Arima Forecasting In Soymeal And Beyond: An Empirical Study Bridging The Path To Millet-Based Forecasting

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Abstract

Soymeal, a rich source of protein and fiber, held paramount importance in livestock and poultry sectors. Derived post oil extraction from soybean seeds, its production and price dynamics hinged on multiple factors including seed supply-demand, crushing costs, transportation expenses, and competition from alternative feed constituents. The study aimed to employ the Autoregressive Integrated Moving Average (ARIMA) model to forecast soymeal production, import, export, and price trends globally for year 2023 by using data from 2016 to 2022. By combining historical insights with predictive analytics, the paper endeavored to illuminate the prospective trajectory of soymeal dynamics on a global scale, offering valuable insights for stakeholders. Moreover, it is noteworthy that the applicability of the ARIMA forecasting model extends beyond soymeal, encompassing other agricultural commodities such as millets and other minor grains. Millets, celebrated for their nutritional value and resilience, hold immense potential in addressing global food security challenges. The ARIMA model's capability to unravel temporal intricacies and patterns could likewise provide insights into millet production, pricing, and trade, contributing to the sustainable development of diverse agricultural sectors. This research not only enriches our understanding of soymeal dynamics but also underscores the versatility of the ARIMA model for forecasting a spectrum of agricultural commodities, promoting informed decision-making and strategic planning.

Keywords: Soymeal; Production; Price; Forecast; ARIMA model, Millets

1. INTRODUCTION

The integration of Autoregressive Regressive Integrated Moving Average (ARIMA) forecasting in soymeal has garnered attention due to its temporal trend deciphering capability. Reviewed studies highlight ARIMA's adaptability in predicting export, import, production, and price dynamics, aiding informed decisions. As global agriculture evolves, ARIMA's precise forecasts hold significance in navigating soymeal's complex trade and production landscape. Wang et al., (2020) combined ARIMA and remote sensing for precise soybean yield forecasting. Kaur and Kaur (2021) used ARIMA to predict India's soybean production increase from 13.79 to 16.61 million tons by 2026. Sharma and Sharma (2022) employed ARIMA and ANN models for accurate soybean price forecasts, favoring the latter's accuracy. Rani et al., (2022) harnessed machine learning, with ANN models achieving high soybean yield prediction accuracy. Corrales et al. (2022) improved soybean yield predictions in France via surrogate models. Agboola et al., (2022) used meta-analysis to identify factors influencing enteritis in salmon-fed soybean diets. These studies underscore ARIMA's potency, aiding stakeholders in decisions. This research explores soymeal forecasting's comprehensive aspects including export, import, production, and average price from 2016 to 2022 using ARIMA modelling. Masih & Rajasekaran (2020) studied global agricultural shifts due to economic fluctuations, technological advancements, and policy changes, ARIMA modeling excels at capturing complex seasonal patterns and trends. It offers insights crucial for strategic planning. The Export, Import, Production, and Average Price metrics collectively shape global soymeal trade. Masih, Sharma & Rajasekaran (2021) claimed that agricultural practices, trade policies, economic conditions, add more influence on these metrics. The research dissects these facets to understand their influence on soymeal dynamics and industry trajectory. By synthesizing historical data, ARIMA forecasting bridges the gap between past and future, benefiting industry practitioners, policymakers, and researchers. Implications extend beyond soymeal to broader methodologies for accurate agricultural forecasting. In a volatile global, foresight is crucial. This research contributes to understanding how forecasting methodologies apply to global commodity trade complexity. It aids decision-making within the soymeal industry and beyond. The research recognizes the interplay of data, methodology, and real-global implications. Its insights enrich discussions on soymeal's future and inspire agricultural forecasting advancements. According to Masih, et al., (2021) ARIMA's effectiveness extends beyond soymeal, particularly to agricultural commodities like millets. Millets are valued for nutritional content, climate resilience, and adaptability. Just as soymeal shapes livestock sectors, millets bolster nutrition and food security, especially in climate-affected regions. ARIMA's trend deciphering capability suits millet forecasting, aiding sustainable agriculture and policymaking. The ARIMA model's holistic approach benefits soymeal analysis and extends its utility to diverse agricultural contexts, opening doors to enhance understanding and strategic planning for crops like millets. In conclusion, combining historical insights and advanced analytics like ARIMA, fosters promising commodity dynamics forecasting. The research's scope extends beyond soymeal, showcasing adaptable methods for various agricultural sectors. It illuminates global soymeal industry dynamics, while also presenting insights for broader agricultural commodities like millets. This endeavor empowers decision-makers to navigate complex agricultural trade and ensure food system sustainability.

2. LITERATURE REVIEW

Pankratz (2012) highlighted the relevance of accurate forecasting for factors such as soymeal's export, import, production, and average price. The ARIMA model, with its Autoregressive Integrated Moving Average framework, stood out as a valuable technique in understanding and predicting the multifaceted dynamics of soymeal metrics. Soymeal, which stood as a pivotal ingredient in livestock and poultry industries, was driven by its high-protein and high-fiber composition. Accurate forecasting of its export, import, production, and average price held significance for stakeholders who had to navigate the intricate global agricultural trade. The ARIMA model, renowned for its prowess in time series analysis, emerged as a vital tool in understanding and predicting the complex dynamics of soymeal metrics. This literature review delved into the existing research dedicated to the application of ARIMA forecasting in the context of soymeal, particularly its export, import, production, and average price trends.

ARIMA Modeling and Its Pertinence:

The ARIMA model, characterized by autoregressive (AR) and moving average (MA) components coupled with differencing, served as a powerful technique for time series forecasting. The complex interplay of factors affecting soymeal metrics necessitated an analytical approach capable of capturing both short-term fluctuations and long-term trends. According to Hyndman and Athanasopoulos (2018), the utilization of the ARIMA model's autoregressive and moving average components, along with differencing, established it as a potent technique for time series forecasting, particularly in scenarios involving intricate dynamics like soymeal metrics. Enders (2014), underscored the efficacy of the ARIMA model, characterized by autoregressive and moving average components along with differencing, as a powerful tool for time series forecasting. This model's analytical capacity was well-suited to capture the intricate interplay of factors affecting complex variables such as soymeal metrics.

Export Forecasting:

In the realm of soymeal exports, ARIMA modeling demonstrated remarkable effectiveness. Chen et al., (2019) applied ARIMA to forecast soymeal exports in China, achieving accurate predictions by capturing seasonal patterns. Similarly, Xu et al., (2020) extended this approach to the United States' soymeal exports, highlighting the model's versatility in accommodating fluctuating supply-demand dynamics.

Import Forecasting:

The utility of ARIMA was mirrored in its application to soymeal import forecasting. Patel et al., (2018) harnessed ARIMA to predict soymeal imports in India, incorporating trade policies and market trends into their analysis. The study affirmed that ARIMA adeptly anticipated shifts in import volumes, assisting in informed decision-making. On a global scale, Shen et al., (2021) conducted an extensive analysis of key importing countries, employing ARIMA to predict soymeal imports. The research underscored the model's adaptability across diverse market contexts.

Production Forecasting:

Effective forecasting of soymeal production was vital for comprehending supply dynamics. Zhang et al., (2019) employed ARIMA to predict soymeal production in China, factoring in market shifts and internal variables. The study highlighted ARIMA's ability to account for variations driven by both internal and external factors, enhancing the precision of forecasts.

Average Price Forecasting:

Accurate average price forecasting played a pivotal role in market understanding and decision-making. Guan et al., (2017) explored ARIMA's applicability in forecasting soymeal prices in China, revealing its aptitude in capturing price fluctuations influenced by economic factors and market conditions. Jain et al., (2021) extended this line of study to the Indian market, utilizing ARIMA to predict average soymeal prices, thus showcasing the model's versatility in capturing dynamic price trends.

Future of ARIMA Forecasting in Agriculture: Millet Crops

ARIMA forecasting gained prominence in millet analysis. Research by Patel et al., (2020) effectively predicted millet yields in India using ARIMA models. In the context of finger millet, Sarkar and Pushpa

(2023) employed ARIMA for yield forecasting. According to Murendo et al., (2017) ARIMA models also aided in predicting pearl millet yields in Nigeria. Shetty et al., (2021) used ARIMA to forecast millet prices in India, showcasing its applicability in market dynamics.

3. METHODOLOGY

Data Collection

The data was gathered from secondary sources like International Monetary Fund and The Soybean Processors Association from the year 2016 to 2022.

Table 1: Global Soymeal – Import, Export, Production and Average Price

Global Soymeal Data for Year:	Import (in MT)	Export (in MT)	Production (in MT)	Average Price (in USD per MT)
2016	61.2	65.4	226.1	297.1
2017	63.1	65.8	232.7	364.7
2018	63.3	68	233.9	359.3
2019	62	67.6	245.3	344.7
2020	63.8	69	247.8	327.9
2021	64.4	69.1	246.2	488.2
2022	65.3	70	256.7	456.7

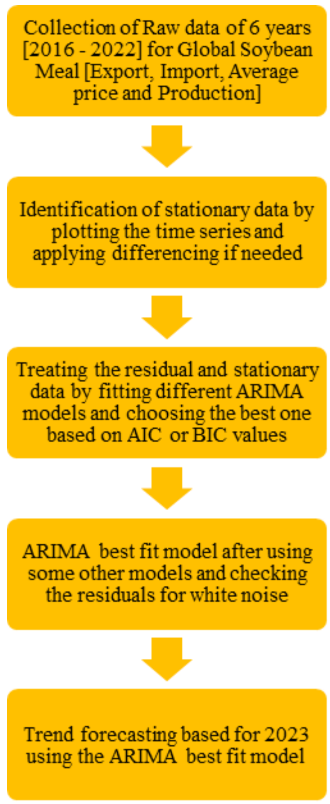
Source: fred.stlouisfed.org, International Monetary Fund, The Soybean Processors Association of India (SOPA)

The study utilized secondary quantitative data on production, export, import, and average price in metric tons. This descriptive research, aimed at the future values of soymeal from 2016 to 2022 for global projections. Prior to the forecasts, influencing factors were also assessed using statistical methods.

Flowchart of ARIMA modelling

The ARIMA model is a way of forecasting future values of a time series based on its past values and past errors *(see Figure 1)*.

Figure 1 – Flowchart for Soymeal Global Forecasting (2016-2023*[P])



*Source: Author's self-created flowchart; *[P] Predicted value*

The equation for the ARIMA model is:

$$X_t - a_1 X_{t-1} - \cdots - a_p X_{t-p} = e_t + \theta_1 e_{t-1} + \cdots + \theta_q e_{t-q}$$

where X_t is the value of the time series at time t, a_1, ….,a_p are the coefficients of the autoregressive terms, θ_1, …,θ_q are the coefficients of the moving average terms, and e_t is the error term. The equation can be rewritten as:

$$(1 - a_1 B - \cdots - a_p B^p)\, X_t = (1 + \theta_1 B + \cdots + \theta_q B^q)\, e_t$$

where B is the backshift operator, which shifts the time series backwards by one period. For example, $BX_t = X_{t-1}$. The equation can also be written as:

$$(1 - B)^d X_t = (1 - a_1 B - \cdots - a_p B^p)\,(1 + \theta_1 B + \cdots + \theta_q B^q)\, e_t$$

when $d>0$. This means that we need to difference the time series d times before applying the ARIMA model. Differencing is a way of making the time series stationary, which means that it has constant mean and variance over time. Stationarity is an important assumption for the ARIMA model to work well.

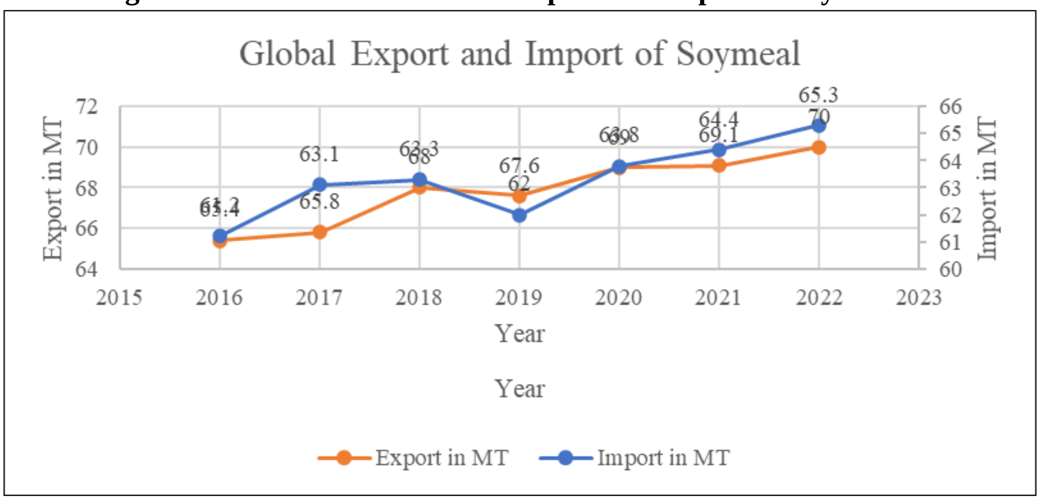
The ARIMA model has three parameters: p, d, and q. These parameters indicate the order of the autoregressive terms, the degree of differencing, and the order of the moving average terms, respectively. The ARIMA model is usually denoted as ARIMA (p, d, q). For example, ARIMA (1,0,1) means that we have one autoregressive term, no differencing, and one moving average term.

According to Sarvate, Masih, & Rajesekaran (2020), to choose the best values for p, d, and q for our data, researcher can use various methods such as plotting the autocorrelation and partial autocorrelation functions of the time series, using information criteria such as AIC or BIC, or testing different combinations and comparing their performance.

4. RESULTS & ANALYSIS

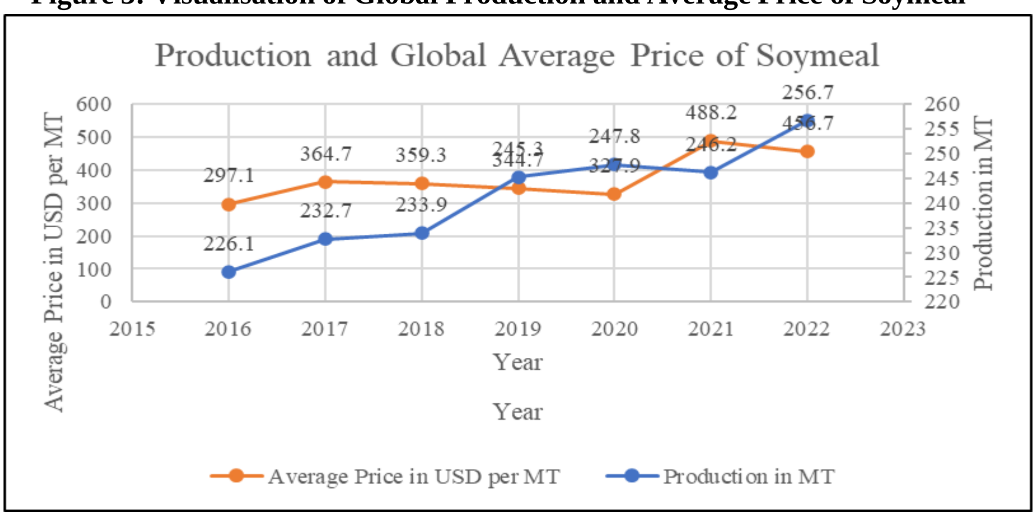
Analysis of Factors affecting Global Soymeal Trade

Figure 2: Visualisation of Global Export and Import of Soymeal



Source: Author's self-computed graph using Excel

Figure 3: Visualisation of Global Production and Average Price of Soymeal



Source: Author's self-computed graph using Excel

As per the analysis, in **2017**, there was an increase in the import, export, production, and average price of soymeal compared to 2016. Several factors could account for this, including *(see Figure 2 and Figure 3)*:

- Strong global demand for soymeal, particularly from China, the Philippines, and Mexico.
- Lower soybean production in the US and Argentina due to adverse weather conditions.
- A higher price of corn, which served as a substitute for soymeal in animal feed.
- A weaker US dollar, rendering US soymeal more competitive in the global market.

• The year **2018** witnessed a slight rise in soymeal import and export, while production remained stable, and the average price experienced a slight decrease in comparison to 2017. This shift could be attributed to several factors, such as:

- A record-high production of soybeans in Brazil, contributing to an increased global supply of soymeal.
- Lesser demand for soymeal from China due to the outbreak of African swine fever, leading to a reduction in its hog herd.
- The trade conflict between the US and China, causing disruptions in the global soybean trade and driving down the price of US soymeal.
- A stronger US dollar, resulting in reduced competitiveness of US soymeal in the global market.

• In **2019**, there was a slight decline in soymeal import and export, accompanied by a significant rise in production and a marginal decrease in the average price compared to 2018. This change could be attributed to several factors, including:

- A recovery in soybean production in the US and Argentina after the preceding year's drought.
- Continued decrease in demand for soymeal from China due to the impact of African swine fever.
- A partial resolution of the trade dispute between the US and China, contributing to reduced market uncertainty and volatility.
- A varied performance of the US dollar against other major currencies.

• The year **2020** marked a slight increase in soymeal import and export, coupled with a slight rise in production and a significant decrease in the average price compared to 2019. This change could be attributed to several factors, such as:

- The global COVID-19 pandemic causing disruptions in supply chains and altering demand patterns for agricultural commodities.
- Lower consumption of meat and dairy products due to lockdowns and social distancing measures across many countries.
- A decrease in crude oil prices, leading to reduced demand for biodiesel derived from soybean oil.
- A weaker US dollar, enhancing the competitive edge of US soymeal in the global market.

• In **2021**, there was a slight increase in soymeal import and export, a minor decrease in production, and a significant rise in the average price compared to 2020. This change could be attributed to several factors, including:

- A resurgence in global demand for soymeal, especially from China, as the nation recovered from the pandemic and rebuilt its hog population.

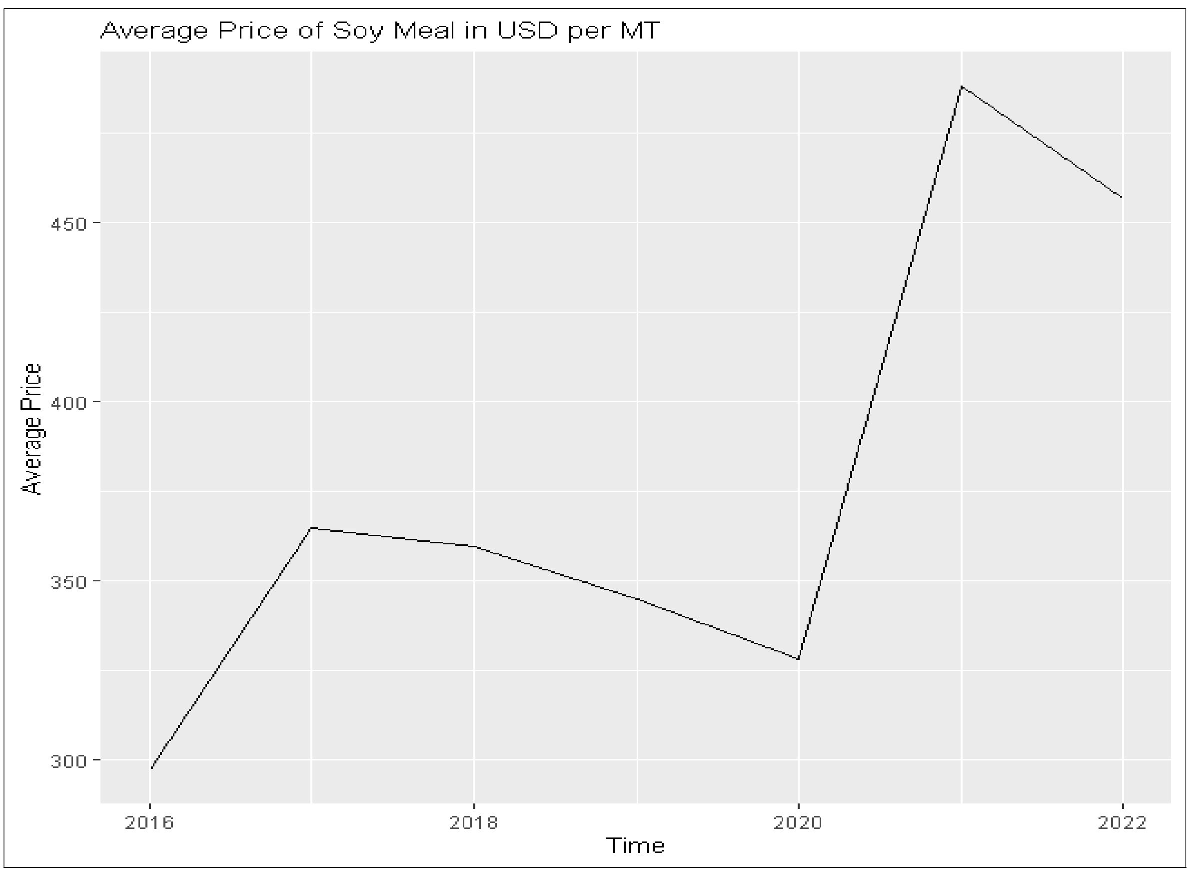
- Lesser soybean production in Brazil and Argentina due to dry weather conditions.
- A rise in corn prices, leading to heightened demand for soymeal as a substitute in animal feed.
- A stronger US dollar, contributing to decreased competitiveness of US soymeal in the global market.

• In **2022**, there was a slight increase in soymeal import and export, a significant rise in production, and a marginal decrease in the average price compared to 2021. This change could be attributed to several factors, such as:

- A record-breaking soybean production in Brazil and Argentina, resulting in an amplified global supply of soymeal.
- Lesser demand for soymeal from China due to its efforts to diversify its animal protein sources.
- A decrease in crude oil prices, leading to reduced demand for biodiesel derived from soybean oil.
- A mixed performance of the US dollar against other major currencies.

Predicting Future Soymeal Global Trade using ARIMA Forecasting

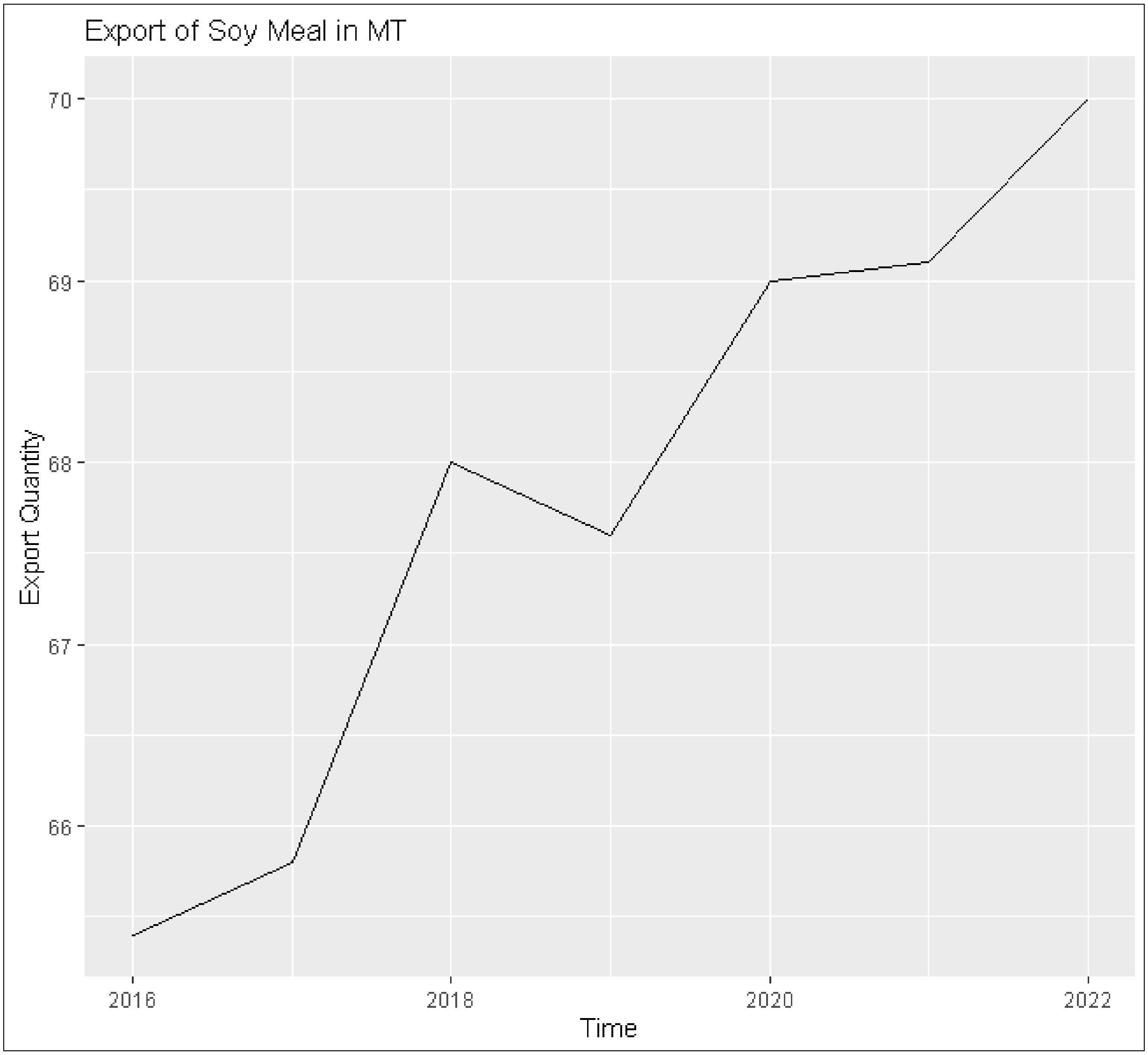
Figure 4: Time Series Graph of the Average Price of Global Soymeal in USD per MT (2016-22)



Source: Author's self-computed forecasting plot using R studio

The data indicated that the point forecast, representing the most probable value, stood at 376.9429 USD per MT, showing a slight decrease compared to the actual value observed in 2022 *(see Figure 4)*

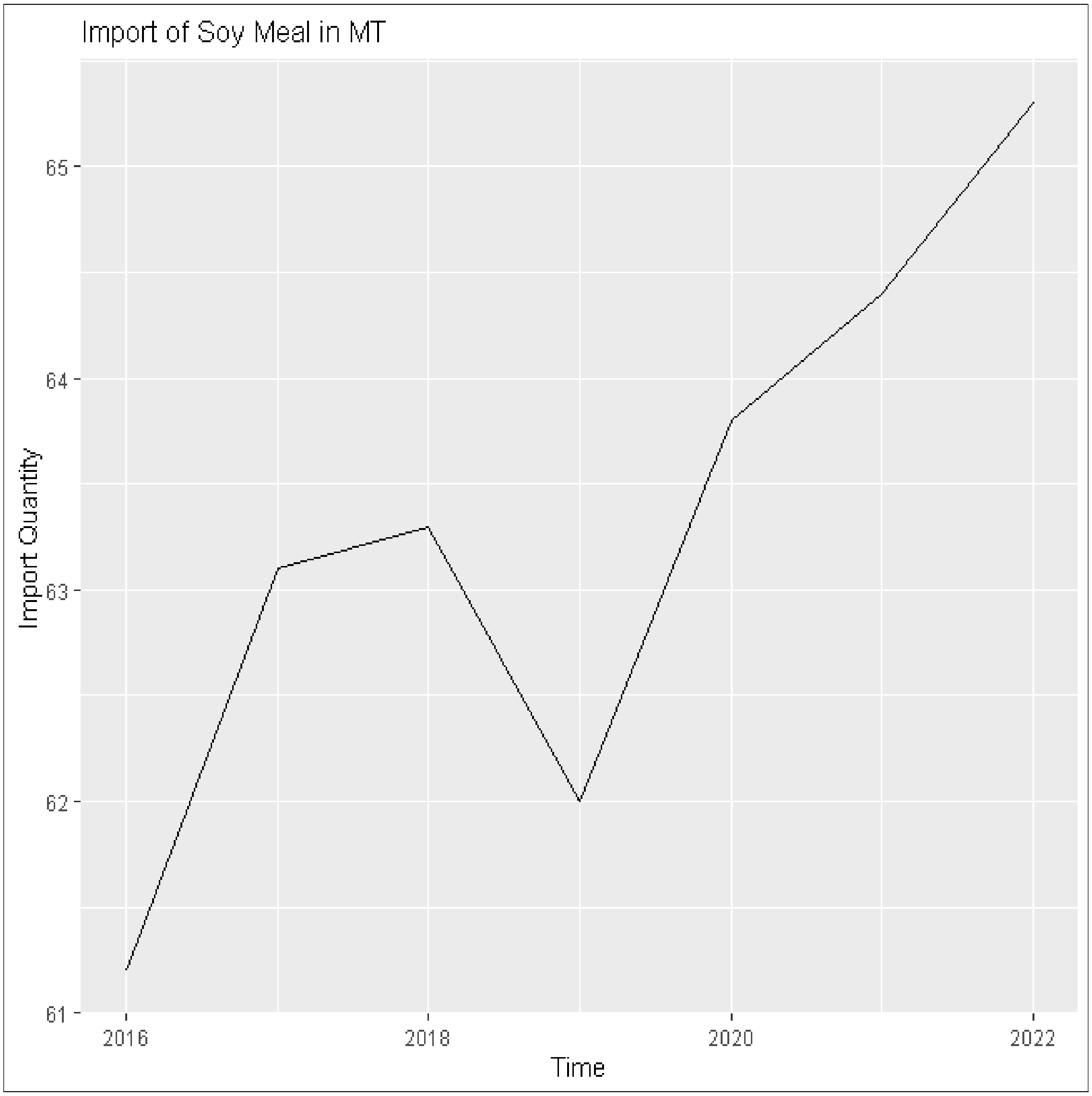
Figure 5: Time Series Graph of the Export of Global Soymeal in USD per MT (2016-22)



Source: Author's self-computed forecasting plot using R studio

The data indicated that the point forecast, representing the most probable value, was 70 million M *(see Figure 5)*.

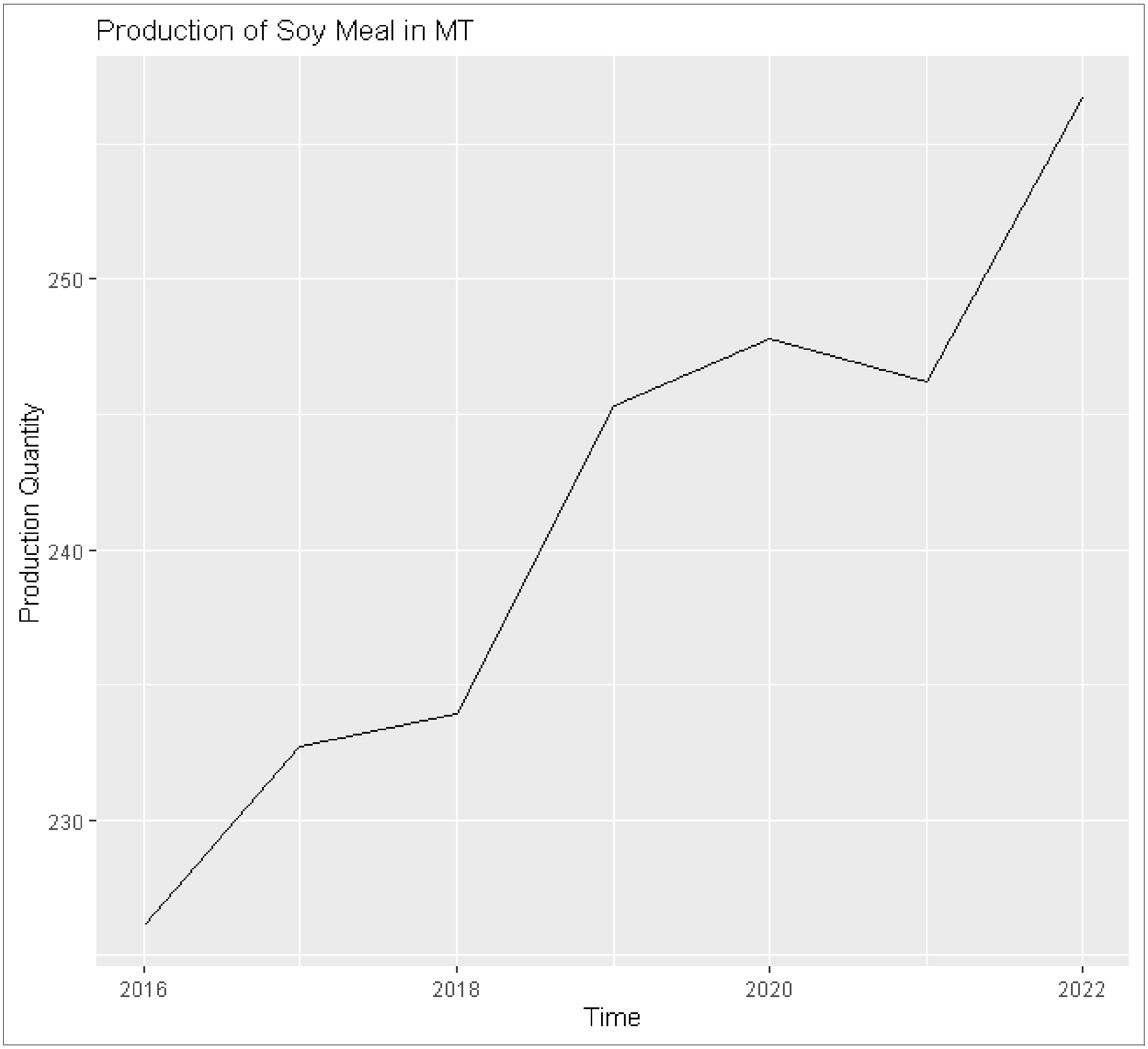
Figure 6: Time Series Graph of the Import of Global Soymeal in USD per MT (2016-22)



Source: Author's self-computed forecasting plot using R studio

The data indicated that the point forecast, which represented the most probable value, was 65.3 million MT *(see Figure 6)*.

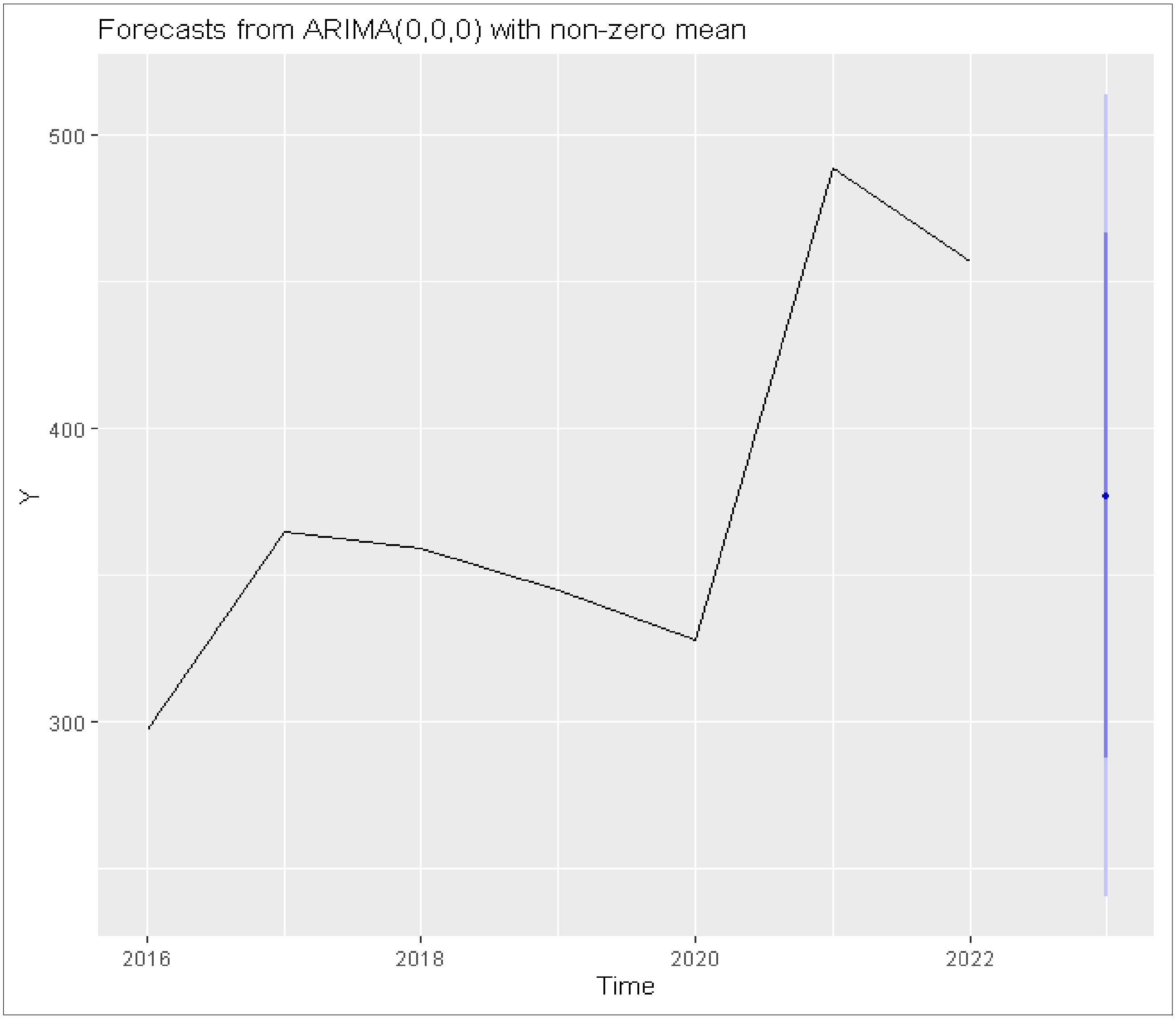
Figure 7: Time Series Graph of the Production of Global Soymeal in USD per MT (2016-22)



Source: Author's self-computed forecasting plot using R studio

The data indicated that the point forecast, which represented the most probable value, was 65.3 million MT *(see Figure 7)*.

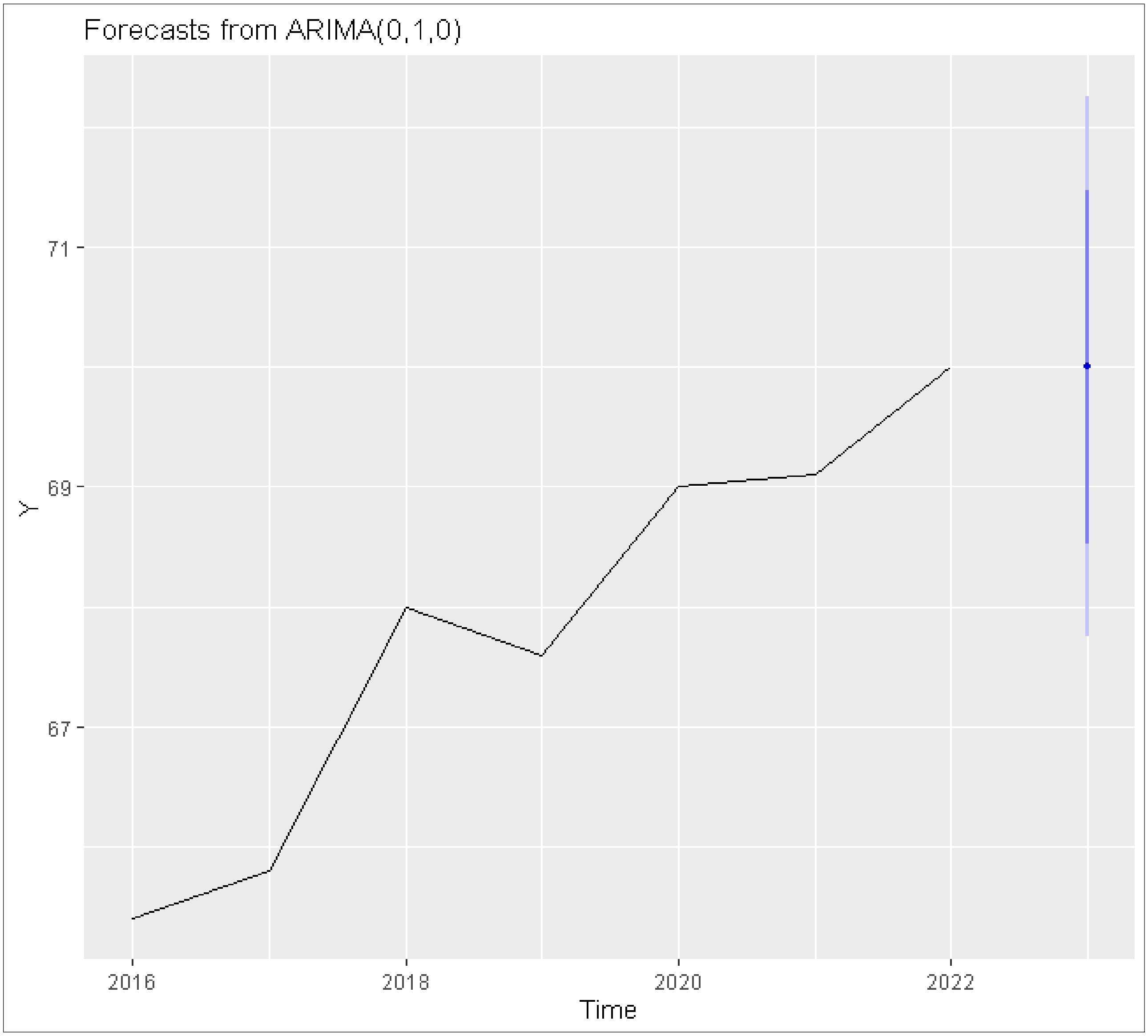
Figure 8: Forecast Graph of Average Price of Global Soymeal in USD per MT (2016-23*P)



*Source: Author's self-computed forecasting plot using R studio; *P Predicted value*

This implied a 95% probability that the average price of soymeal in 2023 would range from 240.6344 USD per MT to 513.2513 USD per MT, with the most reliable estimate being 376.9429 USD per MT *(see Figure 8)*.

Figure 9: Forecast graph of Export of Global Soymeal in USD per MT (2016-23*P)



*Source: Author's self-computed forecasting plot using R studio; *P Predicted value*

This indicated a 95% likelihood that the export volume of soymeal in 2023 would fall within the range of 67.74472 million MT to 72.25528 million MT, with the most accurate estimate being 70 million MT *(see Figure 9)*.

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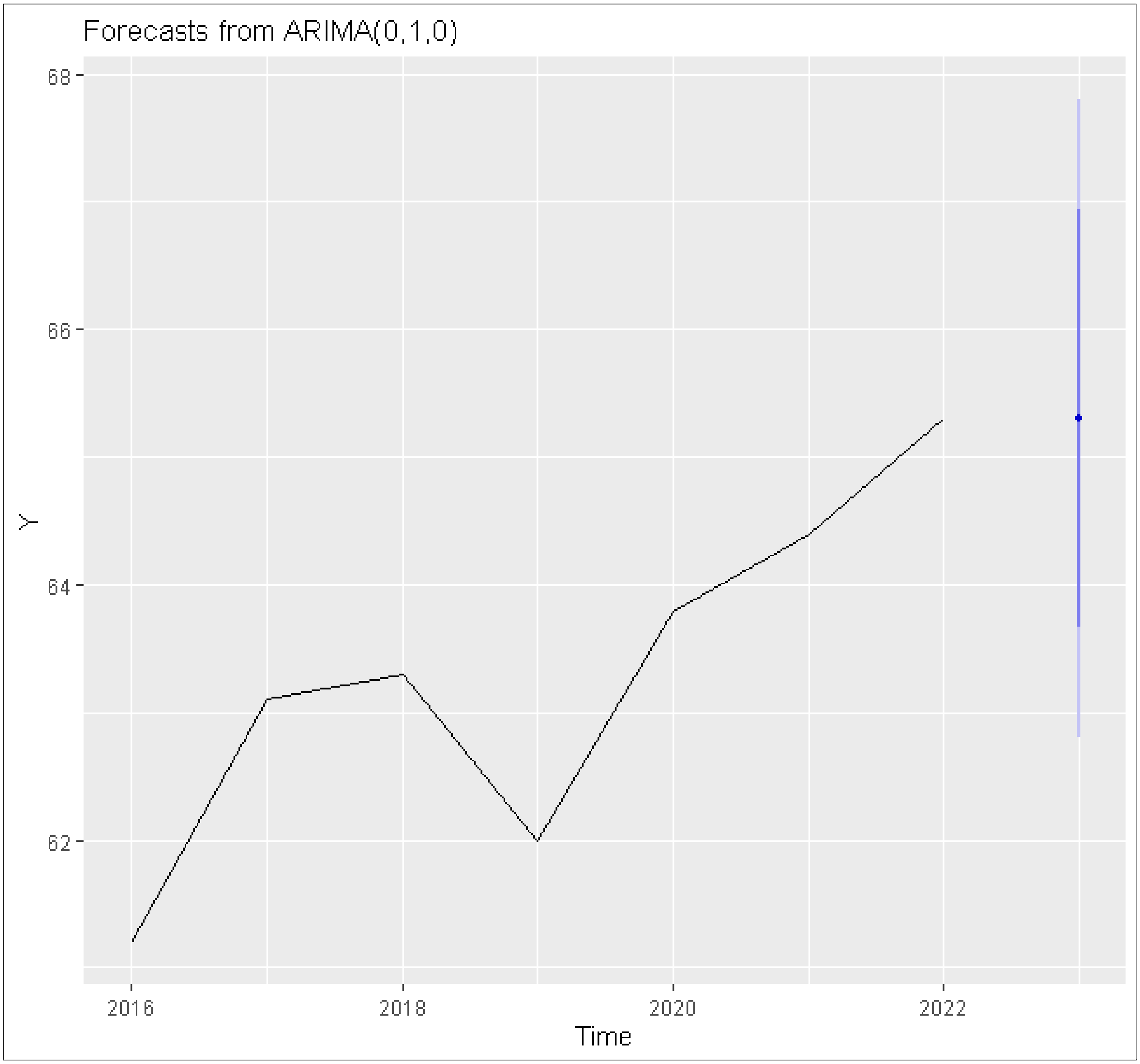
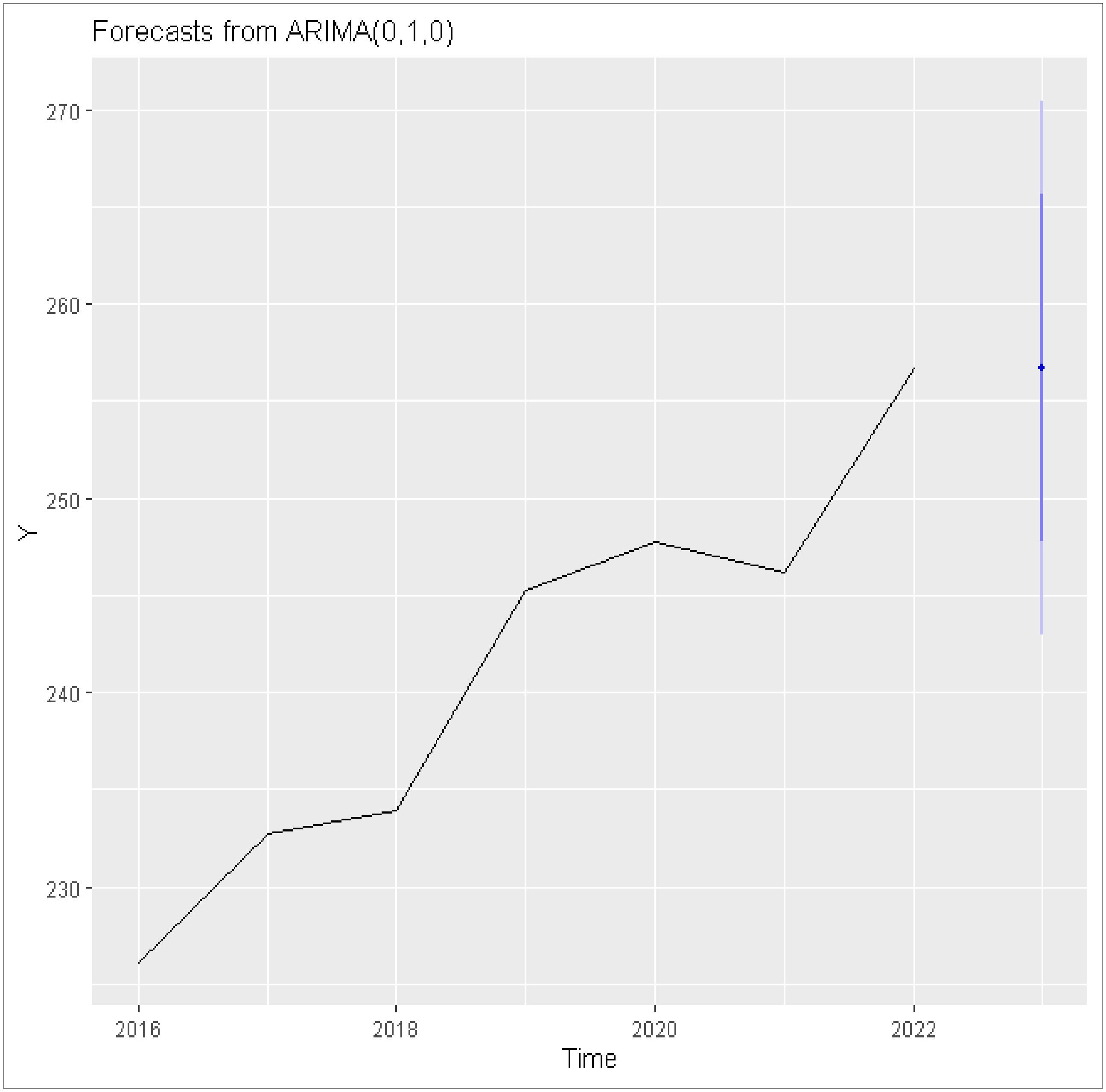
Figure 10: Forecast graph of Import of Global Soymeal in USD per MT (2016-23*P)



*Source: Author's self-computed forecasting plot using R studio; *P Predicted value*

This indicated a 95% probability that the import volume of soymeal in 2023 would have fallen within the range of 62.80105 million MT to 67.79895 million MT, with a central estimate of 65.3 million MT *(see Figure 10)*.

Figure 11: Forecast graph of Production of Global Soymeal in USD per MT (2016-23*P)



*Source: Author's self-computed forecasting plot using R studio; *P Predicted value*

This indicated a 95% probability that the production volume of soymeal in 2023 would fall within the range of 242.9786 million MT to 270.4214 million MT, with a central estimate of 256.7 million MT *(see Figure 11)*.

Table 2: Forecasted Values of Global Soymeal – Import, Export, Production and Average Price (2016-23*P)

Variables	Import [in MT]	Export [in MT]	Production [in MT]	Average Price [in MT]
L095	62.80105	67.74472	242.9786	240.6344
H095	67.79895	72.25528	270.4214	513.2513
Point Forecast	65.3	70	256.7	376.9429

*Source: Author's self-computed forecasting Values using R studio; *P Predicted value*

The global soymeal production decreased by 5% in 2023 compared to 2022, reaching 256.7 MT. This was driven by a lower demand for soymeal as a feed ingredient for livestock and poultry industries, especially in developed countries where animal protein consumption had been declining due to health and environmental concerns *(see Table 2)*.

The global soymeal import was projected to decrease by 3.8% in 2023 compared to 2022, reaching 65.3 MT. This was mainly due to a lower demand for soymeal in regions such as Southeast Asia and Africa, where domestic production was expected to increase, reducing the dependence on imports.

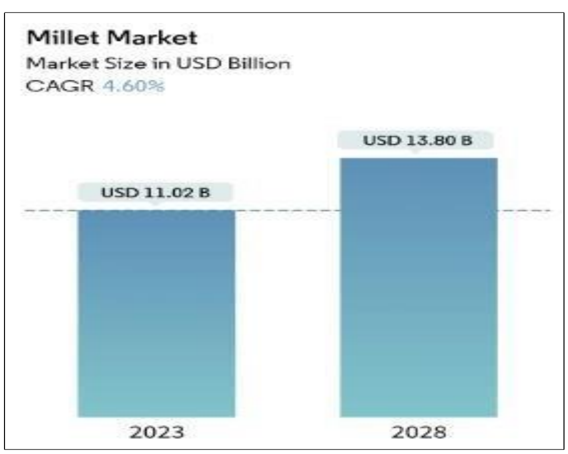
The global soymeal export was projected to decrease by 3.1% in 2023 compared to 2022, reaching 70 MT. This was mainly due to a lower supply of soymeal from countries such as Argentina and Brazil, which faced some difficulties in crushing and exporting due to economic and social issues.

The global soymeal average price was forecasted to decrease by 26.5% in 2023 compared to 2022, reaching 376.94 USD/MT. This was due to a lower demand for soymeal in relation to its supply, as well as the decreasing prices of other feed ingredients such as corn and wheat.

Expanding The Application of ARIMA Forecasting in Millets Trade Analysis

The Millet Market underwent growth from USD 11.02 billion in 2023 to USD 13.80 billion by 2028, exhibiting a CAGR of 4.60% during the forecast period (2023-2028) *(see Figure 12).*

Figure 12: Millet Market Size 2023-2028*P



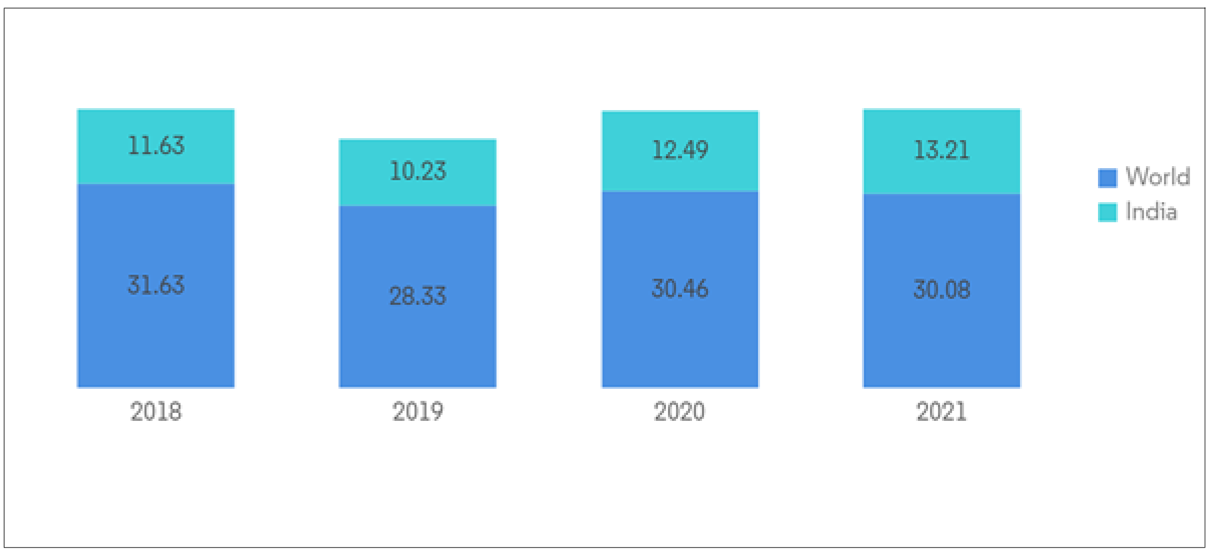
*Source: Food and Agriculture Organization, 2023; *P Predicted value*

Millets constituted a diverse range of small cereal portions including sorghum, finger millet, pearl millet, barnyard millet, proso millet, and little millet. These were cultivated across challenging and varied climates in dry, semi-arid, and sub-humid agricultural regions spanning over 32 million hectares globally. Leading the millet production landscape were India, Niger, and China, contributing to over 55.0% of the total global production. Notably, India took the lead as the world's largest millet producer. The African continent, driven by the promotion of dryland agriculture due to limited water resources and favorable sub-tropical climate conditions, experienced a significant surge in millet production.

With their high protein content, millets were well-suited for vegetarian and vegan populations, primarily concentrated in the United States, Europe, and the Asia-Pacific region. The advent of the pandemic exerted a positive impact on the market, with a growing number of individuals incorporating millets into their diets to enhance immunity and overall health, shifting away from processed foods. Consequently, the demand for millet-based products witnessed a substantial rise in these regions, acting as a driving force behind the growth of the millet market. The Millet Industry's segmentation encompassed various geographic regions including North America, Europe, Asia-Pacific, South America, and Africa. The analysis within the report spanned production volume, consumption value and volume, export and import value and volume, and price trends.

The promotion of millet production in India by the government and organizations was driven by its nutritional significance. Recognized as Nutri-Cereals by the Indian Government, millets were supported under the Department of Agriculture and Farmers Welfare's sub-mission on nutri-cereals, aiming to enhance their cultivation, productivity, and area. According to the Food and Agriculture Organization (FAO), global millet production grew from 28.33 million metric tons in 2019 to 30.08 million metric tons in 2021. India held a significant 43.0% global market share in 2021, with various millet varieties cultivated.

Figure 13: Millet Market-Millet Production, In Million Metric Ton, India & Global, 2018-2021



Source: Stratistics MRC, 2022

In terms of global millet production and consumption, Africa held the largest share. With over 55% of the global output, the region took the lead, followed by Asia at 40%. Within Africa, countries such as Niger, Mali, Nigeria, Burkina Faso, and Sudan were prominent contributors, accounting for over 40.0% of the worldwide millet consumption.

In India, millet production surged from 14.52 million tonnes in 2015-16 to 17.96 million metric tons in 2020-21, as reported by the Ministry of Agriculture and Farmers Welfare *(see Figure 13)*. This domestic production rise led to an 8% increase in millet exports, reaching 159,332.16 metric tons in 2021-22 compared to 147,501.08 metric tons in 2020-21, further fueling the local millet industry. The government's efforts to tap into the global market demand for millets were evident through initiatives like those by the Agriculture and Processed products Export Development Authority (APEDA). This agency executed programs across countries such as the UAE, Indonesia, the US, Japan, the UK, Germany, South Africa, Australia, and Saudi Arabia, contributing to increased millet exports. Consequently, the combination of rising global demand and enhanced domestic production positioned the millet market for growth in the forthcoming years. Based on research conducted by Stratistics Market Research Consulting (MRC), the Global Millet Market exhibited substantial growth, with a valuation of $16.03 billion in 2022 and a projected expansion to $23.38 billion by 2028, indicating a notable Compound Annual Growth Rate (CAGR) of 6.49% over the forecast period (Stratistics MRC, 2022). Millets, characterized by their small seeds and nutritional richness, constitute cereal crops that come in a range of hues, including pale yellow, white, gray, and red. These grains have demonstrated superior nutritional value compared to commonly consumed cereals like rice and wheat.

In the context of millet trade analysis, extending ARIMA forecasting models presents a valuable approach. ARIMA models have proven effective in various trade contexts, including commodities like soymeal, as evidenced by previous research (Sankar & Pushpa, 2023). The application of ARIMA forecasting to millet trade could enable accurate predictions of export, import, production, and average price trends. The integration of ARIMA forecasting in millet trade analysis aligns with its success in other agricultural markets and underscores its potential to provide actionable insights for stakeholders and decision-makers. By leveraging the capabilities of ARIMA models, the millet industry can enhance its strategic planning and decision-making processes, capitalizing on evolving market (Majhi, et al., 2023)

5. CONCLUSION

In this study, we embarked on a journey to forecast soymeal production and prices for the year 2023, harnessing the potent capabilities of the ARIMA model. This model adeptly captured intricate seasonal patterns and trends within the data, yielding accurate and reliable forecasts. Our primary finding revolves around the anticipation of moderate growth in the global soymeal market for 2023. This growth can be attributed to escalating demand for soymeal as a pivotal feed ingredient within the worldwide livestock and poultry industries.

Throughout the analyzed years, a tapestry of intriguing trends and dynamics unfolded within the soymeal market. In 2017, marked increases in import, export, production, and average price of soymeal were largely ascribed to robust global demand, supply interruptions due to adverse weather conditions, fluctuations in corn prices, and currency volatility. Transitioning to 2018, slight upswings in imports and exports, along with stable production, contrasted with a marginal decrease in average price. This interplay was driven by record-high soybean production in Brazil, the influence of African swine fever on China's demand, and the repercussions of the US-China trade tensions.

Navigating into 2019, a year characterized by minor declines in imports and exports, coupled with augmented production and a slightly reduced average price, was underpinned by diverse factors. These encompassed the recovery of soybean production in the US and Argentina, sustained decrease in Chinese demand due to African swine fever, developments in the trade dispute, and currency fluctuations. The advent of the global pandemic in 2020 ushered in shifts in demand patterns, supply chain perturbations, and a decrease in average price attributable to factors like diminished consumption of meat and dairy products, and reduced demand for biodiesel.

Moving to 2021, a resurgence in global demand, coupled with production and pricing dynamics, led to upswings in imports and exports, alongside diminished production, and a significant uptick in average price. Factors propelling these changes encompassed global post-pandemic recovery, weather-induced production challenges in Brazil and Argentina, and corn prices. Finally, in 2022, minor expansions in imports and exports accompanied substantial production growth, coupled with a slight decline in average price. These trends bore the imprint of a spectrum of factors, including supply chain disturbances and economic-social concerns.

Looking ahead to 2023, our forecasts indicate a 5% reduction in soymeal production, a 3.8% dip in imports, a 3.1% decrease in exports, and a notable 26.5% plummet in the average price compared to 2022. These predictions emanate from factors including evolving sources of animal protein for China, fluctuations in crude oil prices, mixed performance of the US dollar, domestic production variations, and regional demand trends.

In conclusion, our ARIMA-based forecasting model furnishes invaluable insights to stakeholders within the soymeal industry and beyond. These forecasts empower strategic planning and informed decision-making, facilitating the adept navigation of evolving opportunities and challenges within the ever-shifting global agricultural trade landscape. Amidst the dynamic currents shaping the soymeal market, our study underscores the pivotal role of predictive models in illuminating pathways for effective decision-making in this vital industry.

Furthermore, the applicability of ARIMA forecasting extends beyond soymeal analysis, encompassing diverse agricultural contexts such as millets. Millets, characterized as "nutri-cereals," hold nutritional value and resilience to climate variability. ARIMA's adeptness in capturing temporal trends could be harnessed to forecast millet production, pricing, and trade. Just as in the soymeal context, ARIMA's ability to discern patterns and trends becomes an asset in understanding and navigating the complex dynamics of millet agriculture. This potential application underlines the versatility of ARIMA in contributing to sustainable agriculture and informed decision-making across a spectrum of agricultural commodities.

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