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AN ANALYSIS OF GROWTH RATE AND TREND OF CHILLI IN TELANGANA

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ABSTRACT

Chilli is one amongst the necessary spices crop cultivated in India. India is the largest producer of dry chilli and pepper contributing 51 per cent to the world production (FAO, 2014). It is additionally, the largest shopper and business person of chilli. The reference period of this study was from 1971-2010, and it absolutely was carriedout within Telangana. A trial has been created to look at the trends in area, production and productivity of chilli crop. Linear and compound growth rates were calculated for this purpose. 10 growth models were fitted to the area, production and productivity of chilli crop to watch the trend, and the best model for trend was chosen based mostly upon least Residual Mean Square Error (RMSE) and vital R^2 . Besides, the necessary assumption of randomness of residuals was checked using one sample run test. The results unconcealed that linear and compound growth rates of area, production and productivity of chilli in Telangana were ascertained to be in considerably increasing trend throughout the study. Among all the trend models, polynomial trend was found to be the best fitted one for all the aspects of Telangana state. The analyses forecast chilli production for the year 2018 to be 308.66 t t. These projections can facilitate formulation of appropriate policies and steps to be taken to improve the crop production further.

KEYWORDS: Chilli, forecasting, growth rate, trends, modelling and production.

INTRODUCTION

Chile is an important commercial spice crop, and is produced throughout India, making our country one of the leading producers in the world market. Synonymously called hot-pepper or wonder spice, it ranks among the most widely used universal spice. Several different varieties of chiles are cultivated for various economic uses like vegetable, pickles, spice, condiments and doubling as a nutraceutical crop (Geetha et al. (2017). As of the year 2014, India ranked 1st in dry chili production (1.49 Mt) and 17th in green chili (0.69 Mt) in comparison to China, Indonesia and Egypt are the 1st three contenders, respectively (FAO, 2014-15). Considering the Indian scenario in the year 2014-15, estimates suggest that Telangana is the 2nd largest producer of dry chilies (0.3 Mt), following Andhra Pradesh and the 6th largest producer of green chilies (0.09 Mt) following Karnataka, Bihar, Andhra Pradesh, Jharkhand & Haryana, respectively. Productivity wise, Telangana ranks 3rd at 3.54 t/ha followed by Andhra Pradesh (4.58 t/ha) and Uttarakhand (3.60 t/ha), respectively. The average productivity in Khammam district was 3453 Kg/ha and production was 11.318 t t, respectively (Velayutham, L.K. and Damodaran, K., 2015). Collars are an important ingredient in many different cuisines across nations adding pungency, taste, flavor and color to food. Indian chili is acclaimed for its color and pungency levels. Some

varieties are famous for the red color and others for quality parameters in Chile like length, width, skin thickness and antioxidant compounds (Howard et al., 2000). A wide spectrum of antioxidants viz. Vitamins, carotenoids, capsaicinoids and phenolic compounds are present in hot pepper fruits. The intakes of these compounds as food, supplement health-protection against several diseases. As consumption continues to increase, hot peppers could provide important amounts of nutritional antioxidants in the human diet. Green chilies are rich in proteins 2.9 g per 100 g. Ca, Mg, P, K, Cu and S. Vitamins like Thiamine, Riboflavin and Vitamin C.

In a recent study by Sathish et al. (2015), it was reported that area in both Andhra Pradesh & Telangana was in a decreasing trend in relation to an area, whereas production and productivity were increasing. It was also duly noted that production of chili showed the highest degree of instability compared to area and productivity. Sarada et al. (2015), the study indicated the impact of weather conditions on production and productivity of chili in Guntur district of Andhra Pradesh and may help in developing forecasting models based on climatic conditions. Rao and Reddy (2005) worked out the growth rates of area, production and productivity of groundnut for the period I (1988-89 to 2002-03) and period II (1953-56 to 2002-03) in the three geographical regions of Andhra Pradesh and also Andhra Pradesh state as a whole. The compound growth rate of the area is significant only in Rayalaseema, production is significant in all three regions and Andhra Pradesh state as a whole and productivity is significant in Coastal Andhra and Andhra Pradesh state as a whole.

Growth models are useful in drawing inferences regarding the exact relationship between time and growth, the rate of growth at each point of time, the turning points in the growth and growth rates are considered as the best indices of growth. Thus, from food, nutritional, medicinal and economic security point of view, study of production behavior and its future prediction is of utmost importance.

MATERIALS AND METHODS

The present study is based on 40 years of data i.e., from 1971 to 2010. The area, production and productivity of chili in Telangana were obtained from the publications of CMIE (Centre for Monitoring Indian Economy), Statistical abstracts of Andhra Pradesh and also from www.indiastat.com. In order to examine the nature of change and degree of relationship in area, production and productivity of chili in Telangana, various statistical measures such as mean, skewness, kurtosis and coefficient of variation were worked out.

Descriptive Statistics

To examine the nature of each series, these have been subjected to get various statistics. Descriptive statistics are typically distinguished from inferential statistics. With descriptive statistics, one simply describes what is or what the data shows. With inferential statistics, one tries to reach conclusions, that extend beyond the immediate data alone. Statistical tools used to describe the above series are minimum, maximum, average, standard error, skewness, kurtosis.

The linear growth rate (LGR) and compound growth rate (CGR) for the crop characteristics i.e., Area, production and productivity of chili crop in three regions of Andhra Pradesh are estimated by fitting the following functions.

Parametric trend models

Table 1

Model	A functional form	Growth rate
Linear function	$Y_t = a + bt$	LGR (%) = $\frac{b}{y} \times 100$
Compound function	$Y_t = a\ b^t$	CGR (%) = (b-1) x 100
Inverse function	$Y_t = a + b/t$	
Quadratic function	$Y_t = a + bt + ct^2$	
Cubic function	$Y_t = a + bt + ct^2 + dt^3$	
Logarithmic function	$Y_t = a + b\ ln(t)$	
S-curve function	$Y_t = Exp\ (a+b/t)$	
Growth function	$Y_t = Exp\ (a + bt)$	
Power function	$Y_t = at^b$	
Exponential function	$Y_t = a\ Exp\ (bt)$	

The models fitted to the time series data of area, production and productivity are linear, logarithmic, inverse, quadratic, cubic, compound, S-curve, growth, power and exponential. It was observed that R^2 is not enough to examine goodness of fit of a model (Reddy, 1978). So, in addition to R^2, the residual mean square error (RMSE) which will measure the accuracy in forecasting is also the best criterion to choose a model from among the alternatives. The most important assumption of randomness of residuals was tested by using one sample run test.

$$Adj R^2 = (\overline{R^2}) = R^2 - \left[\frac{K-1}{N-K}\right](1-R^2)$$

Where,

- K is the number of constants in the equation
- N is the total number of observations

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \hat{X}_i)^2}{n}}$$

The model which showed relatively the least residual mean square error (RMSE), significant R^2 and significant runs are chosen for the purpose of trend fitting.

RESULTS AND DISCUSSIONS

Since 1970, the area under chilli cultivation has been increased from 82.98 t ha to 84.17 t ha till 2010, registering linear and compound rates of almost 1.16 percent and 1.30 per cent per annum, respectively. The average area under chilli being 90.12 t ha. Kurtosis value of area reveals negative and platykurtic. Negative skewness value of area indicates that there has been decreasing early half of the study period. With a mere 46.69 t t of production, it has reached to 300.34 t t during the year 2010 and registering linear and compound growth of almost 4.94 and 6.30 per cent per annum, respectively. Increased production of chilli would not been possible without a substantial increasing per hectare yield of the

crop. Starting with only 562.70 kg of chilli per hectare, it has reached to 3567.97 kg ha^{-1} during the year 2010; the results are given in Table 1. Thus, the joint effect of expansion area and yield has resulted in a brighter picture of chilli production scenario in Telangana. There has been substantial growth in area, production and yield of chilli during the period under investigation.

Trend Behavior of Chilli in Telangana

To work out the trends in area, production and yield of Chilli in Telangana, different parametric models like linear, logarithmic, inverse, quadratic, cubic, compound, S-curve, growth, power and exponential models were attempted among the competitive models. The present study reveals that the area of Chilli in Telangana region showed a constant growth pattern and decreased in the last year during the study period of 1971 to 2010. The results obtained by fitting all the ten growth models R^2 values for all the models were ranging from 0.141 in case of inverse and 0.573 in case of power function, respectively. Almost all the models R^2 values were significant at 1% level of significance. Only quadratic, cubic and power models satisfied the assumption of randomness of residuals. Polynomial function of second degree was found to be the best trend equation for future projection purpose of area, as it has exhibited the least RMS significant R^2, given in Table 2 and also satisfied the assumption of randomness of residuals.

The Production of Chilli in Telangana region showed a systematic growth pattern and increased during the study period of 1971 to 2010. The results obtained by fitting all the ten growth models R^2 values for all the models were ranging from 0.219 in case of inverse and 0.903 in case of cubic function. Almost all the models R^2 values were significant at 1% level of significance. Except logarithmic, inverse and s-curve models, all models are satisfied with the assumption of randomness of residuals. Polynomial function of third degree was found to be the best trend equation for future projection purpose of production; it has exhibited the least RMS and significant $R^{2\ as}$ given in Table 2 and also satisfied the assumption of randomness of residuals.

The Productivity of Chilli in Telangana region showed an increasing trend during the study period of 1971 to 2010. The results obtained by fitting all the ten growth models R^2 values for all the models were ranging from 0.184 in case of inverse and 0.923 in case of cubic function, respectively. Almost all the models R^2 values were significant at 1% level of significance. Except inverse and s-curve models, all models are satisfied with the assumption of randomness of residuals. Polynomial function of third degree was found to be the best trend equation for future projection purpose of productivity; it has exhibited the least RMS and significant R^2 as given in Table 2 and also satisfied the assumption of randomness of residuals.

Observed and Forecasted of Area, Production and Yield of Chilli in Telangana

After identification of best fitted trend model, the same model was used for forecasting of area, production and productivity of chilli crop in Telangana, the results are shown in Table 3. From figure 1, it is clear that there no much different in observed and forecasted values of chilli with respect to area, production and productivity. From the forecast values obtained, it can be said that forecasted production and productivity will increase to some extent in future, and it would be 308.66 thousand hectares and 5366.21 kg ha^{-1}during 2018, whereas forecasted area will decrease to some extent in future and it would be 67.45 t ha, respectively.

CONCLUSIONS

From the present study, it is inferred that among the area, production and productivity of chilli in Telangana, the production exhibited higher growth rates with an increasing trend, due to increased trend in growth rates of area and productivity. The future projections in case of area polynomial function indicated decreasing trend in area, in case of production and productivity, the polynomial function indicated that there would be significant increase in future. And, it was concluded that the linear and compound growth rates of area under chilli even though positive, in recent past, area under chilli is gradually decreasing in Telangana state. So, policy makers and research workers should keep an eye on this aspect and take necessary actions to rejuvenate area under chilli in Telangana by appropriate schemes and regulations which encourage the chilli farmers to take up chilli cultivation.

Table 2: Per Se Behavior of Chilli Production in Telangana during 1970-2010

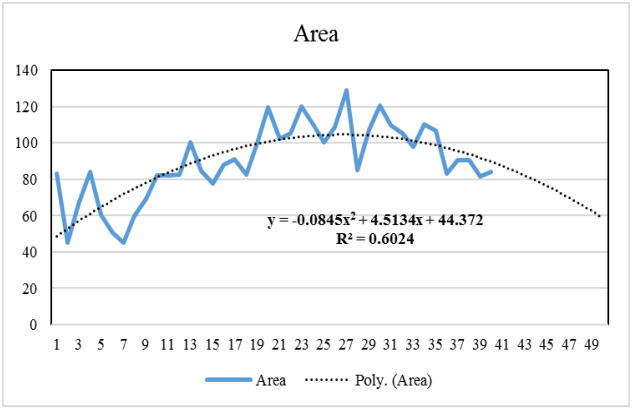
	Area (thousand hectares)	Production (thousand tonnes)	Productivity (Kg ha^{-1})
Mean	90.12	147.21	1553.06
Kurtosis	-0.12	-1.28	-0.28
Skewness	-0.42	0.29	0.75
Minimum	44.97	18.37	277.09
Maximum	129.14	300.35	3567.98
LGR (%)	1.16**	4.94**	4.44**
CGR (%)	1.30**	6.30**	4.90**

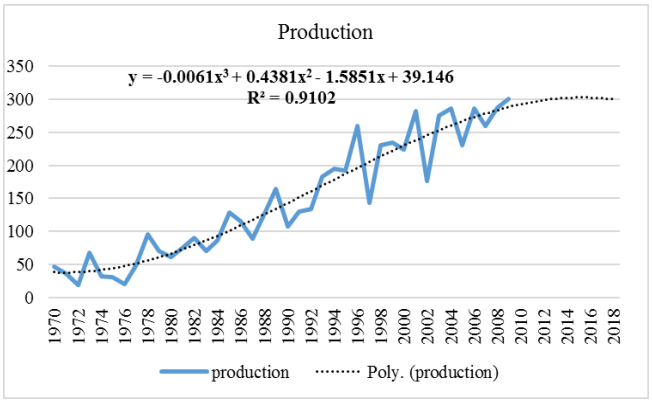
Table 3: Growth models for Area, Production and Productivity of Chilli in Telangana

	Model	Constant	b1	b2	b3	R^2	RMSE	RUNS	F	Sig.
Area	Polynomial	44.37	4.513	-0.084		0.602**	137.69	19	15.866	0
Production	Polynomial	39.14	-1.585	0.438	-0.0006	0.910**	78.64	23	113.954	0
Productivity	Polynomial	446.12	53.83	-1.77	0.588	0.929**	58.23	21	182.94	0

Table 4: Model validation and forecasting of area, production and productivity of chilli of Telangana

YEAR	Area (thousand hectares)		Production (thousand tonnes)		Productivity (Kg ha^{-1})	
	Observed	Predicated	Observed	Predicated	Observed	Predicated
2009	81.67	92.61	287.43	287.60	3519.46	3293.82
2010	84.17	90.49	300.34	292.54	3567.97	3479.32
2011		88.19		296.90		3675.19
2012		85.74		300.67		3881.80
2013		83.11		303.80		4099.48
2014		80.31		306.26		4328.59
2015		77.35		308.01		4569.47
2016		74.22		309.02		4822.46
2017		70.92		309.24		5087.93
2018		67.45		308.66		5366.21





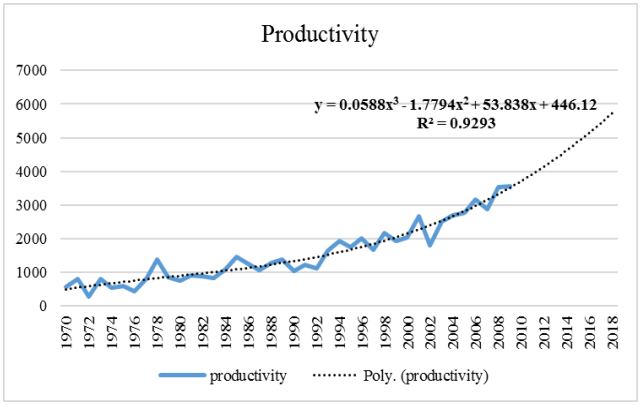


Figure 1: Trend of Chilli Area, Production and Productivity in Telangana

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