www.ThePharmaJournal.com

The Pharma Innovation

Sumit Wasnik
Ph.D. Research Scholar,
Department of Agricultural
Economics, College of
Agriculture, IGKV, Raipur,
Chhattisgarh, India

Sneha Pandey
Ph.D. Research Scholar,
Department of Agricultural
Economics, College of
Agriculture, IGKV, Raipur,
Chhattisgarh, India

Pradip Patel
Ph.D. Research Scholar,
Department of Agricultural
Economics, College of
Agriculture, IGKV, Raipur,
Chhattisgarh, India

Mamta Patel
Ph.D. Research Scholar,
Department of Agricultural
Economics, College of
Agriculture, IGKV, Raipur,
Chhattisgarh, India

Vijay Choudhary
Professor & Dean, College of
Agriculture, Kurud, Dhamtari,
Chhattisgarh, India

Trends in area, production and yield of paddy, wheat and gram in Chhattisgarh state: A critical analysis

Sumit Wasnik, Sneha Pandey, Pradip Patel, Mamta Patel and Vijay Choudhary

Abstract
An attempt has been made in this paper to examine the trends in area, production and yield of paddy, wheat and gram crops in selected districts *viz*., Raipur, Mahasamund, Dhamtari and Durg of Chhattisgarh plains as well the State and India as a whole. Since the main objective, it was also examined percentage changes in area, production and yield of these crops in relative terms. The study was completely based on 20 years of secondary time-series data during 2000-01 to 2019-20. The various parametric linear and non-linear trend models were tried to fit the data out of which statistically most suited parametric models were selected on the basis of adjusted R^2. The findings revealed that the overall performance of paddy found satisfactory as the area, production and yield of paddy in all selected district, the Chhattisgarh State and India as a whole exhibit continuous increasing growth trend line which was highly contributed by per hectare output than by the increased in area. Whereas, the overall growth performance of wheat and gram was found poor in the selected districts of Chhattisgarh plains with few exceptions as well as in the State. Thus, the phenomenon of productivity improvement was greatly responsible for increase production of production of wheat and gram. In the study, overall, the production and yield of gram has decreased by more than proportionate of wheat. Wheat, Gram and other pulses crop deserves some attention in the State and need efforts to increase the area and productivity of these crops.

Keywords: Chhattisgarh state, gram, models, paddy, trend and wheat

Introduction

Over last few decades the growth of Indian agriculture has helped the country in achieving food security at national level. The next big challenge is to sustain this growth and achieve nutritional security as well. India's production of foodgrains has been increasing every year, and India is the world's largest producer of pulses with the per cent share of 24.60 and ranks as the second largest producer of rice and wheat with the per cent share of 21.60 and 11.50 respectively; both accounts the production of 118.87 and 107.86 million tonnes on the land of 43.66 and 31.36 million hectare during 2019-20. India shares more than 26, 14 and 70 per cent area and 16, 14 and 78 per cent of production of rice, wheat and gram to the world.

Chhattisgarh is a state in Central India known for rice cultivation and called 'rice bowl of India'. Since the State have been formed, there is two decadal increases of total foodgrains of the States in which area increase by 9.03 per cent from 2000-01 (4.93 million Ha) to 2019-20 (5.37 million Ha) similarly, production was on the boom that it raises by more than 3 times from 2000-01 (2.90 million T) to 2019-20 (9.37 million T).

In India, paddy, wheat and gram has highest per cent share in terms of area and production to the area and production of total foodgrains among total cereals and pulses as well as the gross cropped area (GCA). Similarly, in Chhattisgarh State the situation was same. Thus, these crops were notified as a major crop contributing highest to the State's as well as in India's total foodgrains output. For the present study, therefore, paddy, wheat and gram had selected for the space of four districts *viz*., Raipur, Mahasamund, Dhamtari and Durg, as these were the representatives of Chhattisgarh plains zone. Similarly, selected four districts had collectively concentrated considerable amount of total area and total production under paddy, wheat and gram. Therefore, it felt necessary to examine the trends depicting the growth of these crops in terms of space, output and yield.

Materials and Methodology

The study was purely based on secondary data on area, production and yield of paddy, wheat and gram crops collected from the various official sources the sources were:

**Corresponding Author
Sumit Wasnik**
Ph.D. Research Scholar,
Department of Agricultural
Economics, College of
Agriculture, IGKV, Raipur,
Chhattisgarh, India

i) Tables of Agricultural Statistics, Commissioner Land Record, Govt. of Chhattisgarh, ii) Department of Agriculture, Land Record and Revenue Department Government of Chhattisgarh State, iii) Government websites, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare and iv) Agri India Stat. To facilitate proper understanding of percentage change and trends in area, production and yield the total 20 years of time-series data was taken from 2000-01 to 2019-20. The performance change in area, production and yield of the crops were analyzed through the simple relative percentage change method compare to base year 2000-01.

To analyze the trends, the different parametric linear, non-linear and time-series models were employed. Various trend models were tried to identify the appropriate trend equation. The trend equations were fitted for the 20 years of time-series data during 2000-01 to 2019-20. The statistically most suited parametric models were selected on the basis of adjusted R^2. Following models were employed to examine trends in area, production and yield of paddy, wheat and gram.

Table 1: Parametric linear and non-linear trend functions

Regression Models of Inquiry	Equation forms
Linear Model	$Y_t = a + bt$
Logarithmic model	$Y_t = a + b \ln(t)$
Quadratic model	$Y_t = a + b_1 t + b_2 t^2$
Cubic model	$Y_t = a + b_1 t + b_2 t^2 + b_3 t^3$
Compound growth model	$Y_t = a b^t$
Exponential model	$Y_t = a e^{bt}$
Power model	$Y_t = a t^b$

Result and Discussion
Change in area, production and yield of paddy
Figure 1 represents half decadal percentage change in area, production and yield of paddy. The area under paddy in India were found more or less stagnant during study period, it was 44.71 million hectares during 2000-01 which was decreased by more than 2 per cent to the 43.66 million hectares during 2019-20. Chhattisgarh State has also the more or less stagnant result for area under paddy during study period, in which it was found increased its area from 3.77 million hectares during 2000-01 to 4.27 million hectares during 2019-20. Under district-wise change in area under paddy, the result further indicated that all the selected districts *viz*., Raipur, Mahasamund, Dhamtari and Durg had found steady continuous increased its area by more than 7, 24, 31 and 21 per cent, respectively during 2000-01 to 2019-20. Although Raipur has maximum area under paddy during 20 years of study periods. Production of paddy in India and Chhattisgarh State during 2000-01 was 84.98 and 2.37 million hectares which was reached to 118.87 and 8.57 million hectares, respectively thus, increase in both was found continuous and was increased by more than 39 and 261 per cent from 2000-01 to 2019-20, respectively. Similarly, under district-wise change in production of paddy has observed drastic and continuous increase in all the districts. Highest production under paddy was observed in Raipur district during 20 years

of study periods.
As regards the yield of paddy, all the selected districts as well as Chhattisgarh State and India as a whole had showed increasing trend during 20 years of study periods. During 2019-20, India and Chhattisgarh State had increased yield by more than 43 and 219 per cent, respectively since 2000-01. Raipur has highest rate of continuous increasing yield and has maximum yield among other districts.

Change in area, production and yield of wheat
From figure 2, the area under wheat in India found increased from 25.73 million hectares (2000-01) by more than 21 per cent to the 31.36 million hectares (2019-20). Chhattisgarh State has more or less stagnant result for area under wheat after 2000-01 (0.78 million hectares), found decreased its area by more than 85 per cent (2019-20). All the districts found increased in area under wheat during the study period except Dhamtari found drastically fallen its area. Production of wheat in India was 69.68 million hectares (2000-01) reached to 107.86 million hectares increased by more than 54 per cent (2019-20). Chhattisgarh State wheat production has declined and remain stagnant after 2005-06 this decline was more than 82 per cent (2019-20). All the districts showed increasing in production of wheat except Dhamtari had steady fluctuations during study period. Similar to area, Durg had maximum production under wheat than other districts during 20 years of study periods. As regards the yield of wheat, all the selected districts as well as Chhattisgarh State and India as a whole had showed increasing trend during 20 years of study periods except Mahasamund has continuous decreasing yield up to 40 per cent (2019-20). During 2019-20, India and Chhattisgarh State had increased yield by more than 27 and 14 per cent, respectively from 2000-01.

Change in area, production and yield of gram
Figure 3 depicted the area under gram in India and Chhattisgarh State were found continuously increased from 5.19 and 0.14 million hectares (2000-01) to the 9.70 and 0.42 million hectares (2019-20), respectively by more than 86 and 199 per cent, respectively. Raipur and Mahasamund had found decline it area under gram, while later had declined by 50 per cent. Dhamtari and Durg both had increased area of gram by 2.8 times from 2000-01 to 2019-20. Production of gram in India was 3.86 million hectares (2000-01) which reached to 11.08 million hectares increased by more than 187 per cent (2019-20). All selected districts as well as Chhattisgarh State in production of gram had found highly declined over the study period. Only Dhahmtari had maximum production during entire period. The State had depicted highly negative performance in production of gram and declined by -85.32 per cent. As regards the yield of gram, all the selected districts as well as Chhattisgarh State as a whole had showed one decade increasing trend up to 2010-11, while then after found declining in yield of gram. India had continuous increasing yield increased by more than 53 per cent in 2019-20.
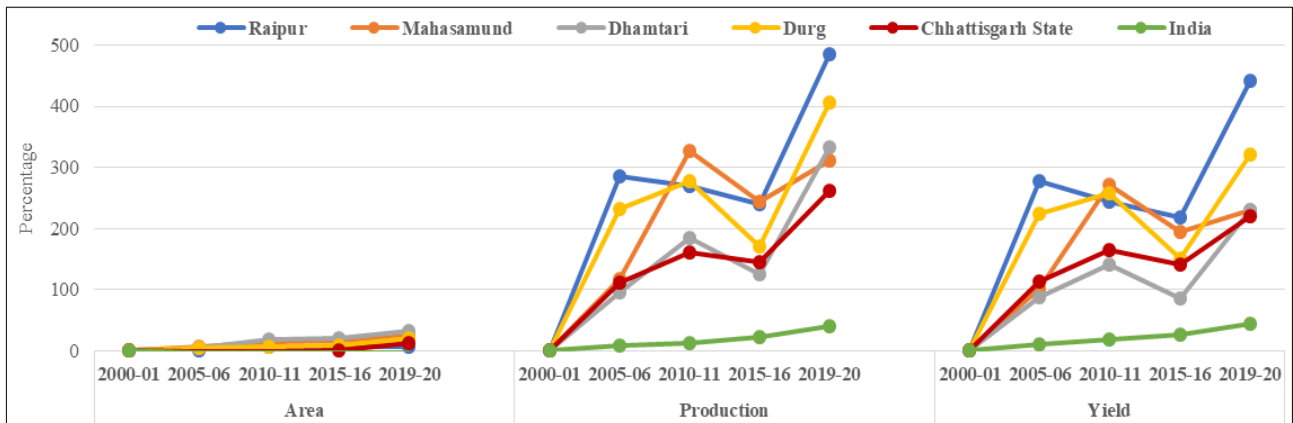
Fig 1: Percentage change in area, production and yield of paddy during 2000-01 to 2019-20
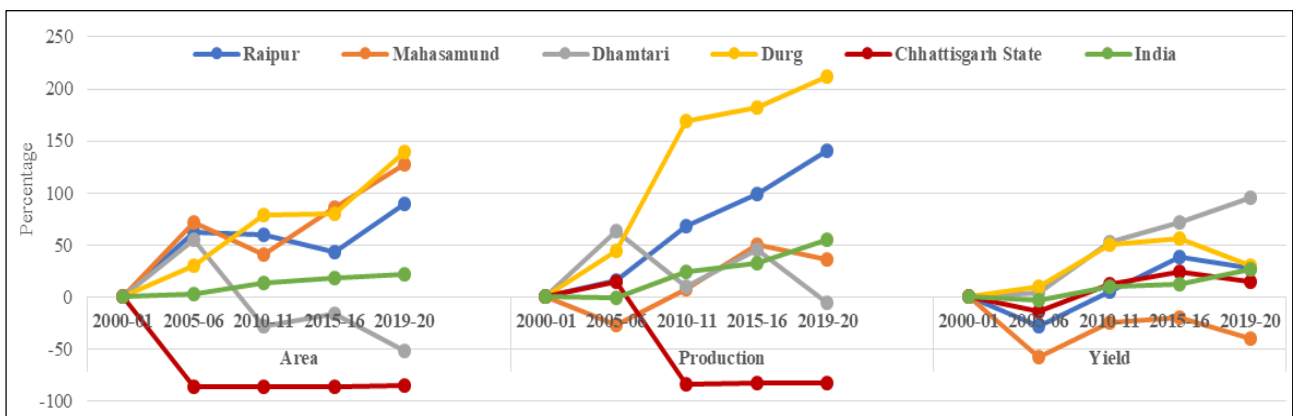

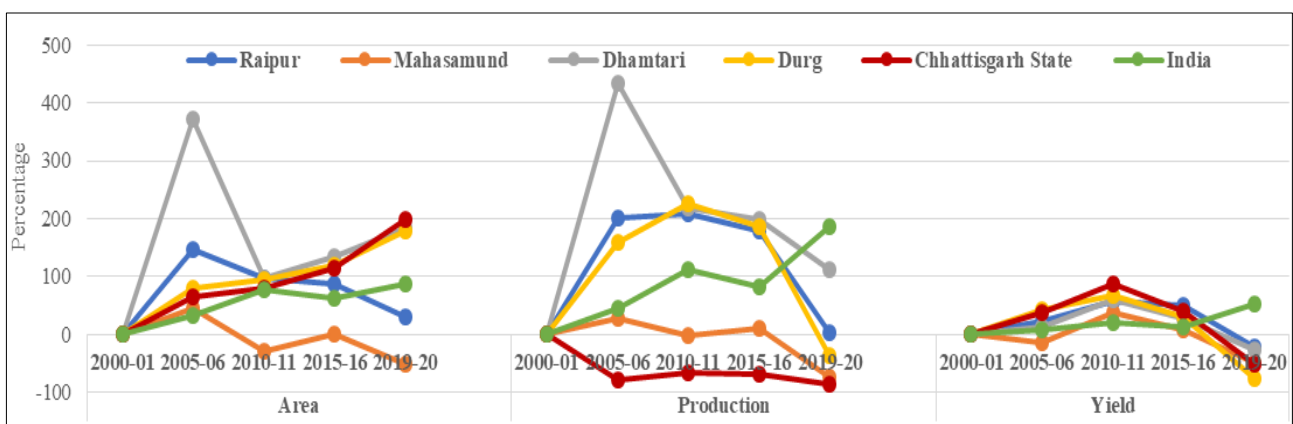**Fig 2:** Percentage change in area, production and yield of wheat during 2000-01 to 2019-20

Fig 3: Percentage change in area, production and yield of gram during 2000-01 to 2019-20

Trends in area, production and yield of paddy
From Table 1, the area under paddy, it was found that, compound trend function was giving most fit to the data suitable with model in both Raipur and Dhamatri districts with highest adjusted R^2 0.63 and 0.49, respectively both models exhibit same increasing growth trend lines. Whereas, linear and cubic trend function was giving most fit to the data suitable with model in Mahasamund and Durg districts with highest adjusted R^2 0.92 and 0.87, respectively both models exhibit same increasing growth trend lines. Under production of paddy, it was depicted that power trend function was giving most fit to the data suitable with model in Raipur, Mahasamund, Dhamatri and Durg districts with highest adjusted R^2 0.68, 0.60, 0.71 and 0.43, respectively, similarly, yield of paddy, power trend function most fit to the data with highest adjusted R^2 0.65, 0.51, 0.74 and 0.37, respectively.

Thus, all these trend models under respective districts had exhibit increasing growth trend under production and yield of paddy. The area of paddy in Chhattisgarh State and India as a whole reveal's overall insignificance of time period in explaining the trend over the study period. For both production and yield of paddy in Chhattisgarh State, power trend function was giving most fit to the data suitable with maximum adjusted R^2 0.58 and 0.58, respectively thus both model exhibits increasing trend lines. Similarly, both production and yield of paddy in India, linear trend function was giving best fit to the data suitable with maximum adjusted R^2 0.81 and 0.89 both exhibit same trend lines i.e., steady slow increase. Thus, it was revealed that all the trend models exhibit significant explanation for given time and exhibit increasing trend in area, production and yield of paddy except in area of the State and India as a whole under paddy.

Table 1: Selected district-wise best fitted linear and non-linear trend equation models for area, production and productivity of paddy during 2000-01 to 2019-20

District	Particulars	Equation type	Parameters					
			α	b₁	b₂	b₃	R²	Adj R²
Raipur	Area	Compound	514.30	1.00***			0.64	0.63***
	Production	Power	311.74	0.40***			0.69	0.68***
	yield	Power	618.59	0.38***			0.67	0.65***
Mahasamund	Area	Linear	233.96	2.76***			0.92	0.92***
	Production	Power	136.96	0.42***			0.63	0.60***
	yield	Power	609.06	0.35***			0.53	0.51***
Dhamtari	Area	Compound	139.63	1.02***			0.51	0.49***
	Production	Power	124.69	0.45***			0.73	0.71***
	yield	Power	953.86	0.35***			0.75	0.74***
Durg	Area	Cubic	416.82	11.86***	-1.180***	0.042***	0.89	0.87***
	Production	Power	289.28	0.38***			0.46	0.43***
	yield	Power	689.56	0.33***			0.40	0.37***
Chhattisgarh State	Area	Compound	3.82	1.00***			0.01	-0.05
	Production	Power	2.76	0.30***			0.60	0.58***
	yield	Power	747.68	0.29***			0.60	0.58***
India	Area	Compound	43.22	1.00***			0.03	-0.03
	Production	Linear	79.34	1.84***			0.82	0.81***
	yield	Linear	1834.64	40.78***			0.89	0.89***

Note: *** and ** represents significant at 1% and 5%

Trends in area, production and yield of wheat

Table 2 depicted for area of wheat, cubic trend function was giving most fit to the data suitable with model in Raipur and Mahasamund districts with highest adjusted R^2 0.39 and 0.44, respectively both models exhibit same growth trend lines i.e., reverse sigmoid increase. Whereas, compound trend function was giving most fit to the data suitable with model in Dhamatri and Durg districts with highest adjusted R^2 0.22 and 0.68 of which Dhamtari exhibit decreasing and Durg exhibit steady increasing growth trend line. Production of wheat, it was depicted that quadratic trend function was giving most fit to the data suitable with model in Raipur and Mahasamund districts with highest adjusted R^2 0.61 and 0.30, respectively and both exhibit increased growth trend lines. The wheat production in Dhamtari district reveals overall insignificance of time period in explaining the trend, while only yield of wheat exhibit steady increasing growth trend line which decreasing area over the study period. Cubic trend function was giving most fit to the data suitable with model to the Raipur, Mahasamund and Durg districts under yield of wheat

with highest adjusted R^2 0.80, 0.76 and 0.79, respectively all exhibit same sigmoid increased growth trend line.

For Chhattisgarh State, it was observed that compound trend function was gave best trend fit to the data for area with maximum adjusted R^2 0.46 exhibit decreasing trend line. Cubic trend function was the most fitted trend for production and yield of wheat with maximum adjusted R^2 0.38 and 0.74, respectively in which production had reverse sigmoid trend line while yield had flat sigmoid trend line. Area of wheat in India, had gave best trend fit by cubic trend model to the data with maximum adjusted R^2 0.89, whereas production and yield has observed best trend fit through quadratic trend model with maximum adjusted R^2 0.90 and 0.78, respectively. Area, production and yield of wheat in India had showed similar steady increasing growth trend. Thus, it was revealed that all the trend models exhibit overall significant explanation for given time period except in production of wheat under Dhamtari. Only India as a whole revealed increasing trend of growth in area, production and yield of wheat over the period of time.

Table 2: Selected district-wise best fitted linear and non-linear trend equation models in area, production and productivity of wheat during 2000-01 to 2019-20

District	Particulars	Equation type	Parameters					
			α	b₁	b₂	b₃	R²	Adj R²
Raipur	Area	Cubic	5.61	1.34***	-0.155***	0.00***	0.49	0.39**
	Production	Quadratic	9.37	0.04	0.018		0.65	0.61***
	yield	Cubic	1757.56	-313.81***	39.517***	-1.20***	0.83	0.80***
Mahasamund	Area	Cubic	1.42	0.25	-0.04**	0.00***	0.53	0.44***
	Production	Quadratic	3.16	-0.26***	0.01***		0.37	0.30**
	yield	Cubic	2470.40	-520.37***	59.05***	-1.79***	0.80	0.76***
Dhamtari	Area	Compound	2.97	0.95***			0.26	0.22**
	Production	Compound	2.70	0.98***			0.04	-0.01
	yield	Quadratic	905.32	33.70	0.49		0.82	0.99***
Durg	Area	Compound	16.49	1.03***			0.70	0.68***
	Production	Cubic	10.66	0.28	0.14	-0.00	0.89	0.87***
	yield	Cubic	720.95	-22.63	7.39	-0.28*	0.78	0.74***
Chhattisgarh State	Area	Compound	0.83	0.88			0.49	0.46***
	Production	Cubic	0.25	0.22	-0.03*	0.00*	0.47	0.38**
	yield	Cubic	1227.23	-134.43**	17.80**	-0.54**	0.78	0.74***
India	Area	Cubic	25.77	-0.10	0.06*	-0.00**	0.90	0.89***
	Production	Quadratic	65.40	1.37*	0.04		0.91	0.90**

| | yield | Quadratic | 2666.64 | -1.16 | 2.07* | | 0.80 | 0.78*** |

Note: ***, ** and * represents significant at 1%, 5% and 10%, respectively.

Trends in area, production and yield of gram

Table 3: Selected district-wise best fitted linear and non-linear trend equation models in area, production and productivity of gram during 2000-01 to 2019-20

District	Particulars	Equation type	Parameters					
			α	b_1	b_2	b_3	R^2	Adj R^2
Raipur	Area	Cubic	3.66	1.49***	-0.12**	0.00*	0.67	0.61***
	Production	Cubic	3.67	0.34	0.05	-0.00	0.56	0.48***
	yield	Cubic	842.22	-99.56	18.40*	-0.69**	0.55	0.46***
Mahasamund	Area	Compound	0.39	0.94***			0.55	0.53***
	Production	Compound	0.29	0.96***			0.34	0.30***
	yield	Cubic	854.91	-99.96	17.12*	-0.63**	0.41	0.30**
Dhamtari	Area	Power	5.03	0.23*			0.14	0.09*
	Production	Power	3.64	0.36**			0.26	0.22**
	yield	Cubic	885.61	-75.39	14.99	-0.57**	0.46	0.36**
Durg	Area	Power	50.25	0.31***			0.92	0.92***
	Production	Cubic	42.87	-1.38	1.34	-0.06	0.56	0.48***
	yield	Cubic	747.62	-41.00	11.98	-0.52	0.34	0.22*
Chhattisgarh State	Area	Cubic	0.11	0.03***	-0.00***	0.00***	0.97	0.96***
	Production	Cubic	0.63	-0.18**	0.02**	-0.00**	0.46	0.36**
	yield	Cubic	685.85	-36.92	10.45	-0.44	0.39	0.27**
India	Area	Quadratic	5.21	0.36***	-0.01		0.87	0.85***
	Production	Compound	4.33	1.05***			0.85	0.84***
	yield	Compound	738.45	1.02***			0.71	0.69***

Note: ***, ** and * represent significant at 1%, 5% and 10%, respectively

Table 3 depicted, cubic trend function was giving most fit to the data suitable with model in Raipur for the area, production and yield of gram, with highest adjusted R^2 0.61, 0.48 and 0.46, respectively all models exhibit same declining growth trend lines. Mahasamund gave best fit by compound trend explaining 53 per cent trend exhibit decreasing trend, while Dhamtari and Durg both fitted by power trend function with highest adjusted R^2 0.09 and 0.92, respectively in which Dhamatri exhibit flat increase and Durg exhibit sharp increasing growth trend lines growth trend line. Under production of gram, it was depicted that compound, power and cubic trend function was giving most fit to the data suitable with model in Mahasamund, Dhamtari and Durg districts with highest adjusted R^2 0.30, 0.22 and 0.48, respectively, while Mahasamund exhibits flat decreasing growth trend, Dhamatri exhibit flat increase and Durg exhibits sigmoid decreased growth trend. Cubic trend function was giving most fit to the data suitable with model to all the districts under yield of gram with highest adjusted R^2 0.46, 0.30, 0.36 and 0.22, respectively in Raipur, Mahasamund, Dhamtari and Durg all of them exhibit same sigmoid decreasing growth trend line. It was found that area, production and yield of gram in the State had described well by cubic trend alone with highest adjusted R^2 0.96, 0.36 and 0.27, respectively and only area exhibit increasing trend while production and yield had sigmoid decreasing trend. Area of gram in India had given best trend fit by quadratic trend function to the data with maximum adjusted R^2 0.85. Compound trend was the most fitted trend for production and yield of gram with maximum adjusted R^2 0.84 and 0.69, respectively. Thus, area, production and yield of gram in India had showed continuous flat increasing growth trend. It was also revealed that all models were exhibiting overall significant trend explained for given time period.

Conclusions

The overall performance of paddy found satisfactory. The area, production and yield of paddy in all selected district, the Chhattisgarh State and India as a whole exhibit continuous increasing growth trend lines of paddy over the study period. The increase in output of paddy was highly contributed by per hectare output than by the increased in area. The overall growth performance of wheat and gram was found poor in the selected districts of Chhattisgarh plains with few exceptions as well as in the State, while the growth in terms yield of both the crops were found remarkable increased. Thus, the phenomenon of productivity improvement was greatly responsible for increase production of wheat and gram. In the study, overall, the production and yield of gram has decreased by more than proportionate of wheat. Wheat, Gram and other pulses crop deserves some attention in the State and need efforts to increase the area and productivity of these crops, while the full yield potential of existing varieties of gram has to be exploited and area shift away from gram has to be arrested.

References

1. Bhagat AA, Shivagaje AJ, Bhoge RS. Selection of appropriate growth model for projection of pigeon pea in area and production of Maharashtra State. Research Journal of Agricultural Sciences. 2018;9(2):462-464.
2. Bibi A, Naheed S, Raza I, Khan N. Past trends and future prospects of rice area and production in Khyber Pakhtun Khaw. International Journal of Agronomy and Agricultural Research. 2014;4(1):40-46.
3. Lathika M, Kumar CEA. Growth trends in area, production and productivity of coconut in India. Ind. Jn. of Agri. Econ. 2005;60(4):686-697.
4. Rajan SM, Palanivel M. Application of regression models for area, production and productivity growth trends of cotton crop in India. International Journal of Economic

and Business Review. 2017;5(10):56-60.
5. Rajarathinam A, Balakrishnan V. Statistical modeling for wheat (triticum aestivum) crop production. International Journal of Statistics and Applications. 2012;2(4):40-46.
6. Singh M, Supriya K. Growth rate and trend analysis of wheat crop in Uttar Pradesh. Int. J Curr. Microbiol. App. Sci. 2017;6(7):2295-2301.
7. Wankhade MO, Bhosale HA. Trend analysis with respect to area, production and yield of cotton in Maharashtra. International Journal of Scientific & Technology Research. 2019;8(9):945-949.
8. Wasnik SB, Suryawanshi SN, Pandey S. Economics of growth performance, instability and decomposition analysis of tobacco in India. Economic Affairs. 2022;67(02):87-94.