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Global status of lentil production with special reference to India

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ABSTRACT

India needs to increase it pulse production to meet the growing demand. Lentil is one of the important pulse crop grown in winter season in tropical and subtropical regions of world. The study analysed the trends in production and trade scenario in India and globally from 2000–2018 and came out with strategies for increasing production. The state-wise analysis was carried out for major producing states like Madhya Pradesh, Uttar Pradesh, Bihar, West Bengal and Rajasthan from 2000–2019. The lentil production in the world reached around 6.33 million tonnes in 2018 with an annual growth rate of 4.4% since last 20 years. Asia alone contributed more than half of total global lentil production. The share of American and Oceania regions in global lentil production increased in recent years. There was increase in lentil yield in recent years in Africa, Asia and American regions due to adoption of improved production technologies. India and Canada together contributed more than 50% of total world lentil production. Lentil yield was highest in Canada (1425 kg/ha), lowest in India (744 kg/ha) in 2018. The lentil production in India touched 1.47 million tonnes with larger share contributed by Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh and West Bengal in 2018. India is the leading importing nation sharing more than one-fourth of total world import during last five years. Adoption of drought, heat, biotic stresses tolerant high yielding cultivars are required to meet estimated demand of 2.00 million tonnes by 2030.

Keywords: Agricultural production, Economics, Legumes, Lentil, Policy Interventions, Trade

Lentil (*Lens culinaris* Medik.) is among the oldest domesticated crop cultivated in the world. Lentil, also known as red dhal, masur or split peas is a staple food often eaten with cereal grains (Reddy and Reddy 2010). It is an excellent source of vitamin A and provides fibre, potassium, B-vitamin and iron. It also has an important role in crop rotation and enhancing soil fertility and providing other environmental services in production systems such as promoting sustainable cereal-based production systems with a potential of fixing free nitrogen up to 107 kg/ha (Chand *et al.* 2015).

Lentil is one of the three largest produced pulses cultivated in 53 nations across the globe and its yield varied between 227 kg/ha in Israel to 2567 kg/ha in China in 2018. The total lentil cultivated area in the world is estimated around 6.10 million ha with annual production and yield of 6.33 million tonnes (MT) and 1038 kg/ha, respectively (FAOSTAT 2019). World lentil production has been increasing in recent years with most of the production coming from North American and Asian countries. By 2030, the estimated consumption of lentil would increase to 5.50 MT in the world indicating 2.0 MT more production. Canada, Australia, USA and Turkey are leading exporting countries sharing 87.02% of total world export trade (3.49 MT) in 2017.

India is the largest cultivator and largest consumer of lentil. It is cultivated in India on 5.21% of total pulses area (29.03 million ha) contributing 6.67% of total pulses production (23.40 MT) in 2018–19. More than 68% of lentil area is in Madhya Pradesh and Uttar Pradesh which contribute more than 71% of production in 2018–19. Lentil cultivation in India is characterized by low yields with high variability and mostly grown by small-holder farmers. The biotic stresses have been reported triggering the reduction in the productivity of lentil by 20–25% in India (Maheshawari *et al.* 2008).

Whenever there is deficit in production, India imports significant quantity from international markets. In this context, it is important to understand the global production scenario and Indian production potential to meet domestic growing consumption needs. Hence, the present study was undertaken with following objectives: i) to analyse growth and variability in area, production and yield of lentil at global level and in India, ii) to work out growth and instability in area, production and yield of lentil in major growing states

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of India, iii) to examine trade scenario of lentil in India to suggest policy options.

METHODS AND MATERIALS

The data pertains to area, production and yield of lentil at global level (2000–18) was taken from FAOSTAT website, data for India (1970–2019) and its various states (2000–19) were extracted from Agricultural Statistics at a Glance published by Directorate of Economics and Statistics, Govt. of India. The triennium endings (three-year average) were toiled out to elude fluctuation in data. Further, decadal average (ten-year average) was also figured out to grasp the performance of lentil in various decades.

To estimate the Annual Compound Growth Rates (ACGRs) and variation/instability in area, production and yield of lentil, the complete period under study i.e. 1970–2019 for India was grouped into six periods—Period-I: (green revolution period-1970–71 to 1979–80), Period-II: (Post-green revolution period-1980–81 to 1989–90), Period-III : (Post-liberalization period-1990–91 to 1999–2000), Period-IV(2000–01 to 2009–10), Period-V: (2010–11 to 2018–19) as Post-Trade Spike Periods, and Overall Period: (1970–71 to 2018–19) . For major states of India, the period was split into three periods, viz. Period-I (2000–01 to 2009–10), Period-II: (2010–11 to 2018–19) and Overall Period: (2000–01 to 2018–19). The ACGRs for area, production and yield for states, major lentil growing nations and various regions of world were also worked out for Period-I, Period-II and Overall Period.

To measure the magnitude of variability in area, production and yield, Cuddy Della Valle Index (CDVI) was employed (Hasan *et al.* 2008). The formula for CDVI is as under.

$$\text{Instability Index (CDVI)} = CV * (1 - R)^{0.5}$$

$$CV = \frac{\text{Standard deviation of the variable}}{\text{Mean of the variable}} \times 100$$

where, CV is coefficient of variation, R is the coefficient of Determination from a time series trend regression adjusted by the number of degrees of freedom.

RESULTS AND DISCUSSION

Status of world lentil production: Lentil production at global level enhanced at a growth rate of 4.39% per annum

Table 1 Area, production and yield of lentil in various regions of world, 2000–18

Particulars	Africa	Asia	Europe	Oceania	Americas	World
Area (lakh ha)						
TE 2002	1.34	28.47	0.45	1.11	6.81	38.17
TE 2010	1.47	22.52	0.5	1.26	11.99	37.74
TE 2018	1.77	29.32	2.52	2.23	22.14	57.99
Production (lakh tonnes)						
TE 2002	0.81	21.54	0.4	1.53	7.53	31.8
TE 2010	1.3	17.44	0.43	0.92	17.98	38.07
TE 2018	2.16	26.5	2.57	2.21	30.72	64.16
Yield (kg/ha)						
TE 2002	602	756	887	1374	1087	833
TE 2010	884	773	850	707	1492	999
TE 2018	1226	910	1061	993	1383	1110
Area (ACGR%)						
Period-I (2000–09)	2.15	-2.48	-1.03	4.15	4.06	-0.64
Period-II (2010–18)	1.41	3.53	19.46	3.59	7.37	5.33
Overall period (2000–18)	2.38	-0.32	9.19	4.69	7.39	2.23
Production (ACGR%)						
Period-I (2000–09)	6.62	-2.41	-1.50	-10.78	8.06	0.87
Period-II (2010–18)	5.45	4.44	22.31	0.46	5.48	5.22
Overall period (2000–18)	7.67	0.76	10.07	4.95	9.65	4.39
Yield (ACGR%)						
Period-I (2000–09)	4.38	0.07	-0.47	-14.33	3.85	1.51
Period-II (2010–18)	3.98	0.87	2.39	-3.02	-1.76	-0.10
Overall period (2000–18)	5.16	1.08	0.81	0.25	2.1	2.11

Source: FAOSTAT, 2019.

during time period 2000–18 and it augmented more than double in last 19 years. The contribution of Asia (67.7%) was highest in TE 2002 but in TE 2018 America became the highest contributor (47.9%) as its production increased over the period due to upsurge in harvested area and yield. The share of Asia in lentil production dropped over time by 26.4% even slight increase in area (3.0%) and yield (756–910 kg/ha) did not stride with other regions.

Though the acreage under lentil initially declined during TE 2002–2010 but thereafter increased by 2.23% per annum during 2000–18 (Table 1). Asia was dominant in lentil area coverage sharing three-fourth (75%) of total global area in TE 2002. The annual increase in area for all regions was also found higher in period-II over period-I.

The growth rates of production in African and American regions were 6.62% and 8.06% in period-I against 5.45% and 5.48% in period-II due to increase in area and yield in both the regions. The growth rate of lentil production in Asia, Europe and Oceania regions in period-I was found negative in first phase but after 2010, it was positive for all three regions. The annual increase in lentil production was highest in Europe (10.07%) and lowest in Asia (0.76%) in last two decades.

The major lentil growing nations in the world are Asia (India, Kazakhstan, Nepal, and Turkey) and America (Canada, USA). The contribution of India was about one-third (31.1%) in total global production followed by Canada (18.9%), Turkey (15.1%), Nepal (4.5%), USA (4.0%) and Kazakhstan (0.8%) in TE 2002. The share of India and Turkey in total lentil production was reduced in TE 2018 while it was amplified for all other countries as area expanded in North America, Nepal and Kazakhstan.

Although contributing a significant share in global lentil production, India reported lowest yield in both TE 2002 and TE 2010. The incremental increase in yield in TE 2018 over TE 2002 in India was 10.6% which was much lower than other nations. As a result, the average yield in TE 2018 was lowest in India (744 kg/ha), while it was maximum in Canada (1425 kg/ha). About half of the world lentil production emanates from India and Canada. Most Indian lentils are consumed domestically, while Canada is the largest export producer of lentils in the world (Materne and Reddy 2007).

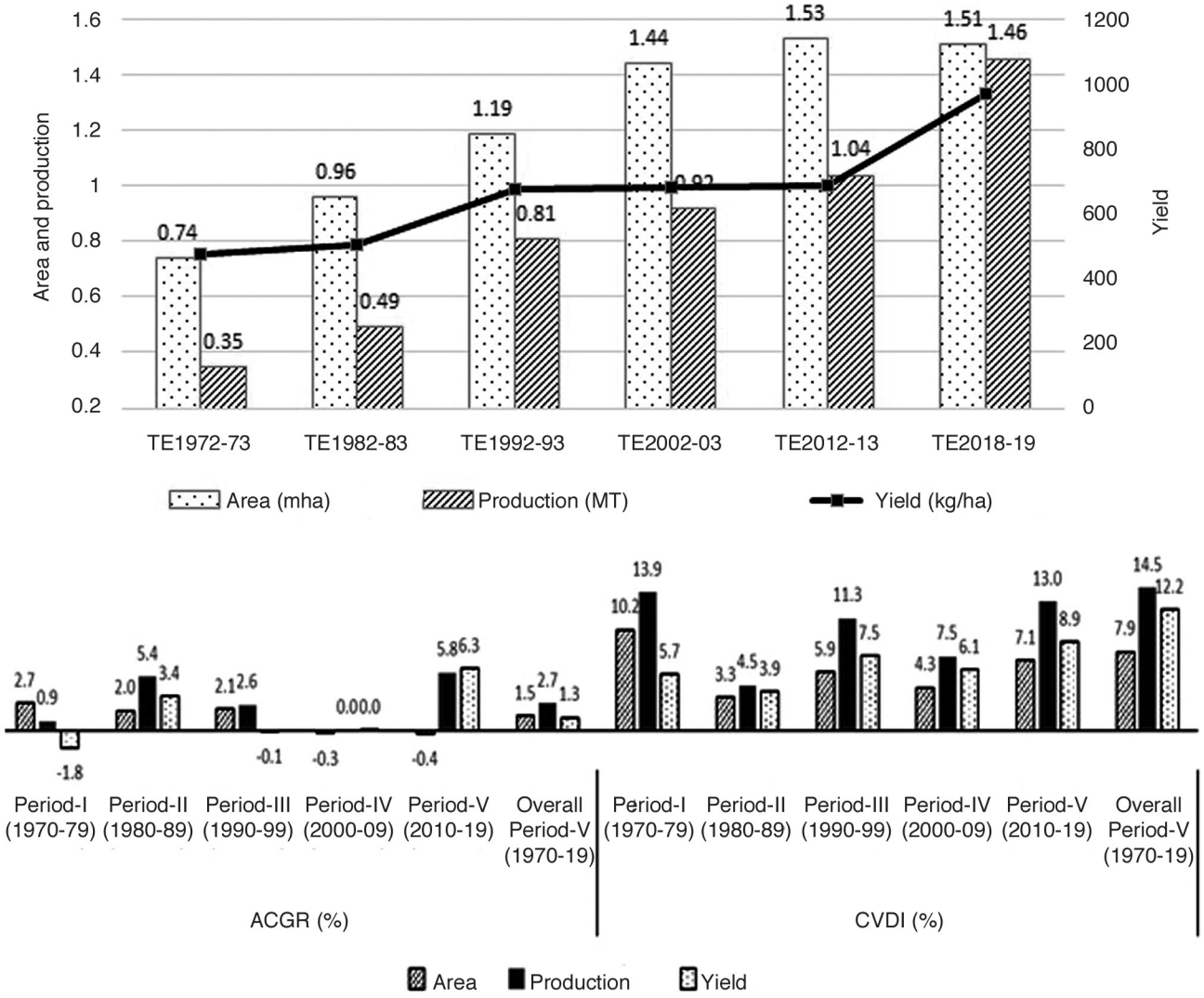

Fig 1 Trends in area, production and yield of lentil in India, 1970–2019.

Indian scenario of lentil cultivation: After chickpea, lentil is next important pulse crop grown in *rabi* sharing 5.21% of total pulses area (29.03 million ha) in India (2018–19). The growers plant lentil after harvesting rice, maize, millet, sorghum etc. as a sole crop under both rainfed and irrigated agro-eco systems. The major constraints for low productivity of lentil are inadequate availability of seeds of improved varieties, biotic and abiotic stresses and poor crop management. Under Indian conditions, both abiotic and biotic stresses like *Fusarium* wilt, root rot, *Aschochyta* blight, and drought, high and low temperatures, water logging, salinity etc. are major restraints in the cultivation of lentil.

Trends in area, production and yield: Trends in area, production and yields from 1972–2019 are given in Fig 1. The area under lentil in India was 0.74 million ha in TE 1972–73 amplified to 1.51 million ha in TE 2018–19 signifying nearly double over a time span of 50 years. The share of lentil in total pulses (21.9 million ha) was 3.38% in TE 1972–73, augmented to 5.09% of total pulses area (29.5 million ha) in TE 2018–19. The average area increased from 0.74 million ha in TE 1973 to 1.51 million ha in TE 2019. The overall decadal increase was 0.61 million ha in harvested area of lentil during last five decades.

Trends in growth rates and instability: Annual compound growth rates and instability of lentil area, production and productivity are given in Fig 1. The overall growth rate in the area of lentil was 1.5% in area, 2.7% in production and 1.3% in yield annually during 1970–2019. The period-wise analysis shows that the growth rate of production was much higher in period-II (1980–89) and period-V (2010–19). The lentil area registered negative growth during the 1990s and 2000s due to a shift of large area to other crops like field pea, chickpea, wheat, and barley in central and eastern India.

The production and yield of lentil showed notable growth of 5.82% and 6.25% per annum in period-V (2010–19) due to introduction of National Food Security Mission (NFSM), Rashtriya Krishi Vikas Yojana (RKVY) and Bringing Green Revolution in Eastern India (BGREI) programs emphasizing better quality seed, distribution of seed minikits, demonstration of production and protection technologies, creation and strengthening of irrigation infrastructure etc. and collaborative development projects of ICARDA in eastern India. The positive growth rate of production and yield of lentil was recorded in India during last five decades. Ahmad *et al.* (2018) also recited the similar outcomes of study conducted for lentil crop in India for the period 2000–16.

Instability not only reduces farmers' willingness to grow crop but also leads to higher fluctuation in prices, as a result both farmers and consumers are adversely affected. The analysis indicates that the highest instability in area (10.2%) and production (13.9%) was observed in period-I (1970–79) because the area diverted from lentil to other crops with inception of green revolution and expanded irrigated area. Growing under residual moisture, erratic rainfall, moisture stress, severe occurrence of *Fusarium* wilt, *Ascochyta* blight, collar rot diseases and pod borer (Ahmad *et al.* 2018), less use of quality seed are some other reasons that resulted large variations in area, production and yield in India.

Lentil production scenario across states: Lentil is mainly cultivated in Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh and West Bengal contributing 91.60% of total area (1.51 million ha) with share of 92.76% in total production (1.58 MT) in India in 2018–19. Lentil is primarily grown as sole crop; inter crop with sugarcane, linseed, mustard; and relay/paira/utera crop with rice in Madhya Pradesh (Sagar, Jabalpur, Bundelkhand and Bhopal), Bihar (Tal lands in south region), Uttar Pradesh (Kanpur) and Rajasthan (Kota). Madhya Pradesh and Uttar Pradesh alone share 68.48% of total area and 71.40% of production.

The states like Madhya Pradesh, West Bengal and Rajasthan exhibited an increase in lentil production in last 20 years. However, almost stagnant production was observed in Uttar Pradesh and Bihar due to decline in area in spite of yield improvement while in other states, it leaped considerably due to combined positive effect of area and yield.

Lentil yield was recorded highest in Rajasthan (1020 kg/ha) and lowest in Madhya Pradesh (430 kg/ha) in TE 2002–03. There was large variation in lentil yield across leading lentil states. This might be attributed owing to varying adoption level of crop management practices, use of seed varieties, level of residual moisture availability, accessibility of irrigation water and amount of precipitation.

Statewise trends in growth rates and coefficient of variation of area, production and yields were presented in Table 2. The acreage under lentil exhibited increase in Madhya Pradesh during last two decades as a result of large net sown area owing to creation of irrigation structure like farm ponds, water tanks, renovation of reservoirs to supplement irrigation to lentil, adoption of micro irrigation system procurement arrangement, etc. West Bengal exhibited remarkable growth rate of area as adoption of improved lentil varieties evolved in India and Bangladesh and adequate residual moisture. Whereas Uttar Pradesh and Bihar exhibited declining rate of 2.14% and 0.86% annually in last two decades and together share about 41% of total lentil area. It is because the lentil cultivated area in these states is replaced by less risky crops like mustard, fieldpea, wheat, barley etc. The growth rate of yield for all lentil leading states was found positive throughout the periods (except Bihar in period-I and period-II and in Rajasthan for period-I). The increase in lentil yield was found higher in period-II as compared to period-I.

The variability in both acreage and production were recorded considerably low in period-I (2000–09) as against period-II (2010–2019). The variation in both area and production in term of value of CDV index were observed highest in Rajasthan (48.88%) because of the large area under rainfed and frequent drought conditions. The instability in production in Madhya Pradesh and West Bengal was acknowledged due to cultivation of short duration promising

Table 2 CGR and variation for area, production and yield in important lentil growing states of India, 2000–19

Period		Madhya Pradesh	Uttar Pradesh	Bihar	Rajasthan	West Bengal
Area						
Period-I	CGR	1.05	-1.53	-0.66	3.45	-4.18
(2000–01 to 2009–10)	CV	5.61	6.40	3.03	35.21	4.02
Period-II	CGR	-0.76	-2.72	-4.54	-0.78	15.25
(2010–11 to 2018–19)	CV	5.62	13.24	13.65	46.71	26.48
Overall period	CGR	1.06	-2.14	-0.86	6.71	3.26
(2000–01 to 2018–19)	CV	6.56	9.41	12.24	48.88	37.86
Production						
Period-I	CGR	2.87	-0.48	-2.12	0.36	-7.25
(2000–01 to 2009–10)	CV	11.84	9.68	11.78	42.37	15.95
Period-II	CGR	16.40	0.08	-4.65	0.61	17.36
(2010–11 to 2018–19)	CV	13.09	27.49	9.51	41.76	25.21
Period-III	CGR	5.70	-1.54	0.79	6.84	4.17
(2000–01 to 2018–19)	CV	27.02	18.75	17.60	47.09	44.51
Yield						
Period-I	CGR	1.79	1.06	-1.46	-3.00	1.46
(2000–01 to 2009–10)	CV	7.80	10.60	11.02	10.23	17.10
Period-II	CGR	17.29	2.88	-0.12	1.40	1.84
(2010–11 to 2018–19)	CV	9.62	18.75	11.04	11.84	8.63
Period-III	CGR	4.59	0.62	1.67	0.13	2.55
(2000–01 to 2018–19)	CV	26.40	15.48	13.69	13.05	12.90

Note: CV is value of CVDI in percentage.

cultivars, increase in crop coverage in rice fallow areas and incentivising farmers for use of latest technologies under NFSM, RKVY and BGREI programs and state programs.

Trends in imports and exports of lentil in India: India's lentil import trends is presented in Supplementary Fig 1. During the 1970s and 1980s, import of pulses in India was restricted in order to protect the interest of domestic cultivators by imposing trade barriers such as quotas, tariffs and quantitative restrictions. But since, 1990s import duties declined steadily due to overall policy of trade liberalization of Government of India. From 2007–12, imports of pulses were made duty free and in 2013 the custom's duty on import of pulses was reduced to zero. The huge shortage of pulses in India in the wake of rising demand and adoption of a more liberal approach to international trade led to a rise in the volume of import of pulses in last two decade (Joshi *et al.* 2017).

The export of lentil to total global export was highest (20.04 %) in 2005 and after that, it was less than 1% during last decade (2007–17) due to ban of exports from India (Supplementary Fig 1). Barring the year 2016, the export was in very small quantity as domestic demand was covered from production and even lentil was imported in large quantity to meet ever rising domestic demand. The lentil was mainly exported from India to Bangladesh, Pakistan, Sri Lanka, United Kingdom and gulf countries where Indian lentil is preferred for consumption.

Strategies followed by the government to increase pulses production: For enhancing production and productivity of pulses government of India came out with specific schemes time to time, these are discussed below (Reddy and Reddy 2010, AICRP 2019).

1. Pulses Development Scheme: It was commenced from the 4th Plan (1969–74) with objective to promote production technologies and improved varieties at farmers' field.
2. National Pulses Development Project (NPDP): It was launched in 1985–86 (7th Plan) but joined with Technology Mission on Oilseeds (TMO) in 1990.
3. Special Food Grain Production Programme (SFPP): It was implemented during 1988–89 to supplement NPDP on 100% funding from Govt. of India.
4. Integrated Scheme of Oilseeds, Pulses, Oil palm and Maize (ISOPOM): It was launched in 2004 (10th Plan) by merging NPDP and TMO with major emphasis on seed production, distribution and adoption of improved technologies, timely supply of necessary inputs, extension support, strengthening the market inventions, effective pricing policies and post-harvest technologies for increasing pulses production in mission approach. The integrated research and extension efforts which aimed at better utilisation of fallow areas have been successful and area under lentil has increased significantly in rice fallows of eastern India.

5. National Food Security Mission (NFSM): Considering the importance of pulses in food security, NFSM was propelled in 2007–08 (11th Plan) to enhance the production of fine cereals (rice, wheat) and pulses by 18 and 2 MT, respectively, by the end of year 2011–12. The key objective was to increase production of pulses through area expansion and productivity enhancement in 468 districts of 16 states. During 12th Plan, it was extended to 638 districts of 29 states in India with additional production target of 4.0 MT by the end of 12th Plan (2016–17). The basic strategies were implementation of interventions in a mission mode through active engagement of all the stakeholders at various levels. The interventions included promotion and extension of improved technologies i.e. seed, integrated nutrient management—INM (biofertilizers, micronutrients, soil amendments), IPM (light trap, pheromone trap, bio pesticides) and resource conservation technology (laser land leveller), planting, harvesting and threshing machines, efficient water application technologies (sprinkler, rain gun, water carrying pipes) along with capacity building of farmers. The mission achieved success in getting additional production of 2.89 MT by 2011–12 over 2006–07 and an additional production of 6.04 MT by end of 2016–17 through effective implementation and concrete efforts made by field functionaries of implementing stakeholders. NFSM is to be continued till 2019–20 in all 29 states with increased amount of incentives for various interventions for increasing pulses production in India.

Besides, Accelerated Crop Production Programme (ACPP) was initiated to take up demonstration of production and protection technologies in a cropping system-based mode in large blocks of crop area. The minimum support price (MSP) of lentil increased to ₹4800 for the year 2019–20 indicated an increase of 20% over price in 2016–17 (₹4000) and procurement arrangement made to ensure at least MSP to cultivators for sustainable cultivation of lentil.

Policy implications: The trend analysis postulates the increasing production of lentil in Asia, African and American regions and across the nations by intensifying area and enhanced yield. Asia alone contributed more than half of area and two-fifth of production of lentil globally. India is a leading nation backed by one-third of total global planted area and production of lentil. In India, it is primarily cultivated in Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh and West Bengal sharing more than 90% of lentil production. All states except Uttar Pradesh and Bihar showed positive signs of growth rates of acreage and production in last two decades due to wide adaptation of short duration and biotic stress tolerant varieties. The large instability in lentil production was detected predominantly in Madhya Pradesh, West Bengal and Rajasthan owing to large variation in area and yield as it is cultivated as rainfed crop or in residual moisture in rice fallow areas. Canada, the leading producer and exporter of red lentil alone shared 61.57% of total lentil export in the world in TE 2017. India alone constituted 29.75% of total lentil global import along with one-fourth (25.71%) of total lentil import worth from Australia, Canada, USA, Myanmar etc.

The options for increase in lentil area in rice fallow areas in eastern Uttar Pradesh, Bihar and West Bengal should be explored. The mounting demand of lentil in India can be met by both increasing domestic production and also following appropriate trade policy. To sustain lentil production in India, several steps like inclusion of lentil in the targeted public distribution system (TDPS), mid-day meal (MDM) program, supplementary nutrition program (SNP) program designed to address nutrient deficiency, implementation of price deficiency payment system, creation of buffer stock to meet contingent condition and price control, provision of insurance cover to all lentil growers at minimal premium, benefit cultivars through post-harvest management practices and value addition at production point and formation of farmer-producer organisations (FPOs) should be instigated. Further, quality seed production through seed village program for faster adoption and better accessibility, motivation for use of biofertilizers, biocontrol agents and IPM module to lessen cost of production and to improve yield should be prompted in major lentil growing areas.

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