# Wool Demand Prediction for Indian Production Companies

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**Abstract.** Wool production industries rely heavily on accurate demand forecasting to manage supply chains and production schedules effectively. Predicting wool demand allows companies to avoid overproduction and resource wastage while meeting market needs efficiently. Traditional forecasting models often struggle with the seasonality and variability of wool demand. The ARIMA (Auto Regressive Integrated Moving Average) model, a time series forecasting technique, is particularly suited for this task due to its ability to capture both trends and seasonal fluctuations in historical data. The data for this research was collected from official records of wool demand across various Indian states for 2016-2023. After data pre-processing (cleaning, sorting, and organizing), the ARIMA model was implemented using Python for analysis and forecasting. Flask was employed to create a web-based interface, allowing users to interact with the predictive model easily. The model parameters (p, d, q) were fine-tuned to fit the data and generate accurate forecasts. The ARIMA model demonstrated a strong ability to predict wool demand, achieving a low Mean Absolute Error (MAE) and Root Mean Square Error (RMSE). The model's forecasts were closely aligned with actual demand figures across different states, capturing both long-term trends and seasonal variations. Graphical representations showed minimal deviation between predicted and actual values, validating the accuracy of the model. The implementation of the ARIMA model for wool demand forecasting has significant practical implications for production planning in the textile industry. Companies can use the system to optimize production schedules, reduce costs, and minimize wastage. This methodology can be extended to other commodities where seasonal demand plays a critical role, offering a versatile tool for various sectors.

**Keywords.** ARIMA, Wool Demand Forecasting, Time Series Analysis, Flask, Python, Indian Textile Industry

## 1 INTRODUCTION

**Background:**
The demand for wool in India fluctuates significantly due to a variety of factors, including seasonality, changes in consumer preferences, and production rates. Wool is predominantly used in the textile industry, and its demand peaks during colder months, with varying intensities across different Indian states. Accurately forecasting wool demand is crucial for production companies to ensure efficient resource allocation, minimize wastage, and avoid stock shortages. However, predicting this demand is challenging due to its inherent variability and seasonality. The need for precise forecasting models has become more pressing in recent years as companies seek to optimize production processes and reduce costs. Wool production is also influenced by external factors such as global wool prices, local weather conditions, and agricultural cycles, which add complexity to demand prediction.

**Hypothesis:**
This research hypothesizes that wool demand can be accurately forecasted using the ARIMA (Auto Regressive Integrated Moving Average) model. ARIMA is particularly suitable for time series data as it captures both long-term trends and seasonal patterns inherent in wool demand. Unlike traditional models, ARIMA's ability to handle non-stationary data and adjust for seasonality makes it a robust choice for this forecasting task. By analysing historical demand data, ARIMA can generate reliable predictions that help production companies plan more effectively.

**Purpose:**
The purpose of this research is to develop a demand forecasting model tailored to the Indian wool industry using the ARIMA algorithm. The model will be built based on historical demand data across several Indian

states and will be deployed as a web-based tool, allowing wool producers to access demand forecasts in real-time. This predictive model will assist companies in planning their production schedules, optimizing inventory management, and responding more efficiently to market demand fluctuations. By improving the accuracy of demand forecasts, this research aims to contribute to enhanced resource management in the wool production sector.

## 2 METHODOLOGIES

### Data Collection

For this study, wool production and demand data was collected from both government and industry reports covering the period from 2016 to 2023. The data sources included official publications from the Ministry of Textiles in India and reports from key industry players in the wool production sector. The dataset included monthly wool demand figures from several major wool-producing states in India, capturing the seasonality and geographical differences in demand. This dataset provided a strong foundation for building a time series model that accounts for historical trends and fluctuations in wool demand across the country.

### Data Pre-processing

The collected data underwent several pre-processing steps to prepare it for time series analysis. First, missing data points were handled by either interpolation or removal, depending on the extent of messiness. Outliers, such as unexpected spikes or drops in demand, were examined and adjusted to prevent them from skewing the model. Next, the dataset was sorted by date and state to maintain consistency, and any irrelevant columns (such as production costs or unrelated metrics) were removed. The data was then transformed into a time series format, allowing for smoother integration into the ARIMA model. Ensuring the data is stationary was a crucial step, achieved by differencing the dataset to stabilize its mean and variance.

**predicted_value = (a / b) * production**

- **a**: Quantity of wool produced by the company last year in a specific month.
- **b**: Total wool quantity produced by the entire state.
- **Production**: The predicted wool demand for the entire state using the ARIMA model.

This formula works by proportionally scaling the total predicted state demand (calculated using ARIMA) to estimate the company's expected production based on its past contribution to the state's wool production. Here's how each component plays a role:

- a / b: This ratio represents the company's share in the state's production for the last year. It calculates how much of the total state production was contributed by the company in the previous year.
- Production: The value from the ARIMA model predicts the current wool demand for the entire state, factoring in trends, seasonality, and other time series dynamics.

By multiplying this ratio with the ARIMA-predicted state production, you estimate the company's production for the present month. This approach assumes that the company's share in the state's production remains constant over time.

## ALGORITHM

The ARIMA (Auto Regressive Integrated Moving Average) model was selected for its proven capability to handle time series data with non-stationary characteristics. ARIMA is composed of three key parameters:

- **p**: The number of lag observations in the model (autoregressive part).
- **d**: The number of times the raw observations differ to make the series stationary (integrated part).
- **q**: The size of the moving average window (moving average part).

The model was built by first identifying the optimal values for p, d, and q through an iterative process, using methods like the **Autocorrelation Function (ACF)** and **Partial Autocorrelation Function (PACF)** plots. These plots helped in diagnosing the temporal dependencies in the data, aiding the selection of the best parameters. The resulting ARIMA model provided accurate forecasts by capturing the trends and seasonal components in the wool demand data, making it a reliable tool for predicting future demand patterns.

## Tools

Python was the primary programming language used for implementing the ARIMA model and pre-processing the data. Key libraries included:

- **Pandas**: For handling and manipulating the dataset.
- **Stats models**: To build and fit the ARIMA model.
- **Matplotlib / Seaborn**: For generating visual representations of the data and model output.

Additionally, Flask was used to create a web interface for deploying the demand forecasting model. This allows users (wool production companies) to input state-specific demand data and receive real-time predictions for future wool demand through an easy-to-use interface. The deployment of this model as a web-based tool ensures that it is accessible to industry stakeholders, offering a practical solution for production planning.

## Results

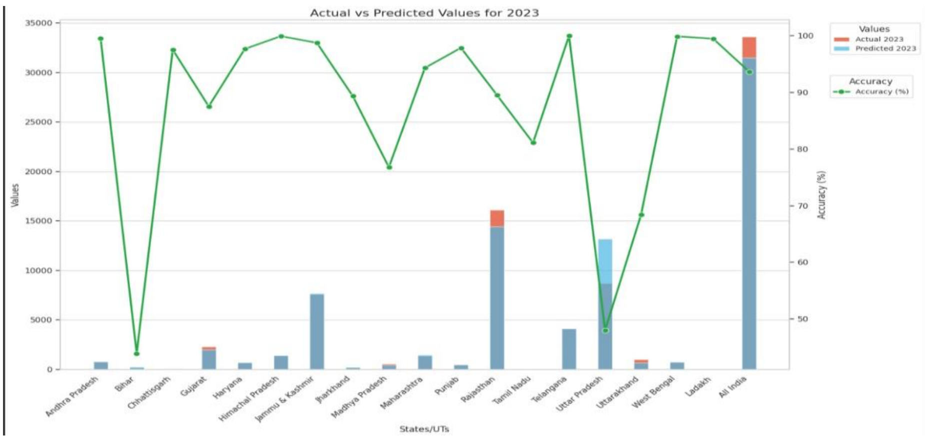



**Fig.1.** Actual vs Predicted Values for 2023

**Table 33: State-wise Estimates of Wool Production During 2016-17 to 2022-23 (figures in '000 Kg.)**

| S. No. | States/ UTs | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | 2022-23 |
|---|---|---|---|---|---|---|---|---|
| 1 | Andhra Pradesh | 791.62 | 794.39 | 797.12 | 801.14 | 0.00 | 0.00 | 0.00 |
| 2 | Arunachal Pradesh | 58.25 | 60.40 | 42.63 | 43.00 | 20.42 | 14.97 | 20.32 |
| 3 | Bihar | 280.87 | 298.10 | 312.38 | 310.78 | 170.16 | 171.74 | 175.26 |
| 4 | Chhattisgarh | 87.29 | 81.77 | 81.95 | 82.99 | 80.04 | 81.39 | 78.23 |
| 5 | Gujarat | 2267.32 | 2294.96 | 2270.51 | 2232.72 | 2003.83 | 2027.41 | 2018.94 |
| 6 | Haryana | 691.22 | 693.39 | 718.50 | 729.52 | 687.22 | 700.54 | 687.58 |
| 7 | Himachal Pradesh | 1475.00 | 1481.87 | 1503.14 | 1516.44 | 1482.24 | 1432.85 | 1434.90 |
| 8 | Jammu & Kashmir | 7265.51 | 7489.43 | 7629.28 | 7477.12 | 7649.74 | 7680.82 | 7580.12 |
| 9 | Jharkhand | 177.65 | 186.59 | 198.59 | 209.97 | 216.87 | 231.52 | 236.97 |
| 10 | Karnataka | 6588.25 | 4305.00 | 3057.92 | 1742.14 | 1051.79 | 862.26 | 732.67 |
| 11 | Madhya Pradesh | 406.22 | 408.16 | 410.17 | 411.85 | 431.07 | 439.80 | 425.61 |
| 12 | Maharashtra | 1406.65 | 1436.77 | 1456.93 | 1412.27 | 1550.22 | 1584.81 | 1591.63 |
| 13 | Punjab | 489.64 | 514.70 | 524.85 | 525.36 | 455.81 | 449.10 | 459.22 |
| 14 | Rajasthan | 14321.27 | 14287.42 | 14521.84 | 12716.83 | 15676.45 | 15207.33 | 16128.87 |
| 15 | Sikkim | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 16 | Tamil Nadu | 2.08 | 1.96 | 2.28 | 2.22 | 1.68 | 1.71 | 1.67 |
| 17 | Telangana | 4658.11 | 4506.02 | 4263.51 | 3960.14 | 3366.06 | 0.00 | 0.00 |
| 18 | Uttar Pradesh | 1286.10 | 1299.62 | 1315.97 | 1328.64 | 886.28 | 815.09 | 819.08 |
| 19 | Uttarakhand | 538.24 | 564.07 | 551.98 | 496.69 | 436.01 | 443.23 | 451.72 |
| 20 | West Bengal | 753.07 | 758.10 | 760.43 | 762.96 | 764.83 | 768.95 | 769.27 |
| 21 | Ladakh | - | - | - | - | 0.00 | 2.43 | 2.41 |
| | **All India** | **43544.37** | **41462.71** | **40420.00** | **36760.57** | **36930.72** | **32915.93** | **33614.48** |

Note "-" Data not reported by State/UTs.
**Source: State/UT Animal Husbandry Departments**

**Fig.2.** Dataset used for making prediction and analysis [1]

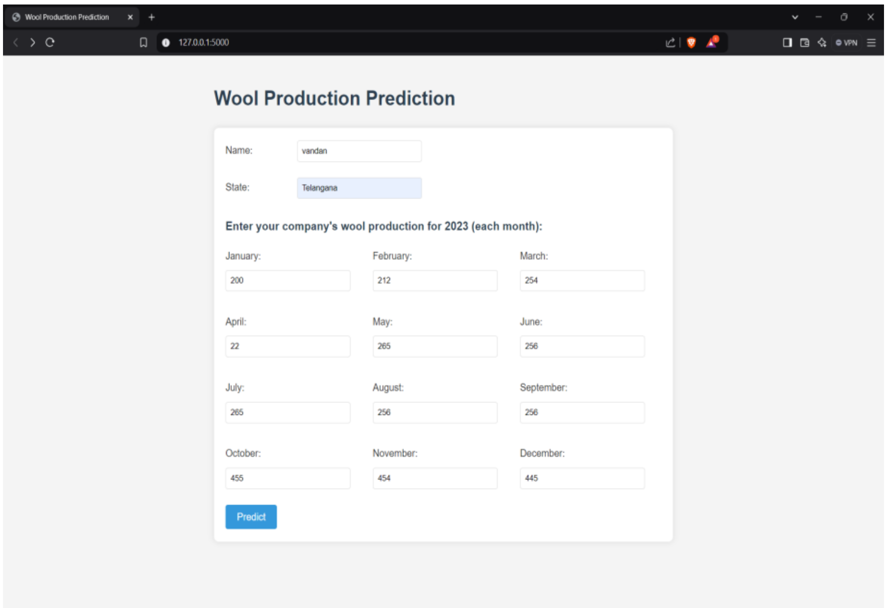
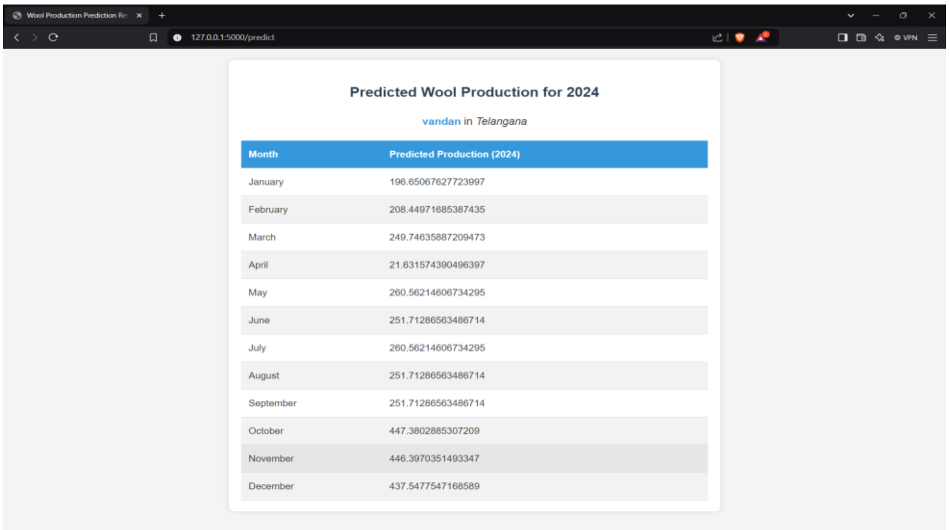



**Fig.3.** Home Page



Predicted Wool Production for 2024

vandan in *Telangana*

| Month | Predicted Production (2024) |
| --- | --- |
| January | 196.65067627723997 |
| February | 208.44971685387435 |
| March | 249.74635887209473 |
| April | 21.631574390496397 |
| May | 260.56214606734295 |
| June | 251.71286563486714 |
| July | 260.56214606734295 |
| August | 251.71286563486714 |
| September | 251.71286563486714 |
| October | 447.3802885307209 |
| November | 446.3970351493347 |
| December | 437.5477547168589 |

**Fig.4.** Result Page

# CONCLUSION & FUTURE SCOPE

## Conclusion

The ARIMA model has proven to be an effective tool for forecasting wool demand in the Indian textile industry. Accurately capturing historical trends and seasonality, the model provides reliable predictions that enable production companies to optimize their resource allocation and production schedules. The low error margins, such as Mean Absolute Error (MAE) and Root Mean Square Error (RMSE), highlight the model's precision in forecasting monthly wool demand across different states. This accuracy is critical for improving decision-making in the industry, allowing companies to minimize wastage, meet market demand efficiently, and adjust their production strategies based on predicted demand patterns. The deployment of the forecasting model as a web-based tool ensures easy access and usability for industry stakeholders, making it a practical solution for addressing the challenges of wool demand volatility.

## Future Scope

While the ARIMA model effectively predicts wool demand based on historical data, there are several opportunities to enhance its capabilities. Integrating external factors such as weather conditions, economic trends, and global wool prices could further improve the accuracy of the predictions. For example, wool production and demand are often influenced by seasonal weather patterns, and incorporating real-time weather data could help the model account for these fluctuations. Additionally, economic indicators such as inflation rates, consumer purchasing power, and trade policies may affect the wool market, and including these variables could provide a more holistic forecast. Furthermore, this model can be expanded to forecast demand for other commodities in the textile industry, such as cotton, silk, or synthetic fibers, where similar seasonal and market dynamics apply. Adapting the ARIMA model for these commodities would provide a versatile tool for textile companies to plan their production across multiple materials. Future research can also explore advanced time series models such as SARIMA (Seasonal ARIMA) or machine learning techniques like Long Short-Term Memory (LSTM) networks to handle more complex patterns and further improve forecasting accuracy.

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