



# A Study on Production of Oilseeds in the State of Telangana by Using Time Series Models

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**Abstract-** In the real mean of research, statistical modeling of non-stationary, non-linear statistics has grown to be a significant challenge. ANN and ARIMA are two of the most widely utilized models. The Artificial Neural Network (ANN) and Box-Jenkin's methods for forecasting the actual production of Oilseeds crop value in Telangana are compared in this book. The primary goal of this investigation is to create a forecasting model that can accurately anticipate Telangana's agricultural production. In order to predict the annual production of the Oilseeds crop in Telangana, a statistical forecasting model utilizing Box-Jenkin's approach and artificial neural networks was created throughout this research. The model's ability to forecast was assessed using Mean Absolute Percent Error (MAPE) and Root Mean Squared Error (RMSE). According to the annual projections, Oilseeds crop production should be 90% accurate over a ten-year period with a regular variance of 1% error measure.

**Keywords-** ARIMA, Box-Jenkin's Methodology, ANN and MAPE

## I. INTRODUCTION

In many areas of analysis, a statistic is the fundamental subject of the investigation. The underlying presumption of conventional statistic modeling is that the series' past and future values have a linear relationship. For the past few decades, agriculture has been recognized as the backbone of the Indian economy, supporting all crop productivity and growth. One of the most important crops in Telangana, Telangana's total annual Oilseeds production is approximately 680,000 tons annually. In Telangana, currently, Oilseeds are under cultivation in about 3.5 to 4.5 lakh hectares area largely in the districts has notified 26 out of its 33 districts for major oilseeds and oil palm cultivation. With the exception of Hyderabad and Medchal-Malkajgiri, oilseed expansion is underway across the state as a key crop diversification initiative. The results supporting Box-Jenkin's technique and artificial neural networks are shown in the following section.

## II. MATERIALS AND METHODS

### Box-Jenkin's Methodology

In this part, Telangana's Oilseeds production was modeled. The methodology of Box-Jenkin's is mentioned. The general kind of ARIMA (p, d, q) model is offered by the Box-Jenkin's process, which is related to fitting the associate ARIMA model of the subsequent type for the given collection of information.

$$\Phi(B)\nabla^d Z_t = \theta(B)a_t$$

$$\text{Where } \Phi(B) = 1 - \Phi_1 B - \Phi_2 B^2 - \dots - \Phi_p B^p$$



$$(B) = 1 - \theta_1 B - \theta_2 B^2 - \dots - \theta_q B^q$$

$$\text{And } \nabla^d = (1 - B)^d$$

The white noise process  $BKZ_t = Z_t$ -kandat has zero mean and variance  $\sigma^2$ . The following four steps make up the Box-Jenkin's process. (1) Model Identification, in which the corresponding Autocorrelation function (ACF) and Partial Autocorrelation Function (PACF) behavior is used to determine the orders  $d$ ,  $p$ , and  $q$ . (2) Estimation: in cases where the model's parameters are a unit that can be calculated using the highest probability methodology. (3) Diagnostic checking using the "Portmanteau Test," in which the Ljung-Box datum applied to the model's residual verifies the suitability of the fitted model. (4) Forecasts are based on the least mean square error methodology for associate degree appropriate models. Stages 1-3 area unit perennials with entirely various values of  $d$ ,  $p$ , and  $q$  are used until an acceptable model is found if the model is deemed unsatisfactory (Box et al., 1994).

### ANN Model

The form and practical features of the biological neural network, a potent predictive model, may inspire an artificial neural network, a mathematical model. A bachelor's degree Any nonlinear continuous function can be estimated by an ANN with any level of precision that is needed. It is extensively utilized in the sciences, business engineering, and a variety of sectors. It is essential to many call activities, including designing, scheduling, purchasing, strategy creation, policy-making, and supply chain operations, and it has the ability to make flawless long-term predictions. The non-linear structure, flexibility, knowledge-driven learning approach, and capacity to estimate method universal functions are the features of ANN that make it suitable for predictions. Neural networks have been demonstrated to have the ability to accurately approximate a wide range of sophisticated sensible relationships due to their universal sensible approximating capability. Given that the goal of any prediction model is to precisely capture the beneficial relationship between the variable to be predicted and various pertinent elements or variables, this can be a very significant and potent feature. Because of the combination of the aforementioned features, ANN is a very general and adaptable modeling technique for prediction. ANNs are unit non-linear models, to sum up. The occurrence of numerous non-linear statistical models in the past ten years can be attributed to the fact that global systems are inherently non-linear. (Ramakrishna et al., 2011; Hornik, 1993).

## III. RESULTS

### ARIMA Model for Forecasting the OilseedsCrop Production

The development of prediction models' victimization is discussed in this paper. There is mention of Box-Jenkin's system for the annual production of Oilseeds. The Directorate of Economics and Statistics provided the information on Oilseeds production annually from 1979 to 2019, or 40 years (80 seasonal). The model was built using the annual crop output from 1979 to 2011, and the model was validated using the annual Oilseeds crop production from 2011 to 2020. Artificial Neural Networks and Box-Jenkin's approach were used to construct the prediction models for the annual production of Oilseeds crops with an average yield of 2601 lakhs, the Oilseeds crop's annual productivity varied. The time trend of the annual production is displayed in the following chart. About the Oilseeds crop between 1979 and 2019. The Oilseeds crop's annual production displays a non-stationary time trend (Fig 1). Because of the low and high levels of rainfall in the aforementioned years, the average Oilseeds production was relatively low in 2003 and high in 2011 (Fig 1).

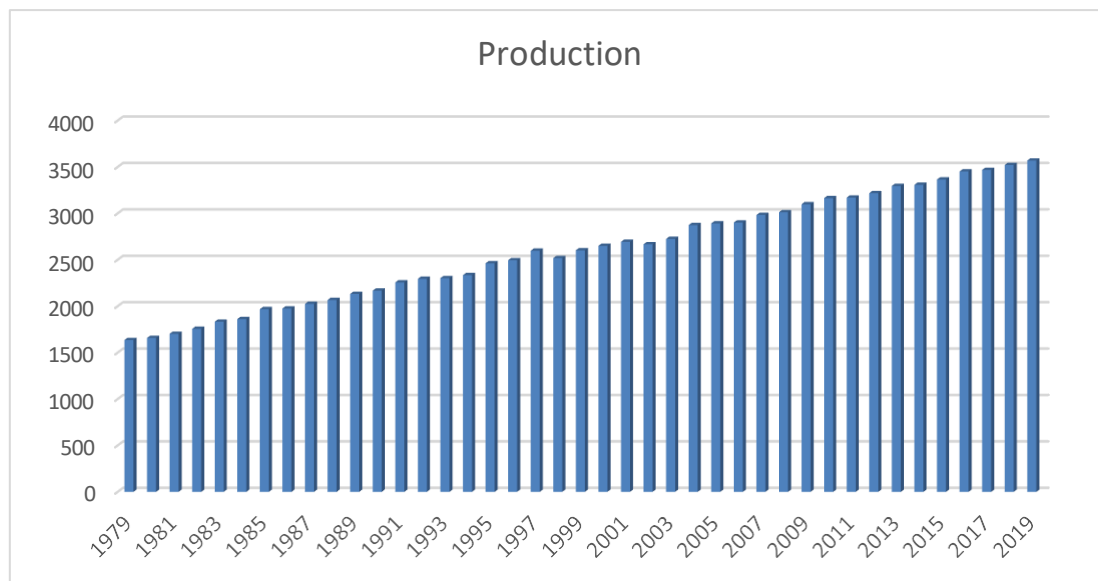
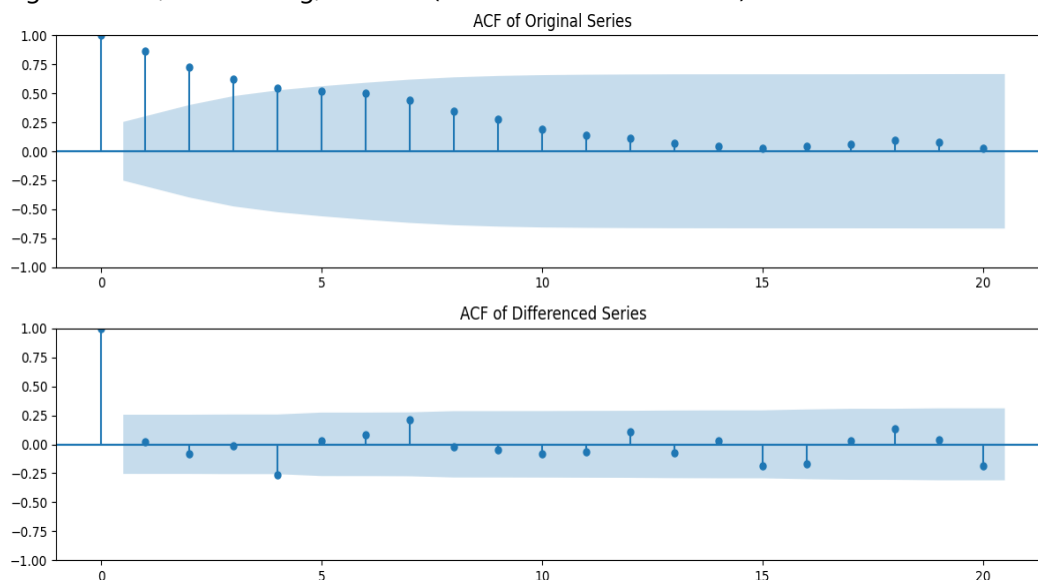


Figure1:The yearly average for the production of the Oilseeds Crop (in tonnes)

The proficient Python developer was used to figuring out the best ARIMA model for Oilseeds production prediction because this plan automatically finds and estimates the best-fitting ARIMA for one or more variable series, removing the need to find a suitable model through trial-and-error. ACF and PACF order-wise differencing and the validation set with the original series are used to test the ARIMA (1, 1, 2) model, which is found to match the data well. Tables 1 and 2 below provide the model parameters square measure.

#### Original Series, Differencing, and ACF (Auto Correlation Function)



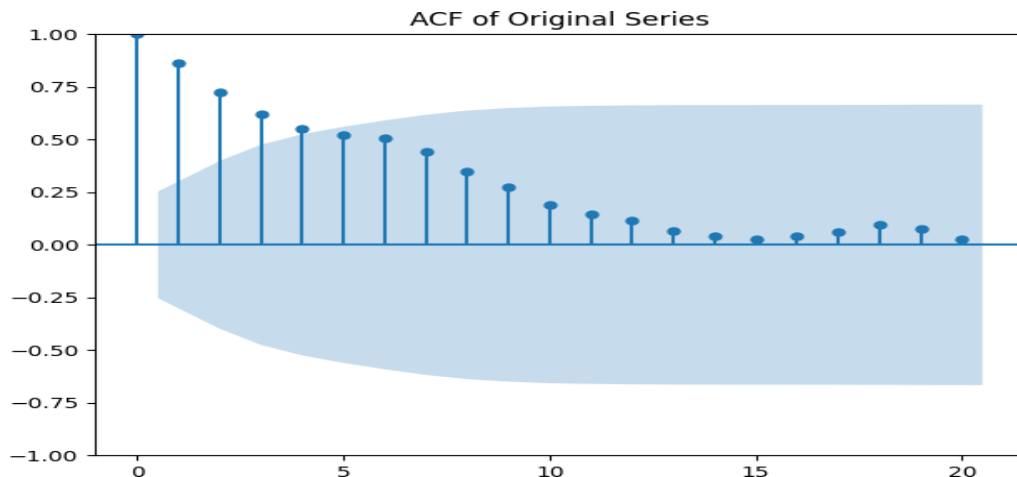


Figure2: Time series of Oilseeds production (tonnes) in Telangana Original Series with ACF

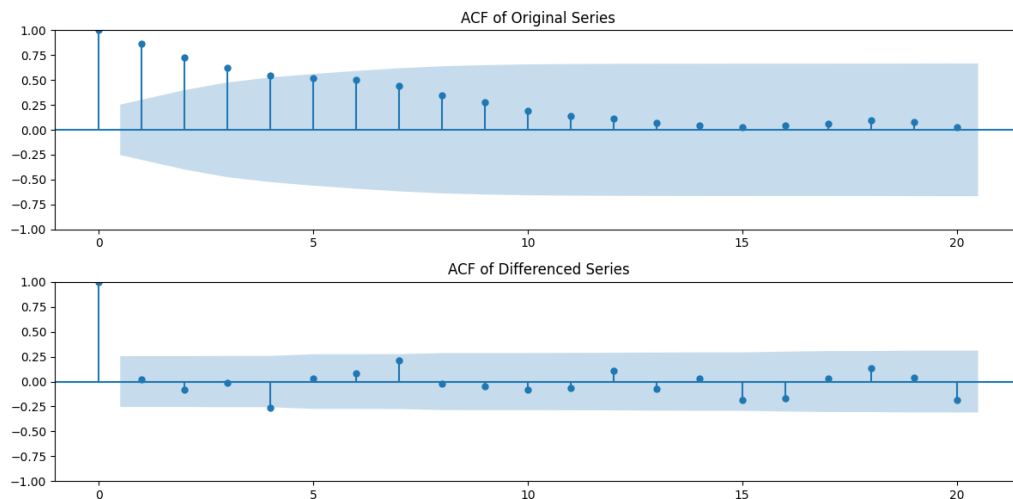
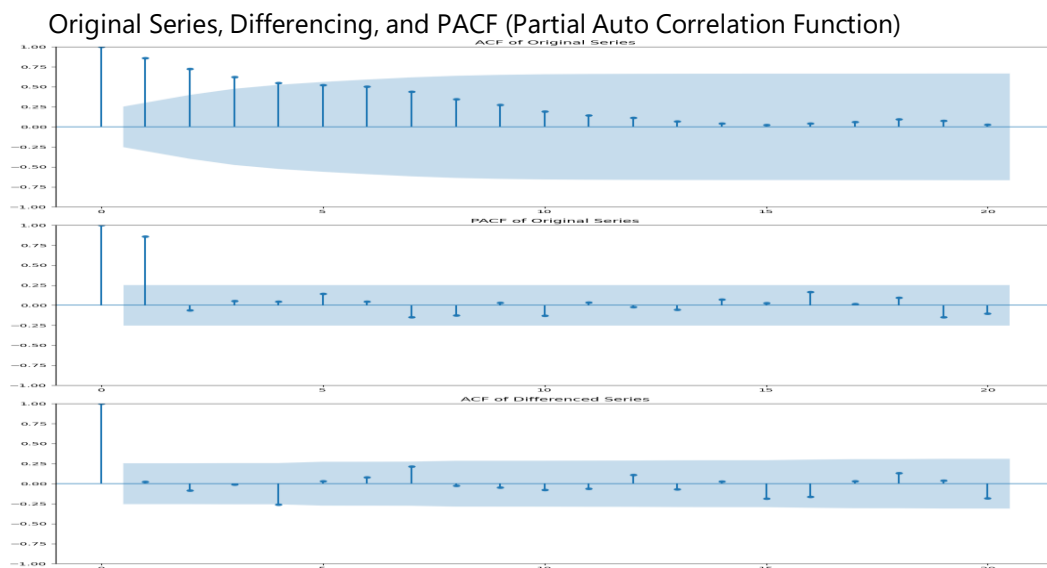


Figure3: Time series of Oilseeds production (tones) in Telangana 1<sup>st</sup> Order differencing with ACF



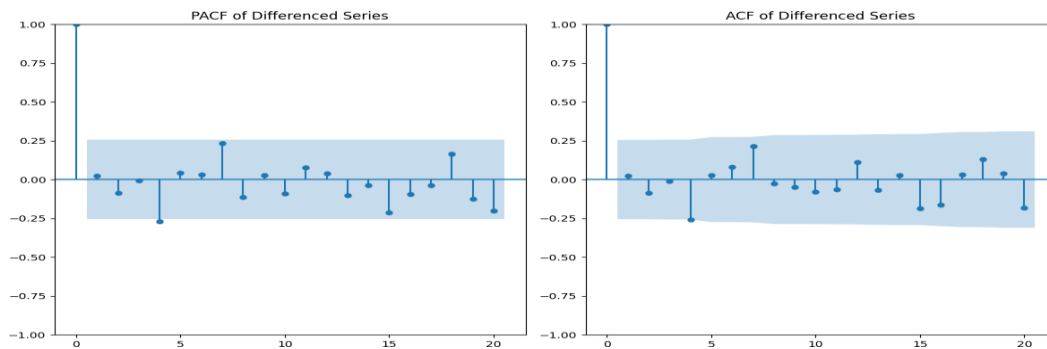


Figure 4: Time series of Oilseeds production (tonnes) in Telangana, 1<sup>st</sup> Order differencing with PACF

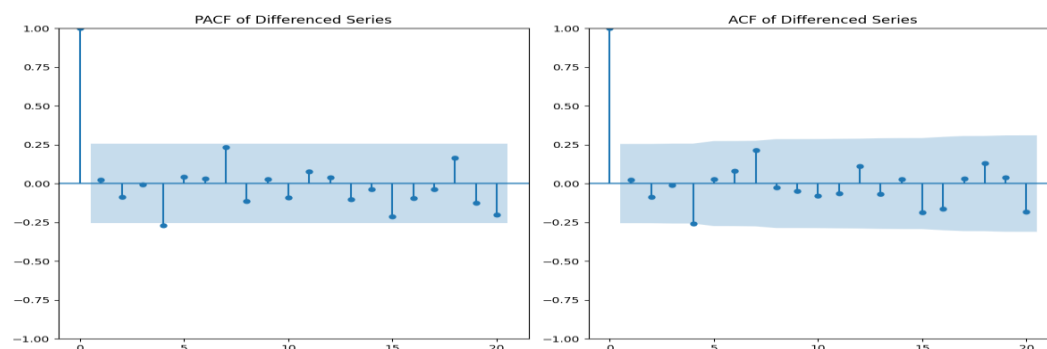


Figure 5: Time series of Oilseeds production (tonnes) in Telangana 1<sup>st</sup> Order differencing with ACF

Table 1. ARIMA Model Parameters

Best model: ARIMA (1,1,2) (0,1,1) [0] intercept

SARIMAX Results

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Dep. Variable:          y  No. Observations:          60
Model:                 SARIMAX (1, 1, 2)  Log Likelihood          -485.724
AIC                   975.448
BIC                   979.603
Sample:                0  HQIC                   977.069
                    - 60
Covariance Type:      opg
=====
coef  std err      z  P>|z|  [0.025  0.975]
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intercept  199.0508  126.627   1.572   0.116  -49.133  447.235
sigma2    8.285e+05  1.76e+05  4.706   0.000  4.83e+05  1.17e+06
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Ljung-Box (L1) (Q):      0.04  Jarque-Bera (JB):      2.30
Prob(Q):                 0.85  Prob(JB):              0.32
Heteroskedasticity (H):  1.86  Skew:                  -0.46
Prob(H) (two-sided):    0.17  Kurtosis:              2.71
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Hence, the fitted model for the forecasting of Oilseeds production in Telangana is ARIMA (1,1,2) and ARIMA (0,1,1)



$$\nabla^1 Z_t = (1 + 0.041B^8 - 0.158B^{13}) at.$$

The Ljung-Box q test statistic was used to assess the model's adequacy, and the results showed that  $Q=1.86$  at 20 degrees of freedom. The null hypothesis of the sufficient model was accepted because the corresponding p-value of the letter check datum is 0.85, which is significantly greater than 0.05. As a result, the provided ARIMA (1,1,2) model might be a suitable model for predicting Oilseeds production. In a similar vein, a Python-based model of synthetic neural networks was created to forecast Oilseeds yield.

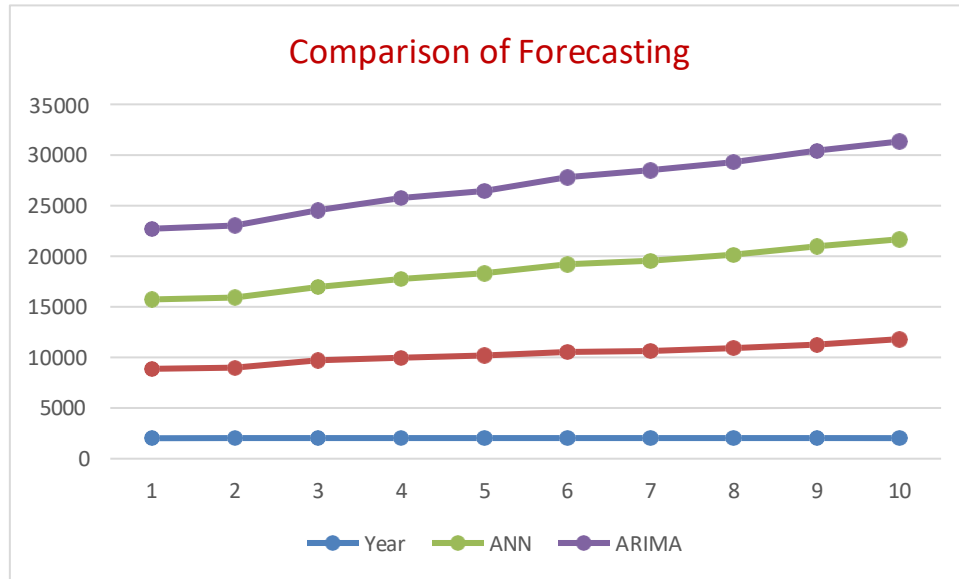


Figure 6: Comparison of forecasts for Oilseeds production in Telangana (in tonnes)

#### IV. ARTIFICIAL NEURAL NETWORKS MODEL

One input layer, one hidden layer, and an output layer make up an ANN model, which is a feed-forward neural network model. The one-step ahead prediction of the silver costs during this ANN model was based on the standardized values of prior observations (Lag-1 or  $Z_t-1$ ). Two hidden neurons make up the hidden layer, which is used to capture the statistic's nonlinearity feature. In the output layer, the identity is utilized as an activation function, whereas in the hidden layer, the hyperbolic tangent function is utilized. An Example feed-forward neural network used to forecast Oilseeds production in Telangana is seen in Figure 6 below. Through trial and error, the ANN model was trained using the exploitation back propagation rule until the testing sample's error measurements were less than those of the coaching sample.

Table1: Production values Forecasted values of Oilseeds Production with 94% Confidence Level (CL)



Year	PRODUCTION VALUES		
	Forecasted values	UCL	LCL
2019-20	758	651	72
2020-21	702	598	24
2021-22	694	568	54
2022-23	590	821	18
2023-24	438	625	31

Test for randomness of the fitted ARIMA (0, 1,2) model

Run Test	Residuals
Total cases	40
Number of runs	14
Z- value	-0.758
Sig (2-tailed)	0.158

In the above table we are observing the production values should be changed according to the conditions and with 95% confidence level.

### Comparison of Arima and Ann Models

The training sample contrasted the predictions made by the two models, and the testing samples confirmed the mean absolute error, mean absolute percentage error, and root mean square error. The error measures from the ARIMA and ANN prediction models are shown in the following Table 3.

Table 2. Comparison of the forecasting performance of ARIMA and ANN models

Measure	Training Sample		Testing Sample	
	ARIMA	ANN	ARIMA	ANN
MAE	681.05	758.21	685.05	758.54
RMSE	735.12	725.54	780.21	781.21
MAPE	0.54	0.72	0.54	0.54

In comparison to the ARIMA Model, the ANN model has relatively Oilseeds error measures in the testing sample. In the training and testing samples, the ANN fits the data better than the ARIMA, but it does not perform better in the testing sample. The ARIMA and ANN models' out-of-sample predictions are displayed in figure 7 below. While the ARIMA forecasts display a linear trend over time, the ANN model forecasts display a trajectory that is comparable to the initial expenses. The following table displays the predictions made by the two models.

Table 3. Out-of-sample forecasts of Oilseeds production in Telangana using ARIMA and ANN Models

Production			
Year	Oilseeds(in tonnes)	ANN	ARIMA
2021	6854.35	6854.12	6985.25
2022	6981.02	6920.02	7102.25
2023	7682.58	7254.12	7589.45



2024	7954.12	7785.14	7982.20
2025	8154.98	8125.24	8154.30
2026	8502.28	8684.00	8589.54
2027	8621.54	8902.28	8954.12
2028	8902.89	9210.58	9158.57
2029	9254.11	9681.30	9452.56
2030	9782.25	9865.01	9658.12
Mean	8269.01	8328.18	8362.63
SD	940.27	1109.20	952.93

## V. CONCLUSION

According to the forecasts, the ANN model outperforms the ARIMA model in predicting Telangana's Oilseeds production. While the ANN model displays the nonlinear fluctuations within the forecasts, the ARIMA model only offers linear trends. The analysis found that during the following five years, there will be a decline followed by a gradual increase of Telangana's Oilseeds production. Oilseed has high nutritional value as it contains high vitamin B levels and phytochemicals such as phenols, flavonoids, phytosterols, and bioactive peptides. Some important minerals such as potassium, calcium, phosphorus, zinc, and iron are also sufficiently present in little millet

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