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Demand Forecasting for Agro Tech Technical Textiles

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Abstract: *Demand forecasting is vital in the agrotech industry, merging technology with agriculture to drive innovation and efficiency. Accurate forecasting helps companies predict market trends, optimize resource use, and enhance operations. By anticipating future demand for agricultural products and technological solutions, businesses can make informed decisions on production, inventory, and marketing. However, demand forecasting in agrotech faces challenges such as seasonal variations, limited data, technological complexity, and market uncertainties. Factors like weather patterns, regulatory changes, and shifting consumer preferences add to the difficulty. To address these challenges, methodologies such as statistical techniques, data analytics, and machine learning are employed. Common methods include time series analysis, regression analysis, and hybrid techniques, which use historical data to forecast future trends. Effective demand forecasting improves resource planning, supply chain management, and customer satisfaction. Aligning production with expected demand and optimizing inventory can cut costs, reduce waste, and boost competitiveness. Demand forecasting is essential for strategic planning in agrotech, enabling businesses to predict market trends, meet customer needs, and achieve sustainable growth in a dynamic environment.*

Keywords: Machine Learning, Python, ABC Category Analysis, XYZ Category Analysis, MAE, MSE, MAPE

I. INTRODUCTION

In the rapidly changing agrotech industry, where innovation meets agriculture, demand forecasting is essential for managing uncertainties and optimizing resources. With the advancement of technology, evolving consumer preferences, and the influence of global factors like climate change, demand forecasting offers both challenges and opportunities for the businesses. In this context, demand forecasting involves predicting the future demand for products, services, or solutions that integrate technology into agricultural practices. This spans a wide range of offerings, including precision farming equipment, agricultural drones, smart irrigation systems, genetic engineering solutions, and more.

We have conducted demand forecasting for "PRIYAFIL," a leading company in the technical textiles industry. Priyadarshini Filaments Pvt. Ltd is a brand leader, manufacturer, and merchant exporter of HDPE monofilament woven and knitted fabrics, Polyknit shade net fabrics, and screens. "Priyafil," brand offers high-quality technical textiles with a variety of applications. Their fabrics are used in sectors such as agriculture, aquaculture, infrastructure, packaging, home textiles and decor, pharmaceuticals, construction, geotechnics, and other important domestic and industrial areas. With a pan-India presence, their robust network and distribution links facilitate easy procurement and global exports.

Priyadarshini Filaments was founded by Sri Ramdas M Prabhu in 1972 in Bangalore. Over the past five decades, they have carved a strong niche in the industry by maintaining a steadfast commitment to quality and consistently meeting customer expectations. Their deep understanding of the multidisciplinary technical textiles field, combined with the reach, application knowledge, and dedication of their distributor teams to quality customer service, has enabled them to develop many mutually beneficial relationships.

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II. LITERATURE SURVEY

Ammar Mohamed Aamer said, in today's fast-paced global economy, driven by mobile internet and social media, many business models face disruption, particularly in supply chain management. Data analytics transforms vast amounts of raw data into valuable insights, enhancing supply chain efficiency. This paper reviews 1,870 papers from Scopus and Web of Science, focusing on 79 related to demand forecasting. Neural networks, artificial neural networks, back vector regression, and support vector machines were frequently used, covering 77% of studies. Most machine learning applications (65%) were in industry, with only 5% in agriculture. [1].

Evangelos Spiliotis and et al, estimated daily SKU demand is challenging due to the sporadic nature of data, especially at granular levels like individual stores or slow-moving items. Accurate forecasts are crucial for effective inventory management. Traditionally tackled with statistical methods like Croston's, recent proposals suggest using machine learning (ML) techniques. This paper compares ML methods with traditional approaches, using a comprehensive daily SKU dataset. Findings indicate some ML techniques provide improved accuracy, with cross-learning proving beneficial for certain methods [2].

Balika J. Chelliah and et al, worked on, India's fertile lands and river deltas make it ideal for agriculture, yet the sector contributes less than 3% to the GPP. This study aims to enhance farming supply chain efficiency through several strategies: setting national targets, reducing producer risk, lowering insurance costs, and optimizing the Public Distribution System. It introduces a machine learning algorithm for target prediction to guide farmers and improve interactions with investors, alongside a crop prediction algorithm to boost agricultural revenue [3].

Zeynep Hilal Kilimci and et al, presented an advanced demand forecasting system integrating historical data analysis, time series methods, support vector regression, and deep learning models. Tested with real data from Turkey's SOK Market, it significantly improves accuracy, demonstrating the effectiveness of its novel ensemble integration approach [4].

Bahrudin Hrnjica and Ali Danandeh Mehr discussed, over the past few decades, AI research has focused on creating systems with intelligent behavior, integrating adaptation, learning, autonomy, and problem-solving. AI enables machines to learn from experiences and apply knowledge to new situations. Machine learning, a key AI subset, develops algorithms that improve machine performance through experience [5].

III. METHODOLOGY

Existing Method

Forecasting the demand for agro-based technical textiles poses a significant challenge within the agricultural industry. It requires precise prediction of future needs for specific fabrics used in agriculture, including HDPE monofilament woven and knitted fabrics, polyknit shade net fabrics, and screens. The complexity arises from managing seasonal fluctuations, accessing limited data, navigating technological intricacies, and addressing market uncertainties that impact agricultural demand. Creating reliable forecasting models that consider these variables is essential for enhancing production efficiency, optimizing inventory management, and ensuring prompt response to customer requirements.

Proposed Method

For the real-time data, the request estimating venture for agro-based specialized materials, utilized modern expository strategies to precisely foresee and handle showcase request. Analyzed past deals information, examined advertise patterns, and considered regular vacillations to make solid determining models customized for the particular characteristics of the agrotech material sector. Then, this set are used to train a model using different approaches: M1, M2, M3 and M4 models. Finally, all these models are evaluated using various evaluation metrics like Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE), Mean Squared Error (MSE).

IV. RESULTS AND DISCUSSIONS

For the real-time data, the analysis revealed that the performance metrics fell short of expectations, indicating that the current model or approach may require further refinement. The trends observed in the data suggest that the solution has not fully met the project objectives, highlighting areas for improvement. Although exact figures cannot be disclosed, it

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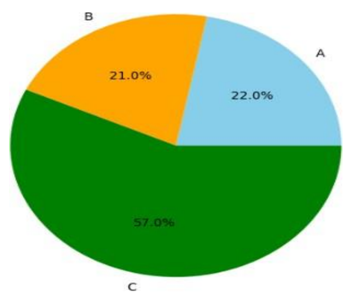
is clear that additional adjustments and optimizations are necessary to enhance performance and achieve the desired outcomes.



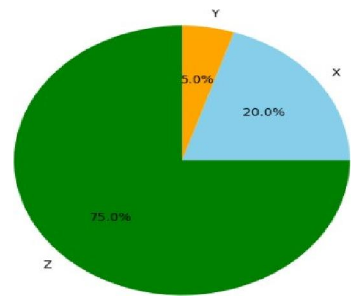


Fig 1: Percentage of ABC Components **Fig 2:** Percentage of XYZ Components

Figure 1: This pie chart illustrates the volume distribution of three components: 57% of component C(green), 22% of component A (blue), and 21% of component B (orange). This breakdown highlights the dominant role of component C in the textile's composition, with components A and B contributingsignificantly but to a lesser extent. This visual aids in understanding the material's structure, guiding decisions in production and quality control

Figure 2: The pie chart shows the volume distribution of XYZ components: 75% for Z (green), 20% for X (blue), and 5% for Y (orange). Component Z is the dominant element, critical to the textile's structure, while component X also plays a significant role. Component Y, though minimal, provides complementary attributes.

4.1 EXPERIMENTAL RESULTS OF THE PROPOSED LEARNING ARCHITECTURE

The initial model results indicate that the forecasting accuracy for volatile items has room forimprovement. The high demand variability for these items has presented challenges in achieving precise forecasts. While the model has provided valuable insights, further refinement and optimizationare needed to better handle the fluctuations and improve accuracy. Moving forward, additionaladjustments to the model will be implemented to enhance its ability to manage demand volatility and better align with project goals.

Best Models for Each Product:

product_id	best_model	MSE	MAE	MAPE
R	M4	2706.411916	43.089304	10.217083

Forecasting Results:

Time ID	Actual Sales	Predicted Sales	Product ID	Model
56	418.12	436.285964	R	M4
57	499.35	452.252528	R	M4
58	325.80	405.692173	R	M4
59	443.28	442.343662	R	M4
60	555.89	477.477428	R	M4
61	391.74	425.771307	R	M4

Table 1: Best Model and Forecasting Results

Table 1 illustrates the best model for each product and forecasting results by giving clear picture on actual and predicted sales. The best model is decided on the basis of the accuracy of the evaluating metrics like MSE, MAE and MAPE.

V. CONCLUSION

In conclusion, while our demand forecasting model for agro-based technical textiles has provided valuable insights, the accuracy for items with high demand volatility has been less than anticipated. The real-time data analysis has highlighted areas where further improvements are needed. Moving forward, we will focus on refining the model to better handle demand fluctuations and enhance overall forecasting precision. Despite the challenges, the project has laid a solid foundation for future enhancements and offers a clear direction for optimizing demand forecasting processes.

VI. ACKNOWLEDGEMNT

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