Statistical investigation of production performance of coriander in India

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ABSTRACT

Coriander or dhaniya is an indispensible spice in Indian as well as in all other cuisines. India is the largest producer and consumer of coriander seed. Coriander production has increased significantly in the past decade and currently hovering around 5 lakh tonnes. The rise in output was primarily on account of rise in yields. However, coriander production has moderated in 2012-13 due to adverse weather conditions. In present investigation time series data of coriander used to see the trend of area, production and productivity in major states in India. Also All data series of coriander productivity fitted with cubic trend and area of coriander in Andhra Pradesh and Rajasthan follows the linear trend. In case of Rajasthan and whole India use of phosphorous fertilizer significantly influence the coriander productivity.

***Keywords*:** Factor of production, Principal component analysis, Regression, Trend analysis,

1. INTRODUCTION

Coriander is native to South-Eastern Europe and grown extensively all over the Europe, Middle East, China, India, and Turkey. This herbaceous plant grows up to 2 feet in height with branching stems, featuring deep green soft, hairless bi or tri-lobed leaves. The mature plant bears small light pink color flowers that subsequently turn into globular or oval-shaped fruits (seeds). The seeds measure about 4-6 mm in diameter and containing some important essential oils. India is the biggest producer, consumer and exporter of coriander in the world with an annual production averaging around 3 lakh tonnes. The production fluctuates widely between years and has varied from below 2 lakh tonnes to above 4 lakh tonnes in this decade. Rajasthan (54%) and Madhya Pradesh (17%) are the two largest producing states in the country contributing over two-thirds to the country's total production in 2006-07. Mishra *et al.* (2017) studied the trend of pepper in India. Mishra *et al.* (2018) investigated the trend the cumin and factors affecting the productivity in India. In present Investigation the factors like fertilizers, environmental factors etc. affecting the production of cumin in India and its future performance using forecasting models. In present study trend of coriander in major states of India and factors affecting the production has been done.

2. MATERIALS AND METHODS

To meet the objective of study the area, production and productivity of major spice namely coriander in India, national level and by following the relative contribution of each and every states production to total India production, the major growing states for coriander have been selected for the study purpose.

2.1. Trend models

Trend models generally picture the overall movement of any time series. For this study parametric models were explored to trace the trends of the production and trade behaviour (Borthakur, and Bhattacharya 1998) of coriander in India. The best fit models which are chosen for estimating the growth pattern is based on the R^2 values obtained. The model with highest R^2 value is considered as the best model.

2.2. Regression analysis

For the purpose of present study, the following regression model will be assumed.

$$Y = f (RF, T_{max}, T_{min}, N, P,K)$$

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Table 1: Trends in area, production and productivity of coriander in major states of India

Area ('000 ha)										
	Model Summary						Parameter Estimates			
	Model	R^2	F	df_1	df_2	Sig.	Const.	b_1	b_2	b_3
Andhra Pradesh	Linear	0.69	35.26	1	40	0.00	129	-2.25** (0.38)		
Madhya Pradesh	Quadratic	0.78	30.77	2	39	0.00	8	5.33** (1.37)	-0.065* (0.03)	
Rajasthan	Linear	0.62	24.29	1	40	0.00	78	2.41** (0.49)		
Tamil Nadu	Cubic	0.86	37.43	3	38	0.00	16	6.21** (1.08)	-0.305** (0.058)	0.004** (0.001)
India	Quadratic	0.51	6.95	2	39	0.01	247	14.87** (4.10)	-0.305** (0.093)	
Production ('000 tonnes)										
Andhra Pradesh	Cubic	0.66	10.01	3	38	0.00	15	3.11* (1.15)	-0.16* (0.06)	0.002* (0.001)
Madhya Pradesh	Cubic	0.79	22.00	3	38	0.00	19	-2.66* (1.37)	0.220* (0.07)	-0.004* (0.001)
Rajasthan	Cubic	0.86	39.46	3	38	0.00	55	-6.24* (4.95)	0.575* (0.26)	-0.008* (0.004)
Tamil Nadu	Cubic	0.85	3.43	3	38	0.00	3	3.10** (0.48)	-0.163** (0.026)	0.002** (0.001)
India	Linear	0.83	92.50	1	40	0.00	111	5.57** (0.58)		
Productivity (kg ha^{-1})										
Andhra Pradesh	Cubic	0.70	12.99	3	38	9.99	179	20.33** (7.16)	-1.102** (0.37)	0.018** (0.006)
Madhya Pradesh	Cubic	0.53	5.17	3	38	0.00	380	-15.42* (5.88)	0.796* (0.309)	-0.011* (0.005)
Rajasthan	Cubic	0.89	53.21	3	38	0.00	657	-35.56* (16.08)	2.560** (0.84)	-0.034** (0.01)
Tamil Nadu	Cubic	0.79	22.05	3	38	0.00	348	17.04** (5.30)	-1.203** (0.27)	0.019** (0.004)
India	Cubic	0.91	62.53	3	38	0.00	409	-13.30* (8.24)	1.048* (0.43)	-0.013* (0.006)

Note: ** significant at 1%; * significant at 5%; figures in the parenthesis indicates Standard Error; df1: Regression degrees of freedom; df2: Residual degrees of freedom.

where

Y = coriander productivity (kg per hectare)

RF = Rainfall (mm)

T_{max} = Mean maximum temperature (^{0}C)

T_{min} = Mean minimum temperature (^{0}C)

N = Total nitrogen fertilizer consumption

P = Total phosphorous fertilizer consumption

K = Total potash fertilizer consumption

Table 2: Regression analysis of factor affecting the productivity of coriander in major states of India

Model		B	SE	Sig.	R^2	Adj. R^2
Andhra Pradesh						
A	(Constant)	-5111.84	2733.35	0.07	0.41	0.30
	N	-0.10	0.15	0.52		
	P	0.05	0.36	0.90		
	K	0.61	0.26	0.02		
	RF	-0.01	0.08	0.92		
	T_{max}	400.04	252.37	0.12		
	T_{min}	-349.61	260.95	0.19		
B	(Constant)	-1874.85	1156.60	0.11	0.38	0.33
	K	0.58	0.20	0.01		
Rajasthan						
A	(Constant)	59.72	3616.63	0.99	0.67	0.60
	N	-0.17	0.49	0.74		
	P	2.72	1.33	0.05		
	K	1.22	1.91	0.53		
	RF	-0.12	0.21	0.56		
	T_{max}	28.73	236.83	0.90		
	T_{min}	-21.87	244.90	0.93		
B	(Constant)	506.63	39.84	0.00	0.65	0.65
	P	2.44	0.29	0.00		
Madhya Pradesh						
A	(Constant)	-1118.77	970.61	0.26	0.27	0.13
	N	0.05	0.10	0.62		
	P	-0.09	0.16	0.59		
	K	0.59	0.64	0.36		
	RF	0.00	0.05	0.96		
	T_{max}	19.95	62.65	0.75		
	T_{min}	41.04	66.43	0.54		
B	(Constant)	-1054.95	409.94	0.01	0.24	0.21
	T_{min}	72.19	21.42	0.00		
Tamil Nadu						
A	(Constant)	18462.19	16883.10	0.28	0.44	0.34
	N	-0.31	0.28	0.29		
	P	-0.55	0.60	0.37		
	K	0.57	0.39	0.16		
	RF	-0.02	0.05	0.67		
	T_{max}	-2004.51	1935.20	0.31		
	T_{min}	1969.96	1923.87	0.31		
B	(Constant)	468.11	26.21	0.00	0.38	0.36
	N	-0.31	0.07	0.00		
India						
A	(Constant)	-831.41	991.61	0.41	0.76	0.71
	N	-0.01	0.02	0.65		
	P	0.10	0.07	0.13		
	K	-0.02	0.09	0.82		
	RF	0.15	0.14	0.30		
	T_{max}	46.85	63.38	0.47		
	T_{min}	-29.09	74.41	0.70		
B	(Constant)	308.70	22.14	0.00	0.73	0.73
	P	0.08	0.01	0.00		

Note: A is full model; B is step-down regression model

Table 3: Principal component analysis of factors effecting productivity of coriander in major states of India

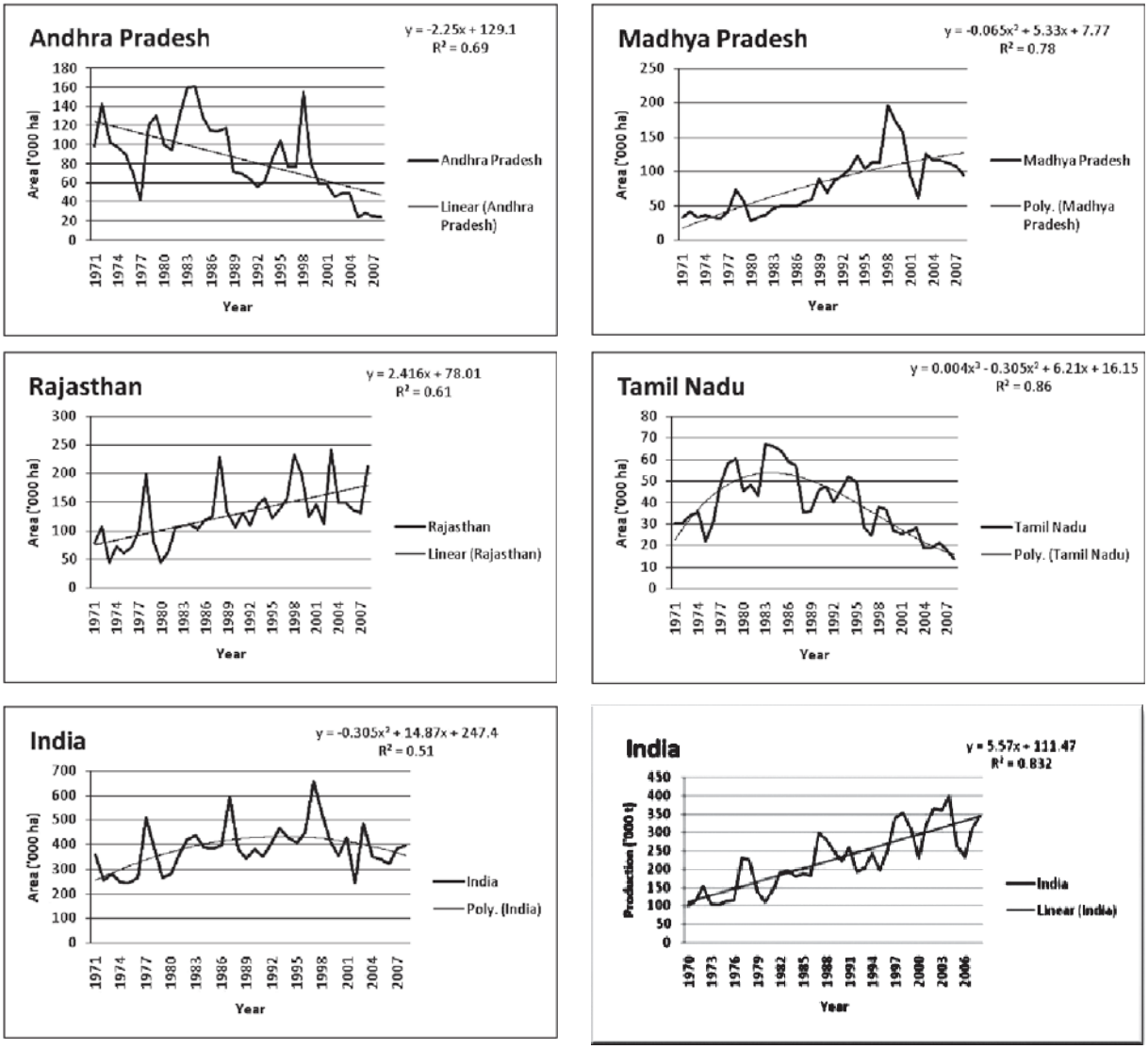
	Andhra Pradesh						Rajasthan					
	PC1	PC2	PC3	PC4	PC5	PC6	PC1	PC2	PC3	PC4	PC5	PC6
N	0.95	0.05	-0.24	-0.19	0.07	-0.01	0.85	0.42	0.10	-0.28	-0.09	-0.08
P	0.94	0.09	-0.30	-0.11	-0.08	0.01	0.88	0.40	0.00	-0.22	0.08	0.10
K	0.89	0.07	-0.36	0.28	0.02	0.00	0.21	0.80	0.22	0.52	0.00	-0.01
RF	0.32	0.89	0.34	0.01	0.00	0.00	-0.11	-0.25	0.96	-0.08	0.01	0.01
Tmax	0.85	-0.29	0.44	0.02	0.01	0.05	0.76	-0.60	-0.02	0.23	-0.10	0.07
Tmin	0.88	-0.27	0.40	0.02	-0.02	-0.05	0.81	-0.55	-0.02	0.17	0.10	-0.08
Eigen Value	4.17	0.96	0.74	0.13	0.01	0.01	2.79	1.69	0.98	0.48	0.03	0.03
% of Variance	69.42	15.92	12.30	2.09	0.18	0.09	46.49	28.22	16.31	7.98	0.55	0.45
Cumulative %	69.42	85.34	97.64	99.73	99.91	100.00	46.49	74.71	91.02	99.00	99.55	100.00
	Madhya Pradesh						**Tamil Nadu**					
	PC1	PC2	PC3	PC4	PC5	PC6	PC1	PC2	PC3	PC4	PC5	PC6
N	0.88	-0.36	0.08	0.24	-0.10	0.14	0.95	0.11	-0.24	-0.11	0.12	0.00
P	0.86	-0.42	0.10	0.23	0.12	-0.13	0.94	0.16	-0.25	-0.08	-0.14	0.00
K	0.77	-0.29	0.20	-0.53	0.00	0.00	0.93	0.16	-0.27	0.18	0.02	0.00
RF	-0.22	0.24	0.94	0.07	0.00	0.00	0.11	0.92	0.37	0.00	0.00	0.00
Tmax	0.68	0.71	-0.08	-0.01	0.15	0.09	0.88	-0.29	0.39	0.00	0.00	-0.01
Tmin	0.77	0.61	-0.06	0.03	-0.15	-0.11	0.87	-0.29	0.39	0.01	0.00	0.01
Eigen Value	3.20	1.32	0.96	0.40	0.07	0.06	4.19	1.09	0.73	0.05	0.04	0.00
% of Variance	53.32	22.02	15.92	6.68	1.12	0.93	69.84	18.15	10.54	0.88	0.59	0.00
Cumulative %	53.32	75.34	91.26	97.94	99.07	100.00	69.84	87.99	98.54	99.41	100.00	100.00
	India											
	PC1	PC2	PC3	PC4	PC5	PC6						
N	0.95	-0.25	-0.14	-0.05	0.14	0.05						
P	0.97	-0.22	-0.12	0.01	0.03	-0.08						
K	0.95	-0.18	-0.14	0.12	-0.15	0.03						
RF	0.51	0.00	0.86	-0.03	-0.01	0.00						
Tmax	0.21	0.96	0.04	0.18	0.07	0.00						
Tmin	0.50	0.83	-0.14	-0.20	-0.06	0.00						
Eigen Value	3.29	1.74	0.82	0.09	0.05	0.01						
% of Variance	54.87	29.03	13.59	1.50	0.86	0.15						
Cumulative %	54.87	83.90	97.49	98.99	99.85	100.00						

Table 4: Regression analysis between factors scores and yield of coriander in major states in India

State	Regression Equation	R^2	Adj. R^2
Andhra Pradesh	Y=294.513+35.96PC1**-6.735PC2**-2.841PC3	0.66	0.62
Rajasthan	Y=768.026+183.015PC1**+96.05PC2*-14.559PC3*	0.73	0.71
Madhya Pradesh	Y=326.385+23.699PC1**+11.75PC2*-0.076PC3	0.65	0.60
Tamil Nadu	Y=350.487-39.959PC1**-3.534PC2*+3.016PC3	0.76	0.69
India	Y=497.718+119.708PC1**-13.387PC2*+2.812PC3*	0.85	0.82

Note: **significant at 1%, * significant at 5%

Fig. 1A: Observed and expected trends of area of coriander in major states of India



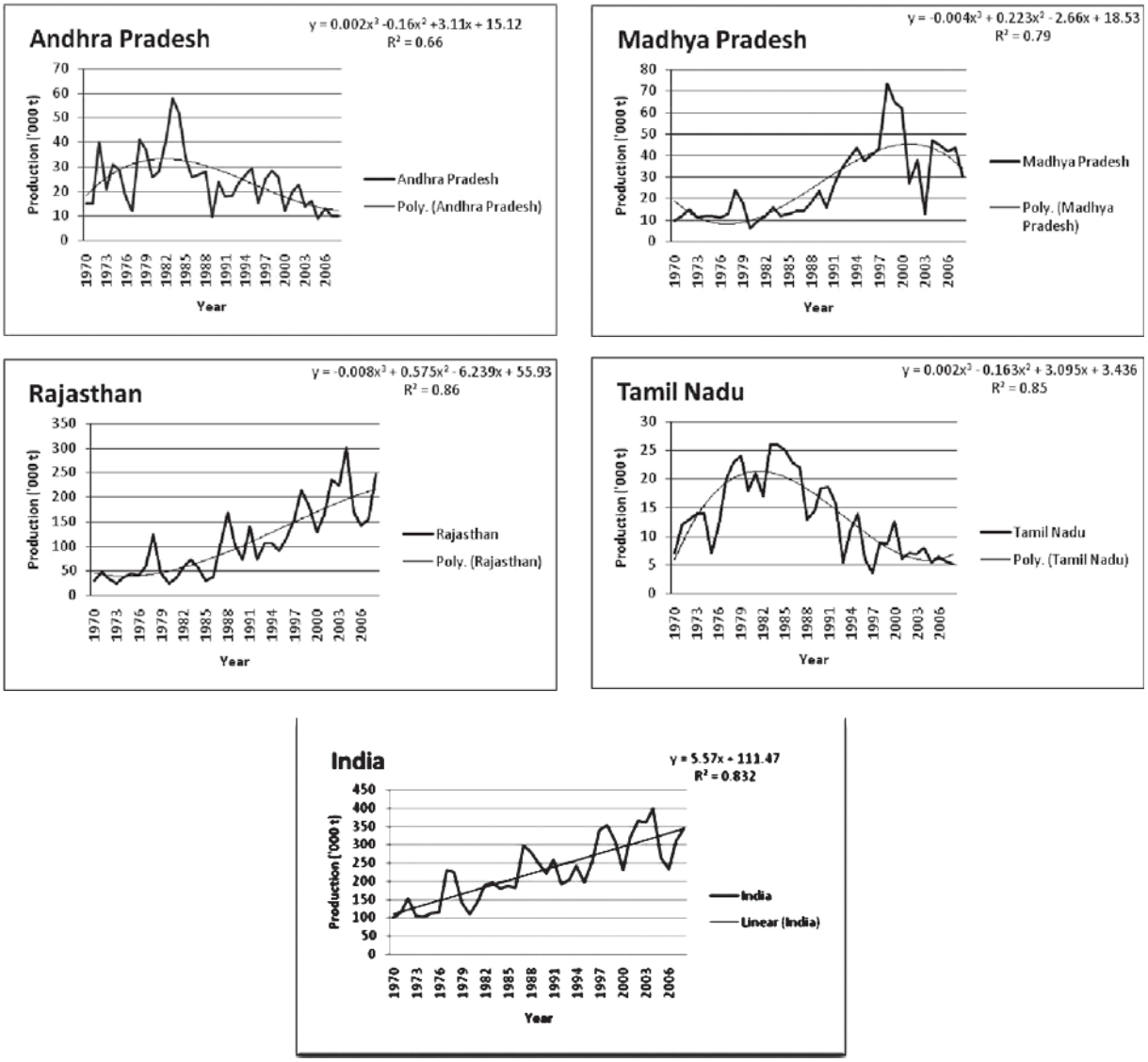
3. RESULTS AND DISCUSSION

3.1. Trends in area, production and productivity of coriander in major states of India

To workout the trends in area, production and productivity of coriander in major growing states different parametric models like linear, polynomial, logarithmic, compound, growth and exponential models were attempted. Among the significant competitive models, the best model was selected based on maximum value of R^2 and significant coefficients. From the table 1, it is clearly understood that, coriander area in Andhra Pradesh and Rajasthan follows the linear trend, Madhya Pradesh and whole India follows the quadratic trend and Tamil Nadu follow the cubic trend. Except production of whole India remaining data series of production and productivity fitted with cubic trend.

The positive b_3 coefficients of production and productivity of coriander in Andhra Pradesh indicates increased trend recently due to collaboration of the All India Coordinated Research Project (AICRP) on spices and Department of Horticulture, Andhra Pradesh. The efforts followed to increase the productivity and production are delivering quality seeds, training to farmers about advanced production practices, introduction of high yielding varieties, area expansion programmes (Sarada, 2008). The main producing coriander states Rajasthan and Madhya Pradesh shows the declining productivity in the recent study period. Providing quality seeds, management of drought, development of water management strategies may enhance the productivity.

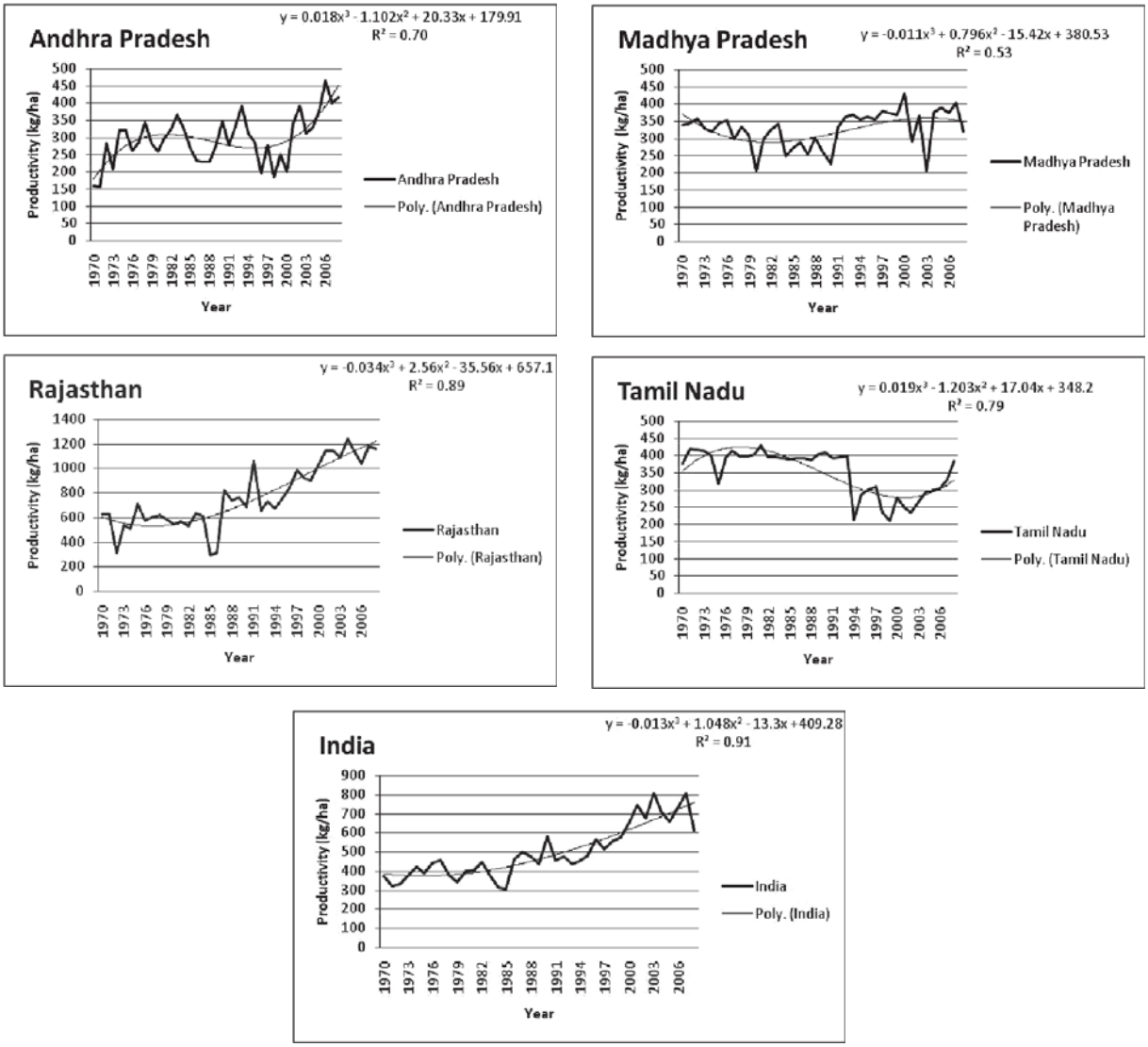
Fig.1B: Observed and expected trends of production of coriander in major states of India



3.2. Regression analysis of factor affecting the productivity of coriander in major states of India

In order to find out the relationship of coriander productivity with N, P, K, RF, T_{max} and T_{min} factors multiple linear regression equations are fitted. The most important factor influencing coriander productivity identified by using step-down regression analysis (Table 2). Coriander productivity is found to be linearly related with potassium fertilizer consumption in Andhra Pradesh, the coefficient is found to be 0.582 which implies that a unit change in use of total potash fertilizer in state would lead to increase in coriander productivity by 0.582 kg ha^{-1}. In case of Rajasthan and whole India use of phosphorous fertilizer significantly influence the coriander productivity. A unit change in the use of phosphorus fertilizer would lead to increase coriander productivity by 2.439 kg ha^{-1} in Rajasthan and 0.732 kg ha^{-1} in whole India. In Madhya Pradesh T_{min} is showing significant positive coefficient of 72.187 on coriander productivity which reveals that a unit change in T_{min} would lead to increase in coriander yield by 72.187 kg ha^{-1} in Madhya Pradesh. Coriander productivity of Tamil Nadu is found to have significant linear relationship with nitrogen fertilizer with a coefficient of -0.31. From the study it can be concluded that not all factors are equally effective on productivity of coriander. In different states, different factors are influencing the coriander productivity; by and large N, P, K fertilizer consumption are the important factors effecting the productivity of coriander.

Fig. 1 C: Observed and expected trends of productivity of coriander in major states of India



3.3. Principal component analysis of factors effecting productivity of coriander in major states of India

Results of principal component analysis are presented in the table 3. Results of analysis revealed that, proportion of variance explained by first principal component is more than 45 percent in all states. First principal component for Andhra Pradesh, Rajasthan, Madhya Pradesh, Tamil Nadu and whole India explains 69.42, 46.49, 53.32, 69.84 and 54.87per cent of total variation in its data sets, whereas second PCs explains per cent variations of about 15.92, 28.22, 22.02, 18.15 and 29.03 per cent respectively and so on. As per criteria given by Hair *et al.*(2005), three principal components are retained for all major states and whole India for regressing with productivity of coriander. In all the states, retained principal components altogether has explained at least 90 per cent of variations in data. Least variation explained by first three principal components in Rajasthan (91.02%) while the maximum variation was explained for data set of Tamil Nadu (98.54%).

3.4. Regression analysis between factors scores and yield of coriander in major states in India

The principal components having Eigen value of more than 0.7 are used to get the principal components scores and productivity of coriander are regressed on these scores and presented in table 4. Results of analysis revealed that, scores developed from all the selected PCs are found to have significant effect on coriander productivity in

Rajasthan and whole India, whereas third PC scores in Andhra Pradesh, Madhya Pradesh and Tamil Nadu remains insignificant. The coriander productivity is found to have significant linear relationship with developed scores with R^2 value of 0.66, 0.73, 0.65, 0.76 and 0.85 in Andhra Pradesh, Rajasthan, Madhya Pradesh, Tamil Nadu and whole India respectively.

4. CONCLUSION

Except for the area of Madhya Pradesh, Andhra Pradesh and whole India, and production of whole India, all the remaining data series fitted well with cubic trend, thereby indicating that there have been different regims of production and scenarios for these crops. For corinder the productivity is greatly influenced by the use of three major fertilizer viz. nitrogen, phosphorus and potassium.

REFERENCES

Anonymous. 2017. Major state wise production of spices in India, http://www.indianspices.com/ last accessed 13/07/2017.

Borthakur, S. and Bhattacharya, B.K. 1998. Trend analysis of area, production and productivity of potato in Assam".*Economic Affairs*, **43(4):**221-26**.**

Hair, F., Anderson, J., Tatham, L. and Black, C. 2005. "*Multivariate Data Analysis*", 5th ed. Prentice Hall, New Jersey.

Mishra, P., Padmanaban, K., B.S. Dhekale and A. K. Tailor. 2018. "Statistical Investigation of Production Performance of Cumin in India." *Economic Affairs*, **Vol. 63(**2**):** 547-55.

Mishra, P., Padmanaban, K. and Dwivedi, M. 2017. Modelling and Forecasting of Black Pepper Production in India. *Indian Journal of Ecology* **44 (4):** 741-45.

Sarada, C. and Giridhar, K. 2008. Threats in production of coriander (Coriandrum sativum) in Andhra Pradesh. *J. Spices Aromatic Crops***. 17**(2): 158- 62.