Growth Dynamics of Sugarcane in North Karnataka, India

Shreya S. Hanji [a++*], Shashi Kiran, A. S. [b#], Gaddi, G.M. [c†] and Somashekar, K.S. [d#]

[a] *IARI, New Delhi-110012 India.*
[b] *Department of Agricultural Economics, College of Agriculture, Hassan, UAS [B} - 573 225, India.*
[c] *Department of Agricultural Economics, GKVK, University of Agricultural Sciences, Bangalore-560 065. India.*
[d] *Department of Agronomy, GKVK, University of Agricultural Sciences, Bangalore-560 065. India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Sugarcane (*Saccharum officinarum*) holds immense significance in India's agricultural, economic and industrial spheres. In Karnataka, sugarcane was cultivated on an area of 6.37 lakh hectares with annual production of 61.15 million tonnes (2021-22). Bagalkote district ranked as the state's second-largest sugarcane producer, accounting for 16.82 per cent of the total cultivated area and contributed for 15.06 per cent in the total production of the state. The present study was conducted to know trends in sugarcane cultivation in Karnataka and Bagalkote district. The secondary data on area, production and productivity of sugarcane for a period of 20 years (2001-2021) were collected

_____

[++] *Ph.D. Scholar;*
[#] *Assistant Professor;*
[†] *Professor;*
Corresponding author: E-mail: shreyahanji12 @gmail.com;

from the publications of Department of Economics and Statistics (DES) and were analysed using Compound Annual Growth Rate (CAGR) and Cuddy Della Valle Index. The results of the analysis revealed a significant compound growth rate of 3.50 per cent annually for sugarcane production in Karnataka, driven by augmented area and productivity and area under sugarcane expanded by 2.92 per cent per annum. In Bagalkote district, sugarcane production increased by 4.21 per cent annually, attributed solely to the increased cultivated area, even though productivity exhibited a slight decline. The Cuddy-Della Valle Index revealed higher instability in production and area compared to productivity in both Karnataka and Bagalkote district. The study highlights the importance of farmers adopting new high-yielding sugarcane varieties that demonstrate resilience to adverse weather conditions, pests, and diseases as a means to sustain and boost productivity for higher sugarcane production.

1. INTRODUCTION

Sugarcane is widely recognized as a renewable and ecologically sustainable agricultural resource due to its capacity to provide value through sugar, fiber, fertilizer and diverse range of by-products and co-products. Further, sugarcane is widely recognized as a highly significant and efficient source of biomass for biofuel production [1].

As per the Food and Agriculture Organization, about 87 per cent of the world's sugar is produced from sugarcane and the remaining 13 per cent from sugar beet. Next to the textile industry, sugar industry holds the second-most significant position as an agro-based industry in India, greatly impacting the livelihoods of approximately 50 million sugarcane farmers and providing direct employment to around 5 lakh workers engaged in sugar mills. Moreover, the sugar industry generates indirect employment opportunities through various ancillary activities, including transportation, trade and the supply of agricultural inputs [2].

The fluctuations in sugarcane area, production and yield are primarily caused by the cyclical nature of sugarcane prices and sugar production. When there is excess sugarcane production, sugar prices in the market decrease, leading to delayed payments to sugarcane farmers by sugar mills. Consequently, farmers tend to shift their focus to other crops. However, after a period of one or two years, when the sugar cycle reverses and prices start to rise due to sugar shortage in the market, farmers revert to sugarcane cultivation. This creates a five-year cyclical cob-web phenomenon, resulting in instability in the sugar economy. In addition to the cyclical nature, other factors contributing to fluctuations in sugarcane production and yield include technological interventions like new varieties, cultural methods, adverse weather conditions, pest and disease problems, poor management practices and traditional planting methods. These factors are collectively contributing to the unpredictable nature of the sugarcane production in turn sugar industry [3].

Most popular varieties of sugarcane recommended for Karnataka are CoC 671, Co 94012, Co 92005, CoSnk 05103, SNK 09211 (Early varieties), Co 86032, CoM 0265, CoSnk 03632, CoSnk 05104, SNK 07680 (Midlate varieties) [4].

The results of a study conducted by Adhale [5] on growth and instability of sugarcane for each district as well as for various regions in Maharashtra for 56 years from 1960-61 to 2015-16 revealed that, sugarcane production was increased mainly due to area expansion and slightly because of productivity. Similarly, study by Wali [6] conducted to know the production performance of sugarcane showed compound annual growth rates of 4.26 per cent, 10.25 per cent and 0.14 per cent for area, production and productivity of sugarcane, respectively in Bagalkot district of Karnataka. Results of Singh [7] showed that CGR of sugarcane production was 1.13 per cent in India during the study period with a significant growth rate in area (1.12%) and yield (0.39%). The instability of sugarcane production was high at 9.67 per cent followed by area (7.20%) and yield (5.26%) during the study period.

Sugarcane is one of the important commercial crops of India and in 2021-22; India has solidified its position as the world's largest producer and

consumer of sugar, as well as the second-largest sugar exporter globally, just behind Brazil. In the same year about 5.18 million ha of land in India was under sugarcane with production of about 439 million tonnes and yield of 82.2 t/ha. Among different sugarcane producing states in India, Karnataka ranks third after Maharashtra and Uttar Pradesh [8].

During 2021-22, Karnataka cultivated sugarcane over an area of 6.37 lakh ha, resulting in a remarkable production of 61.15 million tonnes with an impressive productivity of 96 tonnes per hectare. The major sugarcane growing districts in Karnataka are Belagavi, Bagalkote, Mandya, Vijayapura, Kalburgi, Mysuru, Haveri and Bidar. Among these districts, Bagalkote emerged as the second-largest producer of sugarcane, contributing for 16.82 per cent to the total cultivated area and 15.06 per cent to the production in the state [8].

In areas of cane concentration, healthy socioeconomic change was witnessed, which has improved the living standard of sugarcane growers. The dilemma is that farmers normally do not receive a fair market price for their sugar crop [9].

It is evident that, in recent years farmers are cultivating sugarcane crop with a hope of better returns and which resulted in better standard of living for sugarcane growers in the society. As discussed in the beginning many factors are contributing for variations in sugarcane area, production and productivity, it is important to know its growth performance and perform stability analyse. With this background, the important questions that emerge are; will the area under sugarcane growing significantly over the years? How stable the growth is? What implications will it have in respect of improving the farmer's income?

With all these thoughts, the present paper is an attempt to analyse the growth and instability in area, production and productivity of sugarcane in Karnataka.

2. METHODOLOGY

The study was entirely based on secondary data pertaining to the area, production and productivity of sugarcane collected from the publications of the Directorate of Economics and Statistics and website of Indiastat for two decades period from 2001-02 to 2020-21. The collected data were analysed using growth rates and instability as detailed.

2.1 Growth Rate Analysis

The Compound Annual Growth Rate (CAGR) is a useful measure of growth over multiple time periods. In the present study, the CAGR was used to analyze the trends in area, production and productivity of sugarcane in Bagalkote district and for the Karnataka State. The compound growth rates were worked out for a period of twenty years from 2001-02 to 2020-21. The CAGR was estimated by fitting a semi-log trend equation of the following form for various parameters of sugarcane mentioned above:

$$Y_t = AB^t u_t \tag{1}$$

Where,

Y_t = Area/Production/Productivity of sugarcane during time t
A= Constant / intercept indicating Y in the base period (t=0)
t= Time period
u_t=Error term
B = (1+g)

Where, g = growth rate

The above equation (1) would become linear by taking the logarithm on both the sides.

$$\ln Y_t = \ln A + t\,(\ln B) + \ln u_t \tag{2}$$

Where, ln A and ln B are the parameters of the function obtained by Ordinary Least Square (OLS) method.

Then growth rate g was computed as:

$$g = [\text{Antilog}\,(B)-1] \times 100 \tag{3}$$

Where, g = Compound annual growth rate
B =Regression coefficient

2.2 Instability Analysis

Stability is the quality or characteristic of being stable and lack of stability indicate the situation of instability. The value of any parameter which is not likely to move or change is termed as stable. For example, instability in prices can be defined as the state, in which prices of a commodity subject to change with time in a market. The extent of instability thus, needs to be examined in relation to time and was attempted with respect to area, production and productivity of sugarcane.

Instability analysis represents the uncertainty with the help of indicators like Coefficient of Variation, Standard Deviation, various Instability Indices, etc. In the present study instability in area, production and productivity of sugarcane was analyzed using the Cuddy Della Valle Index (CDVI).

2.3 Cuddy Della Valle Index (CDVI)

The instability in area, production and productivity of sugarcane was analysed using Cuddy-Della Valle Index with modified coefficient of variation (CV) formula as given below [10].

Coefficient of Variation (CV)= (S.D/Mean) *100 (4)

$$CDV = CV * \sqrt{1 - \text{adjusted } R^2} \qquad (5)$$

Where, S.D=Standard deviation

R^2=Coefficient of determination

The extent of instability was categorized into three levels based on the value of CDVI i.e.,

Low instability = 0-15 %
Moderate instability = 15-30 %
High instability = >30 %

3. RESULTS AND DISCUSSION

Sugarcane one of the major commercial crop of Karnataka is being cultivated on large area. Belagavi, Bagalkote, Kalburgi and Bidar are the major districts cultivating sugarcane in North Karnataka. Many of the earlier studies on sugarcane production performance have concentrated on Belagavi district. Hence, present study was focused on Bagalkote district which stands second in area and production of sugarcane in Karnataka [11].

Sugarcane production in Karnataka showed a significant positive compound growth rate of 3.50 per cent per annum over the study period (2001-02 to 2020-21) with a CV value of 27.73 per cent, which was mainly due to increased area under sugarcane. The area under sugarcane increased at the rate of 2.92 per cent per annum with a CV value of 23.35 per cent [12]. These growth rates of area and production were found to be significant at one per cent significance level. While, the growth rate for sugarcane productivity was stagnated as revealed by very low positive growth rate (0.56 %), which was non-significant. This was also supported by very low value of CV of 8.71 per cent (Table 1) indicating stagnated yield levels.

Thus from the estimates of Cuddy-Della Valle Index, productivity of sugarcane was more stable (8.35 %, low instability) compared to CDVI values for area (18.74%,) and production (22.27%) exhibiting medium level of instability. The graphical representation of area, production and productivity of sugarcane in Karnataka over the study period is depicted in Fig. 1.

Table 1. Trends in area, production and productivity of sugarcane in Karnataka (2001-02 to 2020-21)

Particulars	Area ('000 ha)	Production(lakh t)	Productivity (t/ha)
CAGR (%)	2.92***	3.50***	0.56[NS]
Mean	370.93	319.04	85.23
SD	86.60	88.47	7.42
Coefficient of Variation (%)	23.35	27.73	8.71
Cuddy-Della Valle Index (%)	18.74	22.27	8.35

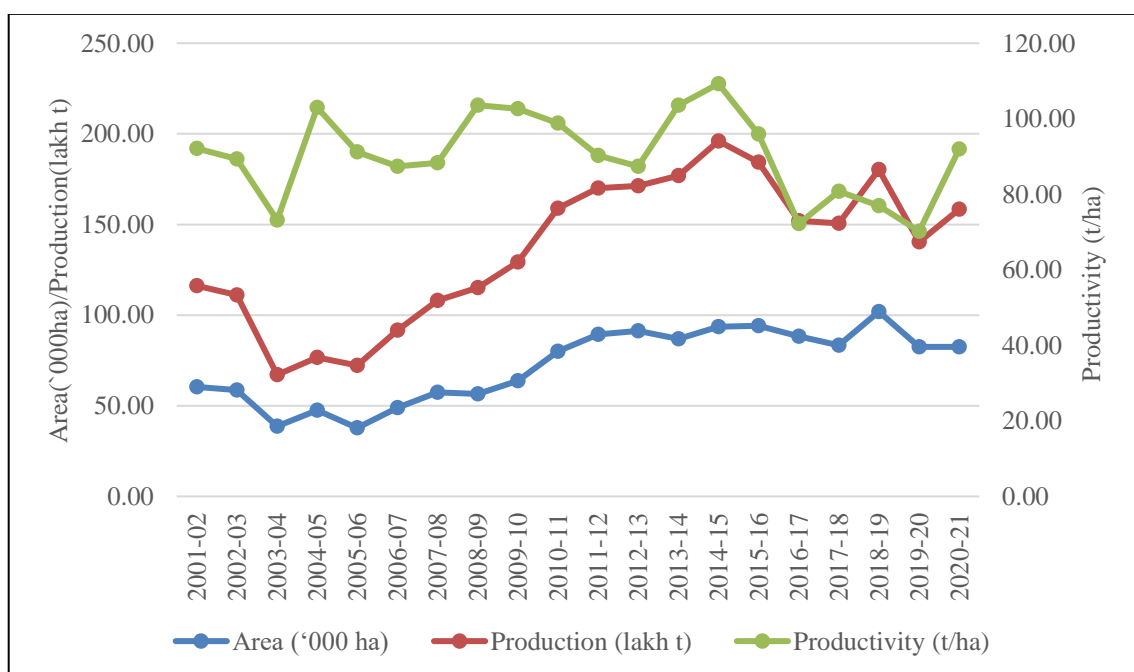*Note: - *** indicate significant at one per cent probability level*

Table 2. Trends in area, production and productivity of sugarcane in Bagalkote district of Karnataka (2001-02 to 2020-21)

Particulars	Area ('000 ha)	Production (lakh t)	Productivity (t/ha)
CAGR (%)	4.26***	4.21***	-0.55[NS]
Mean	72.19	64.15	90.40
SD	20.08	20.79	11.36
Coefficient of Variation (%)	27.82	32.41	12.56
Cuddy-Della Valle Index (%)	17.06	24.91	12.49

*Note:-*** indicate significant at one per cent level of significance*
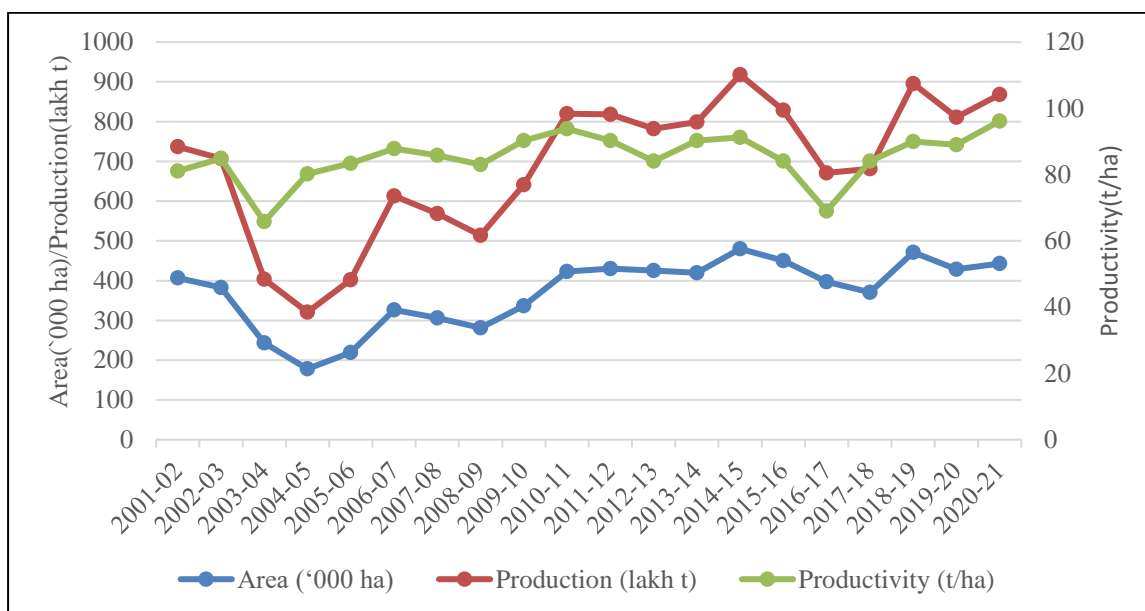
Fig. 1. Area, production and productivity of sugarcane in Karnataka (2001-02 to 2020-21)

Fig. 2. Area, production and productivity of sugarcane in Bagalkote district of Karnataka (2001-02 to 2020-21)

The similar analysis was carried out for Bagalkote district of Karnataka and results pertaining to growth in area, production and productivity of sugarcane in Bagalkote district are presented in Table 2. Sugarcane production in the district has increased at a rate of 4.21 per cent per annum over the study period with a CV value of 32.41 per cent. As in the case of Karnataka State, the growth rate in sugarcane production also area lead growth as sugarcane area registered a positive compound annual growth rate of 4.26 per cent per annum with a CV value of 27.82 per cent. The growth rates for production and area under sugarcane were found to be statistically significant at one per cent probability level. However, the annual growth rate for productivity was decreasing marginally over the years at 0.55

per cent per annum, but was statistically non-significant.

The estimates of Cuddy-Della Valle Index revealed that, instability was relatively more in production (24.91 %) and area (17.06 %) under sugarcane which falls under medium level instability compared to that of productivity (12.49 %, low instability) [13-15]. The trends in area, production and productivity of sugarcane in Bagalkote district of Karnataka over the study period is also graphically presented in Fig. 2.

Growth and instability results of area, production and productivity of sugarcane in Bagalkote district were similar to that of Karnataka; as growth in area and production of sugarcane were significant with almost stagnation in sugarcane productivity [16].

The high positive growth rates in area and production may be attributed by the availability of high-yielding varieties, irrigation facilities, production technology, farm mechanization, coupled with favourable climatic conditions and better access to the nearby sugar factories. Further, farmers will be under impression of high profitable nature of sugarcane, as they receive large lumpsum amount as payment for their cane supplied to factories, even though the Returns per rupee of investment for sugarcane is lower than many of the other seasonal agricultural crops, vegetables, flowers and other horticultural crops. In addition farmers needs to be addressed with the current excess situation of sugar production in the country and inability to find suitable foreign markets for exports and adversely affecting the domestic (low) prices and compelling factories for irregular payments and assure fair and remunerative prices.

4. CONCLUSION

The results revealed that, significant positive compound annual growth rates in the area and production of sugarcane in Karnataka and Bagalkote district as well. Growth rate of productivity of sugarcane was very low indicating stagnation even though it was positive for the Karnataka State and negative for Bagalkote district. Productivity of sugarcane was more stable than area and production in both Karnataka and Bagalkote, which warrants the need for evolving and releasing high yielding varieties

suiting to different agro-climatic conditions of the state.

The positive growth in area clearly indicated, that sugarcane is the preferred crop in the study area. However, instability was more observed in case of sugarcane production, which can be minimised by adopting new high yielding varieties suitable to adverse climatic conditions, resistant to pest and diseases, and improving irrigation facilities. There is also need for very effective extension service for dissemination of production technology, adoption of mechanization in harvesting and handling of sugarcane with support of sugar factories.

This study is more focused on growth and instability in area, production and productivity of sugarcane leaving scope for future economic studies on sugarcane market and price aspects which may help the stakeholders to identify the constraints and come up with better policies to improve the efficiency of sugarcane market. This may further lead to sustainable sugarcane in study area in an environmental friendly manner.

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 manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sindhu R, Gnansounou E, Binod P, Pandey A. Bioconversion of sugarcane crop residue for value added products–An overview. Renewable Energy. 2016;98: 203-215.
2. Anonymous(a). Price policy for sugarcane. Annual report, commission for agricultural costs and prices, ministry of agriculture and farmers welfare, Government of India, New Delhi. 2023;1-4.
3. Gangwar LS, Solomon S, Singh Pushpa, Hasan SS, Sah AK. Socio-economic impact of sugarcane production and diversification in India. A policy paper published by indian institute of sugarcane research, Lucknow; 2014.

4. Shukla SK, Sharma L, Awasthi SK, Pathak AD. Sugarcane in India (Package of practices for different Agro-climatic zones). *Tech. Bull.* No. 1, ICAR-All India coordinated research project on sugarcane, Lucknow. 2017 ;11.

5. Adhale PM, Pokharkar VG, Gulve CM, Khade, SD. Growth and instability of area, production and productivity of sugarcane in Maharashtra. Journal of Pharmacognosy and Phytochemistry. 2019;8(5):703-706.

6. Wali VS, Kadam KL, Wali S, Mohapatra U, Mishra RK. Economics of sugarcane cultivation in Bagalkot district of Karnataka. Pharma Innovation Journal. 2019;8(2):261-265.

7. Singh B, Sharma P, Arya CK, Singh A, Kumar J. Spatial growth and instability analysis of area, production and yield of sugarcane in India. Econ. Aff. 2021;66(2): 245-252.

8. Anonymous(b). Final estimates of district wise area, production and yield of principal crops in Karnataka. Annual report, Directorate of Economics and Statistics, Bengaluru. 2022;34-35.

9. Raza HA, Amir RM, Saghir A, Tahir M. Sugarcane production and protection constraints faced by the growers of Punjab, Pakistan with special focus on the role of agricultural extension worker in related mitigation. Pakistan Journal of Agricultural Sciences. 2020;57(6):1681-1688.

10. Cuddy JD, Valle PD. Measuring the instability of time series data. Oxford Bulletin of Economics and Statistics. 1978;40(1):79-85.

11. Anjum S. Growth and instability analysis in Indian agriculture. International Journal of Multidisciplinary Research and Development. 2018;5(11): 119-125.

12. Available:https://www.indiastat.com

13. Das, Manoj Kumar, Sagarika Dash, Sweety Pattnaik, Dharmabrata Mohapatra. Growth and instability in agriculture production in Odisha, India. Asian Research Journal of Agriculture. 2024;17 (2):184-95. Available:https://doi.org/10.9734/arja/2024/v17i2436.

14. Latha K. Naga V, Srinivasa Rao C. Sarada A, Amarender Reddy, Sreenivasulu KN. Understanding the growth and trend patterns of palm oil imports in India: An innovative trend analysis. Archives of Current Research International. 2024;24 (5):140-49. Available:https://doi.org/10.9734/acri/2024/v24i5691.

15. Thorburn PJ, Meier EA, Probert ME. Modelling nitrogen dynamics in sugarcane systems: Recent advances and applications. Field Crops Research. 2005;92 (2-3):337-51.

16. Muñoz-Rojas J, Caballero-Mellado J. Population dynamics of Gluconacetobacter diazotrophicus in sugarcane cultivars and its effect on plant growth. Microbial Ecology. 2003;46:454-64.

APPENDIX

Appendix I. Area, production and productivity of sugarcane in Karnataka (2001-02 to 2020-21)

Year	Area ('000 ha)	Production (lakh t)	Productivity (t/ha)
2001-02	407.00	33.02	81.10
2002-03	382.70	32.49	84.90
2003-04	243.30	16.02	65.80
2004-05	178.00	14.28	80.20
2005-06	219.00	18.27	83.40
2006-07	326.00	28.67	87.90
2007-08	306.00	26.24	85.80
2008-09	281.00	23.33	83.00
2009-10	337.00	30.44	90.30
2010-11	423.00	39.66	93.80
2011-12	430.00	38.81	90.30
2012-13	425.00	35.73	84.10
2013-14	420.00	37.91	90.30
2014-15	480.00	43.78	91.20
2015-16	450.00	37.83	84.10
2016-17	397.00	27.38	69.00
2017-18	370.30	31.14	84.10
2018-19	471.20	42.41	90.00
2019-20	429.00	38.18	89.00
2020-21	443.00	42.53	96.20

Appendix II. Area, production and productivity of sugarcane in Bagalkote District of Karnataka (2001-02 to 2020-21)

Year	Area ('000 ha)	Production (lakh t)	Productivity (t/ha)
2001-02	60.45	5.57	92.15
2002-03	58.69	5.24	89.30
2003-04	38.74	2.83	73.15
2004-05	47.56	2.91	103.00
2005-06	37.78	3.45	91.20
2006-07	48.91	4.27	87.40
2007-08	57.40	5.07	88.35
2008-09	56.60	5.86	103.55
2009-10	63.83	6.55	102.60
2010-11	79.93	7.90	98.80
2011-12	89.36	8.06	90.25
2012-13	91.36	7.98	87.40
2013-14	86.94	9.00	103.55
2014-15	93.68	10.23	109.25
2015-16	94.09	9.03	95.95
2016-17	88.27	6.37	72.20
2017-18	83.34	6.73	80.75
2018-19	101.92	7.84	76.95
2019-20	82.46	5.79	70.20
2020-21	82.53	7.59	92.00

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/119397