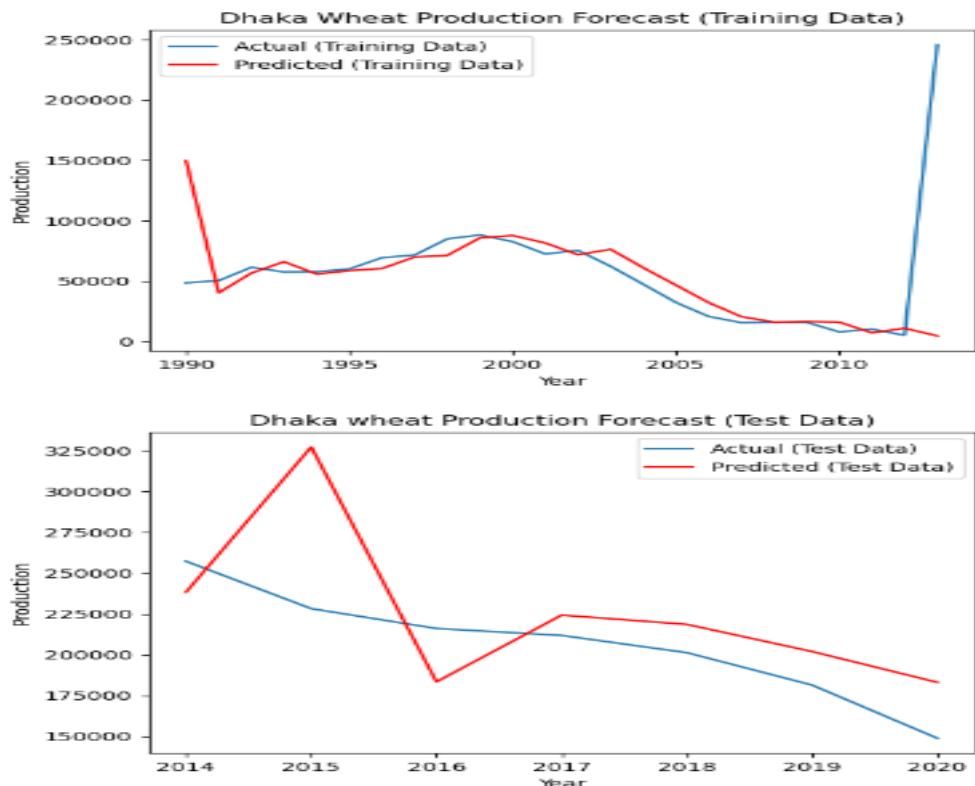


Figure-5.131: Figure of training and Testing dataset.

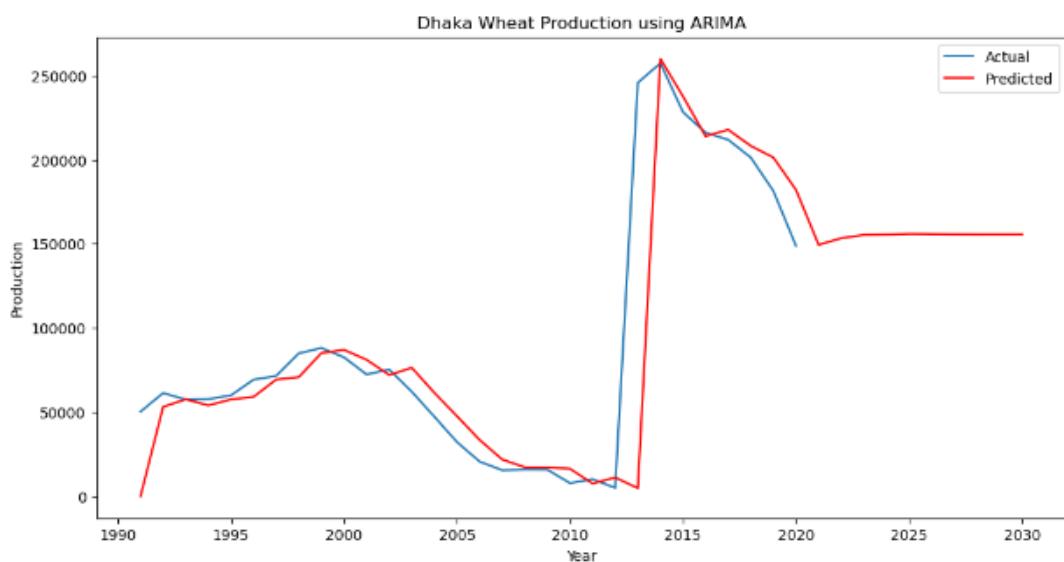


Figure-5.132: The ARIMA (5, 1, 0) model's actual and predicted wheat production figures are visually represented in a plot.

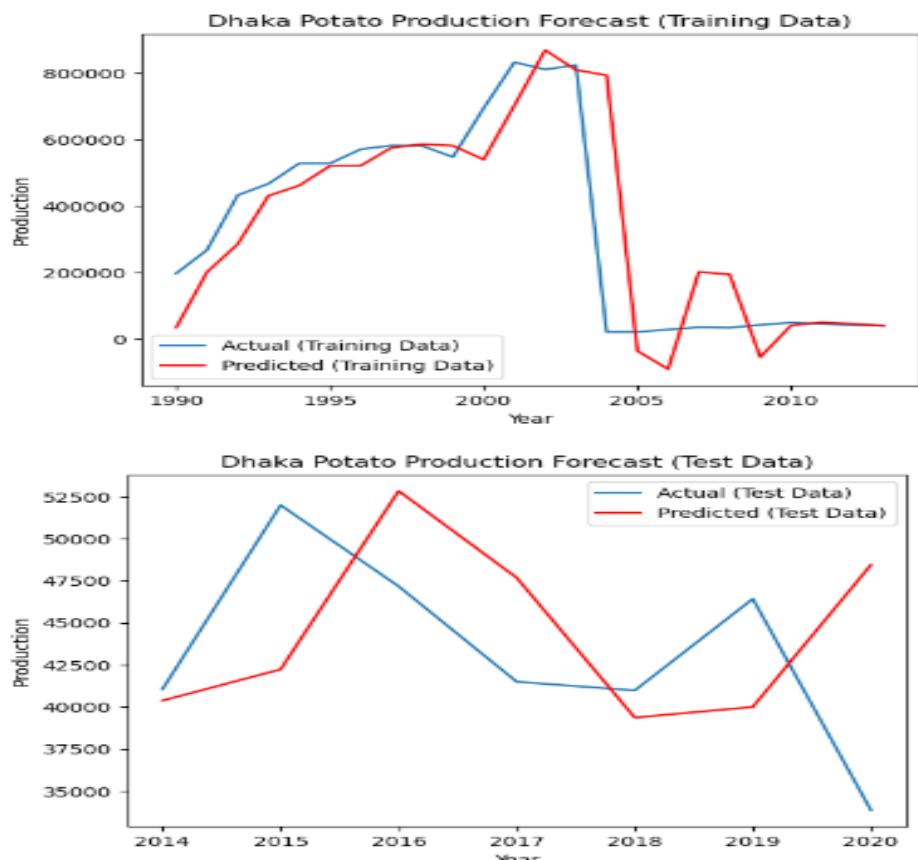


Figure-5.133: Figure of training and Testing dataset.

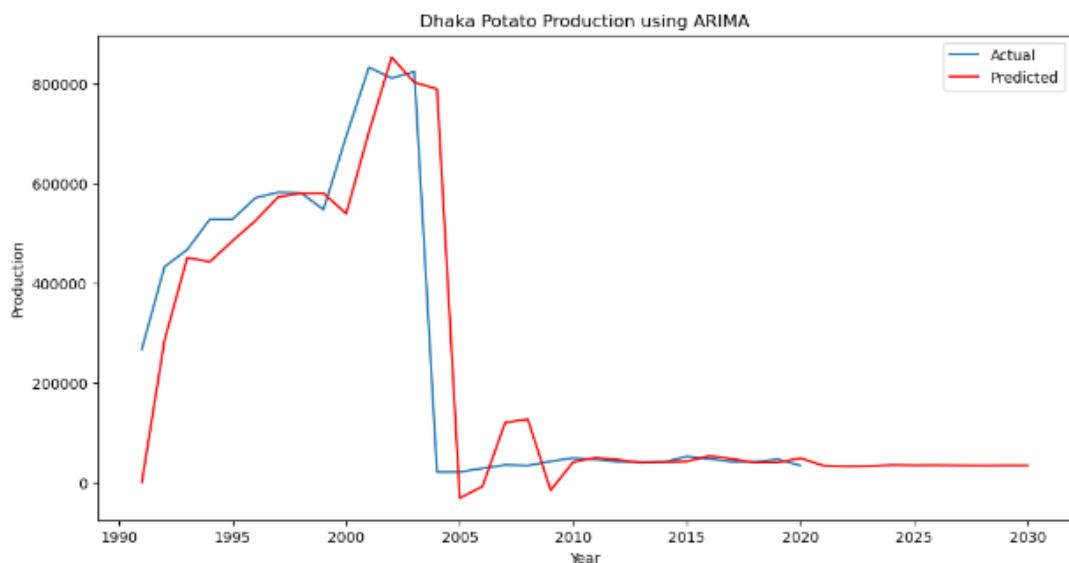


Figure-5.134: The ARIMA(5,1,0) model's actual and predicted potato production figures are visually represented in a plot.

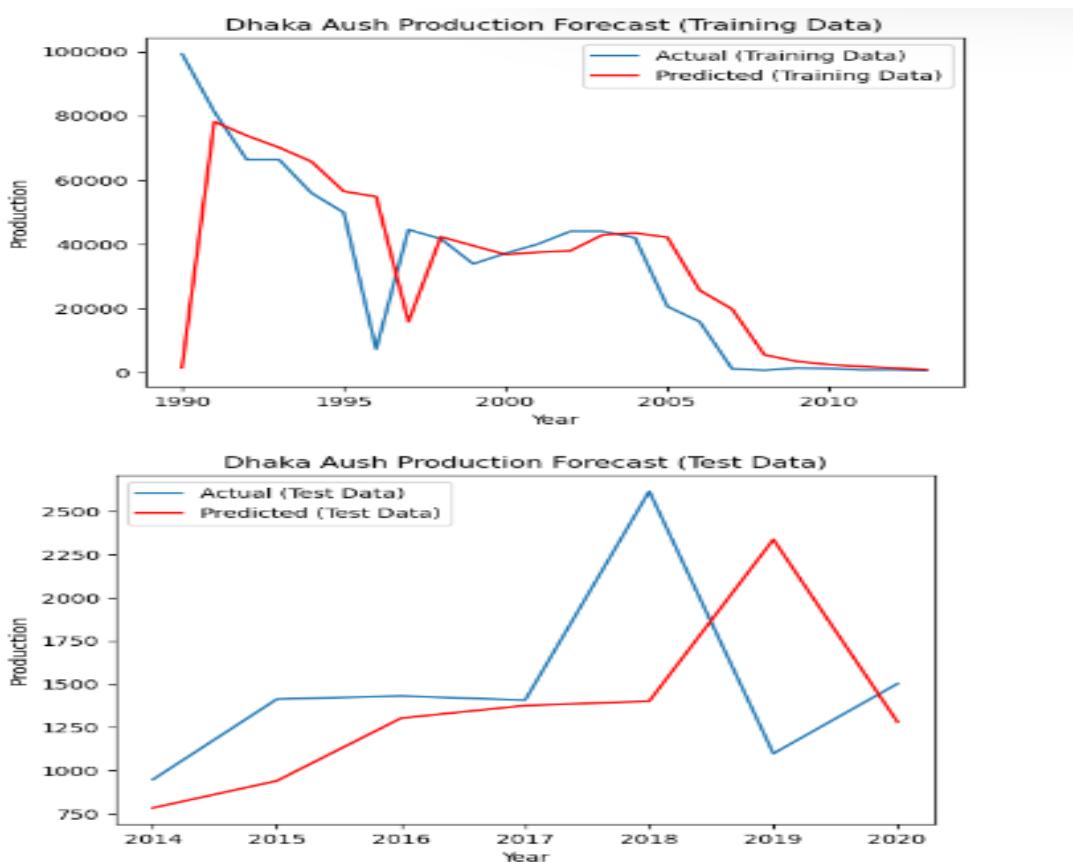


Figure-5.135: Figure of training and Testing dataset.

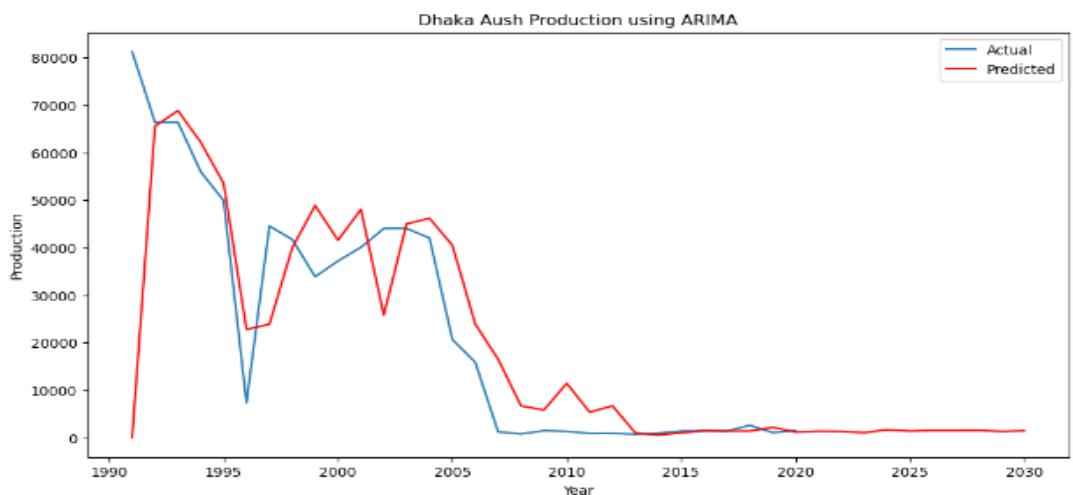


Figure-5.136: The ARIMA (5, 1, 0) model's actual and predicted Aush production figures are visually represented in a plot.

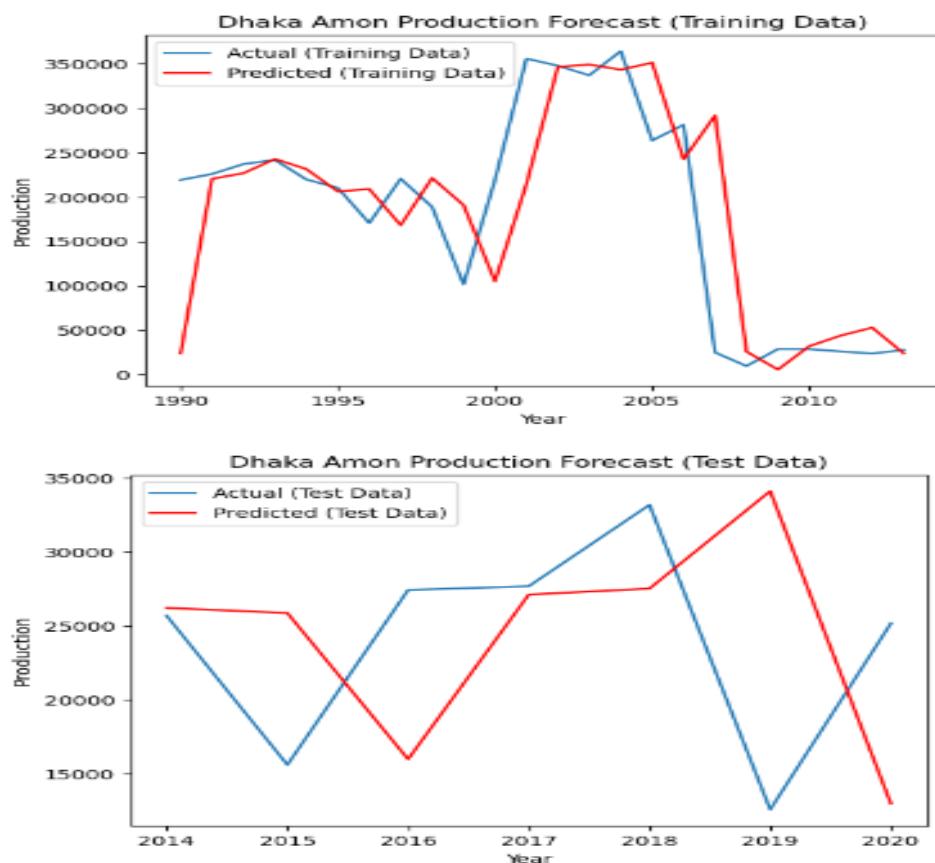


Figure-5.137: Figure of training and Testing dataset.

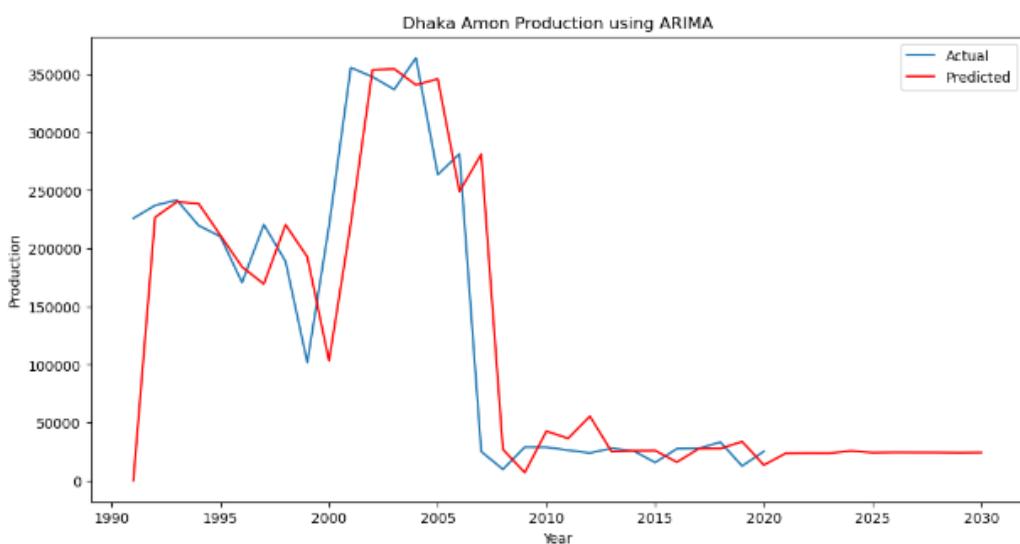


Figure-5.138: The ARIMA (5, 1, 0) model's actual and predicted Amon production figures are visually represented in a plot.

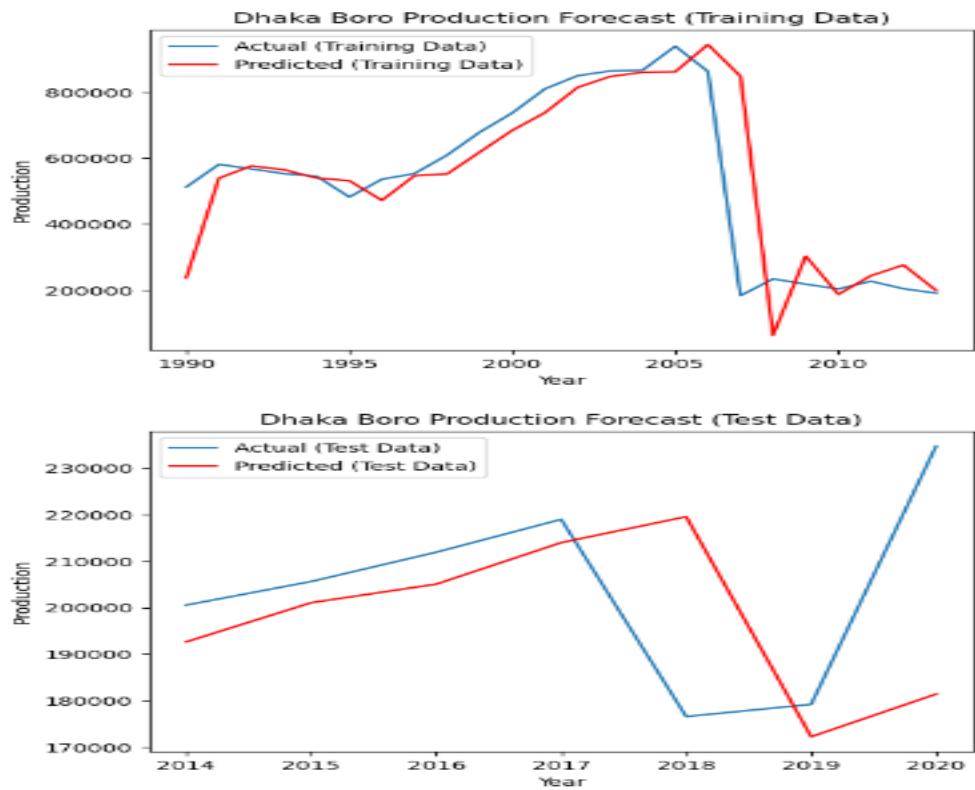


Figure-5.139: Figure of training and Testing dataset.

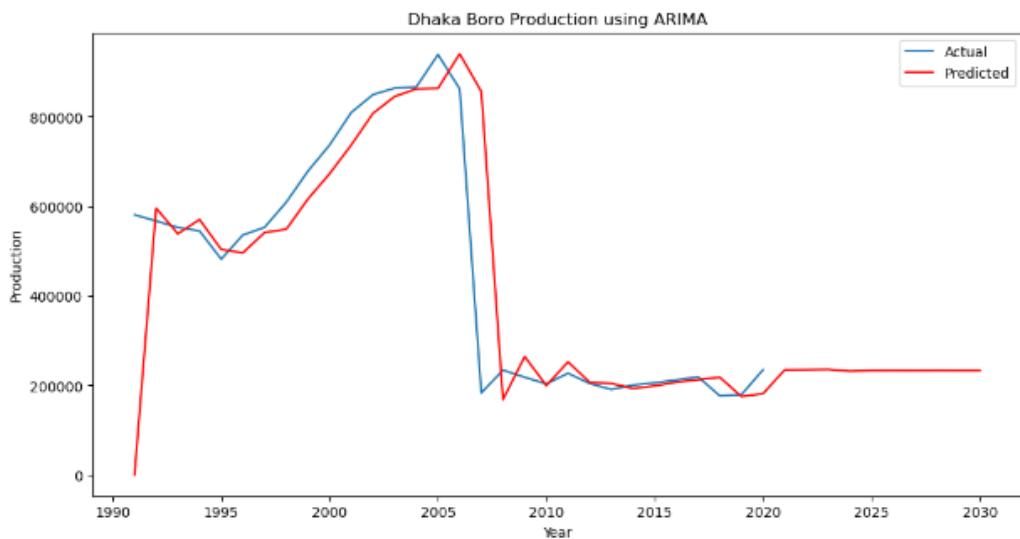


Figure-5.40: The ARIMA(5,1,0) model's actual and predicted Boro production figures are visually represented in a plot.

- The data from the Khulna district.

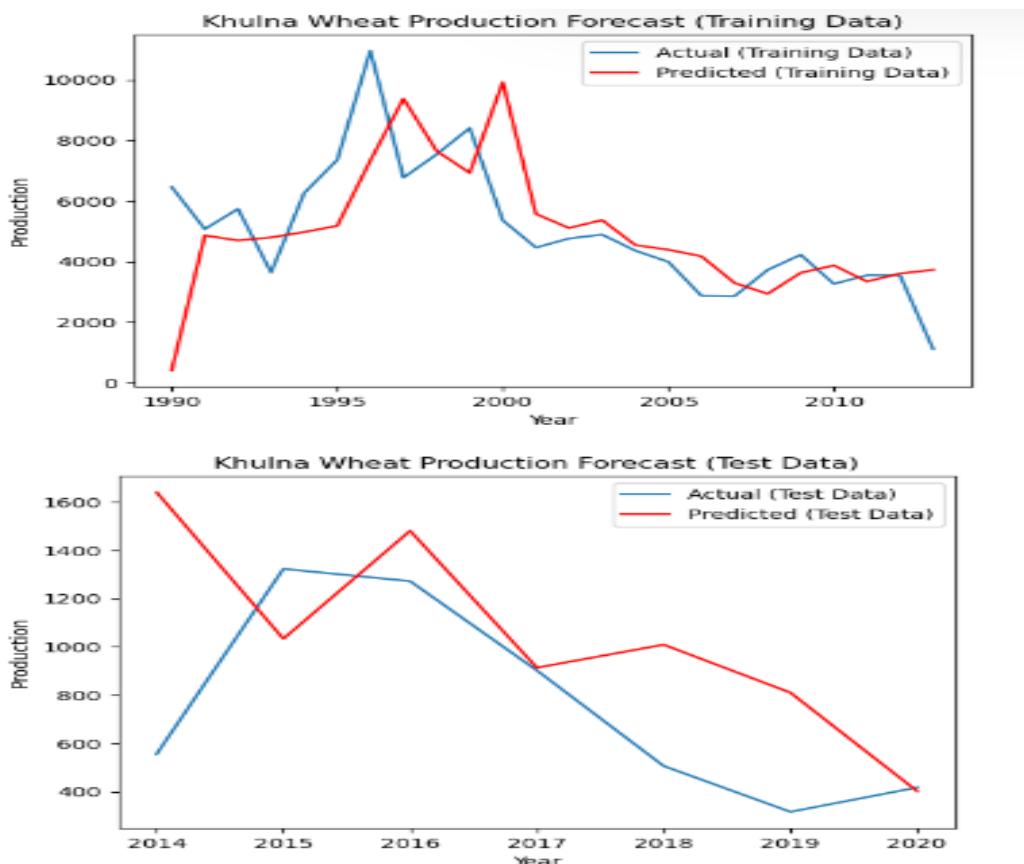


Figure5.141: Figure of training and Testing dataset.

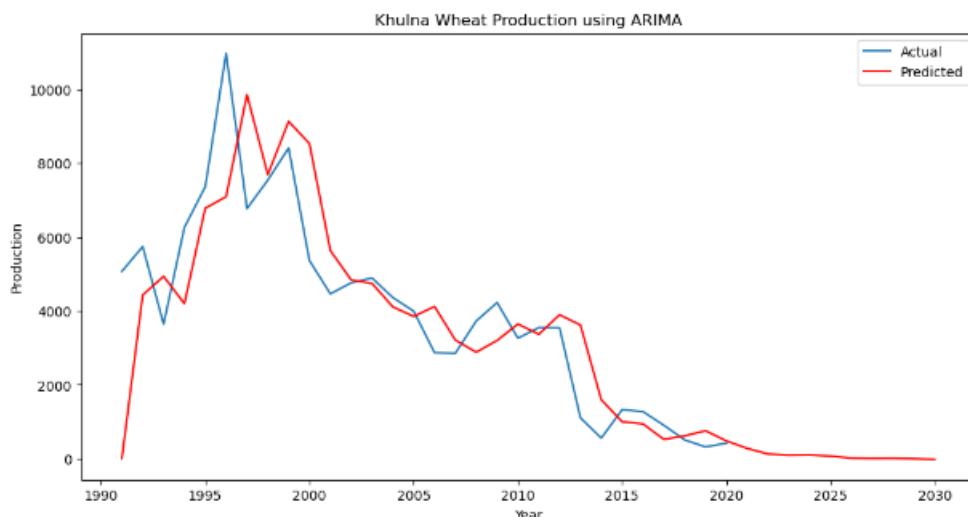


Figure-5.142: The ARIMA (5, 1, 0) model's actual and predicted wheat production figures are visually represented in a plot.

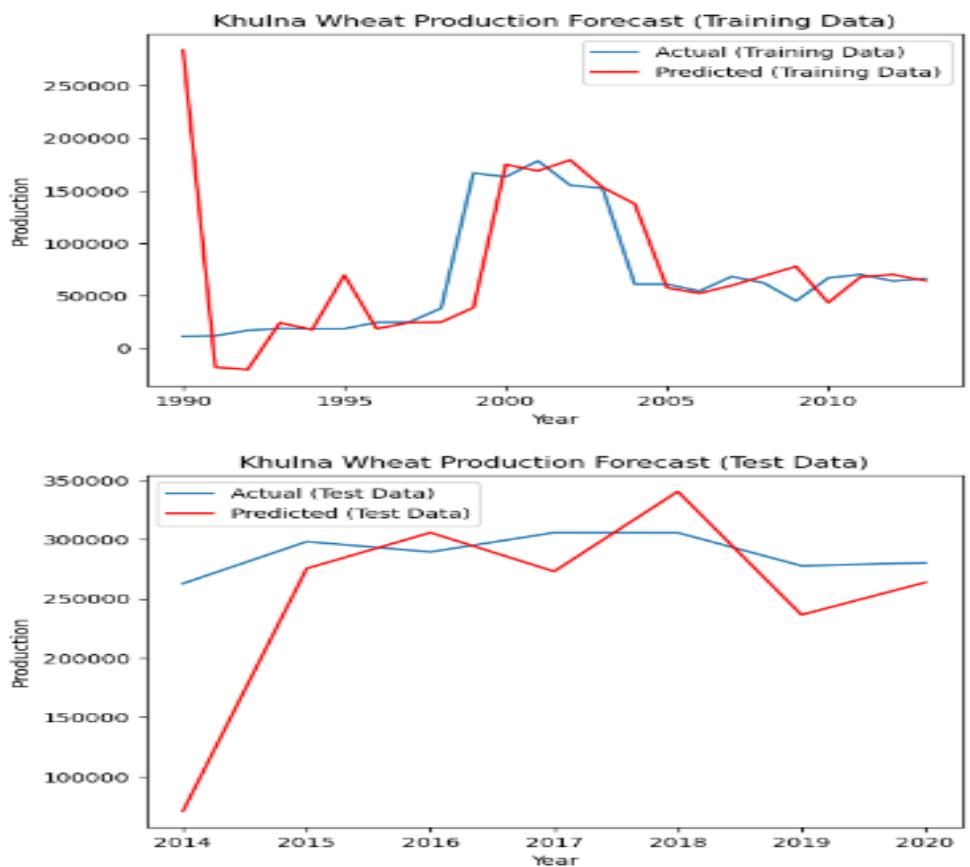


Figure-5.143: Figure of training and Testing dataset.

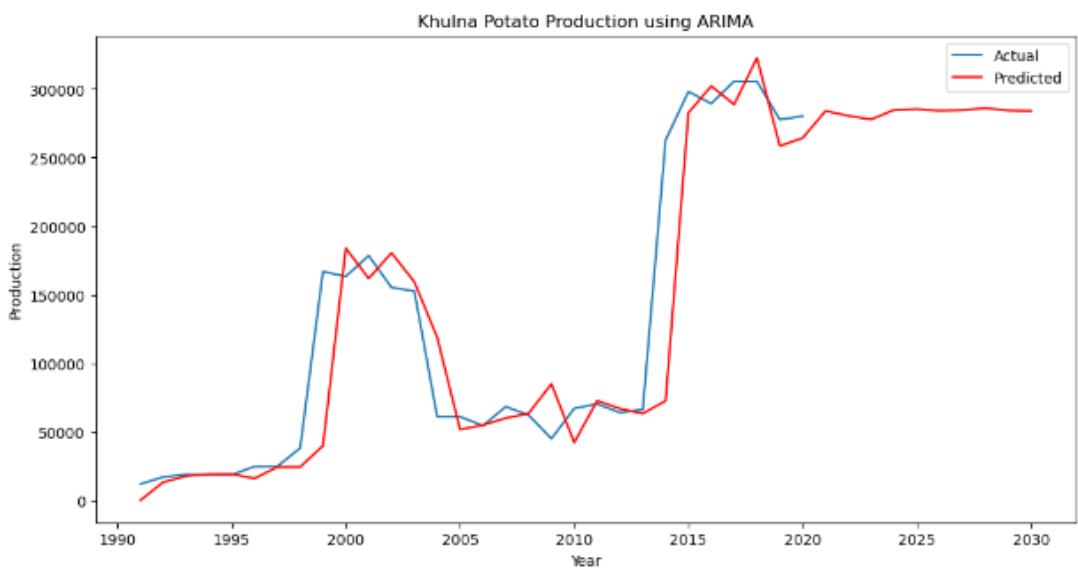


Figure-5.144: The ARIMA (5, 1, 0) model's actual and predicted potato production figures are visually represented in a plot.

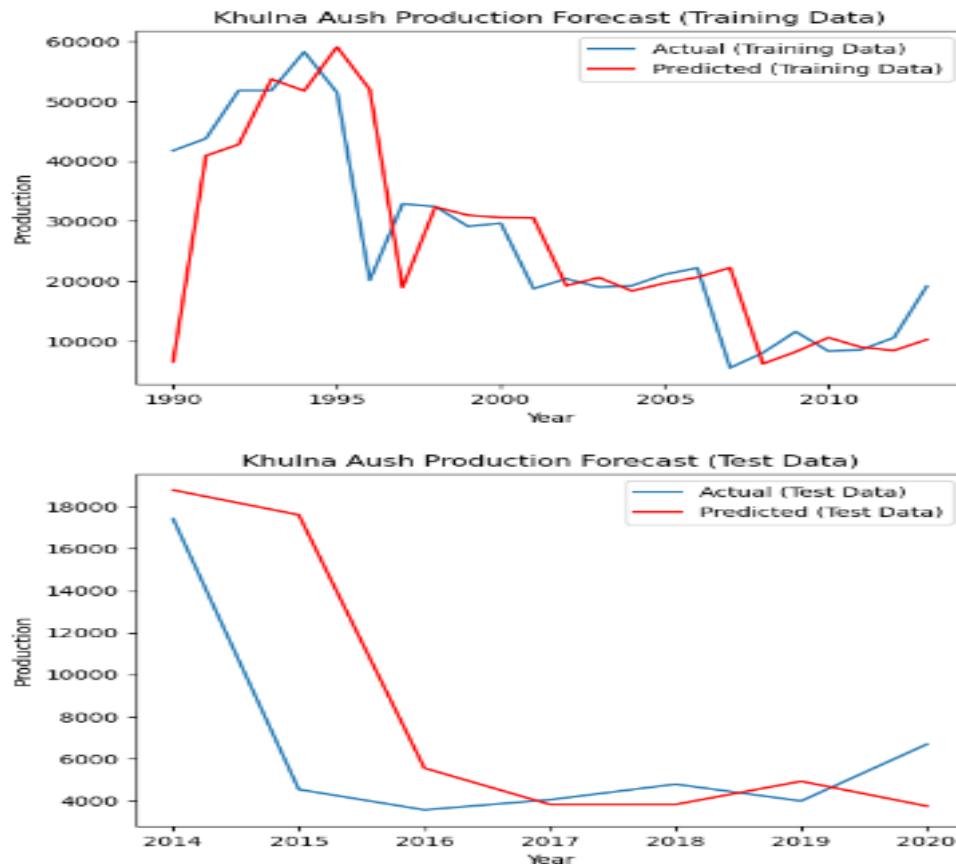


Figure-145: Figure of training and Testing dataset.

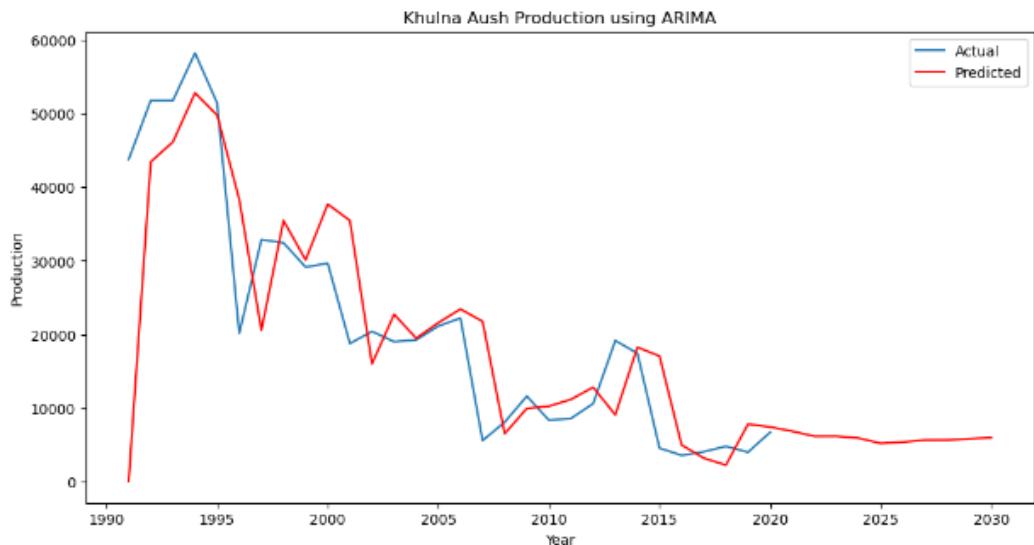


Figure-5.146: The ARIMA (5, 1, 0) model's actual and predicted Aush production figures are visually represented in a plot.



Figure-5.147: Figure of training and Testing dataset.

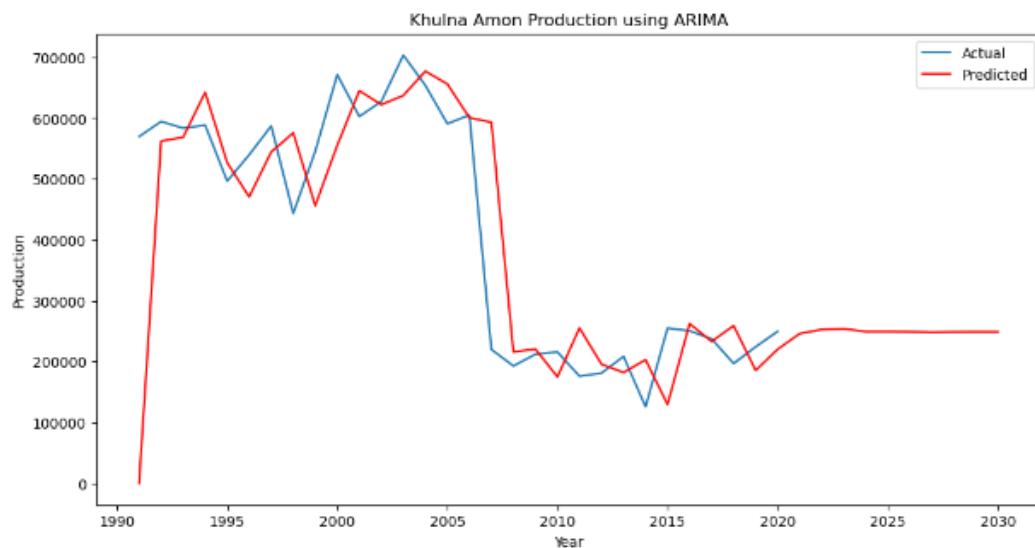


Figure-5.148: The ARIMA (5, 1, 0) model's actual and predicted Aman production figures are visually represented in a plot.

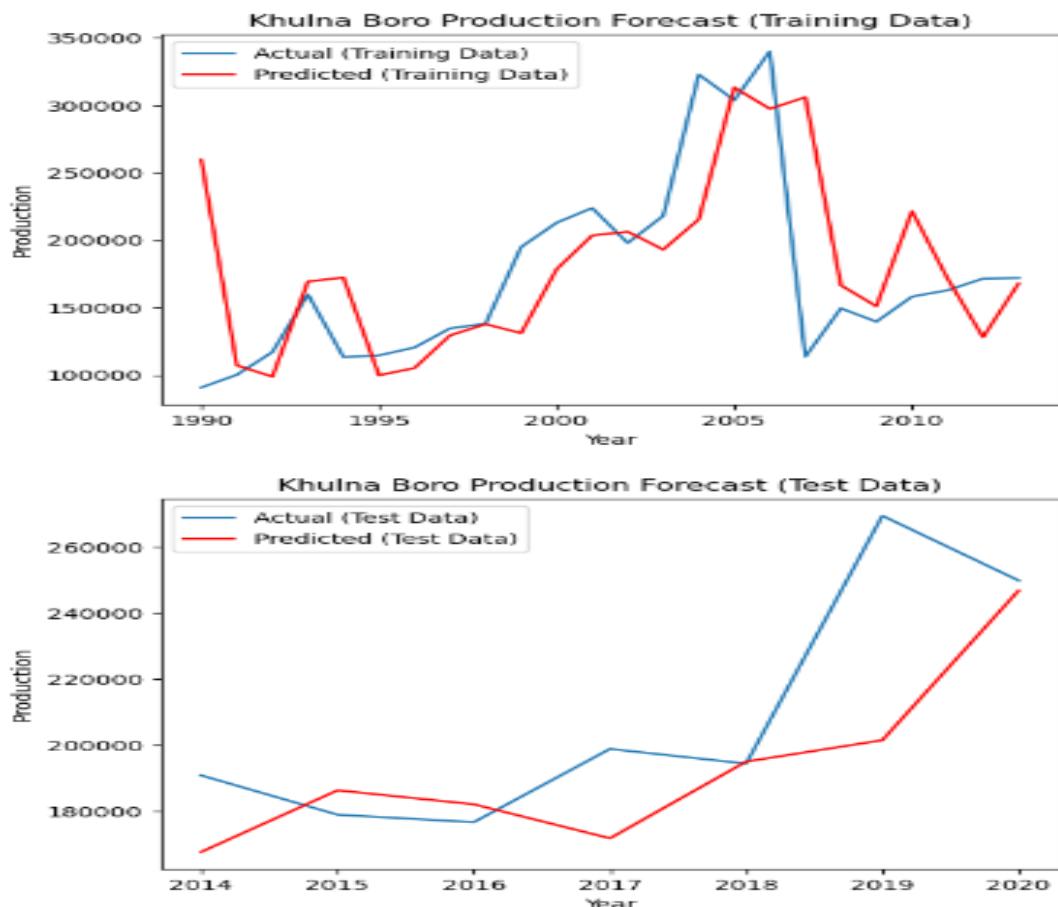


Figure-5.149: Figure of training and Testing dataset.

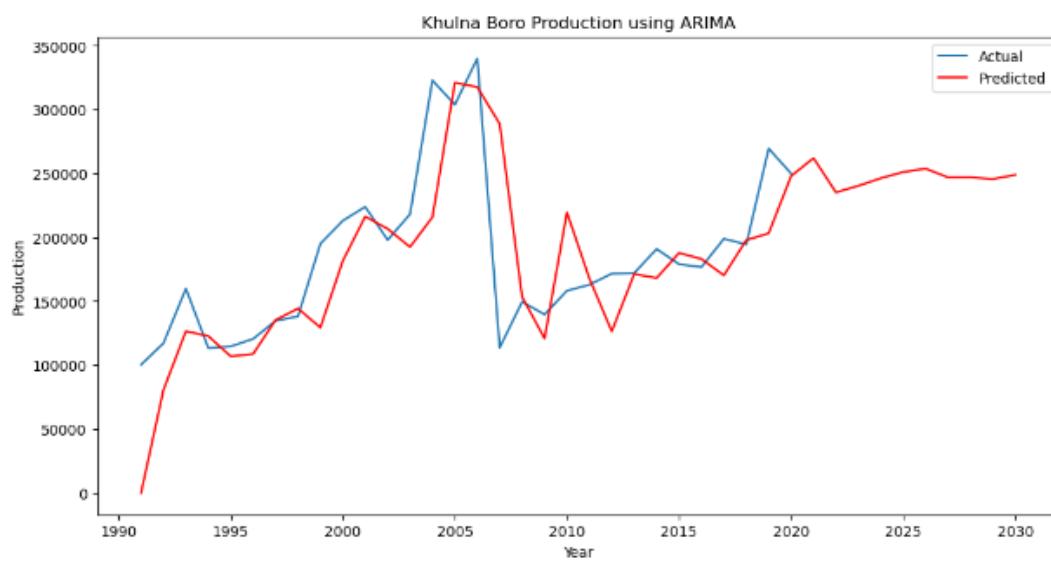


Figure-5.150: The ARIMA(5,1,0) model's actual and predicted Boro production figures are visually represented in a plot.

- The data from the Chattogram District.

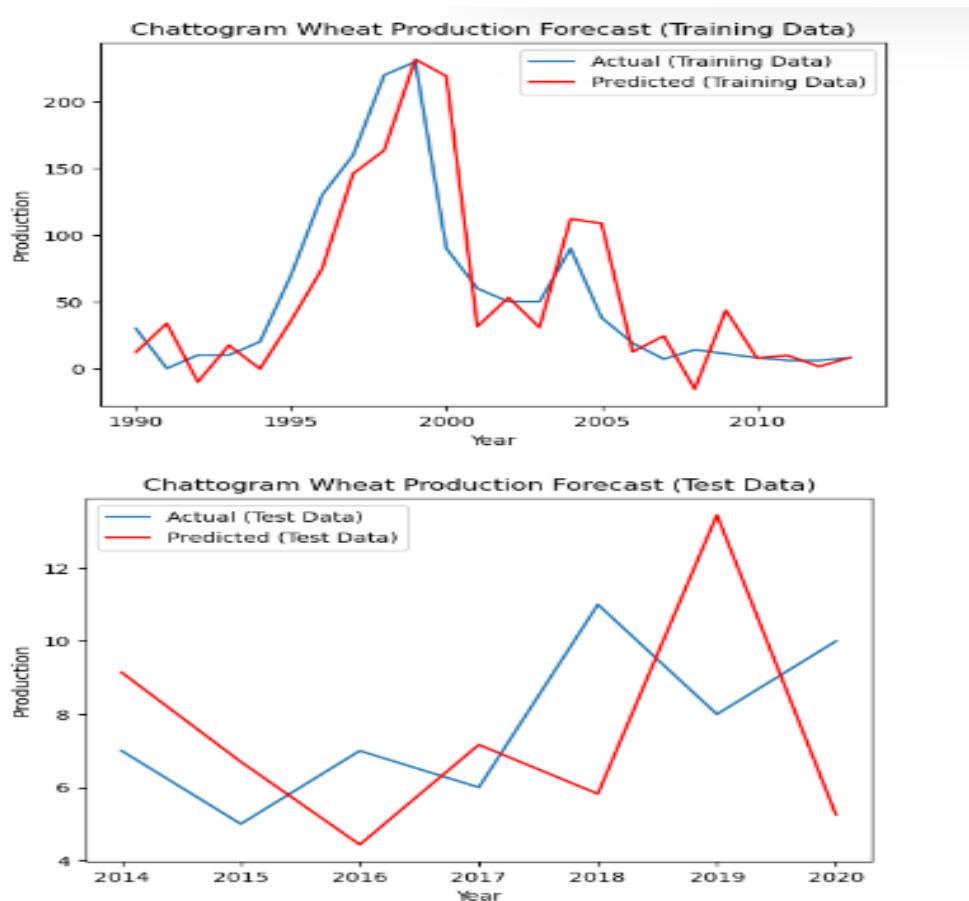


Figure-5.151: Figure of training and Testing dataset.

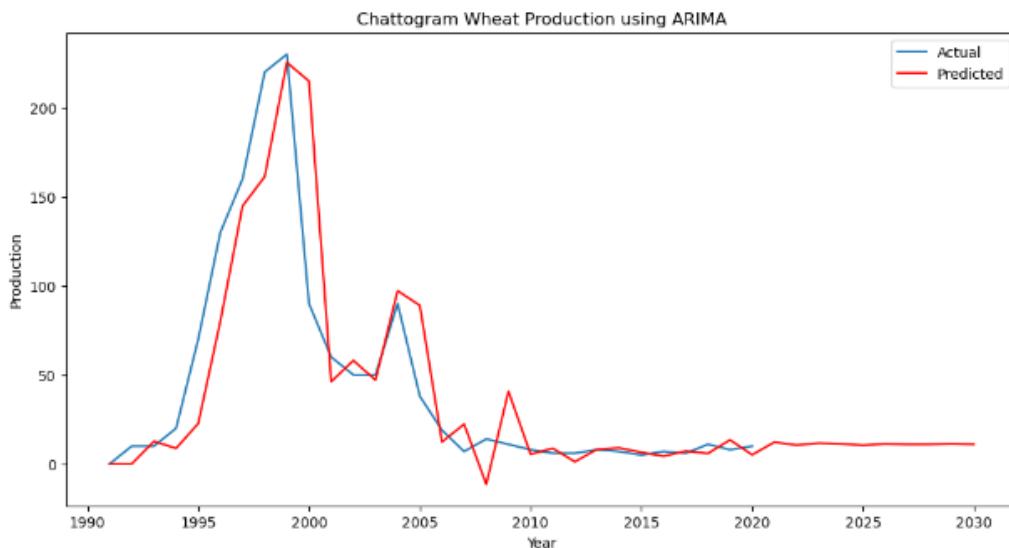


Figure-5.152: The ARIMA (5, 1, 0) model's actual and predicted wheat production figures are visually represented in a plot.

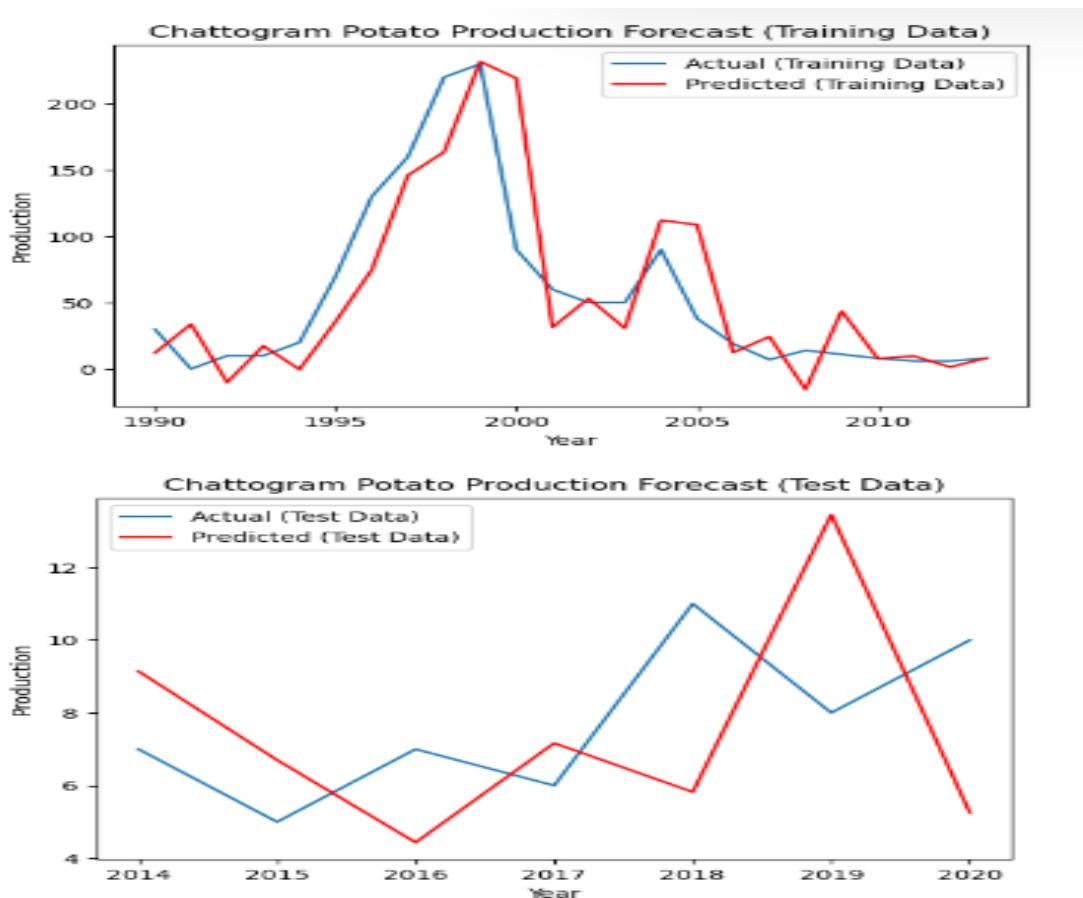


Figure-5.153: Figure of training and Testing dataset.

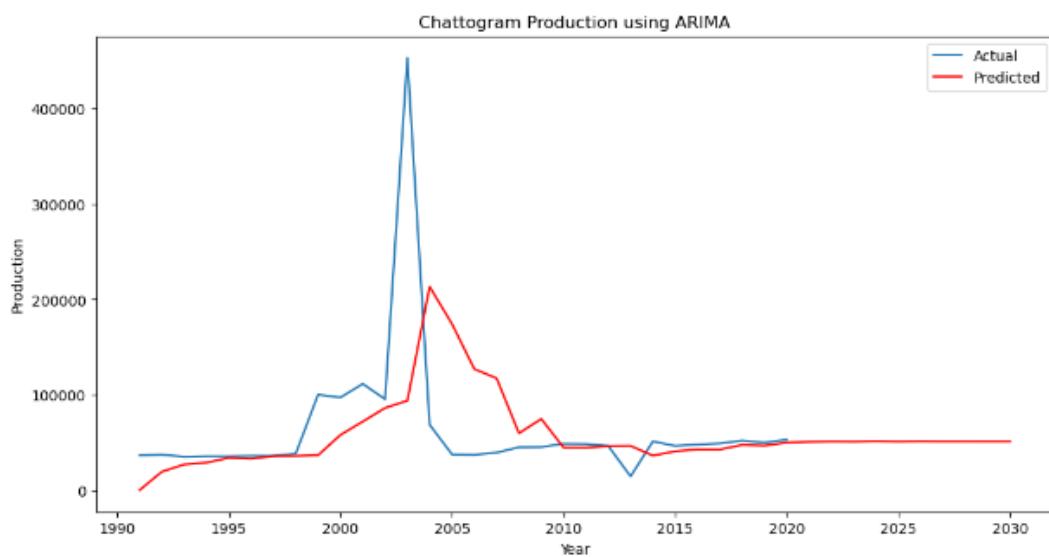


Figure-5.154: The ARIMA(5,1,0) model's actual and predicted potato production figures are visually represented in a plot.

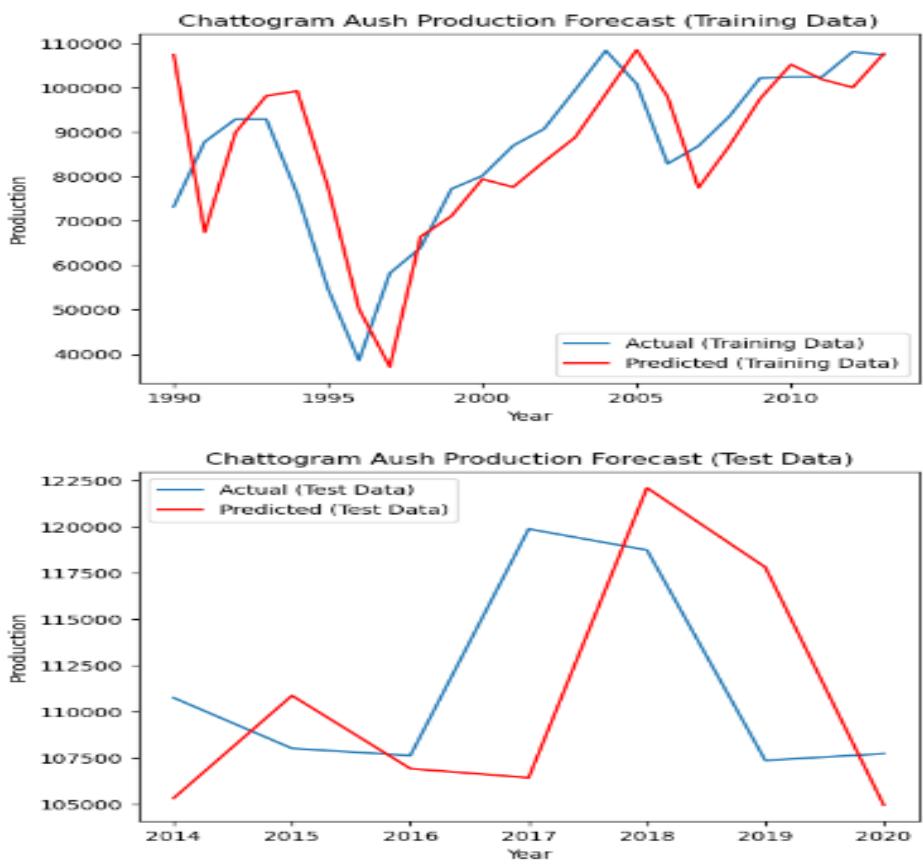


Figure-5.155: Figure of training and Testing dataset.

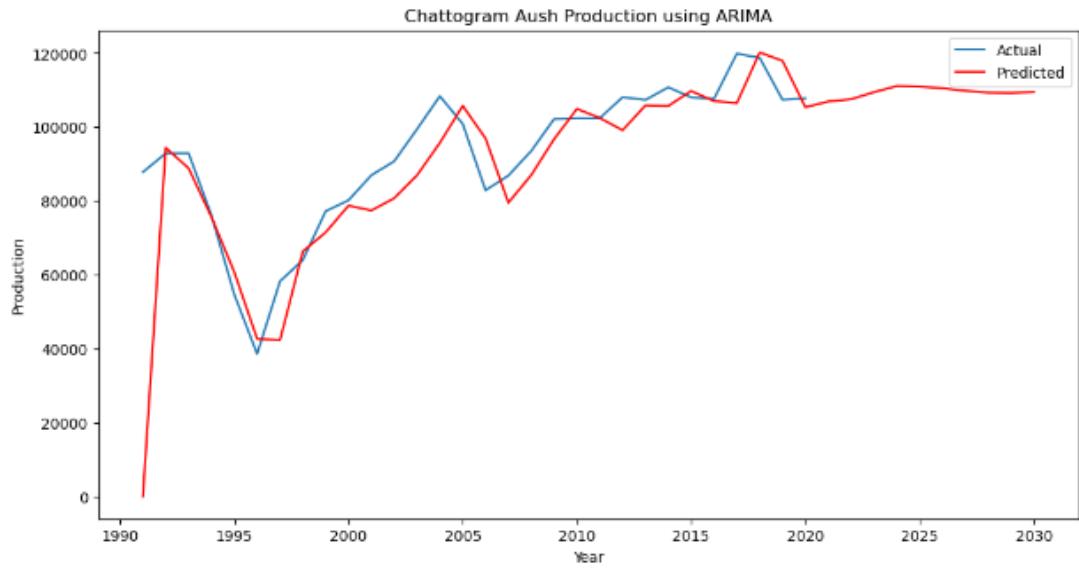


Figure-5.156: The ARIMA (5, 1, 0) model's actual and predicted Aush production figures are visually represented in a plot.



Figure-5.157: Figure of training and Testing dataset.

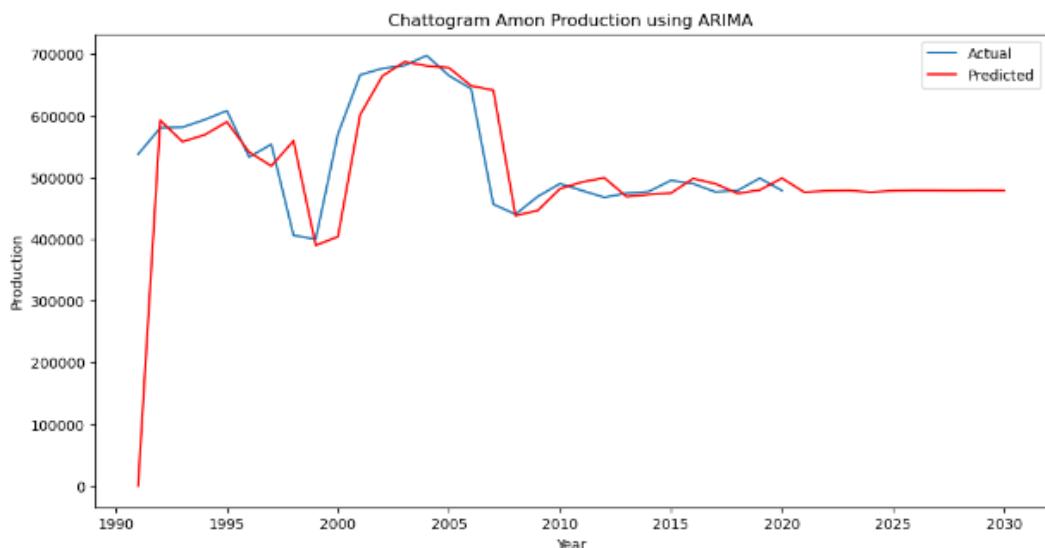


Figure-5.158: The ARIMA (5, 1, 0) model's actual and predicted Amon production figures are visually represented in a plot.

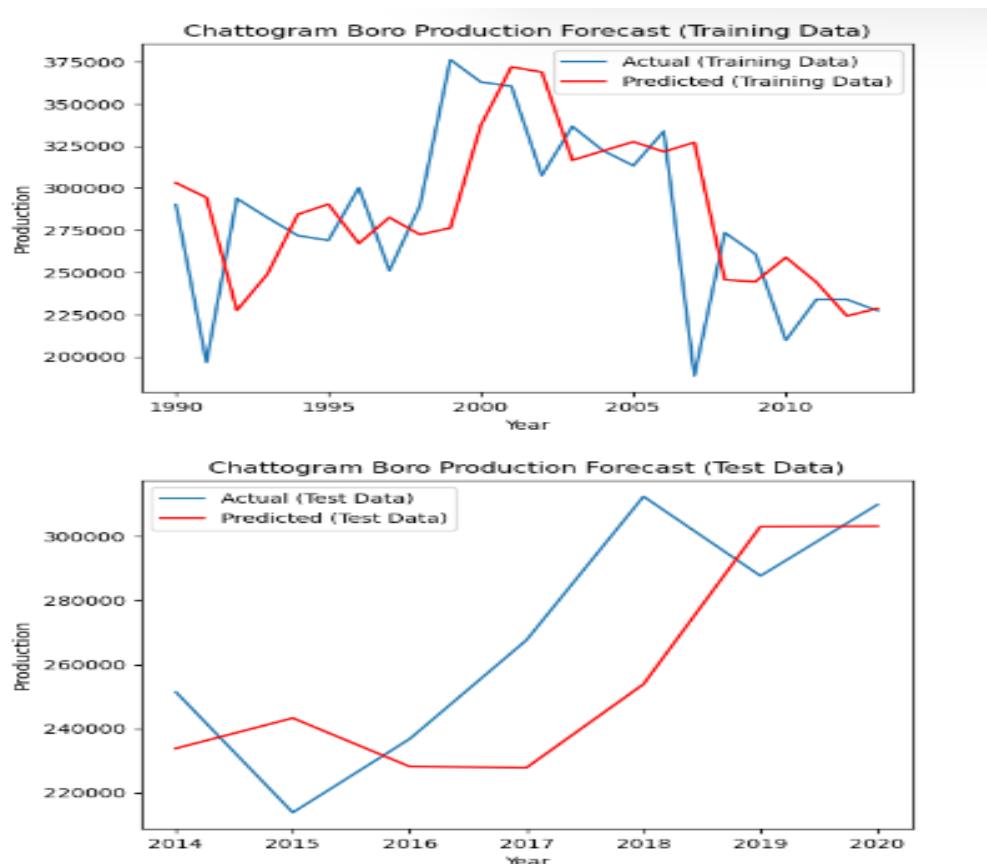


Figure-5.159: Figure of training and Testing dataset.

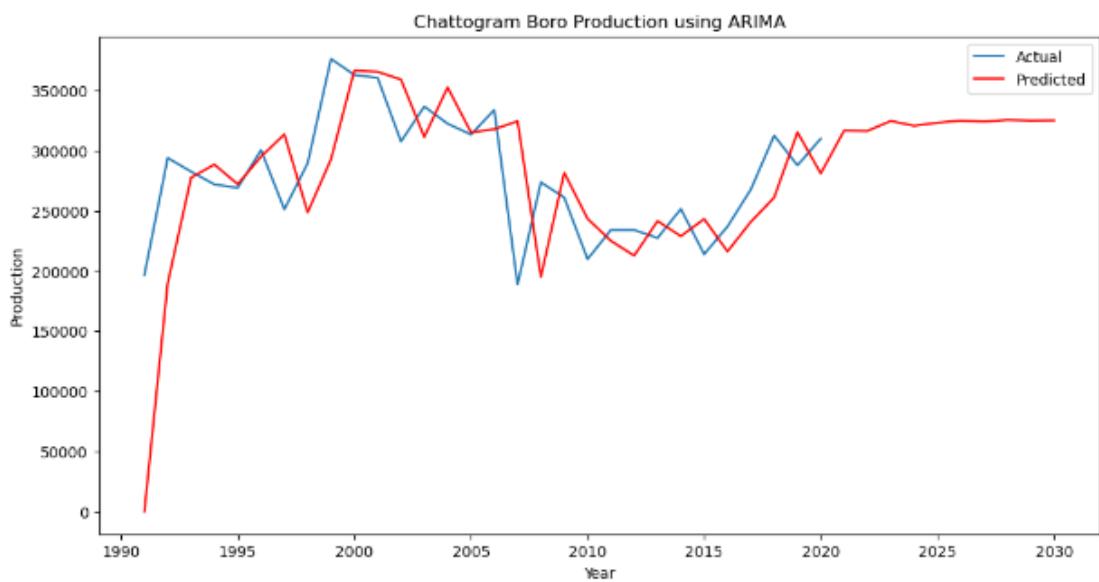


Figure-5.160: The ARIMA (5, 1, 0) model's actual and predicted Boro production figures are visually represented in a plot.

The figures depict the comprehensive process of data analysis, encompassing training, testing, and prediction. In this scenario, 80% of the data is allocated for training, while the remaining 20% is used for testing. Notably, the random forest regression algorithm is employed, resulting in an impressive 99% accuracy.

To visually convey the comparative performance of various models or methods in predicting crop yields for paddy, wheat, and potato, graphical representations have been created. The x-axis typically signifies the independent variable, such as the year, while the y-axis represents the dependent variable—production of paddy, wheat, and potato crop yields. It is worth noting that, depending on the specific dataset and methodologies employed, one crop may consistently exhibit a higher level of prediction accuracy than the others.

Appendix

Aus Production of Dhaka.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Wind speed
1990	99314	16.94	52.27692	175.84	3.09725
1991	81238	16.94	44.96892	30.61	2.92625
1992	66378	27.49	0.459513	69.88	3.039587
1993	66379	20.94	47.95557	148.17	3.028417
1994	55964	20.8	48.03342	165.22	3.04125
1995	49904	20.3	41.492	107.96	3.120167
1996	7366	20.3	51.45372	166.83	3.036446
1997	44560	24.29483	49.03242	200.02	2.563167
1998	41712	17.72	56.86967	353.46	2.825833
1999	33892	17.22	50.802	16.56	3.285917
2000	37185	17.3	59.63033	264.9	3.114876
2001	40070	18.08	51.56042	110.01	2.756583
2002	44034	23.48958	56.8185	196.42	2.758333
2003	44034	62.16	62.041	265.55	2.779083
2004	42038	24.01512	60.84264	197.24	3.231818
2005	20665	24.41483	62.57342	231.16	3.00625
2006	15892	24.61958	59.88525	128.96	2.742417
2007	1239	23.55117	58.07958	236.9	2.851667
2008	804	23.41273	63.56083	128.8	2.602149
2009	1492	24.873	57.96808	102.22	2.811083
2010	1353	24.60183	58.75183	121.62	3.647167
2011	912	23.65075	60.00067	136.54	2.936583
2012	927	24.22174	56.0176	248.05	3.096529
2013	752	24.00767	53.64358	95.71	3.264083
2014	947	24.47467	55.86933	76.94	2.858167
2015	1413	24.22692	58.39317	258.96	2.702083
2016	1431	25.68358	60.05289	196.13	3.021074
2017	1407	23.10317	69.69975	741.8	3.02025
2018	2616	22.78083	70.11542	408.83	2.374
2019	1098	24.00308	60.64125	264.76	2.645083
2020	1502	22.44562	69.20876	429.62	2.287521

Aman Production of Dhaka.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Windspeed
1990	219175	16.94	76.97106	625.42	4.226423
1991	225907	31.07	77.66472	586.08	4.99065
1992	237074	27.49	72.01569	465.7	4.16878
1993	241664	29.14	83.73244	940.28	4.755528
1994	219729	32.26	77.60585	533.98	4.569675
1995	210285	20.3	80.11789	794.47	4.815854
1996	170605	30.83	79.54707	659.73	4.42561
1997	220518	30.05	82.98813	1066.19	4.240894
1998	188794	28.88	87.46512	1319.28	4.394878
1999	101713	32.26	85.2435	1253.67	4.486667
2000	219284	28.26049	101.9828	1231.95	3.938618
2001	355752	28.1913	88.21813	1378.35	4.161057
2002	347742	28.58382	86.34008	1312.98	3.99626
2003	336955	29.08805	82.76512	996.93	4.249919
2004	364189	28.99715	82.37341	1008.49	3.985122
2005	263614	29.13585	82.34033	1050.14	3.734634
2006	281384	28.64472	84.83065	1096.17	3.823171
2007	25042	28.55301	85.98122	1709.14	3.704553
2008	9691	29.04689	83.34393	1050.84	4.043279
2009	28872	28.93756	84.05585	1427.74	3.813089
2010	28772	28.75285	85.98764	1190.28	4.022683
2011	26151	28.42195	85.99537	1309.36	3.724065
2012	23810	29.09268	83.31195	957.04	4.353089
2013	27797	28.37122	87.8687	1310.49	4.650163
2014	25676	29.32984	83.23447	1279.32	4.37878
2015	15604	28.64878	85.99894	1642.54	4.062439
2016	27419	28.65293	86.49545	1979.98	3.746667
2017	27671	28.29699	89.89585	2954.81	3.61122
2018	33169	28.25659	89.84553	2095.34	3.713821
2019	12583	28.9739	86.68512	1977.42	4.046992
2020	25167	28.49106	88.38797	1686.09	3.880976

Boro Production of Dhaka.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Wind Speed
1990	512220	16.94	70.20877	270.03	2.708525
1991	580800	27.49	76.75352	541.65	2.374754
1992	566960	31.26	60.89467	164.47	2.367787
1993	552590	26.56	68.75926	195.22	2.094098
1994	544810	26.46287	58.14066	113.51	4.777541
1995	481820	20.3	74.89984	257.76	2.396148
1996	535750	24.96672	63.46943	213.52	2.140984
1997	552780	27.91	76.59852	323.73	2.480164
1998	608920	28.1	82.4659	341.59	2.524672
1999	678180	23.71967	83.09787	430.35	2.529672
2000	736570	27.87	80.39574	369.49	2.376557
2001	809320	23.81533	81.79959	425.67	2.335984
2002	849220	23.70361	80.63648	352.34	2.319672
2003	863620	23.81828	82.09492	377.92	2.432787
2004	866170	23.36344	82.53738	851.19	2.498689
2005	938662	23.37418	84.65811	618.15	2.481639
2006	862236	23.90803	79.66443	472.59	2.352295
2007	183144	23.24549	84.99361	608.92	2.681885
2008	233939	23.24549	84.99361	608.92	2.681885
2009	217990	23.63992	82.55139	376.68	2.483607
2010	203305	24.16631	83.03057	515.15	2.479508
2011	226879	24.33811	78.00598	251.21	2.532869
2012	204100	22.97025	79.88697	302.84	2.79582
2013	190647	24.0268	82.67795	423.08	2.461148
2014	200561	24.12656	77.34303	330.63	2.198934
2015	205638	24.67336	77.05607	348.92	1.901311
2016	211933	24.42721	84.09164	736.6	2.206885
2017	218997	24.25475	85.03074	1218.35	2.317377
2018	176590	24.09459	76.64074	293.65	2.187049
2019	179206	23.97016	84.60172	757.99	2.304754
2020	234756	24.34926	85.20385	808.02	2.238033

Potato Production of Dhaka.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Wind speed
1990	197120	16.94	66.59216	1071.29	3.347836
1991	267445	25.22792	66.61359	1158.34	3.437589
1992	432780	28.74667	62.88199	700.05	3.195137
1993	467145	25.58175	66.96542	1283.67	3.298137
1994	528360	26.55466	61.37723	812.71	4.136658
1995	528360	20.30274	65.67485	1160.19	3.449589
1996	571065	25.39434	64.90016	1040.08	3.204809
1997	582285	27.4426	69.6889	1589.94	3.100795
1998	581285	24.95025	75.73537	2014.33	3.253918
1999	547600	24.46077	73.2031	1700.58	3.437781
2000	694510	24.50678	80.78534	1866.34	3.145601
2001	833190	23.40438	74.0209	1914.03	3.089288
2002	811225	25.27781	75.00192	1861.74	3.028877
2003	824560	38.19962	75.7277	1640.4	3.158986
2004	20966	25.47219	75.30997	2056.92	3.240601
2005	20966	25.65792	76.61633	1899.45	3.076356
2006	28087	25.73816	82.02592	1697.72	2.976219
2007	35097	25.13455	76.47797	2554.96	3.082329
2008	33679	25.44396	76.17822	1604.25	2.999426
2009	42224	25.83055	74.97619	1906.64	3.039288
2010	49029	25.8551	76.04501	1827.05	3.386164
2011	45670	25.48833	75.05271	1697.11	3.067014
2012	41564	25.44153	73.14675	1507.93	3.418579
2013	40571	25.48452	74.88162	1829.28	3.462795
2014	41062	26.01088	72.26852	1686.89	3.150247
2015	51989	25.83885	73.93395	2250.42	2.895589
2016	47167	26.19251	76.95224	2912.71	2.993525
2017	41497	25.23833	81.62989	4915.96	2.984466
2018	40980	25.06521	78.94526	2797.82	2.763014
2019	46423	25.66718	77.42638	3000.17	3.003753
2020	33871	25.11183	80.98593	2923.73	2.80653

Wheat Production of Dhaka.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Wind speed
1990	48360	16.94	66.59216	1071.29	3.347836
1991	50230	25.22792	66.61359	1158.34	3.437589
1992	61290	28.74667	62.88199	700.05	3.195137
1993	57410	25.58175	66.96542	1283.67	3.298137
1994	57660	26.55466	61.37723	812.71	4.136658
1995	59920	20.30274	65.67485	1160.19	3.449589
1996	69240	25.39434	64.90016	1040.08	3.204809
1997	71440	27.4426	69.6889	1589.94	3.100795
1998	84850	24.95025	75.73537	2014.33	3.253918
1999	88080	24.46077	73.2031	1700.58	3.437781
2000	82530	24.50678	80.78534	1866.34	3.145601
2001	72300	23.40438	74.0209	1914.03	3.089288
2002	75290	25.27781	75.00192	1861.74	3.028877
2003	62080	38.19962	75.7277	1640.4	3.158986
2004	47230	25.47219	75.30997	2056.92	3.240601
2005	32143	25.65792	76.61633	1899.45	3.076356
2006	20552	25.73816	82.02592	1697.72	2.976219
2007	15429	25.13455	76.47797	2554.96	3.082329
2008	15778	25.44396	76.17822	1604.25	2.999426
2009	15732	25.83055	74.97619	1906.64	3.039288
2010	7724	25.8551	76.04501	1827.05	3.386164
2011	10104	25.48833	75.05271	1697.11	3.067014
2012	4910	25.44153	73.14675	1507.93	3.418579
2013	245699	25.48452	74.88162	1829.28	3.462795
2014	257287	26.01088	72.26852	1686.89	3.150247
2015	228222	25.83885	73.93395	2250.42	2.895589
2016	216053	26.19251	76.95224	2912.71	2.993525
2017	211793	25.23833	81.62989	4915.96	2.984466
2018	201220	25.06521	78.94526	2797.82	2.763014
2019	181355	25.66718	77.42638	3000.17	3.003753
2020	148745	25.11183	80.98593	2923.73	2.80653

Aus Production of Chattogram.

Year	Production (M. Ton)	Temperature	Precipitation	Humidity	Wind Speed
1990	73215	24.33358	101.39	67.94	2.13
1991	87790	25.73675	54.7	66.56	2.18
1992	92890	24.04667	32.51	65.81	2.59
1993	92890	24.38683	161.44	64.88	3.2
1994	76110	24.54192	158.05	63.44	2.73
1995	54700	24.7205	88.29	60.38	2.88
1996	38580	24.90283	119.19	67.44	3.59
1997	58230	23.96858	100.77	69.31	2.35
1998	63990	25.51942	349.85	76.69	2.03
1999	77210	25.3565	6.64	65.56	3.28
2000	80160	23.88042	128.9	60.81	2.23
2001	86960	24.89625	53.24	68.56	2.18
2002	90730	23.22858	86.16	57.94	3.61
2003	99430	25.19708	111.49	60.69	2.67
2004	108360	23.97392	68.03	67.12	2.07
2005	100830	24.89625	129.72	69	2.6
2006	82878	25.60192	53.43	49.69	2.82
2007	86859	26.48708	266.32	39.5	2.52
2008	93523	26.56117	64.03	53.62	2.49
2009	102177	23.9685	156.13	43.69	2.28
2010	102418	24.8185	80.27	37.62	2.93
2011	102394	24.15517	141.95	40.31	3.2
2012	108080	22.98875	258.78	38.62	2.23
2013	107343	27.48708	63.02	41.06	2.76
2014	110758	25.72692	63.69	49.38	2.69
2015	108026	25.19542	219.8	55.56	2.86
2016	107643	24.8945	178.91	50.31	2.82
2017	119873	23.22875	854.13	49.69	3.33
2018	118732	25.60283	364.11	60.81	2.7
2019	107376	26.65075	242.34	59.44	2.42
2020	107744	25.81917	419.76	69.12	2.8

Aman Production of Chattogram.

Year	Production (M. Ton)	Temperature	Precipitation	Humidity	Wind Speed
1990	526470	29.6	568.02	77.56	6.71
1991	537650	29.31	589.35	81.56	4.82
1992	580430	29.2	549.77	84.38	6.04
1993	581510	27.8	757.96	83.81	4.21
1994	593680	28.06	723.51	81.94	2.79
1995	608260	26.97	900.28	80.76	5.77
1996	533030	27.54	584.78	78.65	5.79
1997	553840	28.89	1430.84	85.75	6.26
1998	406090	28.58	2358.14	85	5.26
1999	399950	28.3	1632.1	83.5	4.67
2000	570110	27.83	1590.87	82.5	4.97
2001	666350	27.84	1431.47	85.44	5.6
2002	676750	27.95	1000.07	82.56	5.65
2003	681580	28.01	843.67	80.19	4.59
2004	697760	28.58	771.96	80.69	4.71
2005	665129	28.51	1060.13	81.19	4.75
2006	643804	29.28	1520.43	82.31	3.77
2007	456501	28.77	2107.47	86	3.43
2008	440316	28.98	1695.44	86.75	4.53
2009	469112	28.8	2454.86	86.38	5.08
2010	489931	29.02	1878.58	86.06	5.38
2011	478656	29.49	2043.53	83.38	5.8
2012	467750	29.09	1933.78	86.5	5.14
2013	474409	28.98	1996.07	88.19	3.87
2014	477130	29.68	2286.64	86.56	4.4
2015	495198	29.5	2547.39	86.19	4.51
2016	489876	30.08	3139	86.56	3.66
2017	476543	29.51	4618.54	83.38	4.45
2018	478765	30	3967.52	83.38	5.25
2019	498765	29.9	3664.38	79.5	5.8
2020	478765	30.26	2405.03	80.88	5.41

Boro Production of Chattogram.

Year	Production (M. Ton)	Temperature	Precipitation	Wind Speed	Humidity
1990	290260	26.72	174.43	2.66	79.69
1991	196620	26.48	353.9	2.73	83
1992	293840	25.47	128.04	2.97	83.69
1993	282470	25.19	153.17	2.85	80.5
1994	271820	26.3	166.95	2.62	78.12
1995	269000	24.74	194.74	2.58	80.65
1996	300320	24.21	298.14	2.99	75.75
1997	251090	24.94	430.78	2.88	84
1998	289490	25.3	412.41	2.74	83.06
1999	376170	25.22	401.42	2.39	84.19
2000	362880	25.83	268.35	2.66	81.69
2001	360410	25.62	242.11	2.54	83.31
2002	307470	25.12	212.7	2.59	81.75
2003	336580	25.52	272.99	2.23	81.56
2004	322320	25.37	610.81	2.19	82.19
2005	313277	26.09	304.14	2.75	83.12
2006	333753	24.61	423.9	2.59	76.56
2007	188662	24.12	910.55	2.58	78.12
2008	273585	24.33	364.84	3.33	81.62
2009	260882	24.4	508.84	2.42	83.44
2010	209701	23.47	590.15	2.59	79.69
2011	233924	22.99	554.76	2.39	85.31
2012	233916	25.64	302.01	2.99	83.69
2013	227322	25.19	569.12	2.02	84.75
2014	251413	24.26	473.18	2.54	84.75
2015	213771	23.71	694.81	2.78	80.94
2016	236765	23.83	1539.4	2.59	84.62
2017	267654	24.45	1902.21	2.56	80.75
2018	312456	24.38	751.25	2.62	75.94
2019	287654	25.55	1334.43	2.54	76.81
2020	309876	25.94	1400.42	3.06	84.56

Potato Production of Chattogram.

Year	Production (M. Ton)	Wind Speed	Humidity	Temperature	Precipitation
1990	22120	3.493508	69.11745	26.24803	843.84
1991	36515	3.561144	71.07311	26.10575	997.95
1992	37160	3.327745	69.18385	26.16912	710.75
1993	35130	3.505808	70.1146	25.9454	1072.57
1994	35600	3.392395	68.49274	26.07981	1048.51
1995	35600	3.616206	72.46958	25.90337	1203.28
1996	35945	3.550679	72.34679	25.8606	1002.11
1997	35890	3.412585	74.94517	25.27326	1965.82
1998	38350	3.364535	78.48981	25.5463	3120.4
1999	100170	3.556651	76.77044	25.60564	2040.16
2000	97190	3.383848	78.78467	25.05296	1988.12
2001	111480	3.272299	76.7819	25.30849	1734.82
2002	95425	3.232824	75.59429	25.55318	1298.93
2003	453415	3.45069	75.29513	25.67005	1228.15
2004	68660	3.45269	76.43812	25.58874	1450.8
2005	37492	3.313062	77.98485	25.74786	1493.8
2006	37153	3.176994	77.30771	25.67937	1997.76
2007	39375	3.206662	79.32361	25.03362	3288.77
2008	45011	3.114645	79.36441	25.37452	2124.31
2009	45268	3.138368	78.57744	25.59948	3119.83
2010	48666	3.323882	78.55481	25.77047	2549
2011	48474	3.114207	78.18853	25.21058	2740.24
2012	46436	3.39245	78.48846	25.33493	2494.57
2013	14428	3.466689	77.47487	25.43178	2628.21
2014	51170	3.122178	76.81125	25.74277	2823.51
2015	46436	3.116398	77.74479	25.59567	3462
2016	47898	3.191815	81.21994	25.97929	4857.31
2017	48988	2.99474	82.8121	25.40307	7374.88
2018	51987	3.015396	81.19117	25.11123	5082.88
2019	49876	2.92346	78.86644	25.60775	5241.15
2020	52987	3.074211	81.14874	25.3789	4225.21

Wheat Production of Chattogram.

Year	Production (M.Ton)	Wind Speed	Humidity	Temperature	Precipitation
1990	30	3.493508	69.11745	26.24803	843.84
1991	0	3.561144	71.07311	26.10575	997.95
1992	10	3.327745	69.18385	26.16912	710.75
1993	10	3.505808	70.1146	25.9454	1072.57
1994	20	3.392395	68.49274	26.07981	1048.51
1995	70	3.616206	72.46958	25.90337	1203.28
1996	130	3.550679	72.34679	25.8606	1002.11
1997	160	3.412585	74.94517	25.27326	1965.82
1998	220	3.364535	78.48981	25.5463	3120.4
1999	230	3.556651	76.77044	25.60564	2040.16
2000	90	3.383848	78.78467	25.05296	1988.12
2001	60	3.272299	76.7819	25.30849	1734.82
2002	50	3.232824	75.59429	25.55318	1298.93
2003	50	3.45069	75.29513	25.67005	1228.15
2004	90	3.45269	76.43812	25.58874	1450.8
2005	38	3.313062	77.98485	25.74786	1493.8
2006	19	3.176994	77.30771	25.67937	1997.76
2007	7	3.206662	79.32361	25.03362	3288.77
2008	14	3.114645	79.36441	25.37452	2124.31
2009	11	3.138368	78.57744	25.59948	3119.83
2010	8	3.323882	78.55481	25.77047	2549
2011	6	3.114207	78.18853	25.21058	2740.24
2012	6	3.39245	78.48846	25.33493	2494.57
2013	8	3.466689	77.47487	25.43178	2628.21
2014	7	3.122178	76.81125	25.74277	2823.51
2015	5	3.116398	77.74479	25.59567	3462
2016	7	3.191815	81.21994	25.97929	4857.31
2017	6	2.99474	82.8121	25.40307	7374.88
2018	11	3.015396	81.19117	25.11123	5082.88
2019	8	2.92346	78.86644	25.60775	5241.15
2020	10	3.074211	81.14874	25.3789	4225.21

Aus Production of Khulna.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Wind Speed
1990	41771.32	25.46483	49.07675	107.86	3.084
1991	43789.81	27.13508	39.83608	15.84	3.078
1992	51800.25	25.82264	45.89744	24.91	3.075
1993	51800.25	25.68417	44.52533	103.8	3.055
1994	58250.33	25.92333	42.59275	67.34	3.25
1995	51446.45	26.07492	37.33475	45.72	3.22
1996	20139.5	25.98545	46.90983	68.21	3.245
1997	32885.45	24.68142	47.693	204.45	2.741
1998	32440.93	23.85583	54.8535	267.73	2.903
1999	29138.77	25.79633	46.078	7.44	3.332
2000	29664.94	24.57413	53.20992	138.1	2.97
2001	18751.51	24.82875	46.24742	63.54	2.842
2002	20402.59	25.09942	52.40208	103.65	2.85
2003	18996.45	24.36458	54.68258	154.64	2.831
2004	19241.39	24.96322	53.67909	90.75	3.07
2005	21119.26	25.48767	55.69558	109.35	2.957
2006	22209.7	25.65025	50.50642	58.47	2.749
2007	5557	24.50192	51.15892	102.55	2.797
2008	8060	23.77661	60.02438	117.02	2.59
2009	11594	25.5545	50.7585	79.36	2.582
2010	8320	25.36017	52.07125	74.72	2.428
2011	8569	24.28525	55.28567	99.8	2.87
2012	10584	24.8281	52.14223	140.47	3.089
2013	19150	24.53442	47.79575	63.92	3.249
2014	17413	24.77275	52.562	44.08	2.844
2015	4525	24.42633	55.558	222.09	2.748
2016	3552	26.33711	53.92975	130.28	2.864
2017	4035	24.26342	60.22958	308.07	2.973
2018	4776	23.35883	62.08492	264.28	2.379
2019	3974	24.60575	55.53642	222.47	2.819
2020	6677	22.74025	66.53331	400.14	2.194

Aman Production of Khulna.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Wind Speed
1990	593824.1	29.42366	79.17894	754.44	3.879
1991	569621.3	30.30341	74.59146	414.01	4.799
1992	594432.8	30.00236	73.99821	455.94	4.015
1993	583510.3	29.59333	78.62008	661.7	4.437
1994	588409.1	29.62748	78.39333	556.76	4.087
1995	496583.9	29.54837	78.8026	520.35	4.293
1996	539693.3	29.87561	76.32943	656.96	4.094
1997	587130	29.07325	81.90301	855.62	3.792
1998	443558.9	29.58472	81.97439	776.39	3.88
1999	545499.3	28.97472	82.6852	977.69	3.962
2000	671334.9	28.4252	86.3487	1037.49	3.561
2001	602760.8	28.4861	86.97211	1111.21	3.736
2002	627300.1	29.27715	82.87236	883.13	3.638
2003	703449.2	29.87374	78.68089	706.41	3.852
2004	653780.8	29.56992	79.59179	696.07	3.815
2005	590757.8	30.20878	76.25886	590.65	3.643
2006	605053.2	29.13268	82.15163	707.97	3.653
2007	220009	29.21715	82.05992	1390.71	3.443
2008	192869	28.94675	82.74317	901.63	3.577
2009	212203	29.29699	81.96805	1184.47	3.524
2010	215848	28.84732	85.72041	1032.01	3.524
2011	176017	28.82984	83.9922	1256.73	3.357
2012	181186	30.1874	76.7048	700.46	3.929
2013	208540	28.7748	85.77122	1112.38	4.143
2014	125844	29.84748	80.62	991.27	3.878
2015	255133	29.20545	82.70805	1343.08	3.671
2016	250580	28.79073	85.37878	2042.88	3.233
2017	237373	28.55772	87.85951	2155.6	3.19
2018	196908	28.50309	87.71073	1482.53	3.298
2019	224346	29.39407	83.9461	1508.13	3.685
2020	249714	28.48854	88.21081	1630.8	3.507

Boro Production of Khulna.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Wind Speed
1990	90870	24.3173	69.99385	209.71	2.805
1991	100290	23.98467	70.81418	310.18	2.251
1992	117150	25.66508	57.19377	122.4	2.541
1993	159870	24.34697	69.56049	220.03	2.5
1994	113370	25.14811	57.03639	108.36	2.707
1995	114660	23.78623	75.94508	332.99	2.612
1996	120510	23.94787	65.19049	164.84	2.355
1997	134680	23.88057	75.19648	216.91	2.405
1998	138150	23.855	83.0659	405.29	2.395
1999	194981	23.26992	83.36098	444.12	2.487
2000	213007	23.48959	79.18951	373.78	2.121
2001	223920	23.55295	82.19582	332.58	2.192
2002	197938	23.48484	79.14393	252.73	2.342
2003	218132	23.66795	81.34803	344	3.322
2004	322830	23.23082	82.06639	558.02	2.597
2005	303864	23.09549	83.69385	414.66	2.537
2006	340033	23.85467	77.99828	337.28	2.241
2007	113713	22.83098	84.42631	576.73	2.549
2008	149530	23.72361	82.09672	428.96	2.293
2009	139626	23.30721	81.5068	442.57	2.405
2010	158228	24.02434	81.77246	488.83	2.185
2011	162899	23.96156	78.99885	297.33	2.456
2012	171587	22.19787	79.39033	376.87	2.725
2013	172068	23.37746	83.84016	503.33	2.355
2014	190876	23.48467	74.80189	256.01	2.305
2015	178971	24.57443	75.57738	331.7	1.826
2016	176698	23.62877	82.8818	490.17	2.178
2017	198901	23.78115	85.11197	1018.76	2.31
2018	194455	23.83352	75.32164	267.29	2.252
2019	269538	23.52107	85.72639	906.07	2.318
2020	249918	23.9327	84.35697	597.39	2.144

Potato Production of Khulna.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Wind Speed
1990	11465	26.415	66.212	1072.01	3.258
1991	11885	27.149	61.902	740.03	3.382
1992	17050	27.175	59.106	603.25	3.213
1993	18900	26.555	64.383	985.53	3.336
1994	18630	26.912	59.485	732.46	3.351
1995	18630	26.48	64.214	899.06	3.379
1996	24695	26.614	62.89	890.01	3.324
1997	24790	25.894	68.414	1276.98	2.983
1998	38155	25.786	73.423	1449.41	3.063
1999	166885	26.023	70.876	1429.25	3.262
2000	163345	25.507	73.006	1549.37	2.886
2001	178540	25.635	71.987	1507.33	2.926
2002	155270	25.968	71.608	1239.51	2.946
2003	152620	25.988	71.682	1205.05	2.005
2004	61091	25.934	71.85	1344.84	3.163
2005	61091	26.279	71.983	1114.66	3.048
2006	54443	26.224	70.359	1103.72	2.884
2007	68355	25.532	72.692	2069.99	2.932
2008	62268	25.496	75.017	1447.61	2.823
2009	45030	26.064	71.553	1706.4	2.84
2010	67064	26.089	73.338	1595.56	2.045
2011	70310	25.708	72.885	1653.86	2.896
2012	64076	25.752	69.479	1217.8	3.25
2013	66262	25.577	72.641	1679.63	3.252
2014	262804	26.052	69.451	1291.36	3.012
2015	298152	26.086	71.398	1896.87	2.751
2016	289415	26.258	74.149	2663.33	2.759
2017	305726	25.549	77.857	3482.43	2.825
2018	305638	25.251	75.145	2014.1	2.646
2019	277738	25.857	75.201	2636.67	2.943
2020	280253	25.069	79.759	2628.33	2.619

Wheat Production of Khulna.

Year	Production (M. Ton)	Temperature	Humidity	Precipitation	Wind Speed
1990	6460	26.415	66.212	1072.01	3.258
1991	5070	27.149	61.902	740.03	3.382
1992	5740	27.175	59.106	603.25	3.213
1993	3640	26.555	64.383	985.53	3.336
1994	6260	26.912	59.485	732.46	3.351
1995	7360	26.48	64.214	899.06	3.379
1996	10970	26.614	62.89	890.01	3.324
1997	6770	25.894	68.414	1276.98	2.983
1998	7540	25.786	73.423	1449.41	3.063
1999	8410	26.023	70.876	1429.25	3.262
2000	5360	25.507	73.006	1549.37	2.886
2001	4460	25.635	71.987	1507.33	2.926
2002	4760	25.968	71.608	1239.51	2.946
2003	4890	25.988	71.682	1205.05	2.005
2004	4360	25.934	71.85	1344.84	3.163
2005	3990	26.279	71.983	1114.66	3.048
2006	2866	26.224	70.359	1103.72	2.884
2007	2853	25.532	72.692	2069.99	2.932
2008	3723	25.496	75.017	1447.61	2.823
2009	4224	26.064	71.553	1706.4	2.84
2010	3260	26.089	73.338	1595.56	2.045
2011	3545	25.708	72.885	1653.86	2.896
2012	3539	25.752	69.479	1217.8	3.25
2013	1102	25.577	72.641	1679.63	3.252
2014	555	26.052	69.451	1291.36	3.012
2015	1323	26.086	71.398	1896.87	2.751
2016	1272	26.258	74.149	2663.33	2.759
2017	902	25.549	77.857	3482.43	2.825
2018	506	25.251	75.145	2014.1	2.646
2019	316	25.857	75.201	2636.67	2.943
2020	417	25.069	79.759	2628.33	2.619

Aus Production of Rajshahi.

Year	Production (M.Ton)	Humidity	Temperature	Wind Speed	Precipitation
1990	141566.1	37.14617	24.87242	10.799	68.91
1991	124420.4	34.6385	26.16908	10.599	11.18
1992	141067.2	41.97391	25.3055	11.97033	23.01
1993	141067.2	42.69917	24.67992	11.352	65.55
1994	130934	39.91934	25.36508	11.37633	27.57
1995	97513.29	32.65625	25.06933	12.315	21.65
1996	65825.32	37.27508	25.79842	11.95267	40.79
1997	117906.8	37.59375	24.17867	10.971	107.82
1998	119712.1	56.11417	23.27217	11.18067	139.79
1999	88831.52	39.7125	24.52375	11.35267	13.79
2000	94691.94	48.73125	23.46475	10.68533	158.22
2001	89938.3	39.6328	23.87492	9.559	54.07
2002	82771.54	52.1403	24.11508	10.123	154.67
2003	107111.3	55.42134	23.15525	10.167	143.63
2004	113507	57.93308	24.2435	10.63433	140.21
2005	115657	52.0914	24.33675	10.18533	96.33
2006	159200.9	49.09447	23.99425	8.896333	80.76
2007	67169	51.56684	23.76125	10.12967	88.01
2008	84331	54.358	23.32608	9.315333	73.58
2009	115356	44.76725	24.86708	9.609	70.57
2010	85089	51.9865	24.48733	11.37467	48.9
2011	106330	49.64517	23.62917	10.534	109.83
2012	121732	55.60208	24.12558	11.25033	98.51
2013	106267	44.39475	23.44217	13.039	82.55
2014	102336	40.63258	23.8475	11.08033	61.17
2015	111467	51.894	24.05925	11.30233	194.75
2016	112737	51.8445	25.92967	10.794	126.8
2017	103737	60.51492	23.89233	10.99367	252.8
2018	567811	67.42408	22.35817	9.617333	306.05
2019	572285	61.6945	24.4235	10.44467	106.32
2020	134357	95.98067	22.10417	9.151333	225.57

Aman Production of Rajshahi.

Year	Production (M.Ton)	Precipitation	Temperature	Humidity	Wind Speed
1990	663125	470.35	31.60342	65.69117	3.936083
1991	644781.7	309.58	32.86242	59.29717	4.237833
1992	695665.7	219.46	32.79925	57.1945	3.852
1993	642677.1	333.74	32.0985	60.94617	4.491583
1994	553364.7	274.06	32.48767	64.09017	4.321833
1995	523418.5	361.24	32.12208	59.6585	4.17875
1996	613746.9	364.31	32.45758	62.96408	4.5555
1997	653418.1	698.17	31.22867	72.72617	3.734083
1998	664658.2	966.3	30.976	76.26817	3.61325
1999	726047.4	870.08	30.5895	70.34367	3.64975
2000	773892.3	822.83	29.85608	67.77134	3.552333
2001	730565.1	813.62	30.12483	74.5089	3.858333
2002	742812.1	843.12	30.49133	64.5875	3.615333
2003	717655.9	641.97	31.02383	66.56067	3.65525
2004	729356.8	885.33	30.66375	71.75475	3.753667
2005	809962	713.09	31.79542	83.543	3.467667
2006	147656	759.64	30.2645	77.93575	3.50925
2007	177145	1092.58	30.70875	73.30417	3.52875
2008	179016	822.82	30.32925	72.18525	3.343
2009	193581	857.15	31.1585	59.77917	3.460167
2010	201370	679.4	30.7685	67.15067	3.633
2011	185350	1023	30.27925	66.90025	3.50375
2012	196898	580.85	32.06567	67.19684	3.53125
2013	118453	733.2	30.54467	61.6304	3.542583
2014	605457	895.14	31.41867	69.58657	3.583083
2015	209258	1007.34	30.4965	73.71817	3.707417
2016	207047	1027.31	30.68308	96.806	3.61425
2017	272701	1234.41	29.81242	84.80792	3.424833
2018	196177	945.62	29.72258	80.35508	3.307333
2019	196312	1119.34	30.84175	74.27683	3.732917
2020	202992	1288.31	29.58767	102.4724	3.55275

Boro Prduction of Rajshahi.

Year	Production (M.Ton)	Precipitation	Humidity	Temperature	Wind Speed
1990	465122.8	178.88	67.34134	24.98267	2.776667
1991	474194.7	2306.18	61.64867	24.21967	2.371083
1992	487357.9	81.08	45.358	26.20625	2.635
1993	529923	125.96	47.96392	25.82033	2.534833
1994	520198	83.36	41.55858	25.97817	2.74275
1995	580072.2	200.37	62.27725	24.97675	2.685333
1996	588590.7	95.64	57.47817	25.22575	2.54425
1997	628461.5	95.64	65.58225	23.73583	2.307167
1998	829911	409.53	75.54558	23.74767	2.39425
1999	866751.8	306.02	90.46034	23.48683	2.383583
2000	873927	411.34	65	23.66858	2.088917
2001	875573.5	392.62	70.84808	23.66083	2.112917
2002	868485.6	312.03	61.91141	23.38042	2.239417
2003	923591.7	353.33	66.59584	23.67667	2.288083
2004	988683.5	462.24	67.17342	22.97167	2.599583
2005	1049472	558.36	67.08384	23.01658	2.41975
2006	1049238	282.31	64.37608	23.92542	2.3225
2007	237713.8	381.83	71.82967	22.89517	2.545583
2008	281275.9	275.88	75.00617	24.14583	2.1885
2009	268670.8	354.95	60.16425	23.13925	2.31775
2010	224648.5	323.81	57.22867	24.239	2.403417
2011	240799.2	239.15	70.33775	23.74858	2.423
2012	256490.5	2006.61	69.06484	21.83225	2.95275
2013	249297.2	358.91	62.83375	23.45842	2.375167
2014	235729	227.16	64.46817	23.61817	2.179417
2015	298819	221.43	56.90084	24.85717	1.819
2016	284455	416.44	99.81875	23.85883	2.174083
2017	272701	527.79	82.04125	24.02858	2.360583
2018	269551	217.18	73.72158	24.12017	2.23475
2019	272192	655.48	67.74575	23.30683	2.418333
2020	254667	565.63	99.55275	23.93425	2.179417

Potato Production of Rajshahi.

Year	Production (M. Ton)	Humidity	Precipitation	Temperature	Wind Speed
1990	83620	58.11589	718.14	26.78088	3.094521
1991	79945	54.00932	599.94	27.37025	3.043945
1992	80670	48.21683	323.55	27.64295	3.10806
1993	79495	53.96537	525.25	27.15575	3.243096
1994	80005	49.37693	384.99	27.56085	3.257644
1995	80005	54.32041	583.26	27.01419	3.268877
1996	81570	51.70475	500.74	27.37107	3.109617
1997	80745	60.37863	1045.69	26.01967	2.88789
1998	79930	69.10436	1515.65	25.64247	2.894027
1999	132265	66.82679	1189.89	25.84112	2.916658
2000	118750	68.55413	1392.39	25.24243	2.724891
2001	158665	66.78321	1260.31	25.53225	2.748822
2002	161030	69.07896	1309.82	25.63951	2.756877
2003	193055	69.56526	1138.93	25.59641	2.789616
2004	435803	70.4382	1487.78	25.53407	2.954699
2005	435803	69.26359	1367.78	26.02151	2.77274
2006	325023	69.33696	1122.71	25.70438	2.648493
2007	374929	69.55751	1562.42	25.43512	2.829342
2008	530209	70.51893	1172.28	25.50858	2.577158
2009	456867	66.21901	1282.67	26.02679	2.68937
2010	675820	67.7886	1052.11	26.13529	2.919479
2011	707529	69.23926	1371.98	25.53107	2.814329
2012	772555	64.32148	1015.35	25.58148	3.04724
2013	783720	68.12214	1174.66	25.46145	3.01726
2014	768946	65.27285	1183.47	25.93458	2.805233
2015	765013	67.88795	1423.52	26.10836	2.745863
2016	777945	68.16948	1570.55	26.38413	2.782568
2017	1065688	74.28296	2015	25.55622	2.805644
2018	1021886	72.50995	1468.85	25.05236	2.612521
2019	996019	70.98036	1881.14	25.83192	2.880795
2020	872871	77.44863	2079.51	24.79544	2.629508

Wheat Production of Rajshahi.

Year	Production (M.Ton)	Humidity	Precipitation	Temperature	Wind Speed
1990	78540	58.11589	718.14	26.78088	3.094521
1991	92290	54.00932	599.94	27.37025	3.043945
1992	104670	48.21683	323.55	27.64295	3.10806
1993	124400	53.96537	525.25	27.15575	3.243096
1994	119220	49.37693	384.99	27.56085	3.257644
1995	122480	54.32041	583.26	27.01419	3.268877
1996	154100	51.70475	500.74	27.37107	3.109617
1997	152540	60.37863	1045.69	26.01967	2.88789
1998	183640	69.10436	1515.65	25.64247	2.894027
1999	187070	66.82679	1189.89	25.84112	2.916658
2000	227570	68.55413	1392.39	25.24243	2.724891
2001	211810	66.78321	1260.31	25.53225	2.748822
2002	205510	69.07896	1309.82	25.63951	2.756877
2003	199100	69.56526	1138.93	25.59641	2.789616
2004	194490	70.4382	1487.78	25.53407	2.954699
2005	163076	69.26359	1367.78	26.02151	2.77274
2006	127776	69.33696	1122.71	25.70438	2.648493
2007	139314	69.55751	1562.42	25.43512	2.829342
2008	179789	70.51893	1172.28	25.50858	2.577158
2009	192638	66.21901	1282.67	26.02679	2.68937
2010	222162	67.7886	1052.11	26.13529	2.919479
2011	203447	69.23926	1371.98	25.53107	2.814329
2012	240175	64.32148	1015.35	25.58148	3.04724
2013	430922	68.12214	1174.66	25.46145	3.01726
2014	473852	65.27285	1183.47	25.93458	2.805233
2015	478266	67.88795	1423.52	26.10836	2.745863
2016	472554	68.16948	1570.55	26.38413	2.782568
2017	477515	74.28296	2015	25.55622	2.805644
2018	407417	72.50995	1468.85	25.05236	2.612521
2019	403614	70.98036	1881.14	25.83192	2.880795
2020	412825	77.44863	2079.51	24.79544	2.629508

