An Empirical Investigation of Scenario of Instability and Growth of Cotton, Jute and Mestain India

ABSTRACT

The present study focuses on exploring the scenario of instability and growth rates in area, production, and yield of commercial crops viz., cotton, jute and mestain India, on utilizing Cuddy-Della Valle (CDV) instability indices and compound growth rates (CGRs). For the empirical analysis, secondary time series data pertaining to area, production, and yield of the concerned crops have been collected for the period 2000-2021. Furthermore, to carry out the comparative assessment, the concerned period has been classified into period-I (2000-2010), period-II (2011-2021), and the pooled (or overall) period (2000-2021).The statistical coefficients viz., coefficient of variation (CV) and coefficient of determination (R^2) have been evaluated. The key findings of the investigation reveal that, during the overall period, cotton reported highest instability in terms production (i.e., 17.89 %) and yield (i.e., 17.12 %) as compared to the area (i.e., 7.36 %). Moreover, jute and mesta reported least instabilities in area (i.e., 3.30 %), production (i.e., 5.05 %) and yield (i.e., 3.07 %). Furthermore, in terms of growth rate of cotton, the period-I witnessed significant growth in area (i.e., 2.80 %), production (i.e., 13.24 %) and yield (i.e., 10.16 %), as compared to the period-II. However, jute and mesta witnessed negative growth rates in terms of area and production during the period-I, period-II and the overall period of investigation.Hence,focus of attention is required for enhancing the production of jute and mesta, and future policy formulation.

Comment [S1]: Terms of

Comment [S2]: Better to write low

Comment [S3]: What about cotton instability

Keywords:*Coefficient of variation, coefficient of determination, instability index, compound growth rate.*

1. INTRODUCTION

Commercial crops, also known as cash crops, are grown primarily for sale in the market rather than for personal consumption. These crops play an important role in the global economy, providing essential raw materials for various industries and contributing significantly to farmers' income. Commercial crops are typically cultivated on a large scale using advanced agricultural techniques to maximize yields and profitability. The global demand for commercial crops is driven by population growth, rising incomes, and expanding food and industrial needs. However, the market-oriented nature of these crops also subjects farmers to price volatility and economic risks. The major commercial crops that occupy significant position in global trade and export include cotton, sugarcane, coffee, tea, jute and mesta.

Globally, India holds prominent position in the production of cotton, jute and mesta. Cotton is one of India's most essential fiber and cash crops, playing a vital role in the country's industrial and agricultural economy. It provides the fundamental raw material (cotton fiber) for the cotton textile industry.India's cotton-growing areas are classified into three zones: northern, central, and southern. The northern zone includes Punjab, Haryana, and Rajasthan. The central zone includes Madhya Pradesh, Maharashtra, and Gujarat. The southern zone comprises of Andhra Pradesh, Telangana, Karnataka, and Tamil Nadu. Additionally, cotton farming has been expanding in Odisha, and small-scale cultivation is also being practiced in non-traditional states like Uttar Pradesh, West Bengal, and Tripura. Generally,four species of cotton are cultivated worldwide, namely, *Gossypiumarboreum*, *Gossypiumherbaceum*, *Gossypiumhirsutum*, and *Gossypiumbarbadense*. India stands as the only country where all the four cultivated species are grown on a large commercial scale. In the 2021 crop year, India reported a production of 5304 million kg of cotton in 11.91 million hectares of area, achieving a productivity rate of 445.34 kg per hectare (Source:Directorate of Economics & Statistics, Govt. of India [1]).

Comment [S4]: PI check the figure and check whether bales

Jute holds second position in terms of area and production after cotton in India. In textile industry, jute and mesta are grouped together as single term knownas “raw jute” due to their similar uses. Raw jute has versatile applications in textiles, construction, and packaging industries.Generally, two species of jute are commonly known i.e.,*Corchoruscapsularis* and

Corchorusolitorius, which belong to the family Sparrmanniaceae, and are cultivated for fiber production. Moreover, twocommonlyknown species of mesta are*Hibiscus sabdariffa* var. *altissima* and *Hibiscus cannabinus*, which belong to the Malvaceae family, and are alsocultivated for fiber production. In the 2021 crop year, India witnessed a production of1857.60 million kg of jute andmesta in 0.69 million hectareof area, achieving a productivity rate of 2692.17 kg per hectare (Source:Directorate of Economics & Statistics, Govt. of India [1]).

Sincecommercial cropshave significant role in global trade, and contributes in the economic growth of the nation, henceseveral scientists have focused their studies on commercial crops.Deshmukh and Mohanty [2] provided a detailed overview of cotton harvesters and their types, along with the cropping pattern, production and importance of cotton in Indian economy. Naik*et al.* [3]investigated the mechanical extraction of jute andmesta for the quality fibre production. Kumar *et al.*[4]carried out a comparative analysis of machine learning algorithms for detection of organic and nonorganic cotton diseases. The study focused on detection of cotton leaf diseases affecting the plant in early stages.Tokel*et al.*[5]provideda detailed information about the contribution of Bt-cotton technology to theeconomies of leading cottonproducing countries, their commercialization, and explored the current methods used in plants transformation.Sriram et al.[6] investigated the significance of mechanization in cotton farming for improving cotton yield and profitability by enhancing efficiency, reducing labor, and enabling the cultivation of larger areas with better resource utilization.

Comment [S5]: delete

The time series analysis of commercial crops is of utmost importance for anticipating global demand,market dynamics and trade policies.Khatun and Deka [7]examined the growth rate and instability of jute production in Assam. Mal and Pandey [8]investigated instability and trend in area, production, and productivity of cotton crop in India.Molla and Sabur[9] analyzed growth and instability of jute in Bangladesh using time series data from 1981-82 to 2009-10.Dhekale*et al.*[10] analyzed growth, instability,and forecasting of cotton production scenario in India.Rani *et al.*[11]estimated the compound growth rate, instability index and annual fluctuation of cotton in Pakistan during the period 1981-2015.Elamathy*et al.*[12]conducted an econometric analysis for evaluating the performance of Indian cotton sector. In the study, the growth rate and factors affecting cotton acreage and production in India from 1981-82 to 2020-21 was estimated. Radha *et al.*[13] assessed the growth performance and instability in area,

Comment [S6]: better to write the rwsults also

production, and productivity of cotton crop at various levels. Some other noteworthy contributions towards time series analysis of crops, apart from cotton, jute and mesta, have been made by Joshi *et al.*[14], Saha*et al.* [15],Kumar and Menon [16], Rana and Kumar[17], Kumar *et al.* [18], and Prakash et al. [19].

Comment [S7]: where

The objective of present investigation is to examine the instability and growth rates in area, production, and yield of commercial crops viz., cotton, jute, and mesta in India,acrossthree periods viz., period-I (2000-2010), period-II (2011-2021), and the pooled (or overall)period (2000-2021).Moreover, the comparative assessment has also been made across the concerned periods. To carry out the empirical analysis, the statistical measures such asCuddy-Della Valle (CDV) instability indices and compound growth rates (CGRs) are computed.

2. MATERIALS AND METHODS

In the present analysis, the secondary time series data on area, production, and yield of cotton, jute andmesta pertaining to the period 2000 to 2021 in India has been utilized. The study period is classified into three periods i.e. period-I (2000 to 2010), period-II (2011 to 2021), and the overall period (2000 to 2021). The time series data has been obtained from the Directorate of Economics & Statistics, DAC&FW, Govt. of India.

Significant variations are observed in the area, production, and yield of cotton, jute andmesta considered under analysis during the concerned period of study. Toestimate these variations,the Cuddy-Della Valle (CDV) instability index and compound growth rate (CGR) are computed.

The Cuddy-Della Valle (CDV) instability index is given by

$$I = CV\sqrt{1 - R^2}$$

where R^2 denotes the coefficient of determination, which is obtained on fitting linear model to the concerned time series data on area, production, and yield of cotton, jute andmesta. Also, CV represents the coefficient of variation.

The compound growth rate (CGR) in area, production and yield of cotton, jute andmesta is obtained on using the following function:

$$y_t = y_0(1 + r)^t$$

where

y_t = observed time series value of area, production, or yield (as the case may be) of cotton, jute andmesta at time t

y_0 = initial time series value of area, production, or yield

r = compound growth rate.

Here, the compound growth rate (r) is measured in terms of percentage as follows:

$$r = \left[\left(\frac{y_t}{y_0}\right)^{\frac{1}{t}} - 1\right] \times 100$$

3. RESULTSAND DISCUSSION

The secondary time series data on the area, production, and yield of cotton, jute andmesta in India is elaborated in Table 1.Moreover, the values of various statistical coefficients, i.e., coefficient of variation (CV), coefficient of determination (R^2), and Cuddy-Della Valle Instability Index (I) for area, production, and yield of cotton, jute andmesta in India are depicted in Tables 2, 3, and 4 respectively. The values of R^2 are obtained on fitting linear regression models to the respective time series data on area, production, and yield of the concerned commercial crops. Furthermore, the compound growth rates (CGRs) are computed for area, production, and yield of cotton, jute andmesta, and the finding are summarized in Table 5.

Table 1. Time series data onarea, production and yield of cotton, jute andmestain India

Year	Cotton	Jute and Mesta

	A	P	Y	A	P	Y
2000	8.53	1618.40	189.73	1.02	1900.80	1863.53
2001	9.13	1700.00	186.20	1.05	2102.40	2002.29
2002	7.67	1465.40	191.06	1.04	2030.40	1952.31
2003	7.60	2334.10	307.12	1	2010.60	2010.60
2004	8.79	2793.10	317.76	0.92	1848.60	2009.35
2005	8.68	3145.00	362.33	0.9	1951.20	2168.00
2006	9.14	3847.10	420.91	0.94	2028.60	2158.09
2007	9.41	4399.60	467.55	0.96	2017.80	2101.88
2008	9.41	3787.60	402.51	0.9	1866.60	2074.00
2009	10.13	4083.40	403.10	0.91	2127.60	2338.02
2010	11.24	5610.00	499.11	0.87	1911.60	2197.24
2011	12.18	5984.00	491.30	0.9	2052.00	2280.00
2012	11.98	5817.40	485.59	0.86	1967.40	2287.67
2013	11.96	6103.00	510.28	0.84	2102.40	2502.86
2014	12.82	5916.00	461.47	0.81	2003.40	2473.33
2015	12.29	5101.70	415.11	0.78	1893.60	2427.69
2016	10.83	5538.60	511.41	0.76	1972.80	2595.79
2017	12.59	5577.70	443.03	0.74	1805.40	2439.73
2018	12.61	4766.80	378.02	0.7	1767.60	2525.14
2019	13.48	6131.90	454.89	0.67	1778.40	2654.33
2020	13.29	5992.50	450.90	0.66	1683.00	2550.00
2021	11.91	5304.00	445.34	0.69	1857.60	2692.17

Note: A = Area (in million Hectares), **P** = Production (in million Kg), and **Y** = Yield (in Kg per Hectare).(**Source:** Directorate of Economics & Statistics, DAC&FW, Govt. of India).

Table2. Values of various statistical coefficients for area of selected commercial crops

	Period-I	Period-II	Overall Period

Crops	CV	R^2	I	CV	R^2	I	CV	R^2	I
Cotton	10.89	0.61	6.83	5.63	0.12	5.29	17.31	0.82	7.36
Jute and Mesta	6.25	0.74	3.18	10.11	0.95	2.26	13.70	0.94	3.30

Table3. Values of various statistical coefficients for production of selected commercialcrops

Crops	Period-I			Period-II			Overall Period		
	CV	R^2	I	CV	R^2	I	CV	R^2	I
Cotton	39.84	0.90	12.39	7.50	0.09	7.16	35.42	0.74	17.89
Jute and Mesta	4.46	0.002	4.46	6.64	0.69	3.70	6.00	0.29	5.05

Table4. Values of various statistical coefficients for yield of selected commercialcrops

Crops	Period-I			Period-II			Overall Period		
	CV	R^2	I	CV	R^2	I	CV	R^2	I
Cotton	30.84	0.87	11.26	8.37	0.26	7.22	24.43	0.51	17.12
Jute and Mesta	6.07	0.72	3.21	5.11	0.70	2.79	10.83	0.92	3.07

The Table 2 reveals that there is a slight decline in instability in area of cotton, jute and mesta in period-II as compared to the period-I. During the overall period, the instability in area of cotton is observed to be highest (i.e., 7.36%) as compared to jute and mesta (i.e., 3.30%). Moreover, from Table 3, it is observed that there is a significant decline in instability in production of cotton with a transition of 5.23%, whereas there is a slight decline in instability in production of jute and mesta in period-II as compared to the period-I. The overall period witnessed highest instability in production of cotton (i.e., 17.89 %) as compared to jute and mesta (i.e., 5.05%). Furthermore, Table 4 exhibits that there is a significant decline in instability in yield of cotton with a transition of 4.04%, whereas there is a slight decline in instability in the yield of jute and mesta in period-II as compared to the period-I. Also, the overall period

witnessed highest instability in yield of cotton (i.e., 17.12%) as compared to jute and mesta (i.e., 3.07%).

Table 5. Compound Growth Rates (CGRs) for area, production and yield of selected commercialcrops

Crops	Period-I			Period-II			Overall Period		
	A	**P**	**Y**	**A**	**P**	**Y**	**A**	**P**	**Y**
Cotton	2.80	13.24	10.16	-0.22	-1.20	-0.98	1.60	5.82	4.15
Jute and Mesta	-1.58	0.06	1.66	-2.62	-0.99	1.68	-1.84	-0.11	1.77

It is revealed from Table 5 that there is a negativegrowth rate of area of cotton during period-II (i.e., -0.22%) whereas, positive growth rate is observed in period-I (i.e., 2.80%). Moreover, the growth rate in area of jute and mesta is observed to be negative and least in period-II (i.e., -2.62%) as compared to period-I (i.e., -1.58%). During the overall period, the growth rate in area of cotton is positive (i.e., 1.60%), whereas the growth rate in area of jute and mesta is negative (i.e., -1.84%).

The growth rate in production of cotton is observed to be negative and least in period-II (i.e., -1.20%), whereas it is observed to be positive and high during period-I (i.e., 13.24%). Furthermore, the growth rates in production of jute and mesta are observed to be negative during period–II (-0.99%) wheras, positive during period-I (0.06%). The overall period witnessed a positive growth rate in production of cotton (i.e., 5.82%) and negative growth rate in production of jute and mesta (i.e., -0.11%).

The growth rate in yield of cotton is negative in period-II (i.e., -0.98%) whereas it is positive in period-I (i.e., 10.16%). There is a slight rise in growth rate of yield of jute and mesta during period-II (i.e., 1.68%) as compare to period-I (i.e., 1.66%). The overall period witnessed positive growth rates in yield of cotton (i.e., 4.15%), jute and mesta (i.e., 1.77%).

The period-wise compound growth rates (CGRs) in area, production, and yield of cotton, jute andmesta in India are demonstrated graphically in Figs. 1 and 2, respectively.

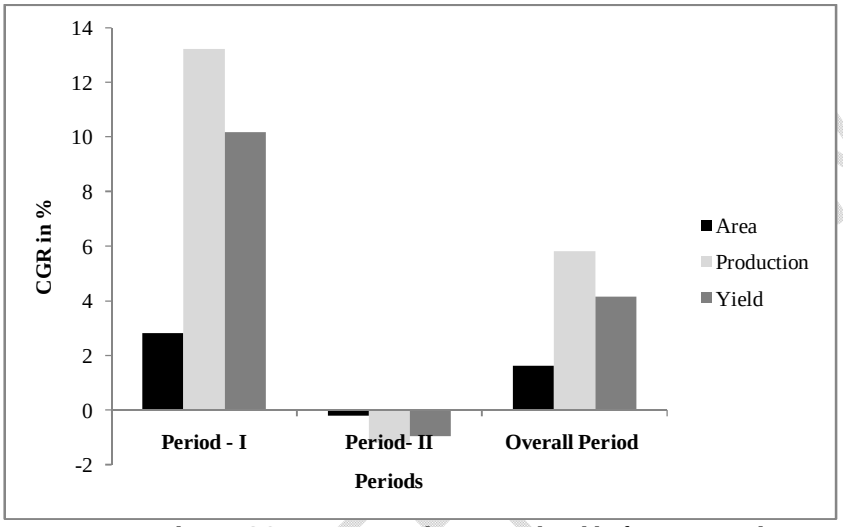

Fig.1 Period-wise CGR in area, production, and yield of cotton in India

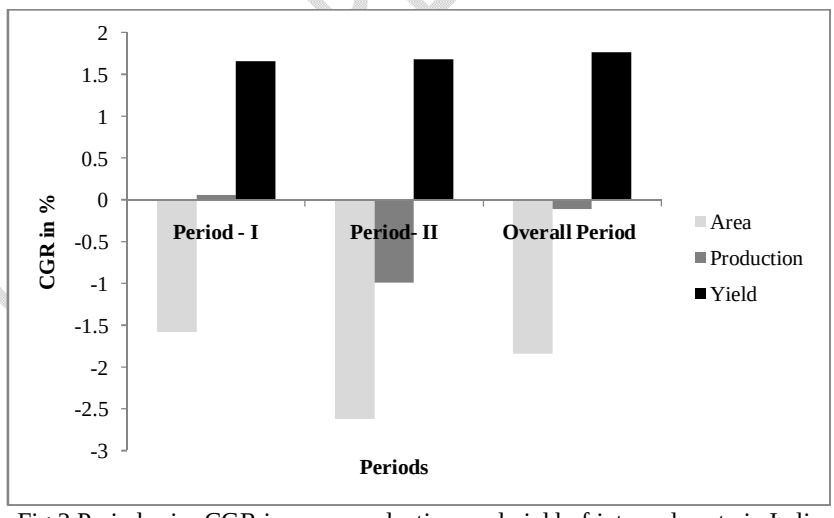

Fig.2 Period-wise CGR in area, production, and yield of jute andmesta in India

4.CONCLUSION

In the present investigation, the comparative analysis of instability and growth rate in area, production, and yield of cotton, jute andmesta in India is carried out acrossthree periods viz., period-I (2000-2010), period-II (2011-2021) and the overall period (2000-2021).In India, cotton revealed a significant decline in instability in area, production, and yield during period-II as compared to period-I. A similar pattern of decline in instability is reported in area, production, and yield of jute andmesta. During the overall period, cotton reported highest instability in terms productionand yieldas compared to the area. Furthermore, jute and mesta reported least instabilities in area, productionand yieldduring the entire period of analysis.In terms of growth rate of cotton, the period-I witnessed significant growth in area, production and yield, as compared to the period-II. However, jute and mesta witnessed negative growth rates in terms of area and production during the period-I, period-II and the overall period of investigation.

Hence, the findings of the investigation reveal that jute and mesta requiremore focus of attention by researchers and policymakers in developing strategies for enhancement of area and production jute and mesta for attaining sustainable agriculture and global trade.

Comment [S8]: write for cotton also

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

References

1. DES (2022). Agricultural Statistics at a Glance. *Directorate of Economics & Statistics, DAC&FW, Government of India.*
2. Deshmukh, A. S. and Mohanty, A. (2016). Cotton mechanisation in India and across globe: a review. *International Journal of Advance Research in Engineering, Science & Technology*, 3(1): 66-74.

3. Naik, R.K., Mazumdar, S.P., Majumdar, B. and Behera, M.S. (2018). Mechanical extraction of jute and mesta for quality fibre production. *Journal of the Indian Society of Coastal Agricultural Research*, 36(1): 76-79.
4. Kumar, S., Jain, A., Shukla, A. P., Singh, S., Raja, R., Rani, S., *et al*. (2021). A comparative analysis of machine learning algorithms for detection of organic and nonorganic cotton diseases. *Mathematical Problems in Engineering*, 2021(1): 1-18.
5. Tokel, D., Genc, B.N. and Ozyigit, I.I. (2021). Economic impacts of Bt (Bacillus thuringiensis) cotton. *Journal of Natural Fibers*, 19(12):4622–4639.
6. Sriram, J., Kannan, S.V., Ragavan, T., Sheeba, S. and Sivasankari, B. (2024). Mechanization in cotton farming: addressing labor shortages and enhancing productivity in India. *Journal of Scientific Research and Reports*, 30 (10): 617-630.
7. Khatun, S. and Deka, N. (2013). Growth and instability of jute production in Assam. *Economic Affairs*, 58(4): 411-416.
8. Mal, M. and Pandey, A. (2013). Instability and relative growth trend analysis of area, production and productivity of cotton crop in India. *International Journal of Agricultural Economics and Management*, 3(2): 35-42.
9. Molla, M.M.U. and Sabur, S.A. (2015). Analysis of growth and instability of jute in Bangladesh. *The Journal of Agriculture and Natural Resources Sciences*, 2(2): 429-436.
10. Dhekale, B.S., Sahu, P.K., Vishwajith, K.P. and Mishra, P. (2017). Analysis of growth, instability, modelling and forecasting of cotton production scenario in India. *Indian Journal of Economics and Development*, 13(2a): 211-216.
11. Rani, S., Habib, N., Raza, I. and Zahra, N. (2017). Estimating compound growth rate, instability index and annual fluctuation of cotton in Pakistan. *Asian Journal of Agriculture and Rural Development, 7*(4): 86-91.
12. Elamathy, S., Karunakaran, K. R., Saravanakumar, V. and Chandrakumar, M. (2022). Performance of Indian cotton sector-an econometric analysis. *Asian Journal of Agricultural Extension, Economics & Sociology*, 40(10): 106-113.
13. Radha, S., Suhasini, K., Alibaba, M., Reddy, D.S. and Chary, D.S. (2024). Growth performance and instabilities of cotton crop-macro level insights. *Environment and Ecology*, 42(3B): 1320-1331.

14. Joshi, P., Gautam, P. and Wagle, P. 2021. Growth and instability analysis of major crops in Nepal. *Journal of Agriculture and Food Research*, 6: 1-6.
15. Saha, J.K., Adnan, K.M.M., Sarker, S.A. and Bunerjee, S. 2021. Analysis of growth trends in area, production and yield of tea in Bangladesh. *Journal of Agriculture and Food Research*, 4: 1-7.
16. Kumar, M. and Menon, S.V. (2022). Statistical modeling and trend analysis of jackfruit production in the districts of Kerala in India. *International Journal of Agriculture, Environment and Biotechnology*, 15(03): 745-752.
17. Rana, S.K. and Kumar, M. (2022). Growth rate and instability analysis of sugarcane in selected states of India. *International Journal of Agriculture, Environment and Biotechnology*, 15(04): 837-843.
18. Kumar, M., Singh, G., Singh, S. and Mishra, A. (2024). Performance of the major pulses crop in India: growth and instability. *Asian Journal of Research in Crop Science*, *9*(4): 348–357.
19. Prakash, G., Kumar, M., Rana, S.K. and Gowda K.E., S. (2025). A statistical approach for assessment of growth rate and instability of wheat in selected states of India. *Journal of Modern Applied Statistical Methods*, 24(1): 76-89.