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An Economic Analysis of Cotton Price Forecasting Using ANN in Andhra Pradesh, India

G. Raghunadha Reddy, K. V. S. D. Pravallika, B. Meher Gita and M. Chandrasekhar Reddy

Division of Agricultural Economics, Regional Agricultural Research Station, Lam, Guntur, Andhra Pradesh (522 034), India

Corresponding Author

G. Raghunadha Reddy
e-mail: g.raghunadhareddy@angrau.ac.in

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Abstract

Cotton is essentially produced for its fibre, which is universally used as a textile raw material. Cotton is an important commodity in the world economy. A remunerative price environment for the growers is very important for increasing production. In this context the study on area, production, export, import, supply and demand and their compound growth rates as well as influence on prices of cotton were analyzed using descriptive statistical tools and Artificial Neural Network model (ANN). The results showed that, compound growth rate of exports was negative and significant with -2.41 per cent whereas, imports showed a positive and significant growth rate with10.44per cent from 2006-07 to 2021-22. The seasonal indices of cotton arrivals in Andhra Pradesh were highest in the months of January (177.54), December (153.67) and November (146.10) because of holding of previous seasons crop by traders and farmers in anticipation of higher prices. The return on rupee investment was 0.596 which is concerned to tenant farmers and return on variable costs was 0.848 which is mostly related to owner farmers. The lower seasonal indices for cotton prices were observed in the months of December (97.23) and November (101.50). The results of ANN model revealed that, neural network 9-29-1(9 input nodes, 29 hidden nodes, and 1 output) outperformed all other neural networks with lower MAPE (2.904), RMSE (140.59), MAE (90.02), and MASE (0.114) values. It was expected that demand will persist in 2022-23 harvesting season also with a price around ₹ 8269/ q.

Keywords: Artificial Neural Network (ANN), compound growth rate, cotton, forecast

1. Introduction

Cotton is one of the most important fiber and a cash crop of India and plays a dominant role in the industrial and agricultural economy of the country. In 2021-22, worldwide area under cotton was 32.10 million hectares and production and productivity accounted for 257.71 million bales and 1370 kg ha^{-1} respectively. India has emerged as the largest producer of cotton in the world and occupies the first position in terms of total area and production. Also, India is the largest producer of organic cotton in the world, contributing nearly 50% of world's produce. Among the major cotton exporting countries in the world, India occupied 1stposition with exports of 68.71 million bales (China–62.24 million bales, USA–28.71 million bales) (https://fas.usda.gov, 2021).

In India during 2022-23, production of cotton was 341.90 lakh bales (1st Advance estimates, eands.dacnet.nic.in) cultivated under an area of 127.50 lakh hectares with a productivity of 456 kg per hectare. According to the 1st advance estimates of 2022-23, cotton production in Andhra Pradesh was 17.85 lakh bales cultivated under an area of 6.02 lakh hectares with a productivity of 504 kg ha^{-1} (des.ap.gov.in) contributing 5.22 per cent to total country's production. In India, there are nine major cotton growing states which fall under three zones, viz. the North Zone (Punjab, Haryana and Rajasthan), the Central Zone (Maharashtra, Madhya Pradesh and Gujarat), and the Southern Zone (Andhra Pradesh, Telangana, Karnataka and Tamil Nadu). Nearly 65% of the cotton crop is cultivated under rainfed conditions in the country. Nearly 2/3rd of the Cotton production in India comes from the states of Maharashtra, Gujarat, Andhra Pradesh and Telangana, collectively known as the Cotton Basket of India.

The COVID-19 pandemic in India and across the globe has created an unprecedented crisis leading to serious impact on the Indian cotton textiles and clothing industry, thereby affecting cotton demand. The slowdown in the international markets due to the covid outbreak as well as increased production in the country, caused the prices to fall in the domestic markets. As the prices in the domestic market fell below MSP, the Cotton Corporation of India (CCI) started MSP operations and began purchasing cotton from farmers amid of Covid. Because of many other countries-imposed lockdowns pandemic spread, the demand for cotton fell drastically, reflecting on the prices. In the year 2021-22, cotton prices started rising as the textile production, which was paralyzed during the lockdown, resumed at a rapid

pace around the world, increasing the demand for yarn. The units are facing not only spike in raw material prices but also shortage in availability due to lower cultivation. Following the price increase for natural fibres in the domestic market, the Government had earlier put restrictions on the export of cotton. Currently, the Government has removed the export restrictions, and has put cotton exports under the Open General License (OGL). The study on area, production, export, import, supply and demand and their influence on prices of cotton assume importance.

2. Materials and Methods

The present study is based on secondary data which includes growth parameters of cotton in world, India and Andhra Pradesh, exports & imports, mill consumption of cotton in India,prices and arrivals of cotton in Andhra Pradesh. The data was compiled from United States Department of Agriculture,Directorate of Economics and Statistics, Andhra Pradesh and India, Cotton Corporation of India, India stat,Agri-watchand from different Agricultural Market Committees (AMCs) for the period May 2002 to May 2022. The analysis was carried by using the compound growth rate, Ratio to trend method for seasonal index analysis and Artificial Neural Network technique for forecasting of cotton prices.

2.1. Compound growth rate (CGR)

To estimate the CGR, the exponential time trend equation of the form:

$Y=a\ bt$

$Ln\ Y=Ln\ a + t\ Ln\ b1$

Where, Y: Variable whose growth rate is being computed t: Time trend (1, 2…n) a and b are regression coefficients to be estimated.

2.2. Seasonal indices

The analysis of seasonal indices was carried out with the help of the secondary data on month-wise arrivals and prices of cotton from major markets of Andhra Pradesh for a period of June 2005 to May 2022. Seasonal indices were calculated using ratio to trend method. In the ratio to trend method the data was adjusted according to months and years. The trend values for each month were computed using least squares equation. Percentage ratio was obtained with original data to corresponding trend value. Aggregate average of the months gives the seasonal indices values.

2.3. Forecasting models

The monthly prices of cotton from September 2002 to September 2022 (20 years) were used for model building and data pertaining to the period September 2002 to September 2022 was used to model validation for forecasting. The analysis has been carried out in R software using tseries, forecast, fnonlinear, aTSA and nnetar packages to model and forecasting cotton prices for a period of 6 months from October 2022 to March 2023.

2.3.1. Artificial neural network (ANN) model

Artificial Neural Networks are the data-driven flexible models, which are capable of approximating the larger class of non-linear problems. ANN has outperformed the classical statistical methods and can be used to model non-linear time series for forecasting of prices. Many studies have been reported in the application of ANN, Jha and Sinha (2014) stated that Time Delay Neural Network (TDNN) is the one of the promising and potential methods for time series forecasting. The ANN model is adaptively formed based on the structure and pattern of the data (Zhang, 1998, Ray et al., 2016, Naveena et al., 2017, Rathod et al., 2017). The ANN model performs a nonlinear functional mapping from the past observations (y_{t-1}, y_{t-2},.,y_{t-p}) to the future value , *i.e.,*

$y_t=f(y_{t-1},y_{t-2},....,y_{t-p},w)+\varepsilon_t$

where is a vector of all parameters and is a function determined by the network structure and connection weights. The important task of the ANN modelling for a time series is to choose an appropriate number of hidden nodes (k) as well as the dimensions of the input vector p (the lagged observations). The ANN model was employed as outlined in Areef and Radha (2020).

A multilayer feed forward neural network was fitted to the data with the help of nnetar package, which is extensively used for fitting uni-variate time series. According to the AIC, the optimal number of lags used as inputs. As a result, the fitted model is called an NNAR (p,P,k)[m] model.

2.4. Forecast evaluation methods

The forecasting ability of different models is assessed with respect to common performance measures, *viz*. the root mean squared error (RMSE) and the mean absolute error (MAE), mean average percentage error (MAPE) and percent deviation from actual values.

• Root mean squared error (RMSE)

$$RMSE=\frac{\sqrt{\sum_{t=1}^{T}(\hat{Y}_t-Y_T)^2}}{T}$$

• Mean absolute percentage error (MAPE)

$$MAPE=[\sum_{t=1}^{n}\left|\frac{y_t-\hat{y}_t}{y_t}\right|\times 100]/n$$

• Mean absolute error (MAE)

$$MAE=\frac{1}{T}\sum|y_t-\hat{y}_t\times 100|$$

• Deviations of predicted prices from the actual prices

$$\text{forecast error}(\%)=\frac{(y_t-\hat{y}_t)/y_t}{y_t}\times 100$$

Where, = actual prices, = predicted prices, =forecast error, T= sample size

3. Results and Discussion

The impact of pandemic on cotton area and production was not significant although it affected cotton consumption in a big way. Due to the lockdown and movement of the migrant workforce to their native villages, the processing industry

was brought to a standstill. Even though it began functioning, after lifting of the lockdown, it was a very slow start. Mill consumption decreased to 233.7 lakh bales during 2019-20 from 270.78 lakh bales of preceding year (Table 1). Similarly, S.S.I consumption and non-textile consumption also showed a decline. Thus, the total consumption got reduced by 42 lakh bales during 2019-20. This decreased consumption and increased crop size resulted in increasing the closing stock to 120.79 lakh bales. Mill consumption recovered to its full extent during the 2020−21 season and it was 297 lakh bales. The pandemic effect on cotton sector was minimal and after the second wave, the mills activities have started to pick up the pace. In 2022−23, total supply was estimated to be 397.51 lakh bales with demand of 351 lakh bales.

Table 1: Cotton balance sheet for the year 2015−16 to 2021−22 (in lakh bales)

Particulars	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Supply						
Opening Stock	43.76	42.91	56.52	120.79	71.84	45.60
Production	370.00	333.00	365.00	353.84	312.03	341.91
Import	15.80	35.37	15.50	11.03	18	10.00
Total Supply	429.56	411.28	437.02	485.66	401.87	397.51
Demand						
Mill Consumption	280.11	270.78	233.70	297.45	276.90	275.00
Consumption By SSI	26.18	22.43	20.49	22.42	20.87	20.00
Non-Mill Consumption	12.77	18.00	15.00	15.00	16.00	16.00
Exports	67.59	43.54	47.04	77.59	42.50	40.00
Total Demand	386.65	354.76	316.07	412.46	356.27	351.00
Ending Stock	42.91	56.52	120.79	73.20	45.60	46.51

Source: Cotton Association of India, 2022; Bale -170 kg. P-Provisional

The average exports of Cotton from India are 73.81 lakh bales from 2006-07 to 2021-22 whereas the average imports to India are 14.23 lakh bales. The compound growth rate of exports showed a negative and significant decline growth rate of -2.41 per cent whereas imports in India showed a positive and significant growth rate of 10.44 per cent from 2006-07 to 2021−22. The cotton exports have jumped to 60 % from 47.04 lakh bales in 2019−20 to 75 lakh bales in 2020−21, the highest in six years due to revival of global demand from China and Bangladesh. Even though, the growth rate of exports showed negative from 2014−15 to 2021-22 exports in absolute terms, have increased from 57.72 lakh bales to 77.59 lakh bales, whereas imports have decreased from 22.79 lakh bales to 11 lakh bales, signaling the better terms of trade for cotton (Figure 1). 2021−22 data has to be finalized.

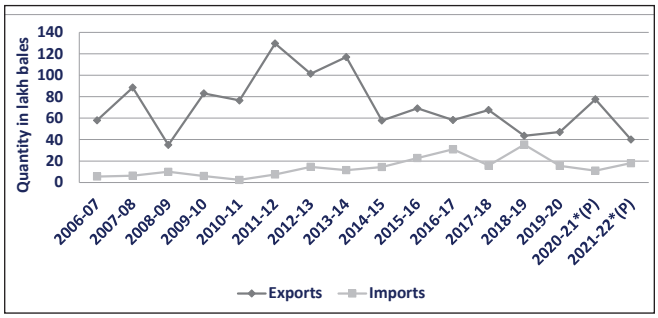

Figure 1: Cotton exports and imports of India

Cotton is one of the most important fiber and cash crop of India and plays a dominant role in the industrial and agricultural economy of the country. Maharashtra is the major producing state of cotton and occupies 1/3rd crop cultivation area. Table 2 shows that in the year 2021−22, Maharashtra cotton production is estimated to be 89.86 lakh bales under an area of 39.37 lakh hectares. Andhra Pradesh state ranked 6th in cotton production with 20.26 lakh bales. Cotton production in the country is estimated to be 362.18 lakh bales for the year 2021−22 by Cotton Corporation of India.

Cotton Corporation of India procures the cotton from the farmers at MSP by arranging infrastructure in the form of regular procurement centres as well as satellite centres so that farmers are not compelled to travel long distances to sell their cotton kappa's produce. Besides MSP operations, to fulfill the raw material requirements of the domestic textile industry, CCI also undertakes viable commercial purchase operations as and when required, but found negligible. The main aim of these operations is to meet at least the annual cost of the minimum infrastructure maintained by the Corporation for Price Support operations. Table 3 shows that in the year 2020, CCI procured 8459.87 thousand bales of cotton from all over India, of which 8459.57 thousand bales were at MSP and only 0.30 (from Maharashtra only) thousand bales were at commercial price. Procurement of cotton was highest in Telangana, Maharashtra, Gujarat, Haryana, Punjab and Rajasthan.

Table 2: Major state wise area, production and yield of cotton in India

State/Year	2016-17			2020-21			2021-22*			Rank
	A	P	Y	A	P	Y	A	P	Y	
Punjab	2.85	9.00	537	2.52	10.23	690	3.04	11.66	652	9
Haryana	5.70	20.50	611	7.40	18.23	419	6.48	18.94	497	5
Rajasthan	4.71	16.50	596	8.08	32.07	675	7.56	24.36	548	4
Gujarat	23.82	95.00	678	22.70	72.70	544	22.55	85.16	642	2
Maharashtra	38.00	88.50	396	42.86	95.88	380	41.82	75.28	306	1
Madhya Pradesh	5.99	20.50	582	5.72	17.83	530	5.90	14.92	430	7
Telangana	14.09	48.00	579	23.59	59.95	432	20.51	65.87	546	3
Andhra Pradesh	4.72	19.00	684	6.06	16.04	450	5.48	14.84	471	6
Karnataka	5.10	18.00	600	8.20	23.20	481	6.91	18.33	451	8
Tamil Nadu	1.42	5.00	599	1.12	2.50	379	1.25	2.96	403	11
Odisha	1.36	3.00	375	1.71	4.99	496	1.93	6.59	580	10
Others	0.50	2.00	680	0.11	0.22	340	0.19	0.31	277	12
Total	108.26	345.00	542	130.07	353.84	417	119.66	315.43	448	-

(A-Area in lakh hectares, P-Production in lakh bales, Y-Yield in kgs/hectare); Source: Cotton Corporation of India, 2022, *-2nd Estimates need to be finalized

Table 3: State-wise Cotton purchases (at MSP & Commercial price) by Cotton Corporation of India (CCI) for 2020-21 (Quantity in '000 bales)

States	Total Cotton Purchases
Punjab	536
Haryana	1057
Rajasthan	911
Gujarat	415
Maharashtra	1751
Madhya Pradesh	444
Andhra Pradesh	342
Karnataka	126
Odisha	205
Telangana	3401
Tamilnadu	0.20
Total	9189.50

Source: Agricultural Statistics at a glance of India, 2021

Andhra Pradesh stands fifth in acreage and sixth in production of cotton (2020-21). Farmers' returns have declined as cotton productivity and quality were hit by the attack of thrips and pink bollworm pest which led to decrease in cotton area from 6.06 to 5.54 lakh ha and similarly the production had declined from 16.04 to 12.77 lakh bales in 2020-21 to 2021-22. In 2022-23, the area under cotton is estimated as 6.02 lakh ha with a production of 17.85 lakh bales (DES-AP, 1st Advance Estimates).

Inter-district comparison of Andhra Pradesh for cotton crop is explained in Table 4. It shows that Kurnool ranks first in the area whereas Guntur district tops highest in production. Anantapur district ranks third in area and fifth in production. Among 13 districts of Andhra Pradesh, five districts namely Kurnool, Guntur, Anantapur, Krishna and Prakasam cover 91% under cotton acreage with 93.18% production. It is seen from the table 4 that the cotton acreage has declined in 2021-22 in all the major districts of state because of severe damage caused by pink bollworm infestation in 2020-21 and the cotton area was shifted to chilli crop in 2021-22.

The cost-return structure of cotton in Andhra Pradesh for the year 2021-22 is presented in Table 5. The total variable cost was Rs. 104048 in which nearly 20% of cost was pertained to picking of kapas by labour. Cost of Production in cotton was Rs. 14006/quintal. Gross margin implies the returns over variable costs which is pertained to owner farmers and net returns implies returns over the total costs which is pertained to tenant owners. Thegross margin and net returns were Rs. -15775 per ha and Rs. -59791per ha respectively. The return on rupee investment was 0.596 which is concerned to tenant farmers and return on variable costs was 0.848 which is mostly related to owner farmers.

3.1. Seasonal indices of arrivals and prices of cotton

The seasonal indices of arrivals were highest in the months of January (177.54), December (153.67) and November (146.10) because of usage of late season varieties and holding of crop by traders and farmers in anticipation of higher prices. According to Pavithra et al. (2018), in Shimoga the seasonal indices of arrivals were highest in January (158.46)

Table 4: Inter-district comparison of Andhra Pradesh for cotton crop

Major Districts	2019-20				2021-22		
	Area (in '000 ha)	Rank in Area	Production (in lakh bales)	Rank in production	Area (in '000 ha)	Rank in Area	Production
Kurnool	275	1	9.04	2	255	1	NA
Guntur	182	2	9.86	1	112	2	NA
Prakasam	46	5	1.34	4	62	3	NA
Anantapur	52	3	0.91	5	43	4	NA
Krishna	48	4	2.22	3	38	5	NA
Total of 5 districts	603		23.37		510		
Other Districts	53		1.71		44		
Andhra Pradesh	656		25.08		554		
Share (%) of 5 districts	91.92		93.18		92.05		

Source: Agricultural Statistics at a glance of Andhra Pradesh, 2021; 2021-22 data from apagrisnet.gov.in

Table 5: Cost-return structure of Cotton in Andhra Pradesh (2021-22)

Particulars	Cotton
Labour costs (₹ ha^{-1})	53290(35.99)
Material costs (₹ ha^{-1})	48968(33.07)
Variable costs (₹ ha^{-1})	104048(70.27)
Fixed costs (₹ ha^{-1})	30556(20.64)
Total cost (₹ ha^{-1})	148064(100)
Yield (q ha^{-1})	11
Price (₹ q^{-1})	8350
Gross returns (₹ ha^{-1})	88273
Net returns (₹ ha^{-1})	-59791
Gross Margin (₹ ha^{-1})	-15775
Return on rupee BCR	0.596
Return on VC	0.848
COP (₹ q^{-1})	14006

and lowest in months of May (4.62) and June (4.23). As the cotton sowing time starts from July and August the seasonal indices of arrivals were found lowest (25.58 and 27.94) in these months on the contrary the seasonal indices of prices were shown highest (112.84 and 109.74) which implies that the arrivals and price have an inverse relationship (Figure 2). The lower seasonal indices for prices were in the months of December (97.23) and November (101.50). The results were in accordance with Mahesh et al. (2018) in which the arrival indices were highest in the month of December and lowest in the months of May and September.

3.2. Fitting of ANN model

The time series plot of cotton prices of major markets in

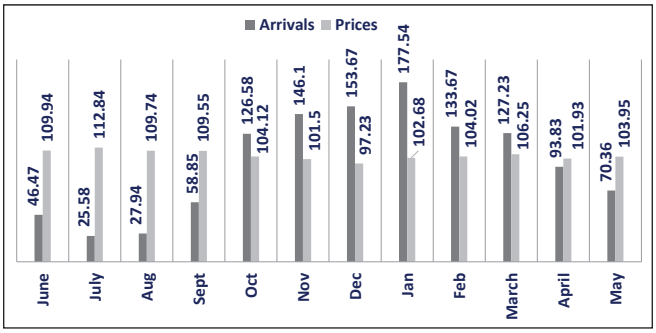

Figure 2: Seasonal Indices of arrivals and prices of cotton in Andhra Pradesh

Andhra Pradesh September 2002 to September 2022 has been depicted in Figure 3 and Table 6. The original time series was found to be non-stationary, so first differencing was done to make the stationary time series and later Augmented Dickey Fuller unit root test (ADF) was run to check for stationarity of the time series data.

Various network topologies were trained by increasing the

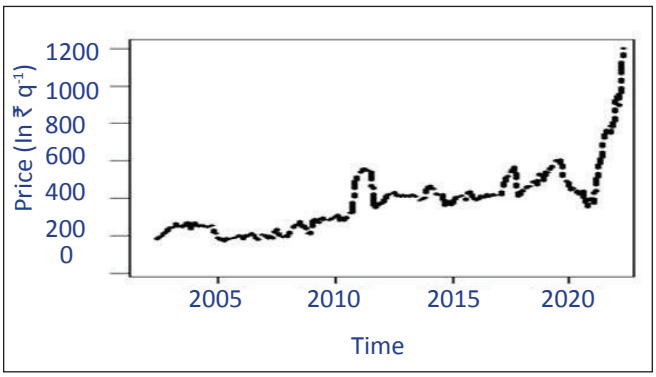

Figure 3: Time series data on cotton prices of major markets in Andhra Pradesh

Table 6: Augmented Dickey Fuller test for prices of cotton in Andhra Pradesh

Lags	At levels		At first difference	
	ADF	p-value	ADF	p-value
0	1.122	0.99	-13.639	0.01
1	0.698	0.99	-9.290	0.01
2	0.693	0.99	-6.157	0.01
3	-0.279	0.99	-5.255	0.01
4	-0.536	0.97	-4.539	0.01

number of hidden nodes from 1 to 35 with sigmoidal activation function with one output layer with linear identity function was selected. Among several, the 8 best performing models are listed in Table 7 based on the lowest of MAPE, RMSE, MAE, and MASE values. Similar parameters were used in the study of Rathod et al. (2018). A neural network 9-29-1 (9 input nodes, 29 hidden nodes, and 1 output) outperformed all other neural networks with lower MAPE (2.904), RMSE (140.59), MAE (90.02), and MASE (0.114) values. The model has been cross validated 100 folds to minimize the error. The p-value of the Ljung-box test for cotton prices was 0.8926 (>0.05), indicating the independence of residuals and Figure 4 illustrated the residuals values of the selected model.

Table 7: Performance of different numbers of neural network models of cotton prices

Network structure	RMSE	MAE	MAPE	MASE
9-25-1	142.98	92.18	2.969	0.117
9-26-1	142.47	91.55	2.950	0.116
9-27-1	142.25	91.67	2.951	0.116
9-28-1	141.69	91.57	2.949	0.116
9-29-1	140.59	90.02	2.904	0.114
9-30-1	141.89	91.60	2.939	0.116
9-31-1	139.61	90.19	2.906	0.114
9-32-1	141.929	91.64	2.954	0.116

In this context, a nonlinear artificial intelligence technique like neural networks can be an effective way to improve forecasting performance. Both ex-ante and ex-post forecasts prices obtained through best fitted ANN model were compared to actual prices of cotton of Andhra Pradesh presented in Table 8 and an illustration is given in Figures 5 which reveals that there were narrow variations in between the actual and predicted values of ANN. The per cent deviation of predicted price from actual price for cotton using best fit ANN model was less than 20 per cent (Darekar and Reddy, 2017) (Figure 4, 5 and table 8).

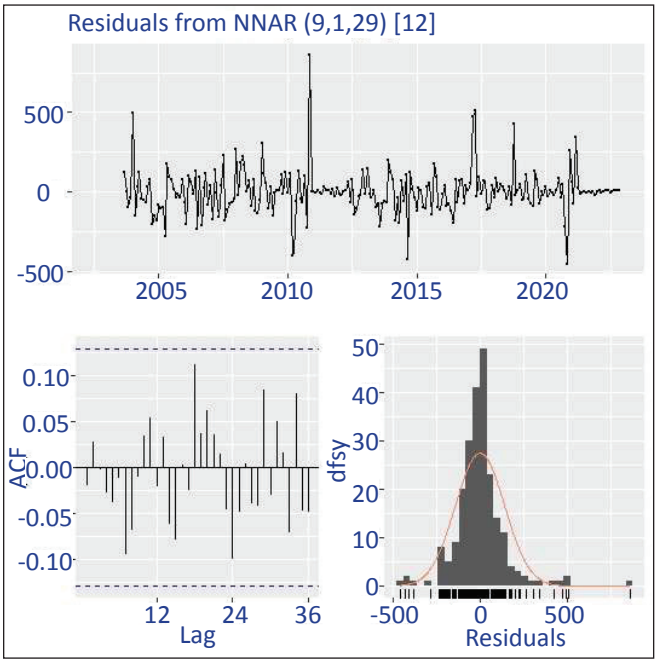

Figure 4: ANN residuals plot of cotton

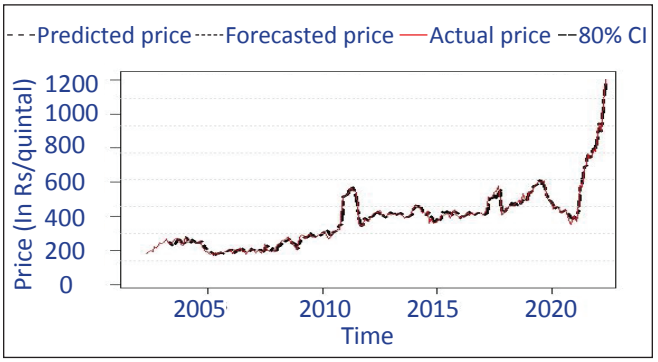

Figure 5: Actual v/s fitted plot of ANN model cotton prices of Andhra Pradesh

Table 8: Comparison of predicted values with actual prices of cotton in Andhra Pradesh

Period	Actual Prices (₹ q^{-1})	Predicted Prices (₹ q^{-1})	Per cent deviation
Sep-21	7368	7831.25	-6.29
Oct-21	7466	7627.71	-2.16
Nov-21	7911	7928.63	-0.22
Dec-21	7802	8157.12	-4.55
Jan-22	8884	8061.43	9.26
Feb-22	9493	8630.48	9.09
Mar-22	8939	8152.62	8.80
Apr-22	10623	9765.33	8.07
May-22	11007	11462.4	-4.14
Jun-22	9625	8922.18	7.30

Table 8: Continue...

Period	Actual Prices (₹ q^{-1})	Predicted Prices (₹ q^{-1})	Per cent deviation
Jul-22	9867	10623.2	-7.66
Aug-22	11549	11270.4	2.41
Sep-22	9249	9074.32	1.89
Oct-22		8612.99	
Nov-22		8576.28	
Dec- 22		8760.27	
Jan- 23		8361.49	
Feb- 23		8080.15	
Mar-23		8805.62	

4. Conclusion

The compound growth rate of exports showed a negative and significant growth rate of –2.41 per cent whereas imports showed a positive and significant growth rate of 10.44per cent from 2006-07 to 2021-22. The seasonal indices of cotton arrivals in Andhra Pradesh were highest in the months of January (177.54), December (153.67) and November (146.10) because of usage of late season varieties and holding of crop by traders and farmers in anticipation of higher prices. The lower seasonal indices for cotton prices were in the months of December (97.23) and November (101.50). Cost of Production in cotton was Rs. 14006/quintal. Gross margin implies the returns over variable costs which is pertained to owner farmers and net returns implies returns over the total costs which is pertained to tenant owners. The gross margin and net returns were Rs. -15775 per ha and Rs. -59791 per ha respectively. The results of ANN model revealed that, neural network 9-29-1 (9 input nodes, 29 hidden nodes, and 1 output) outperformed all other neural networks with lower MAPE (2.904), RMSE (140.59), MAE (90.02), and MASE (0.114) values. The per cent deviation of predicted price from actual price for cotton using best fit ANN model was less than 20 per cent.The area under cotton may increase by replacing other commercial crops (chilli&turmeric). During 2021-22, 5.5 lakh ha of cotton was cultivated, which increased to 6.02 lakh hectares in 2022-23 kharif season because of current level of prices. It is expected that the raw cotton will get cleared this year without a place for the old stocks. So, demand may persist in the next harvesting season also with an expected price around Rs. 8269/ quintal, keeping the price at remunerative level.

5. Further Research

1. Though India is the world's largest cultivator of cotton with an area of nearly 37% but its productivity is comparatively less (500 kg/ha). So, measures need to be taken to increase the per hectare production by encouraging micro-irrigation.

2. India is the second largest consumer & exporter of fibre in the world. Most of thecotton exported from India is in the form of yarn & fibre. In order to trigger profits, value added production of cotton (soft toys, blankets, pillows, fabric etc.,) may be encouraged by consolidating garment & fabric industries at unit level.

3. As the cotton prices in world market are favourable, exports need to be encouraged which in turn increase thedomestic production and well-being of famers, as evident during 2021-22.

4. Pink boll worm in Andhra Pradesh caused severe crop damage and low yields resulted in increase of cotton prices in Andhra Pradesh to Rs. 12000/qtl in May 2022 when compared with Rs. 5710/qtl in May 2021,To manage this pest menace, awareness need to be created at all levels in all the growing seasons of the crop.

5. Cultivation of cotton organically need to be promoted as "organic cotton" is having high demand in the world market due to its texture & comfort whose prices are increasing annually in international trade, and costs incurred for organic cotton are less when compared with conventionally grown cotton.

6. Mechanization in cotton cultivation need to be encouraged with the help of establishing Farmer Producer Organisations as the labour cost occupies a major share in cotton cultivation. If its harvesting is mechanised using cotton pickers, costs incurred will be less compared to conventional farming which may increase the net returns to cotton growers.

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