

RESEARCH ARTICLE

PRODUCTION POTENTIAL OF BANANA IN NEPAL: GROWTH TREND AND A COMPARATIVE ANALYSIS

Binod Ghimire^a, Shiva C. Dhakal^b, Santosh Marahatta^b, Narayan Kafle^c, Ram C. Bastakoti^d, Sujeeta Sharma^a^aMinistry of Agriculture and Land Management, Lumbini Province^bAgriculture and Forestry University, Rampur, Chitwan, Nepal^cMinistry of Agriculture and Livestock Development, Nepal^dTCF to ADS, MOALD/Government of Nepal^{*}Corresponding Author Email: binodghim@gmail.com

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ABSTRACT

Fruit crops are the dynamic source of nutrition, employment and income. The growth trend in area, production and productivity of Banana fruit in Nepal for 30 years (1990-2019) was estimated from secondary data using compound annual growth rate (CAGR), instability and decomposition analysis along with comparative review on benefit cost analysis with India. Tremendous high growth in world's banana area (57.19%), production (160.58%) and yield (65.77%) were observed in time period between 1989 to 2019 A.D. India is the largest producer whereas; Indonesia represents highest yield with 55.06 mt/ha. The overall CAGR of 30 years in area, production and productivity for Nepalese Banana is 5.96%, 6.38% and 0.40% respectively which seems very positive and showing greater potentiality and need to maintain stability with significant growth in yield. Decomposition analysis resulted yield effect 86.90% and was most responsible for increasing production of banana with interaction effect 10.66% indicating that the area has been playing a driving force in the differential production of Banana in Nepal. Higher income from banana farming was observed in India, compared to Nepal. Although, study shows greater opportunity and potentiality; lack of adequate research and high yielding varieties, small farm size, poor management and post-harvest technologies, smooth value chain linkages and seasonal production and price fluctuations are the major constraints of banana sector.

KEYWORDS

Banana, CAGR, Decomposition, Instability, Nepal

1. INTRODUCTION

Banana (*Musa paradisiaca* L.) of the family Musaceae also known as "Apple of paradise" is one of the globally important tropical fruits all over the world and its name come from the Arabic word 'banan', which means finger (Sharma and Kispotta, 2017). It grows well in a temperature range of 15-35°C with relative humidity of 75-85% and is a rich source of potassium and fair source of phosphorus, calcium and magnesium (Hazarika, 2020). As a diet, banana is an affluent source of carbohydrate with calorific value of 67 calories per 100g fruit and is one of the most well-liked and widely traded fruits across the world (Emaga et al., 2008; Kumar et al., 2012). Further, this fruit possess immense potential for the improving farmers' economic status as well providing strength to poverty reduction (Shrestha et al., 2018). Most of the cultivars of tropical fruits grown in Nepal were introduced from India. William Hybrid, Harichhal, China Champa, Robusta, Cavendish Dwarf of banana; were the popular cultivars of introduced tropical fruits (Kaini, 1994). Fruits are more nutritive than cereal crops and gives return for long time once it is established (FDD, 2017). Globally, banana stands with 5158 thousand hectare of productive area, 116718 million tons of production with productivity of 22.63 Mt/ha (FAOSTAT, 2019). In Nepal, Banana is positioned third in production and fifth in territory among fruit crops in Nepal (FDD, 2017). Citrus, mango and banana are the most important

tropical and sub-tropical fruit crops in Nepal.

Banana possessing potential productive area of 16615 ha, production of 278,890 tons and with yield of 16.79 mt/ha, is a prioritized high-value agricultural product contributes 0.85% in national AGDP of Nepal (MoALD, 2019). Although being the important fruit, it is suffering from various challenges and even bears crop failure with biotic and abiotic reasons. Works on fruit research is inadequate and extension program is very general and cereal crop dominated in Nepal (FDD, 2017). During marketing banana have to bear the post-harvest losses of about 10-15 percent in banana (FDD, 2017). Smallholding banana farmers of developing countries face larger sets of production challenges especially related to resource (land, labor and capital) uses and technical know-how (Tinzaara et al., 2018). To derive the fruit potentiality, past and present scenarios are needed. However, very limited scientific studies have been done so far to analyze the growth trend, instability, decomposition and comparative review along with constraints and way forward.

In this context, the present study made an attempt to analyze the growth, instability and decomposition in area, production and productivity of banana in Nepal over time with the objective of measuring the growth trend, reviewing the economics of production, challenges and potentialities for banana sector. Also, comparative review with neighboring country India and others will provide great insight for the actors involved in banana value chain in Nepal and other producers.

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2. METHODOLOGY

The current study made use of secondary time series data on area, production and yield of banana in Nepal pertaining for 30 years (1990 to 2019) retrieved from FAOSTAT. The entire study period was further divided into three subperiods assuming programs and policies changes in a decade as: Period I (1990 to 1999 A.D.), Period II: (2000 to 2009 A.D.) and Period III: (2010 to 2019). Further, to excavate economics, constraints, potentialities and recommendations for banana sector in Nepal and India, different literatures were reviewed and presented in tables, diagrams, and percentage using Microsoft excel with descriptions. The procedural and statistical methodologies employed are described as follows.

2.1 Compound Annual Growth Rate (CAGR) Analysis

In Nepal, to analyze the CAGR of Banana production for the pertaining period of 30 years, the exponential form of regression analysis was employed (Potnuru et al., 2018).

$Y_t = ab^t e^u$ Where,

Y_t = dependent variable (area/yield/production)

a = intercept term

$b = (1+r)$ and “ r ” is the compound growth rate

t = time period

e^u = error term

The above model in the Logarithmic form was expressed as,

$\ln Y = \ln a + t \ln b + \ln u$

In a and $\ln b$ values were obtained using the ordinary least squares procedures and the R^2 was computed for testing the goodness of fit. The compound growth rate “ r ” was computed by using relationship; $r = (\text{Antilog of } (\ln b) - 1) * 100$.

2.2 Instability Analysis

To examine the extent of variability in the production, area, and yield of Banana fruits in Nepal, the Cuddy-Della Valle Index was used (Cuddy and Della Valle, 1978).

$CDVI \text{ index } (\%) = CV * \sqrt{1 - AdR^2}$

Where;

CV = Coefficient of variation (in percent)

R squared = Coefficient of determination from a time-trend regression adjusted by the number of degrees of freedom.

Following (Sihmar, 2014), the range and interpretation for Cuddy-Della Valle Instability Index as; $CDVI = 0$ to 15 = Low Instability; $30 < CDVI > 15$ = Medium Instability; $CDVI > 30$ = High Instability

2.3 Decomposition Analysis

For analyzing the contribution of area, yield and effect of area as well as yield in total production of Banana following model was used. A number of studies have applied same model to analyze similar objectives (Bastine and Palanisami, 1994; Kakali and Basu, 2006; Sharma et al., 2017).

$\Delta P = A0 \Delta Y + Y0\Delta A + \Delta\Delta Y$

Change in production = Yield effect + Area effect + Interaction effect

Where,

ΔP = change in production, $A0$ = area in the base year, ΔA = change in area, ΔY = change in yield and $\Delta\Delta Y$ corresponds to the interaction effect

3. RESULTS AND DISCUSSION

3.1 World's Banana Production

World's harvested area, production and yield of Banana were 5158 thousand ha, 116781.7 mt and 22.64 mt/ha, respectively (FAOSTAT, 2019). India, China, Indonesia, Brazil, Ecuador are the major banana producers in the world. The top 10 producing countries account for 71.53% of global production. India ranked first accounting for 26.08% of total world Banana production, cultivated over 866,000 hectares with a yield of 35.1 mt/ha. followed by China which accounts for 9.98% of total world Banana production cultivated over 344,010 hectares with a yield of 33.8 mt/ha. India is the leading banana producer in the world with 16.79% share in area and 26.10% share in production followed by China (6.67% and 9.99%) and Indonesia (6.55% and 6.24%). Nepal only shares 0.32% in area and 0.24% in production of Banana in the world. From the table 1, tremendous high growth in world's banana area (57.19%), production (160.58%) and yield (65.77%) can be observed in time period between 1989 to 2019 A.D. But the growth in area (-2.6%) is found negative between the period 2009 to 2019. Globally, Indonesia represents highest yield with 55.06 mt/ha. followed by Guatemala (48.11mt/ha.), Brazil (46.17 mt/ha.), Ecuador, China and India with around 35 mt/ha. Nepal possesses yield of 16.79 mt/ha. which is higher than Tanzania (11.25 mt/ha.) and Angola (16.21mt/ha.).

Table 1: Growth in Area, Production and Yield of Banana Globally

Year	Area Harvested (000' Ha.)	% Growth	Production (000' MT)	% Growth	Yield (MT/Ha.)	% Growth
1989	3281.7	N/A	44816.0	N/A	13.65	N/A
1999	4427.0	34.9	69947.0	56.1	15.80	15.6
2009	5294.5	19.6	103092.3	47.4	19.47	23.2
2019	5158.6	-2.6	116781.7	13.3	22.63	16.2
Growth (1989-2019)		57.19		160.58		65.77

Source: FAOSTAT, 2019 and author's illustrations

Table 2: World's Top Banana Producers and Their Share in Area and Production, 2019

Country	Area (000' Ha.)	Share in World Area	Production (000 Mt)	Share in World Production	Yield (Mt/Ha.)
India	866	16.79	30460.0	26.10	35.17
China	344	6.67	11655.7	9.99	34.40
Indonesia	132.2	6.55	7280.6	6.24	55.06
Brazil	461.7	8.95	6812.7	5.84	46.17
Ecuador	183.3	3.55	6583.5	5.64	35.90
Philippines	185.9	3.60	6049.6	5.18	32.54
Guatemala	90.2	1.75	4341.5	3.72	48.11
Angola	162.2	3.14	4036.9	3.46	16.21
Tanzania	302.7	5.87	3406.9	2.92	11.25
Colombia	105.6	2.05	2914.4	2.50	27.59
Nepal	16.6	0.32	278.8	0.24	16.79
World	5158.6		116718.6		

Source: statista.com, 2019

3.2 Banana Production in Nepal: Trend Analysis (1990-2019 A.D.)

Area and production of banana in Nepal during the period of 1990 to 2019 shows increasing trend. From 2011, area and production seem increasing continuously which may be due to focused program with subsidy and higher market demand. In 2019, Nepal's banana area and production was found increased to 16615 ha. and 278890 MT. from 3100 ha, and 46350 MT in 1990. The time series data was taken from FAOSTAT and illustrated in figure 1.

3.3 CAGR Analysis in Area, Production and Yield of Banana in Nepal

The overall CAGR of 30 years in area, production and productivity for Nepalese Banana is 5.96%, 6.38% and 0.40% respectively. In terms of production, Nepal's annual production grows at 6.38 percent per annum. The significant positive growth rate was observed may be due the substantial positive change in area, production and yield of Banana supported with promotion programs and cash earnings by farmers.

The sub-period wise compound growth trend analysis for the area under

Banana in Nepal shows high growth of 12.38% in period III (1989-1995) from negative growth of 1.12% in period I and positive 8.55% in period II. In production, compound annual growth trend analysis showed significantly high growth of 13.25% in period III from negative growth of 0.18% in period I and positive growth of 7.91% in period II. Further, the result shows negligible growth in yield variables in the entire period. The sub-period wise compound annual growth trend analysis for yield found higher growth of 0.95% per cent in period I (2012-2019) and thereafter negative growth in period second and positive growth of 0.77% in period III. It can be concluded that the growth in area and production of banana for 30 years seems very positive showing greater potentiality and need to maintain stability with significant growth in yield. Introduction of high yielding varieties and yield improvement program for existing varieties is recommended.

The year wise growth revealed that higher growth in area and production was observed during the year 2011 and 2012 but with negative growth in yield. So, great effort should be needed to enhance yield of banana in Nepal.

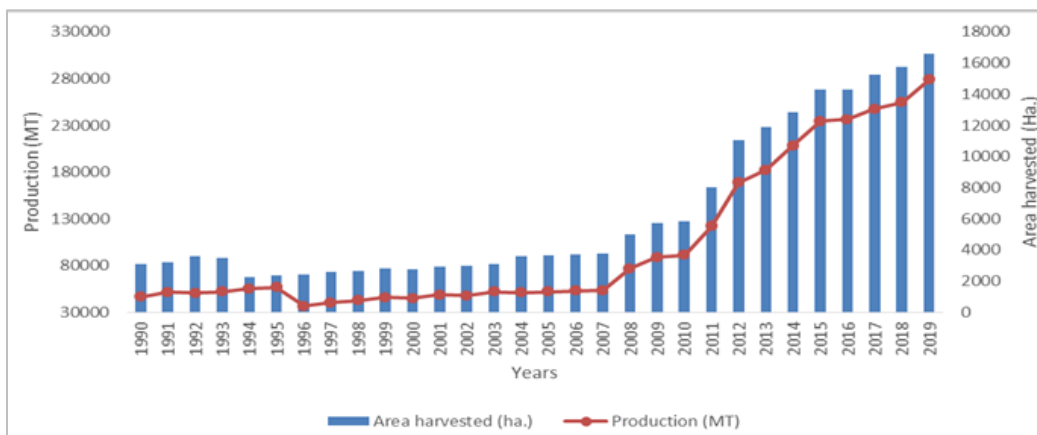


Figure 1: Growth trend of area and production of Banana in Nepal (1990-2019)

Table 3: CAGR (in %) of Area, Production and Yield of Banana in Nepal (1990-2019)

Banana	Period I	Period II	Period III	Overall
Percent change in Area (ha)	-1.12	8.55	12.38	5.96
Percent change in Production (Mt)	-0.18	7.91	13.25	6.38
Percent change in Yield (Mt/ha)	0.95	-0.60	0.77	0.40

Source: FAOSTAT, 2019 and authors' computation

3.4 Instability Analysis

Details of instability in area, production and yield of Banana in Nepal for the overall period (1990 to 2019) and sub-periods are presented in Table 4 below. During the entire period, low instability was found in yield. Wherever, highest variation was noticed for area and production in comparison to yield. The variation in area and production was 39.80 per cent and 42.5 per cent respectively, while the variation in yield was 14.29 per cent.

During the sub-period analysis, low to medium instability was found. Medium instability was noticed in yield (23.05) in period I and production (15.97) of period II. The lowest instability has been observed in the period III with yield (2.12), area (8.71) and production (8.13). However, in period III, the instability in all variables found low with increasing positive growth trend in Nepal. Farmers can be encouraged for area extension and volume-based production of banana in Nepal as this fruit crop holds a significant portion in cropping pattern of the country.

3.5 Decomposition Analysis

Relative contribution of area and yield in the growth of banana in Nepal for the overall period (1990 to 2019), and then in each sub-period separately was done through decomposition analysis method. From the results presented in Table 5, the analysis of the overall period shows that the yield and interaction effects were 86.90 per cent and 10.66 per cent respectively and area effect was 2.44 per cent. The yield effect 86.90 % was most responsible for increasing production of banana with interaction effect 10.66%. Interaction effect is positive indicating that the area has been playing a driving force in the differential production of Banana in the country. This states that area and yield together contributed towards

growth of Banana in Nepal. Interaction effect is also contributing significantly may be due to use of improved varieties and technologies of crop management supported by some national level banana fruit promotion program.

The sub-period wise analysis suggests that area had a negative effect with positive yield and interaction effect in period I. During the second sub-period (1996-2003) again area and interaction had a negative effect, with positive yield effects. During third period positive influence of area and yield on banana production was observed. Highest yield effect (90.06), lowest area effect (3.48) and lowest interaction effect (6.46) was observed during period III (2012-2019).

3.6 Cost Benefit in Banana Production: A Comparative Study of Nepal and India

This section consist the comparative economics of banana production illustrated from the review of different literatures and study done in Nepal and India (table 6 and 7). In Nepal, the benefit cost ratio of banana production found ranging from 1.42 to 2.23. Similarly, the benefit cost ratio for banana production in India ranging from 1.53 to 2.68 and is higher while compared to Nepal. This signifies that farmers in India are getting higher return from banana when compared to Nepal. Land leasing, manure and fertilizer and labor cost are found with higher share in total cost in Nepal whereas, labor and planting materials costs share are found higher in India. Similar to this, Sharma et al., (2021) resulted share for cost of labor and suckers in the study areas were already higher as compared to other studies and recommended mechanization in banana farming especially to support intercultural operations could be an alternative to solve the problem of unavailability and underutilization of labors, which could further increase return.

Table 4: Cuddy Della Valle Instability Index (CDVII) of Area, Production and Yield of Banana During The Study Period (1990-2019)

Period	Variables	CV	AdR ²	CDVII	Inference
Period I	Area (ha)	16.56	0.24292816	14.409	Low Instability
	Production (Mt.)	13.78	0.11039648	12.997	Low Instability
	Yield (Mt./ha.)	21.84	-0.1140697	23.052	Medium Instability
Period II	Variables	CV	AdR ²	CDVII	Inference
	Area (ha)	25.85	0.80001676	11.560	Low Instability
	Production (Mt.)	25.22	0.59878936	15.975	Medium Instability
Period III	Variables	CV	AdR ²	CDVII	Inference
	Area (Ha.)	27.68	0.90082374	8.717	Low Instability
	Production (Mt.)	30.05	0.92670161	8.136	Low Instability
Overall (1989-2019)	Variables	CV	AdR ²	CDVII	Inference
	Area	77.08	0.732388	39.874	High Instability
	Production	78.41	0.70516766	42.575	High Instability
	Yield	14.28	-0.0013373	14.290	Low Instability

Source: FAOSTAT (2019) and authors' computation, 2022

Table 5: Percentage Decomposition of Area, Yield and Their Interaction Towards Increasing Production of Banana in Nepal (1990-2019)

Effect/Period	Period I (1990-1999)	Period II (2000-2009)	Period III (2010-2019)	Overall (1990-2019)
Area effect	-551.43	-5.34	3.48	2.44
Yield effect	598.06	111.17	90.06	86.90
Interaction effect	53.36	-5.83	6.46	10.66

Source: FAOSTAT (2019) and authors computation, 2022

Table 6: Cost, Share in Cost, Net Profit And B:C Ratio of Banana in Nepal

Country	Cost NRs./Ha.	percent share in cost	Net Profit NRs./ha.	B:C Ratio	Reference
Nepal	NRs. 288412.8 in small farms	31.5% in land leasing, 17.5% manure, 16.1% chemical fertilizer, 11.2% labor, 12.9% suckers' cost	NRs. 333845.1	2.23 in small farms	Dulal and Kattel, 2020
Nepal	NRs. 455857.80 /ha	Rent 21.34%, labor 15.32%, machine 15.12%, planting materials 9.95%	NRs. 197853.23	1.50	Ghimire et al., 2019
Nepal	NRs. 408,165.50 for first and 332,894.80 for succeeding cropping season	Sucker 7.80%, labor 20.46%, manure and fertilizer 25.74% for first cropping season	NRs. 230788.4 for first and 306059.20 for succeeding crop	1.57 in first and 1.92 in succeeding cropping season	Sharma et al., 2021
Nepal	NRs. 174744.8 as investment and 113487.52 in second year for William hybrid/tissue culture	Human labor 21.88%, sapling 22.03%, land lease 14.8%	NRs. 102512.5 from second year	1.90 in second and 2.17 in third year in Nawalparasi	APMDD, 2015
Nepal	NRs. 358546.5	19.48% in labor, 19.23% in animal/machine, planting material 12.66%	NRs. 197853.4	1.55	Shrestha et al., 2018
Nepal	NRs. 238634.40 /ha in investment phase and 133552.68 in second year	Expenses on planting materials, manures, fertilizers and micro-nutrients have positive significant effect on yield	NRs. 110894.64	1.83 in second year and 2.43 from third year	Phularaa et al., 2020
Nepal	NRs. 338700	14.7% in human labor and 14.7% in Sucker	NRs. 142800	1.42	DoAD, 2076

*Figure above were calculated to derive percentage, converted figure in hectare basis for homogenous. (NRs. =Nepalese Rupee)

Table 7: Cost, Share in Cost, Net Profit and B:C Ratio of Banana in India

Country	Cost IRs./Ha.	percent share in cost	Net Profit IRs./ha.	B:C Ratio	Reference
India	IRs. 246130.83	Human labor 6.36%, cost of plant 11.82%, manure and fertilizer 16.02%, irrigation 19.12%, rental value 4.07%	IRs. 272219.17	2.10	Singh et al., 2017
India	IRs. 313337.47	Suckers 4.91%, manures and fertilizer 32.10%, rental value 14.43%	IRs. 133 634.91 (small farms)	1.53	Rama Krishna et. al, 2017
India	IRs. 151734.84	Plantlet (tissue culture) 22.45%, hired human labor 9.05% and management 9.1%	IRs.108135.13 (non-drip farm)	1.71 (over cost C2)	Dave et, al., 2016
India	IRs. 165515.00	Human labor 27.18%, sucker 24.89%, manure and fertilizer 8.66%, rental value 21.15%	IRs. 89485.00	1.54	Pal, 2019
India	IRs.198605.62	Labor 25.28%, seed 21.14%, Rent 32.06%,	IRs. 192992	1.96 (Small farms)	Kumar and Nishad, 2018
India	IRs.119881.63	Labor 52.17%, manure and fertilizer 21.52%, staking 8.62%, planting materials 3.11%	IRs. 124502.37 (Nendran)	2.03 (Nendran)	Gowri and Shanmugam, 2015
India	IRs.103279.09	manures, planting materials and hired human labor are the major resources used	IRs.104064.91	2.00 (Organic Banana)	Hile et al, 2008
India	IRs. 59041.30	41.79% in family labor, 29.88% in hired labor, 9.62% in marketing	IRs. 101819.82	2.68	Murry and Das, 2019

*Figure above were calculated to derive percentage, converted figure in hectare basis for homogenous. (IRs. =Indian Rupee)

3.7 Major Problems and Suggestions in Banana Sector

Banana sector in Nepal is suffering from various problems related to production and marketing chain. Whereas, India one of the countries's leading at banana sector, is also facing some problems at complete value chain. Most of the bananas producing countries are facing issues of input management, sustained value chain activities, technology and quality for sustainable and profitable production of banana. Shrestha et al. (2018) mentioned various production and marketing problems such as storage, grading, processing, orchard management, disease and pest management in Nepal. In India, Fonsah and Amin (2017) pointed constraints on adoption of complete value chain, including production, transportation, distribution, marketing, overall quality, price fixation and large variation in the quality of banana. Similarly, issues are usually interlinked with the various aspects of the banana industry with limited market access and information asymmetry particularly on output prices and quality of inputs provided in Phillipines (Digal, 2007). Also, Zhang et al., (2020) mentioned low soil fertility, high rates of fertilizer application and low yields and quality are major problems in intensive banana production in acid soils in China. Also, there are some constraints of production system sustainability in the long term (Frizo et al. 2019).

Banana producing countries has been promoting different strategies and policies for its promotion. Nepal has been implementing banana pocket, block and zone program in different potential district for commercial promotion under Prime Minister Agriculture Modernization Project and other support program through provincial and local government. Dulal and Kattel (2020) suggested promotion of insurance scheme on banana farming through awareness. Biotechnology such as tissue culture is contributing to produce disease free saplings in banana and citrus (FDD, 2017). Two government owned projects, RJKIP and RISM-FP have supported in fruit sector Nepal where RJKIP has supported commercial banana farmers in Kailali district and RISM-FP has supported in fruit cultivation, cold storage construction and processing in ten districts of mid and Far-Western Development Regions through competitive matching grant funds. India's banana promotion strategy is mainly focused on yield improvement for competing international market. Fonsah and Amin, (2017) suggested the development of models to improve the entire banana value chain in India at international norms and standards. Also, development of larger banana orchards to increase the production of high-quality bananas for the supermarket trade, possibly by establishing a larger management structure for banana growers in Indonesia is suggested (Setyadjit et al., 2003).

4. CONCLUSION

The present study was conducted to analyze the growth and trend pattern of area, production and yield of banana in Nepal with critical review on its cost, associated problems and strategies. As the significant positive growth rate was observed from the study, the compound annual growth rate analysis indicated that the increase in production of banana fruit in Nepal was due to increase in area, rather than yield, which demands for intensive interventions of the strategies that increase the yield which may include integrated crop management practices with introduction of high yielding varieties. As low instability is being observed in recent years, farmers can be encouraged for area extension and volume-based production of banana in Nepal as this fruit crop holds a significant portion in cropping pattern of the country. While reviewing, although the banana farmers of Nepal found to have low return as compared to India due to various problems associated with production and marketing. From the perspective of growth trend analysis it can also be concluded that there is profound scope and immense potentiality of commercial banana promotion with a systematic value chain development approach and adequate improved technological backstopping. As the land leasing, fertilizers and labor cost share higher in total cost in Nepal, financial support and subsidy should be provided with minimum support price and easily accessible insurance scheme to protect farmers and make their farming profitable.

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