Research Journal of Agriculture and Forestry Sciences _____ISSN 2320 – 6063
Vol. **10(4),** 27-34, October **(2022)** *Res. J. Agriculture and Forestry Sci.*

Review Paper

Lentil production in Nepal: analysis of trends, instability and decomposition (1989-2019)

Ghimire B.[1*], Dhakal S.C.[1], Marahatta S.[1] and Bastakoti R.C.[2]
[1]Agriculture and Forestry University (AFU), Chitwan, Nepal
[2]Monitoring and Evaluation Expert, TCF to ADS, MOALD/Government of Nepal
binodghim@gmail.com

Available online at: www.isca.in, www.isca.me
Received 29th March 2022, revised 28th July 2022, accepted 30th Septmber 2022

Abstract

Lentil is a nutritive and an economic pulse crop throughout the globe. Nepal is among the top five producer of lentil after Canada, India, Australia and Turkey with 4.38% of global share. This study was based on the secondary data retrieved from FAOSTAT pertaining for the period of 30 years (1989-2019A.D.) and undertaken to know the pace of lentil growth in Nepal analyzing compound annual growth rate (CAGR), instability and decomposition analysis. The overall growth (CAGR) of 30 years for area, production and yield of Nepalese lentil is 1.85%, 4.14% and 2.25% respectively. Result showed positive growth in area, production and yield in all four-time period in between 1989 to 2019. During the entire period, low instability was found, wherever, production showed highest variation (9.30%) compared to area (6.55%) and yield (7.77%). Trend and instability results showed positive growth and lower instability in Nepalese lentil. The decomposition analysis for the period revealed that the area and yield effects were 39.84 per cent and 30.89 per cent respectively; and interaction effect found 29.27 per cent. The area effect 39.84% was found mostly responsible in increasing lentil production with yield effect of 30.89%. Both area and productivity were found influential factor responsible for increased production of lentil in the country. Expansion of area with high yielding varieties and improved package of practice is highly recommended.

Keywords: CAGR, Decomposition, Instability index, Lentil, Nepal.

Introduction

Lentil (*Lens culinaris L.*) is an economically important pulse crop and also a primary component of farming system which plays significant role in soil fertility improvement and also a protein source for human and animals as well. Lentil is widely grown throughout the Indian subcontinent, Middle East, Northern Africa and East Africa, Southern Europe, North and South America, Australia and Asia. Canada, India, Turkey, Australia, USA, Nepal, China and Ethiopia are the major lentil producing countries in the world. Further, the lentil based cropping system is profitable and also have comparatively high productivity, hence, it is suitable for mostly un-exploited rice-fallows under water deficit conditions[1]. Among the lentil producing countries, Canada ranks first in lentil production followed by India, USA, Turkey, Kazakhstan and Nepal. In case of productivity Canada ranks first followed by Turkey, USA, Nepal, Kazakhstan and India[2].

Nepal's economy is largely dependent on agriculture sector. For a under developed country like Nepal, growth in agriculture is very necessary to attain overall economic growth for combating poverty and food insecurity situations. Agriculture in Nepal continues to hold the important place in Nepalese economy where 65 percent people are involved directly and contributing about 27 percent in national GDP. In Nepal production of lentil is generally confined to terai and inner terai region growing mainly as a winter season crop accounting 63% of total pulse area (0.33 million ha.) and 67% of total pulse production (0.4million MT) with national average yield of 1.2 MT/ha[3]. Nepal accounts for 4.35% of world's lentil area (208766 ha.), 4.38% of world's lentil production (251185 MT) and is the fifth largest producer after Canada, India, Australia and Turkey[2]. Being the fifth largest producer of the world, trend growth and stability of Nepalese lentil over periods has higher significance. Lentil dominates all other pulses grown in Nepal sharing 63.5% in area and 67.2% in production[4].

Nepalese lentil contributes for nutrition security, farm and family income and also accounts remarkable share in world export market. Understanding the overall growth, positions, instability scenario and driving forces of this economically significant crop is of utmost importance. While analyzing growth for overall 30 years of study period, dividing periods and phases may give insight on differences on growth and instability.

In this background, this study has made an attempt to analyze growth, instability and decomposition in lentil area, production and yield and interaction effect in the growth in line with pre

and post WTO phases in Nepal. The results and information gained from this study would help in planning process for effective program formulation taking consideration to trend, production pattern and stability situation.

Methodology

To accomplish the objectives of the study, 30 years tie series data pertaining for the period from 1989 to 2019 A.D. on area, production and yield of lentil was retrieved from FAOSTAT and used for analytical process. The thirty years period was again divided to sub-periods marking 2004 as a base year when Nepal became member country of WTO. Four sub-periods i.e., two periods on pre-WTO and two periods on post-WTO phase were further divided with the implicit assumption that the each sub-period would have distinct nature and pattern of development due to WTO. The period were classified as: Pre-WTO phase, Period I (1989 to 1995), Period II: (1996 to 2003) and post-WTO phase, Period III: (2004 to 2011) and Period IV: (2012 to 2019). The procedural and statistical methodologies employed in time series data are described in the following subsection.

Compound Annual Growth Rate (CAGR) Analysis: For analytical purpose, the entire thirty years period was divided subjectively in to further categorization of the year in each phase was due to formulation and implementations of the programs and policies related to lentil promotion in Nepal. To analyze the CAGR based upon periods and phases, following, the exponential form of regression analysis was employed[5].

$Y_t=ab^te^u$
Where, Y_t= dependent variable (area/production/yield), a= intercept term, b= (1+r) and "r" is the compound annual growth rate, t= time period, e^u= error term
The above model in the logarithmic form was expressed ass,
Ln Y= ln a+ t ln b+ln u
Where, ln a and ln b values were obtained using ordinary least square method. The compound growth rate "r" was computed using relationship; r= (antilog of (ln b)-1)*100.

Instability Analysis: High growth in production accompanied by low level of instability for any crop is desired for sustainable development of agriculture[6]. Instability is simply the deviation from the trend and is one of the important decision parameters in development dynamics, more so in the context of agricultural production. The magnitude of fluctuation depends on the nature of production technology, sensitivity to weather, economics, environment, material inputs availability and many other factors[7]. Instability results provide great insight in the adjustment or improvement in the production scenario of the crops.

Instability in area, production and yield of lentil during the study period was measured using coefficient of variation[8].
CV=(SD/MEAN)*100 where, CV is co-efficient of variation, SD is the standard deviation of the variables used.

Cuddy Della Valle Instability Index (CDVII): In time series data characterized by long trends, the simple coefficient of variation overestimates the level of instability. Cuddy-Della Valle Instability Index corrects the coefficient of variation. To analyze the extent of variability in area, production and yield, CDVII was used[10].

Cuddy-Della Valle instability index (%)= $CV*\sqrt{(1-ADR^2)}$
Where; CV= Coefficient of variation in percent. R squared= Coefficient of determination from a time-trend regression adjusted by the number of degree of freedom.

For result interpretation, the range of Cuddy-Della Valle Instability Index stated as below[11].
CDVII=0 to 15= Low instability
30<CDVII>15= Medium instability
CDVII>30= High instability

Decomposition analysis: To measure the relative contribution of area and yield on total production of lentil over a period of time in Nepal, component analysis model was applied. The total change in production due to area and yield can be decomposed in to three effects i.e. yield effect, area effect and interaction effect. Decomposition analysis helps us to know about the constituent elements of a particular parameter. Numbers of studies have applied same model to analyze similar objectives [12,13,14].

$\Delta P= A_0\Delta Y + Y_0\Delta A + \Delta A\Delta Y$

Change in production (ΔP)= Yield effect+ Area effect + Interaction effect
A_0= Area in the base year
Y_0= Yield in the base year
$\Delta A\Delta Y$ corresponds to the interaction effect
ΔY= Change in yield
ΔA= Change in Area

Results and discussion

Global and regional status of Lentil: World lentil area, production and yield were 4800017ha, 5734201 mt and 1.19 mt/ha, respectively[2]. Globally, the yield of lentil crop seems to be continuously increasing from 0.65 to 1.19 in four decades. From the Figure-1, high growth in world's lentil area and production can be observed in time period in between 2009 and 2019. Globally, Asia region alone contributes more than 50% of world's lentil area and about 42% of world's production followed by America and Oceania region (Figure-2). Although occupying more than half share in world's lentil area, Asia region have lower production share compared to America due to its higher yield (1.4) compared to Asia (1.0). In four decades, world's area and production of lentil have been increased tremendously. Although covering less area and production, Oceania region represents higher yield (1.5 MT/Ha.).

Growth trend and production share of world's lentil: Canada is the leading producer with 37.79% world's share followed by India and Australia. Russia federation shares only 2.03% but had achieved tremendous growth in 5 years followed by Australia. Nepal ranks 5th in world's lentil production with only 4.38% share. Table-1 shows that there is only about 10 percent growth in Nepal's lentil production within 5 years. The neighbor India shares about 21 percent in world's lentil production and had achieved more than 20 percent positive growth in 1-year, 3-year and 5-year growth. Being fourth in rank, Turkey had gained only 2.5 percent positive growths in last 5 years[17].

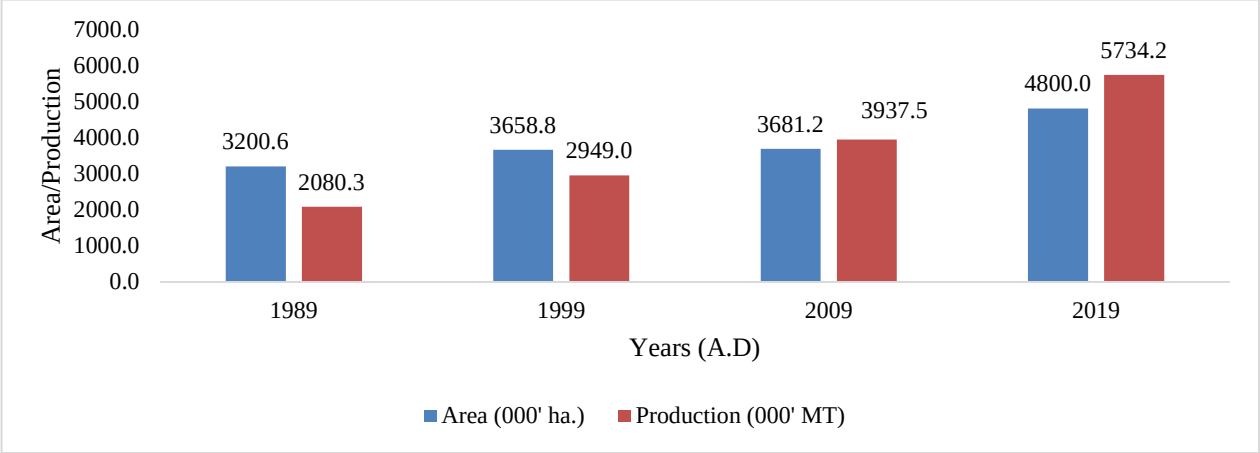

Figure-1: World's area and production of lentil (1989-2019A.D.)[2].

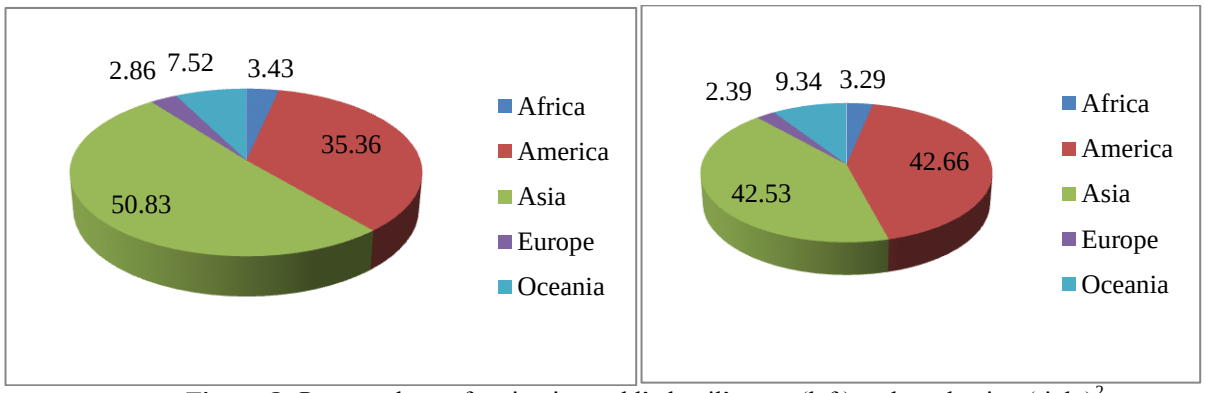

Figure-2: Percent share of region in world's lentil's area (left) and production (right)[2].

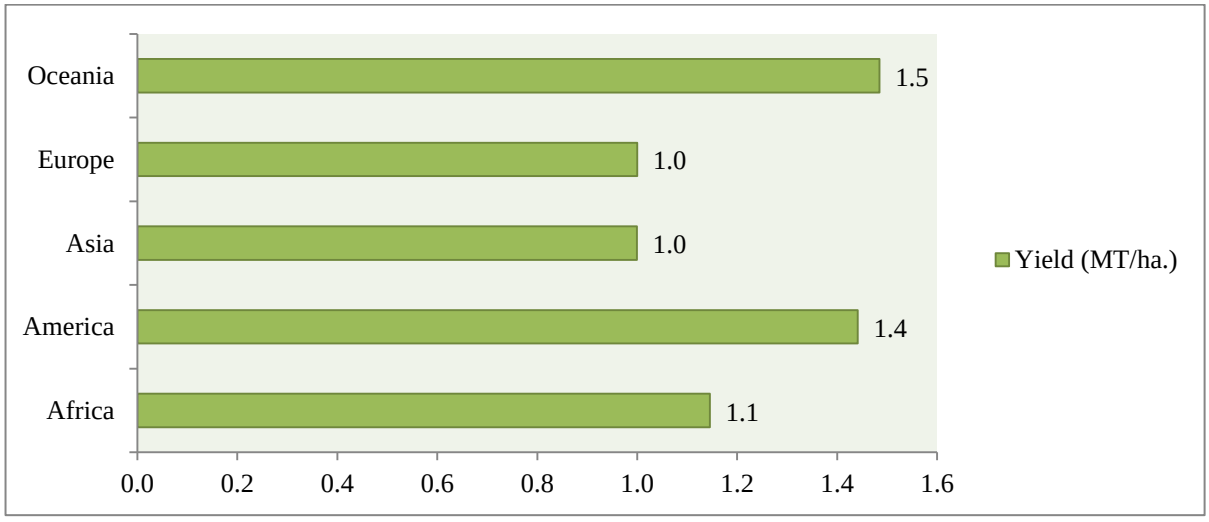

Figure-3: Lentil's yield in different regions.

Trend analysis on lentil area, production and yield in Nepal (1989-2019): Trend analysis result during the period of 1989 to 2019 showed that Nepalese lentil area and production has increasing trend. Before 2011, the yield level was very nominal may be due to lack of improved varieties. From 2011, productivity equals to 1 and increasing thereafter. Yield found to be dropped down in 2009 and 2010 and increasing thereafter. In 2019, Nepal's lentil area and production was found increased to 208766 ha and 251185 MT. from 120360 ha, and 74360 MT[2] respectively. Yield trend of lentil over the study years shows positive increment by 93 per cent in comparison to base year 1989, whereas area in the same duration is increased by about 73 per cent. The time series data was taken from FAOSTAT and illustrated in Figure-4.

Table-1: Production share and growth trend of world's top lentil producers, 2019 [17].

Country	Production MT	Global production share	1-year growth (2018-19)	3-years growth (2016-19)	5-years growth (2014-19)	Rank
Canada	2166900	37.79	3.57	32.15	9.05	1
India	1227820	21.41	24.29	25.8	20.7	2
Australia	533755	9.31	48.55	21.56	120.47	3
Turkey	353631	6.17	0.18	3.11	2.52	4
Nepal	251185	4.38	0.68	0.73	10.74	5
USA	244400	4.26	35.92	57.89	56.38	6
Bangladesh	175384	3.06	0.71	10.84	11.71	7
China	164239	2.86	4.61	5.84	31.39	8
Ethiopia	119329	2.08	15.26	28.23	13.12	9
Russian Federation	116618	2.03	40.11	78.8	477.2	10

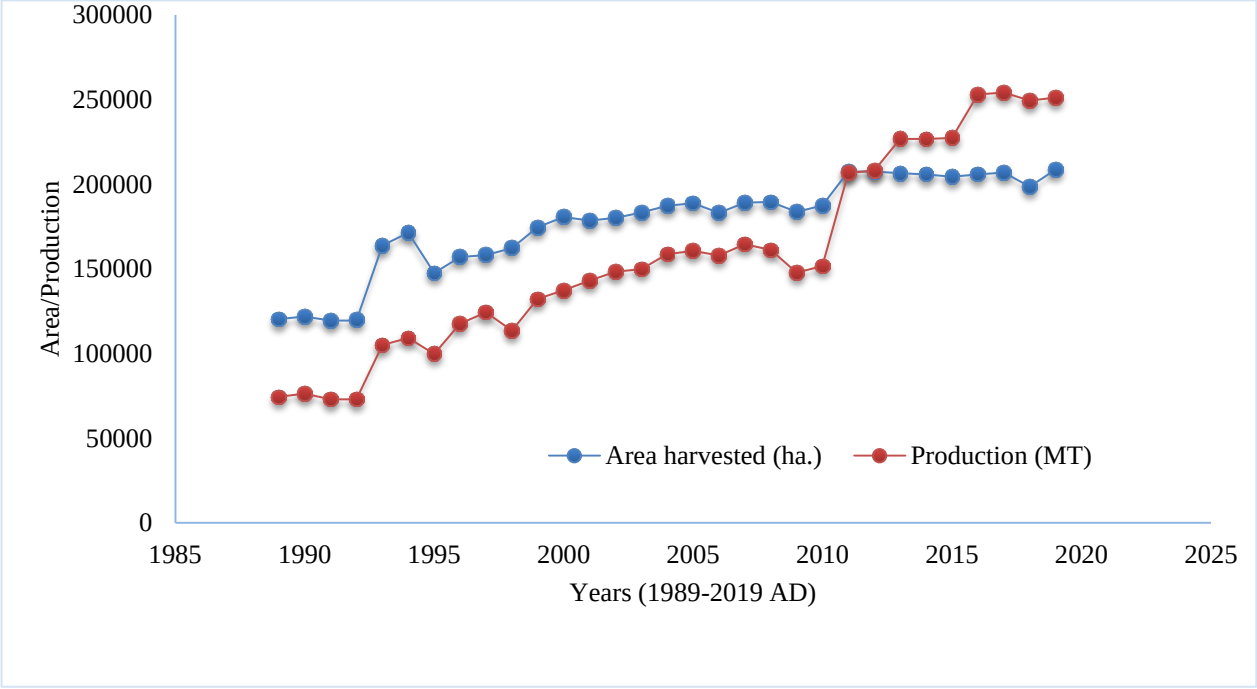

Figure-4: Growth trend of area and production of Nepalese lentil (1989-2019 A.D.).

Compound annual growth in area, production and yield of Nepalese lentil: Result from CAGR analysis (Table 3) depicted that there is positive growth in area, production and yield of lentil in Nepal for all four-time period in between 1989 to 2019 A.D. The overall CAGR of 30 years for Nepalese lentil area, production and yield is 1.85 percent, 4.14 percent and 2.25 percent respectively. Nepal's annual production grows at 4.14 percent per annum. The significant positive growth rate was observed during the study period may be due to the substantial positive increment in area, introduction of new improved varieties and change in cultivation practices. Similar to this result, the overall annual growth rate of lentil regarding area, production and yield was 2.45 percent, 4.70 percent and 2.16 percent and were significant at 1% level of significance (1980-2014)[15].

Growth in Area: During the study period of 1989 to 2019, total area under lentil in Nepal found increased from 120360 hectares to 208766 hectares. CAGR in area during the entire period showed an overall significant annual growth rate of 1.85%. The sub-period wise CAGR for the area under lentil showed high growth of 3.45 percent in period I (1989-1995) with continue decline till period II (2.23 percent), period III (1.47 percent) and period IV (0.078 percent). The result showed that there is no any significance change in area of lentil with or without involvement in world trade organization in area of lentil.

Growth in Production: Total production of lentil in Nepal increased from 74360 Mt. to 251185 Mt. during 1989 to 2019. The CAGR of lentil production during the 30 years period showed a positive growth rate of 4.14 percent. The sub-period wise CAGR analysis resulted high growth of 5.02 percent in period I with declining to period II (3.52) and slightly increment in period III (3.86) and again decreasing in period IV (2.72 percent). Result showed that the period III of post WTO phase seems slightly increased growth rate as compared to period II of pre-WTO phase.

Growth in Yield: Yield of lentil in Nepal increased from 0.62 MT per hectare to 1.20 MT per hectare during 1989 to 2019. Yield variable of lentil during the entire period shows significant annual growth rate of 2.25 percent. The sub-period wise CAGR analysis for yield of lentil shows high growth of 2.64 percent in period IV (2012-2019). Least growth in yield (1.26) was observed in period II of pre-WTO phase. The growth in lentil yield showed positive and significant change in post-WTO phase as compared to pre-WTO phase in Nepal (Table-2).

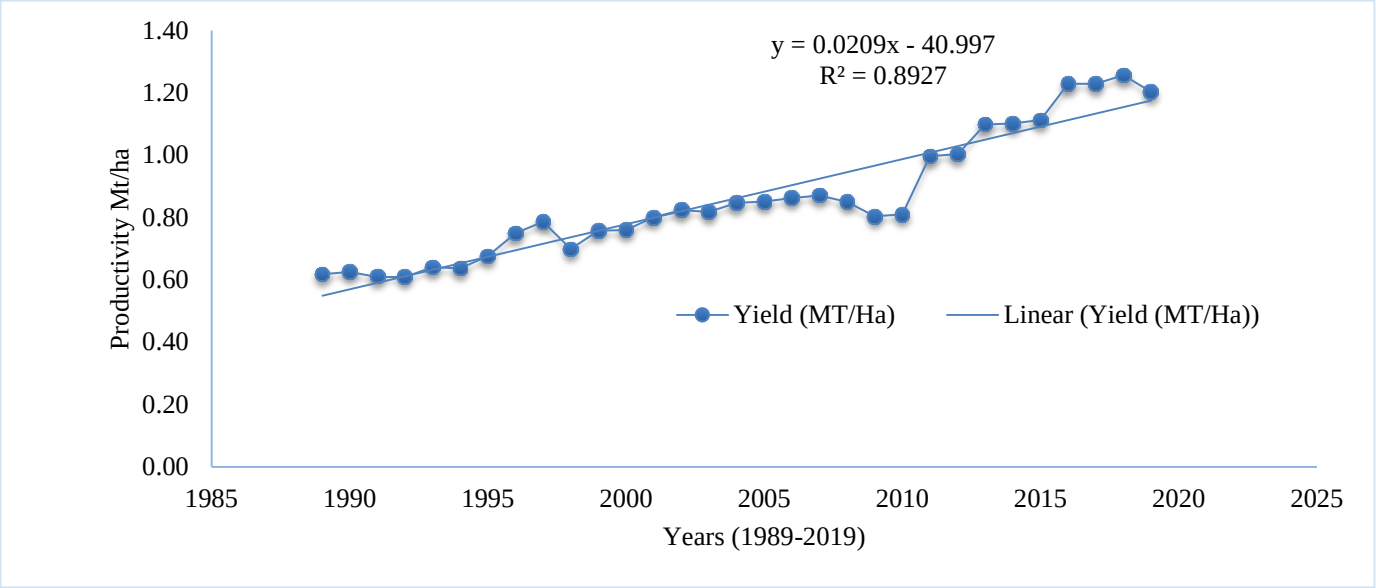

Figure-5: Growth trend of yield of Nepalese lentil (1989-2019 A.D.).

Table-2: CAGR (in %) of area, production and yield of lentil in Nepal (1989-2019)[2].

Lentil	Period I	Period II	Period III	Period IV	Overall
Percent change in Area (ha)	3.45	2.23	1.47	0.078	1.85
Percent change in Production (Mt)	5.02	3.52	3.86	2.72	4.14
Percent change in Yield (Mt/ha)	1.51	1.26	2.35	2.64	2.25

Instability in area, production and yield of Nepalese lentil: Sustainable agriculture system demands positive growth of area, production and yield of crops with reduced instability. Instability in agricultural production for any reason, results in unpredictable behavior and decision making from the population engaged in primary sector which is passed on the economy as a whole[7]. Details of instability in area, production and yield parameters of Nepalese lentil for the overall period (1989-2019) and divided sub-periods are presented in table 3 below.

During the entire period low instability was found in all variables. Wherever, highest variation was noticed for production in comparison to area and yield. The variation in production was 9.30 percent, while the variation in area and yield were 6.55 percent and 7.77 percent respectively. Low instability in area, production and yield was observed in both pre and post WTO period in Nepal. Likewise, a moderate and significant growth in production accompanied by a low level of instability of any crop is desirable for sustainable development of agriculture in India as compared to high growth in production and high level of instability[16].

Sub-period analysis resulted highest instability in area (7.43) for pre-WTO phase (1989-2003) and production variable (8.30) of post-WTO phase (2004-2019). The lowest instability has been observed in the yield (4.32) in Pre-WTO period (1989-2003) and in area (3.19) in post-WTO period (2004-2019). The result is somehow similar with the study which resulted that lentil crop has recorded lower instability in its area (1.34%), production (1.99%) and yield (1.73%) during the post-period (1996-2014 and for overall period (1980-2014) only production of lentil was showing 6.16% of instability whereas it was only 5.33% in area and 2.19% in yield of lentil[15].

The positive growth in production and lower instability in area, production and yield for Nepalese lentil implies that lentil crop holds a significant portion in cropping pattern of the country. Taking in consideration to positive compound annual growth with stability in variables, farmers can be encourage for area extension of lentil.

Relative contribution of area and yield in the production growth of Nepalese lentil: In this study, the decomposition analysis was done to estimate the area, yield and interaction effect on production growth of lentil in Nepal for the overall period 1989 to 2019 A.D. and divided sub-periods separately. The result presented in table 4 revealed that for the overall period of 30 years the area and yield effects were 39.84 percent and 30.89 percent respectively, whereas interaction effect was 29.27 percent. It can be interpreted that the area effect 39.84 percent was most responsible for increasing production of lentil with yield of 30.89 percent. Interaction effect is positive indicating that the area has been playing a driving force in the differential production of lentil in Nepal. This further explained that area and yield together contributed and has influential effect on growth of lentil production in the country. As interaction effect is also contributing significantly may be due to use of improved varieties and technologies of crop management supported by national level lentil promotion programs.

While analyzing in a sub-period basis, area and yield had a positive effect of 27.60 percent and 66.16 percent respectively during the first sub-period of pre-WTO phase. During the second sub-period (1996-2003) area, yield and interaction effects were 33.48 percent, 60.93 percent and 5.59 percent respectively. During third and fourth period of post WTO phase, positive influence of area and yield on lentil production was observed. Highest area effect (96.82), lowest production effect (2.65) and lowest interaction effect (0.53) was observed during fourth period (2012-2019) of post-WTO phase. Likewise, the study reported high interaction effect (99.11) 0n lentil production in India[1].

Table-3: Cuddy-Della Valle Instability Index of area, production and yield of Nepalese lentil during pre and post WTO period (1989-2019).

Period	Variables	CV	AdR^2	CDVII	Inference
Pre-WTO (1989-2003)	Area (ha.)	15.6	0.773	7.43	low instability
	Production (Mt.)	24.98	0.923	6.93	low instability
	Yield (Mt./ha.)	11.46	0.858	4.32	low instability
Post-WTO (2004-2109)	Variables	CV	AdR^2	CDVII	Inference
	Area (ha.)	5.06	0.603	3.19	low instability
	Production (Mt.)	20.76	0.840	8.30	low instability
	Yield (Mt./ha.)	16.64	0.837	6.71	low instability
Overall (1989-2019)	Variables	CV	AdR^2	CDVII	Inference
	Area (ha.)	15.67	0.83	6.55	low instability
	Production (Mt.)	36.22	0.93	9.30	low instability
	Yield (Mt./ha.)	23.31	0.89	7.77	low instability

Table-4: Percentage decomposition of area, yield and their interaction towards increasing production of lentil in Nepal (1989-2019).

Effect/Period	Period I (1989-1995)	Period II (1996-2003)	Period III (2004-2011)	Period IV (2012-2019)	Overall (1989-2019)
Area effect	27.60	33.48	58.21	96.82	39.84
Yield effect	66.16	60.93	35.51	2.65	30.89
Interaction effect	6.24	5.59	6.28	0.53	29.27

Conclusion

The growth trend of area, production and yield showed increasing in nature for lentil at both regional and global level. With only small proportionate growth in a decade, Nepal ranks fifth in world's lentil production. Globally, Canada, India, Turkey, Australia and USA are the giant producers of lentil. Regionally, Asia region is a key producer with almost fifty percent share in both area and production. Although occupying more than half share in world's lentil area, Asia region holds comparatively less share in production with lower yield. Yield enhancing technical programs and introduction of high yielding varieties is compulsory in Asia region to achieve potential yield from large area cultivated.

The analysis with the thirty years data in this study showed increasing trend and positive growth in area, production and yield of Nepalese lentil. The positive growth in production and yield found higher in post-WTO phase as compared to pre-WTO in Nepal. Instability indices for area, production and yield found low for Nepalese lentil which implies that growing lentil in Nepal can be considered as less risky for the crop growers. With result of positive growth in production trend and stability situation, farmers can be encouraged for area extension of lentil in the country. From decomposition analysis, interaction effect is positive and playing a crucial role in the growth of lentil production in Nepal.

Conclusion can be drawn that both area and productivity influence the production of lentil in Nepal. Based on this analysis, recommendation can be made that government of Nepal need to take initiative on lentil promotion and support program especially to increase area under cultivation, introduce high yielding varieties, technology intervention, implementing minimum support price and insurance scheme to further ensure stability and higher growth in future to achieve higher rural income and productivity.

Acknowledgement

The authors are grateful, and would like to acknowledge the support of all helping hands especially for secondary data collection and analysis to accomplish this study. Post Graduate Studies and Directorate of Research and Extension of Agriculture and Forestry University, Nepal are also highly acknowledged.

References

1. Ahmad, N., Sinha, D.K. and Singh K.M. (2018). Economic analysis of production and instability of lentil in major lentil growing states of India. *Int. J. Pure App. Biosci*. 6(1): 593-598. doi: http://dx.doi.org/10.18782/2320-7051.6213.

2. Faostat (2019). Agricultural data on primary crops**,** 2018. Retrieved on June, 2021. http://www.fao.org/faostat/en/data/QCL

3. MoALD. (2019). Statistical Information on Nepalese Agriculture 2018/19. Retrieved June 2021 from the Ministry of Agriculture and Livestock Development, Government of Nepal.

4. Acharya P., Basnet, D.B. and Sanjel, P.K. (2019). Pulses Value Chain Development Activities for Achieving Food and Nutrition Security and Contributing to SDGs: Present Status, Challenges and Way Forward in Nepal. SAARC Agriculture Centre. Chapter 6. 94-114.

5. Potnuru, S.K., Kulkarni, V.S. Sajjan, S.S. and Israel, K.S. (2018). Growth performance of area, production and productivity of ginger in India: An economic analysis. *Journal of Pharmacognosy and Phytochemistry*, 3(2). Rohni, New Dehli, 198-200.

6. Tripathi, A. and Prasad, A.R. (2009). Agricultural development in India since independence: A study on progress, performance, and determinants. *Journal of Emerging Knowledge on Emerging Markets,* 1(1), 63-92.

7. Krishan B. and Chanchal, A. (2014). Agricultural Growth and Instability in Western Himalayan Region: An Analysis of Himachal Pradesh, India. *Journal of Agriculture and Life Sciences.*, 1(1). 21-27.

8. Dhakre, D.S. (2015). National trends on agricultural crop (tea) production and export, A statistical analysis. *International Journal of Biological Research, Environmental, Agriculture Science*, 1(1), 39-44.

9. Thomas S., Singh, N., Noel, A.S. and Paul, A. (2020). Economics of Growth and Instability of Green Cardamom

in India: Kerala, Tamil Nadu and Karnataka. *Int. J. Curr. Microbiol. App. Sci*., 9(12), 1317-1324.

10. Cuddy J.D.A. and Della Valle, P.A. (1978). Measuring the Instability of Time Series Data, Oxford Bulletin of Economics and Statistics. 40(10), Oxford OX1 3UQ, 79-84.

11. Sihmar, R. (2014). Growth and Instability in Agricultural Production in Haryana: A District level Analysis. *International Journal of Scientific and Research Publications*, 4(7): 1-12.

12. Basitine, C.L. and Palanisami, K.P. (1994). An analysis of growth trends in principal crops in Kerala. *Agric. Situation in India*, 48(12), 885-891.

13. Kakali, M. and Basu, P. (2006). Measurement of growth trend: An econometric study of food grains production in west. *Bangladesh J. Agric. Econ*., 3(3), 44-55.

14. Sharma, R., Kumar, A. and Joshi, P.K. (2017). Nepal-India Agriculture Trade: Trends, Issues and Prospects. *Agriculture Economics Research Review*, 30(2), 245-263.

15. Rimal, N.S and Gurung, B. (2017). Growth and dynamics of pulses production in Nepal: 1980-2014. Agriculture and Food Security Project, Kathamandu, Nepal.

16. Senapati A.K. and Goyari, P. (2018). Agricultural growth and production variability of principal crops in India: an empirical investigation. *Adv Plants Agric Res.*, 8(1), 45–51. DOI: 10.15406/apar.2018.08.00290

17. Tridge. (2021). www.tridge.com. Lentil. Retrieved on June, 2021.