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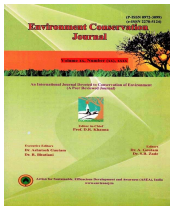

# Growth trends of lac production during XII plan *vis-a-vis* XI plan period in Chhattisgarh, India

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**ABSTRACT**

**The study is based on secondary data on lac production during the XI (2007-08 to 2011-12) and XII plans (2012-13 to 2016-17). Some econometric parameters, viz. Minimum, maximum, mean production, growth rate, percentage changes in mean during the XII plan over the XI plan period, and instability were rated. The state of Chhattisgarh, which contributed 30.21 per cent of national production during the XI plan period, decreased during the XII plan to 16.03%. During the XII plan, there is a 39.49 per cent reduction in the mean value. The negative growth rate recorded during the XI plan of 25.17 per cent decreased to 4.32 per cent during XII plan. The district-related percentage change in the mean from the XI to the XII plan showed that only the Bastar district recorded an increase of 39.18 per cent. The mean value decreased in the rest of the districts. Highest decline was recorded in Rajnandgaon (-72.23 %) followed by Raipur (-57.06%), Korba (-46.55%), Dhamtari (-41.97%), Bilaspur (-40.06%), Bastar (-39.18%), Durg (-34.05%), Kanker (-28.89 %), Janjgir-Champa (-22.44 %), Mahasamund (-17.61%), and Surguja district (-7.65%). In respect of instability in production during the XII plan, only Bastar and Janjgir districts recorded lower instability than states record of 14.85 per cent. Crop wise lac production data for different lac growing districts were also analyzed to assess major suffered districts during XI and XII plan periods in Chhattisgarh.**

## Introduction

Lac resin, the only one of its kind from the animal kingdom, is an example of such a well-exploited system. The lac insect's resinous protective layer is employed for human benefit in the form of paint, varnish, cosmetics, and nutraceuticals, among other things. Few insects, such as the lac insect (*Kerria lacca*), spend their entire lives on a specific host plant. Being sap-sucking insects, they cause minimal direct tissue destruction by using a specialized mouth part, the stylet, to drain sap from the phloem sieve elements of the plant vascular tissue. Though massive infestations of the lac insect can create a chronic lack of photosynthetic energy and severely limit the host plant's development potential, a well-managed population can be used to produce natural goods without harming the host plant. Lac insects, as well as lac-host plants, influence the quantity and quality of the lac produced. Also, there is a high degree of variability in resin producing efficiency of lac insects as well as of host plants which can be exploited for selection/evolution of high yielding varieties. With better management of lac insects and the host plants, the quantity and quality of the lac can be significantly improved. Lac is a key source of income for forest and sub-forest people (Jaiswal *et al.*, 2006). Recently the impact of scientific lac cultivation on lac production in India has been

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reported by Jaiswal *et al* (2020). The potential demand for lac is known about its use in various industries. The principal lac host plants in India include *Schleichera oleosa, Ziziphus mauritiana,* and *Butea monosperma.* Of the two types of lac, *S. oleosa* is most suited for *kusmi* lac while *B. monosperma* for *rangeeni* lac. *Z. mauritiana* is suitable for both *rangeeni* and *kusmi* lac but only during a specific season. They are exploited for their commercial products, such as resin, dye, and wax, and their use in a variety of sectors, including food, pharmaceuticals, cosmetics, paints, and varnishes (Mohansundaram *et al.* 2022). Due to economic value, the forest dwellers protect these trees for their sustainable livelihood. There are two crop cycles in a year from each lac insect strain, *Rangeeni* summer crop starts in October-November and mature in June-July, covering eight months' period. *Rangeeni* rainy crop starts in June-July and matures in October-November, covering four months only. Similarly, *kusmi* summer crop starts in January- February and the crop mature in June-July. *Kusmi* winter crop starts in June- July and mature in January-February. Several studies have been carried out on growth analysis of lac production during past years (Jaiswal *et al.*, 2011a, b, 2012, Jaiswal and Singh, 2014d). Besides this, lac crop production estimates were also made through correlation and regression studies. Chhattisgarh state remained forest-rich and known for its substantial minor forest produce. Production of lac is also one of the important livelihood activities mainly by forest dwellers. The potential and performance assessment of different districts in respect of lac production will help develop a strategy to enhance livelihood opportunities in the state. Considering this in view, crop-wise and district wise secondary data on lac production have been analyzed for XI and XII plan period and assessed the trend.

## Material and Methods

Secondary lac production data for the years 2007-08 to 2011-12 and 2012-13 to 2016-17 were gathered from published sources such as the Annual Lac Bulletin, Directorate of Lac Development, Ranchi; Lac Bulletin, Indian Lac Research Institute, Ranchi (Pal *et al.*, 2006, 2007, 2008, 2009, 2010a, 2010b, 2011); and various issues of "Lac, Plant, Resins and Gums Statistics: At a Glance" (Pal *et al.*, 2012, 2013; Yogi *et al.*, 2014, 2015, 2017, 2018, 2020). Eleven major lac growing districts of Chhattisgarh state namely Bastar, Bilaspur, Dhamtari, Durg, Janjgir-Champa, Kanker, Koba, Mahasamund, Raipur, Rajnandgaon, Surguja and a few other districts categorized as others have been covered under the study. Minimum, maximum, mean values, growth rate (simple) and instability in lac production were considered as standard parameters for each district and crop-wise compound annual growth rate (CAGR) of lac production have been calculated as per the standard procedure. CAGR has been calculated by the adoption of procedure followed by Jaiswal *et al* (2020). The percentage change in mean value from XI plan to XII plan period was also calculated. The instability in production was calculated in terms of percentage by adopting the formula (Instability = (Standard deviation/mean) X 100).

## Results and Discussion

According to data, the average state production under the XII plan was 2971 tonnes per year. During these five years, the lowest annual production was 2336 tonnes and the highest was 3381 tonnes. The average production during the XI plan, was 4908 tonnes. It means that production fell by 39.49% compared to the XI plan. During XII plan period amongst different districts, the highest mean production was recorded in Korba district followed by Kanker, Bilaspur, Raipur, Bastar, and others. The state's average output is about 12% lower than the highest amount ever recorded. It means at least this much production can be achieved easily by some key interventions. Minimum production value indicated that this much production is ensured without much effort. As evident, Korba district alone contributes around 30.02 per cent of state lac production followed by Kanker (21.37%). Thereby about half of the state's lac production is from only these two districts. The other districts which contributed in a major way include Bilaspur (6.90%), Raipur (6.20%), Rajnandgaon (5.49%), Bastar (4.54%), Surguja (4.23%), Janjgir-Champa (4.07%), and others. The districts which increased their share in-state production during the XII plan include Bastar, Janjgir-Champa, Kanker, Mahasamund and Surguja. Districts that share almost the same quantity during the XII plan include Bilaspur, Dhamtari and Durg. Districts that reduced their

**Table 1. District wise mean (tons), per cent share and change in lac production during XII plan *vis-a-vis* XI plan periods in Chhattisgarh state**

| Districts | Plan period | Attributes | *Rangeeni* | | | *Kusmi* | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Summer | Rainy | Total | Summer | Winter | Total | |
| **Whole state** | **XI** | **Mean** | 1823 | 870 | 2694 | 1164 | 1050 | 2214 | 4908 |
| | **XII** | **Mean** | 736 | 560 | 1296 | 656 | 1019 | 1675 | 2971 |
| | **XII** | **% Share** | 25 | 19 | 44 | 22 | 34 | 56 | 100 |
| | **XI-XII** | **% Change** | -60 | -36 | -52 | -44 | -3 | -24 | -39 |
| **Bastar** | **XI** | **Mean** | 7 | 5 | 13 | 45 | 39 | 84 | 97 |
| | **XII** | **Mean** | 19 | 11 | 30 | 33 | 72 | 105 | 135 |
| | **XII** | **% Share** | 14.07 | 8.15 | 22.22 | 24.44 | 53.33 | 77.78 | 100 |
| | **XI-XII** | **% Change** | 157 | 112 | 138 | -27 | 85 | 25 | 40 |
| **Bilaspur** | **XI** | **Mean** | 199 | 91 | 290 | 25 | 27 | 52 | 342 |
| | **XII** | **Mean** | 20 | 12 | 32 | 5 | 16 | 18 | 48 |
| | **XII** | **% Share** | 41.67 | 25.00 | 66.67 | 10.42 | 33.33 | 37.50 | 100 |
| | **XI-XII** | **% Change** | -90 | -87 | -89 | -80 | -41 | -65 | -86 |
| **Dhamtari** | **XI** | **Mean** | 40 | 25 | 65 | 58 | 50 | 108 | 173 |
| | **XII** | **Mean** | 40 | 24 | 64 | 37 | 38 | 75 | 139 |
| | **XII** | **% Share** | 28.67 | 17.29 | 45.97 | 26.66 | 27.38 | 54.03 | 100 |
| | **XI-XII** | **% Change** | -1 | -4 | -2 | -36 | -24 | -31 | -20 |
| **Durg** | **XI** | **Mean** | 23 | 14 | 37 | | | | |
| | **XII** | **Mean** | 13 | 11.4 | 24.4 | | | | |
| | **XII** | **% Share** | 53.28 | 46.72 | 100 | | | | |
| | **XI-XII** | **% Change** | -43 | -19 | -34 | | | | |
| **Jang-Champ** | **XI** | **Mean** | 62 | 26 | 88 | 40 | 28 | 68 | 156 |
| | **XII** | **Mean** | 49 | 17 | 66 | 21 | 34 | 55 | 121 |
| | **XII** | **% Share** | 40.50 | 14.05 | 54.55 | 17.36 | 28.10 | 45.45 | 100 |
| | **XI-XII** | **% Change** | -21 | -35 | -25 | -48 | 21 | -19 | -22 |
| **Kanker** | **XI** | **Mean** | 50 | 53 | 103 | 410 | 380 | 790 | 893 |
| | **XII** | **Mean** | 40 | 52 | 92 | 235 | 308 | 543 | 635 |
| | **XII** | **% Share** | 6.30 | 8.19 | 14.49 | 37.01 | 48.50 | 85.51 | 100 |
| | **XI-XII** | **% Change** | -20 | -2 | -11 | -43 | -19 | -31 | -29 |
| **Korba** | **XI** | **Mean** | 830 | 347 | 1177 | 265 | 195 | 460 | 1637 |
| | **XII** | **Mean** | 237 | 192 | 429 | 159 | 304 | 463 | 892 |
| | **XII** | **% Share** | 26.57 | 21.52 | 48.09 | 17.83 | 34.08 | 51.91 | 100 |
| | **XI-XII** | **% Change** | -71 | -45 | -64 | -40 | 56 | 1 | -46 |
| **Mahasamund** | **XI** | **Mean** | 70 | 39 | 109 | 13 | 12 | 19 | 108 |
| | **XII** | **Mean** | 40 | 51 | 91 | 8 | 11 | 19 | 110 |
| | **XII** | **% Share** | 36.23 | 46.20 | 82.43 | 7.43 | 10.14 | 17.57 | 100 |
| | **XI-XII** | **% Change** | -43 | 31 | -17 | -37 | -7 | 2 | 2 |
| **Raipur** | **XI** | **Mean** | 42 | 28 | 70 | 189 | 170 | 359 | 429 |
| | **XII** | **Mean** | 16 | 9 | 25 | 49 | 92 | 141 | 166 |
| | **XII** | **% Share** | 9.63 | 5.54 | 15.16 | 29.48 | 55.35 | 84.84 | 100 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **XI-XII** | **% Change** | -62 | -67 | -64 | -74 | -46 | -61 | -61 |
| **Rajnandgaon** | **XI** | **Mean** | 296.00 | 156.00 | 452.00 | 74.00 | 61.00 | 135.00 | 587 |
| | **XII** | **Mean** | 72 | 44 | 116 | 17 | 30 | 47 | 163 |
| | **XII** | **% Share** | 44.17 | 26.99 | 71.17 | 10.43 | 18.40 | 28.83 | 100 |
| | **XI-XII** | **% Change** | -76 | -72 | -74 | -77 | -51 | -65 | -72 |
| **Surguja** | **XI** | **Mean** | 88 | 40 | 128 | | | | |
| | **XII** | **Mean** | 82 | 44 | 126 | | | | |
| | **XII** | **% Share** | 65.02 | 34.98 | 100 | | | | |
| | **XI-XII** | **% Change** | -7 | 10 | -2 | | | | |
| **Others** | **XI** | **Mean** | 110 | 44 | 154 | 45 | 56 | 101 | 255 |
| | **XII** | **Mean** | 68 | 58 | 126 | 39 | 62 | 101 | 227 |
| | **XII** | **% Share** | 29.90 | 25.51 | 55.41 | 17.33 | 27.26 | 44.59 | 100 |
| | **XI-XII** | **% Change** | -38 | 32 | -18 | -12 | 11 | 0 | -11 |

share during the XII plan in the states total production include Korba, Raipur and Rajnandgaon. A comparison of annual average production of both plan periods indicated a sharp decline in all districts studied except in Bastar which registered a 39.18 per cent increase. The highest decline was observed in Rajnandgaon (-72.23%) followed by Raipur (-57.06%), Korba (-6.55%), Dhamtari (-41.97%), Bilaspur (-40.06%), Durg (-34.05%), Kanker (-28.89%), Janjgir-Champa (- 22.44%) and Mahasamund (-17.61%). The state as a whole produced around 44 per cent *rangeeni* and 56 per cent *kusmi* lac. Surguja and Durg districts may be considered as purely *rangeeni* crop growing districts while other districts produced both *rangeeni* and *kusmi* both lac. Bilaspur, Janjgir-Champa, Mahasamund and Rajnandgaon are the districts where the share of *rangeeni* lac is more than half and thus may be considered as *rangeeni* dominant districts. (Table1). The state recorded 14.85 per cent instability in production during the XII plan. Only Bastar (8.67%) and Janjgir-Champa (7.94%) districts registered lower instability than the state average. The rest of the districts registered higher instability. Durg district recorded the highest (43.32%) instability in production followed by Mahasamund (32.61%), Raipur (29.42%), Surguja (24.39%) Dhamtari (24.26%), Kanker (21.15%), Bilaspur (19.95%), Rajnandgaon (19.83%) and Korba (16.93%). The state registered negative growth of 4.32 per cent per annum in lac production during the XII plan. Both of the major lac producing districts, Korba and Kanker, saw negative growth of 6.57 and 9.42 percent per year, respectively during XII plan. These negative growths impacted a substantial downfall in overall production in the late years of the XII plan. During XII plan Dhamtari is the only district that registered a positive growth of 19.74 per cent per annum. The growth rate in Janjgir-Champa remained more or less stable (0.43%). The highest negative growth was recorded in Kanker district followed by Korba, Mahasamund, Rajnandgaon, Raipur, Durg, Bilaspur, Surguja and Bastar. The districts which registered a higher negative growth rate than the state (-4.32%) during the XII plan include Kanker, Korba, Mahasamund and Rajnandgaon. Overall, the declining trend in the state lac production which was very fast during the XI plan (-25.17% per annum) slowed down during the XII plan (-4.32% per annum). The same pattern of improvement was recorded in all districts except in Bastar where, a more or less stable figure registered during the XI plan, showed a declining trend during the XII plan (Table 2.). Summer and winter crop of *rangeeni* contributes 25 and 19 per cent of total lac produced in the state. All districts except Dhamtari showed a negative growth rate for *rangeeni* lac production during the XII plan. The highest negative growth rate for *rangeeni* lac was recorded in Raipur district followed by Mahasamund, Korba, Rajnandgaon, Bilaspur, Kanker, Durg, Janjgir-Champa, Surguja and Bastar district. Raipur, Mahasamund, Korba, Rajnandgaon, Bilaspur and Kanker showed higher

**Table 2. Compound annual growth rate % for lac production during XII plan *vis-a-vis* XI plan periods in Chhattisgarh State**

| Districts | Plan period | *Rangeeni* | | | *Kusmi* | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | Summer | Rainy | Total | Summer | Winter | Total | |
| **Whole State** | **XI** | -32.51 | -30.71 | -31.91 | -15.91 | -18.54 | -16.92 | -25.17 |
| | **XII** | -6.33 | 0.62 | -3.43 | -9.53 | -2.56 | -5.56 | -4.32 |
| **Bastar** | **XI** | 44.61 | 34.93 | 40.51 | -2.09 | -9.13 | -5.60 | -0.61 |
| | **XII** | 0.77 | -3.97 | -0.69 | -8.90 | 2.92 | -1.89 | -1.16 |
| **Bilaspur** | **XI** | -32.65 | -33.60 | -34.02 | -21.08 | 1.71 | -8.50 | -29.92 |
| | **XII** | -12.74 | 6.49 | -4.58 | 2.26 | -0.80 | 0.20 | -2.84 |
| **Dhamtari** | **XI** | -18.77 | -38.30 | -26.82 | -27.23 | -50.79 | -37.66 | -33.40 |
| | **XII** | 28.97 | 17.46 | 24.39 | 22.32 | 17.79 | 17.01 | 19.74 |
| **Durg** | **XI** | -20.57 | -32.10 | -25.49 | - | - | - | -25.49 |
| | **XII** | -9.34 | 4.14 | -3.04 | - | - | - | -3.04 |
| **Janjg.-Champa** | **XI** | -12.59 | -27.14 | -17.46 | -12.27 | -13.96 | -13.15 | -15.63 |
| | **XII** | -4.59 | 5.92 | -2.10 | -11.34 | 16.65 | 4.10 | 0.43 |
| **Kanker** | **XI** | -24.03 | -16.40 | -19.77 | -14.87 | -21.62 | -17.98 | -18.38 |
| | **XII** | -5.71 | -4.29 | -4.26 | -10.93 | -10.29 | -10.59 | -9.42 |
| **Korba** | **XI** | -37.90 | -36.65 | -37.37 | -6.70 | -4.97 | -5.04 | -27.47 |
| | **XII** | -11.60 | -5.05 | -8.77 | -4.70 | -4.63 | -4.64 | -6.57 |
| **Mahasamund** | **XI** | -24.21 | -4.59 | -16.40 | -34.02 | -35.48 | -34.80 | -19.68 |
| | **XII** | -11.60 | -5.05 | -8.77 | -4.70 | -4.63 | -4.64 | -6.57 |
| **Raipur** | **XI** | -15.86 | -12.59 | -14.40 | -17.62 | -16.17 | -16.68 | -16.47 |
| | **XII** | -25.10 | -24.21 | -24.52 | 33.51 | -5.11 | 1.73 | -3.84 |
| **Rajnandgaon** | **XI** | -38.30 | -47.73 | -41.76 | -43.10 | -49.88 | -46.17 | -42.83 |
| | **XII** | -10.70 | -2.21 | -7.63 | -7.67 | 6.49 | 0.00 | -5.63 |
| **Surguja** | **XI** | -26.19 | -8.38 | -21.15 | - | - | - | -21.15 |
| | **XII** | 0.85 | -7.36 | -1.92 | - | - | - | -1.92 |
| **Others** | **XI** | -32.10 | -8.16 | -25.10 | -8.94 | -11.34 | -10.30 | -19.73 |
| | **XII** | 4.73 | 4.55 | 5.06 | -22.92 | -10.98 | -15.45 | -3.72 |

negative growth than state average during the XII plan. Dhamtari is the only district that registered negative growth of high magnitude (-26.82%) during the XI plan but showed positive growth to the tune of 24.39 per cent per annum during the XII plan. This positive growth rate was witnessed in both summer and rainy crops. Similarly, Raipur is the only district where the negative growth rate is higher during the XII plan than the XI plan periods and both summer, as well as rainy crop, was affected substantially. In all other districts, the negative growth rate for *rangeeni* lac production is lower than the XI plan period, indicating improvement in terms of growth rate.The highest positive growth rate for *kusmi* lac production during the XII plan was recorded in the Dhamatari district followed by Janjgir-Champa and Raipur. But highest negative growth was recorded in Kanker district followed by Korba, Mahasamund and Bastar district. More or less stable production was recorded in Bilaspur and Rajnandgaon districts. Districts that registered negative growth rate during the XI plan but showed positive growth rate during the XII plan include Bilaspur, Dhamtari, Janjgir-Champa and Raipur. In all other districts, the negative growth rate is lower during the XII plan when compared to the XI plan. A comparison of data on the mean value for the XI and XII plan indicated that there is a 39 per cent reduction in lac production during the XII plan. The reduction in the mean value for *kusmi* and *rangeeni* was to the tune of 24 and 52 per cent respectively. Summer crop of *rangeeni* (-60%) and *kusmi* (-44%) both declined substantially in comparison to *rangeeni* rainy (-36

%) and *kusmi* winter crop (-3%). Districts that registered substantial decline (>state figure of -52%) in the mean value of *rangeeni* lac production during XII plan include Bilaspur, Korba, Raipur and Rajnandgaon. Dhamtari, Durg, Janjgir-Champa, Kanker, Mahasamund, Surguja registered a lower per cent decline than the state's average. However, there is a substantial increase of 138% in *rangeeni* lac production during the XII plan vis-à-vis XI plan. In respect of *kusmi* lac, Bastar, Bilaspur, Dhamtari, Kanker, Raipur and Rajnandgaon registered higher decline than the state mean value (-24 %) during XII plan but other districts which recorded lower decline include Janjgir-Champa, Korba, and Mahasamund. In respect of *rangeeni*-summer crop, districts which record higher decline, in comparison to the rainy crop during XII plan include Bilaspur, Korba, Rajnandgaon and Mahasamund. This indicated possibility of high-temperature mortality in these districts. Saha and Jaiswal (1993a) evaluated lac production growth and instability and found a negative growth rate of 3.6 percent over a period of 30 years (1960-1961 to1989-1990). Jaiswal and Saha (1998) performed a decade-by-decade growth analysis of lac output over a 65 years' period and found that growth rates were negative except in the thirties, fifties, and nineties, with the highest growth rates in the sixties. Jaiswal *et al.* (2022) and Kumar *et al.* (2022) evaluated the growth analysis of lac production in Odisha and West Bengal and showed its changed pattern in these states of India. Jaiswal *et al.* (1999) found that the increase rate of lac production does not equal domestic consumption in all states except in Madhya Pradesh. Aside from farmer interest and the quantity of host trees used, lac output is also influenced by scientific methods, as well as abiotic and biotic variables present during the crop development stage. The contribution of rainy season *rangeeni* lac to total *rangeeni* lac is roughly 35%, and the crop's output is mostly in the form of broodlac (seed) collected in October-November, but scraped lac reaches the market in December. The dramatic drop in *rangeeni* rainy season yield compared to summer crop reflects the need for better management practises, since the crop is vulnerable to heavy rain during larval emergence in July, as well as pest and disease incidence. It was also recorded that in many parts of Chhattisgarh, trees located on borders of paddy field is harvested after paddy harvesting in order to avoid losses of paddy crop due to felling of branches in the form of broodlac. A comparison of per cent change in mean value between *kusmi* summer and *kusmi* winter crop indicated increased mean values for *kusmi* winter crop in Baster, Janjgir-Champa and Korba districts only. In other districts decline in mean value is for both *kusmi* winter and summer crops. However, in respect of *kusmi* summer lac crop, districts that recorded a higher rate of decline, in comparison to winter crops during the XII plan include Bilaspur, Dhamtari, Kanker, Raipur and Rajnandgaon (Table 1). The lac crop is vulnerable to weather condition as it is produced by living lac insect. Dry weather during summer crop and high humidity for prolonged period during rainy season resulted mortality of insect resulting decreased yield. The production is also affected if inoculation of lac crop is done with relatively less quantity of broodlac. It normally happened when there is shortage of broodlac due to one or other reasons especially high price during inoculation period (Bhattacharya *et al.*, 2016). The declining per cent in mean values and negative growth rate is a serious issue and needs to be addressed quickly, as also this is one of the important sources of livelihood especially for forest dwellers in the state.

## Conclusion

Lac farming should be promoted by the government and other line departments for better livelihood and to prevent deforestation. The possibility should be also explored for loans and subsidies on the line of agriculture so that sustainable lac production is achieved by the state. Action may also be initiated for intensive farming of lac by planting trees on the line of sericulture. Besides this, border planting of *Ziziphus mauritiana* on paddy fields is also suggested, which will increase *kusmi* broodlac production and ultimately enhance the availability of *kusmi* broodlac for inoculation of more trees of *Schleichera oleosa* during the summer season. Loans and subsidies for lac producers on the agricultural line, as well as the implementation of scientific lac cultivation methods, will help to boost production, productivity, and employment opportunities in forest and sub-forest areas.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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