



Growth and Stability Analysis of Lac Production in Madhya Pradesh, India

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ABSTRACT

Lac is produced in different districts of Madhya Pradesh (MP), covering ten out of its eleven agro-climatic zones. This paper investigated the prospects of stakeholders from an assessment of the potential and performance of the state's primary lac producing districts in Madhya Pradesh, India. Based on secondary data of lac production during Plans XI (2007-08 to 2011-12) and XII (2012-13 to 2016-17), data was evaluated crop by crop and district by district, and the trend was examined. Econometric measures, such as mean production, growth rate, and percent changes in mean value, were analyzed. Madhya Pradesh state that has contributed 13.66 per cent share during the XI plan has come down to 12.91 per cent during the XII plan. The state which recorded a negative growth rate to the extent of 30.15 per cent during the XI plan, reduced to 3.20 per cent during the XII plan. Chhindwara, Dindori and Mandla are the districts, which recorded decline growth during the XI plan but witnessed positive during the XII plan period. Data on crop-specific lac production were evaluated to determine less performing crops during these periods in the state. The state may initiate proper strategies to cope up with issues and problems of less performing districts.

INTRODUCTION

India is the world's largest supplier of Non-Wood Forest Products (NWFPs) based raw materials for the food, paint, cosmetic, varnish, and pharmaceutical industries. In India, there are approximately 621.4 million lac host trees, but only about 5 per cent of this vast inoculated land is used for production. Using the maximum capacity of existing host plants for lac cultivation with recommended technology could be a good method for reducing migration and increasing local job opportunities. As a result, the income level and, the standard of living of tribal farmers may improve (Gupta et al., 2018). Madhya Pradesh is the second largest state in India. The forest cover of the state is around 28.3 per cent. In addition to preserving ecological balance, lac is one of the important forest products of commercial value that is a vital

source of income for those who live in forests and subforests areas (Claude & Ou Bingrong, 1994; Jaiswal et al., 2006; Singh et al., 2018). *Schleichera oleosa*, *Ziziphus mauritiana*, *Butea monosperma* are the major lac host species in India (Kumar et al., 2017). *S. oleosa* is best suitable for *kusmi* lac, whereas *B. monosperma* is best suited for *rangeeni* lac, among the two forms of lac. Both *rangeeni* and *kusmi* lac are acceptable for *Z. mauritiana*, but only in a particular season. They are exploited for their usage in a number of industries, such as food, pharmaceuticals, cosmetics, paints, and varnishes, as well as their commercial products, such as resin, dye, and wax (Mohansundaram et al., 2022).

Each lac insect strain has two crop cycles every year. The eight-month summer harvest of *Rangeeni* begins in October or November and matures in June or July. Only four months are covered by the *rangeeni* rainy crop, which begins in June or July

and matures in October or November. *Rangeeni ari* (pre-mature) lac crop is the commercial crop for *rangeeni* lac and harvested in May-June. Similarly, the *kusmi* summer crops begins in January or February and matures in June or July. Beginning in June or July, the *kusmi* winter crop matures in January or February. Several studies have been conducted in the last years on the growth analysis of lac production (Saha & Jaiswal, 1993; Jaiswal & Saha, 1998; Jaiswal et al., 2011a, b, 2012; Jaiswal & Singh, 2014). Estimates of the lac crop productivity were also made using correlation and regression analyses (Jaiswal & Saha, 1993). Recently, a district and crop-wise lac production growth study was also carried out during the XI and XII plan periods for the state of Jharkhand, West Bengal, Odisha and Chhattisgarh, India (Kumar et al., 2022 a,b; Jaiswal et al., 2022 a,b). A strategy to improve livelihood prospects in the state may developed with the aid of an evaluation of the potential and performance of various districts for lac production. With this in mind, secondary annual data on lac output during the XI and XII plan have been analysed crop- and district-wise to assess the performance of various lac-growing areas.

METHODOLOGY

The district-wise and crop-wise secondary data on lac production, for Madhya Pradesh have been collected from published reports namely "Lac Bulletin", Indian Lac Research Institute, Ranchi and various issues of "Lac, Plant Resins and Gums Statistics: At a glance" for the period 2007-08 to 2011-12 and 2012-13 to 2016-17.

The study has focused on eight major lac-growing districts of the state of Madhya Pradesh and a few other districts categorized as others have been covered under this study. The minimum, maximum, mean values, and the volatility of lac production and crop-wise Lac production's compound annual growth rate (CAGR) has been computed using the standard methodology. The Annual Compound Growth Rate (ACGR) was worked out by fitting the exponential function given below:

$Y = ab^t$ {Y = the dependent variable (export), a = Constant term, b = Regression

Co-efficient, t = Time variable in years}.

The equation is rewritten in the logarithmic form as follows:

$\log Y_t = \log a + t \log b$ {where, Y_t = export of jth commodity in the year, ACGR in % (r) = (Antilog of log b-1) x 100 Where, r = Compound growth rate per annum (%)}

The percentage change in mean value from the XI plan to the XII plan was indicated by Jaiswal et al., (2020). In time series data with long-term trends, the coefficient of variation (CV) frequently includes the trend component and overestimates the degree of instability. The instability (Coefficient of variation) in lac production was computed as the ratio of Standard deviation and the mean for the same duration (Donnahoe, 1988). Instability or Coefficient of variation = (Standard deviation/mean) X 100).

To overcome this problem, the instability index given by Cuddy & Dell (1978) was applied which corrects the coefficient of variation. The instability index was estimated by using the equation given below:

Instability index = $CV \cdot \sqrt{1-R^2}$ {Where, CV = Co-efficient of variation, R^2 = Coefficient determination of the trend equation}

Trend equation (linear) is given as

$Y = a+bt$ {wherein Y = NRGs export, b = Regression coefficient and t = Time}

RESULTS AND DISCUSSION

A perusal of data indicated that during the XII plan, the average production in the state was 2421 tons per annum. The minimum production was 2222 tons and the maximum 2586 tons per annum during these five years. During the XI plan, the average production was 2220 tons. It means the average production increased to 9.04 per cent in the XII plan over the XI plan. Seoni, Balaghat, Mandla, Dindori, Hoshangabad, Chhindwara, Narsinghpur and Anoopur-Sahadol were the districts with the greatest mean production, respectively.

The state's average production is almost 6.81 per cent less than the highest ever recorded (2586 tons). Approximately 43.73 per cent of the state's lac production is produced in Seoni district alone, followed by Balaghat (34.9%). Thus, only these two districts account for nearly 79 per cent of the state's lac production. Additionally important districts included Mandla (5.50%), Dindori (3.68%), Hoshangabad (2.02%), Chhindwara (1.54%), Narsinghpur (1.03%) and others. The districts that saw an increase in their share of state production under the XII plan included Balaghat, Dindori, Seoni and other marginal lac-producing areas. Anoopur-Sahadol, Hoshangabad and Mandla are among the districts that witnessed a reduction in their contribution to the state's overall production during the XII plan. *Rangeeni* Lac's mean value climbed by 41.06 per cent over the XII plan, whilst *Kusmi*'s mean value declined by 64.7 per cent. The production of summer crops increased significantly (35.04%), which accounts for the percentage increase in *rangeeni* crop. Both the summer and winter crops of the *kusmi* crop significantly shrank. Chhindwara, Dindori, Mandla and Narsinghpur are some of the districts where the mean *rangeeni* lac changed more than the state average. The only district where *rangeeni* lac mean production fell under the XII plan was Anoopur-Sahadol. All other districts recorded increased production. The highest was in Dindori followed by Chhindwara, Narsinghpur, Mandla, Barghat, Hosangabad and Seoni districts. In respect of *kusmi* lac, Dindori, Chhindwara, Hoshangabad and Mandla recorded a higher decline than the state mean value (-64.7%) but other districts which recorded increased production include Balaghat and Seoni (Table 1).

The state is predominantly *rangeeni* lac producing state. Out of total lac produced, around 95.26 per cent is *rangeeni* and the rest 4.74 per cent *kusmi*. Balaghat and Seoni both are predominantly *rangeeni* lac producing districts. From *rangeeni*, the summer season crop is the main commercial crop constituting around 72 per cent of the total lac produced in the state. Summer and winter crop of *kusmi* contributes only 2.36 and 2.38 per cent, respectively, of the total lac produced (Table 1).

The state recorded only 6.69 per cent instability in lac production during the XII plan but 55.86 per cent during the XI plan period. The same trend of lower instability was observed

Table 1. Lac production attributes (tons), percent share and change in lac production during XI and XII plan periods in Madhya Pradesh state

Districts	Plan period	Attributes	<i>Rangeeni</i>			<i>Kusmi</i>			Grand Total
			Summer	Rainy	Total	Summer	Winter	Total	
Whole State	XI	Minimum	313	205	528	90	64	157	685
		Maximum	2095	1040	3010	437	308	745	3755
		Mean	1291	574	1635	198	157	325	2220
	XII	Minimum	1143	413	2095	45	43	101	2222
		Maximum	2005	1010	2485	69	71	127	2586
		Mean	1744	562	2306	57	58	115	2421
			% Share	72.03	23.23	95.26	2.36	2.38	4.74
	XI-XII	% change	35.04	-1.99	41.06	-71.17	-63.27	-64.72	9.04
Anooppur-Sahadol	XI	Minimum	5	5	10	2	1	4	15
		Maximum	15	10	20	5	5	10	30
		Mean	10	8	14	4	3	6	20
	XII	Minimum	2	0	7	2	1	4	10
		Maximum	10	8	18	5	5	10	22
		Mean	6	4	7	3	2	3	15
			% Share	41.56	25.97	67.53	22.08	10.39	37.47
	XI-XII	% Change	-33.33	-44.74	-48.57	-5.56	-35.71	-39.29	-19.39
Balaghat	XI	Minimum	120	90	210	0	0	0	217
		Maximum	900	800	1400	5	5	10	1400
		Mean	364	348	620	4	3	5	625
	XII	Minimum	400	150	730	5	2	10	741
		Maximum	720	390	790	10	5	12	890
		Mean	622	204	826	7	4	11	837
			% Share	74.31	24.37	98.69	0.88	0.43	1.31
	XI-XII	% Change	70.88	-41.38	33.23	85.00	28.57	129.17	33.96
Chhindwara	XI	Minimum	3	2	5	5	5	10	15
		Maximum	10	10	20	80	40	120	140
		Mean	8	6	12	33	25	54	66
	XII	Minimum	10	5	15	5	2	10	25
		Maximum	20	20	35	10	8	14	47
		Mean	14	10	24	7	5	12	37
			% Share	38.04	28.26	66.30	20.11	13.59	33.70
	XI-XII	% Change	84.21	62.50	103.33	-77.58	-80.00	-77.04	-44.24
Dindori	XI	Minimum	5	5	7	5	5	10	20
		Maximum	5	5	10	20	20	40	50
		Mean	5	4	7	12	12	22	29
	XII	Minimum	35	5	40	5	1	7	50
		Maximum	100	20	110	10	5	13	122
		Mean	67	10	36	7	3	6	88
			% Share	76.14	11.82	87.95	8.18	3.86	12.05
	XI-XII	% Change	1240.0	136.36	391.89	-40.00	-71.67	-72.73	199.32
Hoshangabad	XI	Minimum	10	5	15	50	15	45	60
		Maximum	30	20	50	120	80	200	250
		Mean	19	11	27	64	41	96	123
	XII	Minimum	10	5	20	5	1	7	33
		Maximum	45	25	60	15	10	20	67
		Mean	22	12	34	10	5	14	48
			% Share	45.64	24.90	70.54	19.92	9.54	29.46
	XI-XII	% Change	15.79	9.09	25.93	-85.00	-88.78	-85.21	-60.81
Mandla	XI	Minimum	20	15	35	5	10	15	50
		Maximum	100	40	140	80	80	160	300
		Mean	48	28	64	28	29	53	117
	XII	Minimum	50	35	85	2	5	10	100
		Maximum	100	60	160	6	20	25	185
		Mean	71	43	114	4.6	13	17.6	131.6
			% Share	53.95	32.67	86.63	3.50	9.88	13.37
	XI-XII	% Change	47.92	53.57	78.13	-83.57	-55.17	-66.79	12.48

Table 1 contd...

Districts	Plan period	Attributes	Rangeeni			Kusmi			Grand Total	
			Summer	Rainy	Total	Summer	Winter	Total		
Narsinghpur	XI	Minimum	5	3	8	2	3	5	13	
		Maximum	10	5	15	60	30	90	100	
		Mean	6.00	3.60	8.60	19.40	9.60	29.00	37.20	
	XII	Minimum	1	2	10	0	1	1	14	
		Maximum	20	20	23	2	5	7	30	
		Mean	6.25	4.5	10.75	24.25	12	36.25	46.5	
		% Share	13.44	9.68	23.12	52.15	25.81	77.96	100	
	XI-XII	% Change	53.33	94.44	88.37	-91.75	-75.0	-86.21	-45.70	
Seoni	XI	Minimum	125	60	210	5	5	10	225	
		Maximum	1300	300	1360	10	5	15	1375	
		Mean	795	140	838	8	5	10	848	
	XII	Minimum	440	140	850	5	5	15	865	
		Maximum	1000	410	5145	15	10	20	1185	
		Mean	816	213	1029	9	8	17	1046	
		% Share	78.01	20.36	98.37	0.86	0.76	1.63	100	
	XI-XII	% Change	2.64	52.14	22.79	12.50	60.00	70.00	23.35	
Others	XI	Minimum	35	5	25	5	5	10	35	
		Maximum	50	40	80	70	50	120	180	
		Mean	37	23	60	27	29	56	116	
	XII	Minimum	50	6	100	5	10	15	115	
		Maximum	125	65	185	10	20	30	207	
		Mean	88	47	135	7	16	23	159	
			% Share	55.49	29.76	85.25	4.67	10.09	14.75	100
		XI-XII	% Change	137.84	105.22	125.33	-72.59	-44.83	-58.21	36.72

with both *rangeeni* and *kusmi* lac as well as in both seasons at the state level. In general, all districts except Anoopur-Sahadol and Hoshangabad registered lower instability during the XII plan in comparison to the XI plan. A similar observation was made for *kusmi* lac in all districts except Anoopur-Sahadol. No definite trend of instability was observed for *rangeeni* lac production. During the XII plan, all districts recorded higher instability than the state figure and the highest was recorded in the Hoshangabad district followed by Dindori, Narsinghpur, Mandla, Chhindwara, Seoni and Balaghat. As far as instability for *kusmi* lac production is concerned during the XII plan, Balaghat is the only district which recorded lower instability than the state figure of 9.49 per cent. Similarly for *rangeeni* lac, all the districts showed higher instability than the state figure of 7.44 per cent during the XII plan (Table 2).

In terms of growth of lac production, the state saw negative growth of 3.20 per cent annually throughout the XII plan. Two main lac-producing districts, Balaghat and Seoni, respectively registered negative growth of 3.40 and 7.53 per cent during the XII Plan. Chhindwara, Dindori and Mandla are the only districts which registered a positive growth of 12.47, 23.77 and 17.06 per cent per annum respectively during the XII plan period. Though, three together contributed only 10.72 per cent of the state's total lac production. Other districts registered negative growth rates, including Anoopur-Sahadol, Hoshangabad and Narsinghpur. Hoshangabad is the only district which reported a lower negative growth rate than the state average of (-)3.20 per cent per annum. Districts with negative growth during the XI plan period but

positive growth during the XII plan period include Chhindwara, Dindori, and Mandla. Overall, the XII plan saw a slowing of the state lac production's downward trajectory, which had been particularly rapid during the XI plan (-) 30.15 per cent per annum. The improvement trend followed the same course in every district that produces lac (Table 3).

With the exception of Chhindwara, Dindori and Mandla, every lac-growing district had a decline in *rangeeni* lac production under the XII plan. *Rangeeni* lac experienced the largest decline growth rate (-14.21%) in the Anoopur-Sahadol district, followed by Seoni, Narsinghpur, and Balaghat. Dindori had the highest *rangeeni* lac growth, followed by Mandla and Chhindwara. The comparison of growth rate in *rangeeni* lac production between XI and XII plans indicated substantial improvement during the XII plan in the state. For *rangeeni* lac, the state had a negative growth rate of 29.43 per cent in the XI plan, but it reduced to (-) 3.53 per cent in the XII plan. Only in the Anoopur-Sahadol district did the negative growth rate increase during the XII plan compared to the XI plan. The XII plan reverses the poor growth experienced in the districts of Chhindwara and Mandla. Only Narsinghpur has a decline in growth rate from the XI plan to the XII plan. Two major districts namely Balaghat and Seoni registered substantial negative growth during XI plan (-) 31.17 per cent and (-) 31.68 per cent, respectively, slowed down to (-) 3.50 and (-) 7.69 per cent per annum respectively.

In respect of *kusmi* lac, the state registered growth of 3.35 per cent per annum. During the XII plan, only Hoshangabad and Narsinghpur districts had negative growth. The remaining ones

Table 2. Instability in lac production during XII plan *vis-a-vis* XI plan in Madhya Pradesh state

Districts	Plan period	<i>Rangeeni</i>			<i>Kusmi</i>			Grand total
		Summer	Rainy	Total	Summer	Winter	Total	
Whole State	XI	60.27	67.80	61.94	75.13	64.99	76.70	55.86
	XII	20.73	44.91	7.44	18.57	18.40	9.49	6.69
Anooppur-Sahadol	XI	37.99	33.03	31.30	37.27	52.97	44.82	25.88
	XII	54.69	73.33	62.50	33.53	107.78	83.24	33.99
Balaghat	XI	89.75	87.19	75.44	42.59	62.36	62.91	64.78
	XII	21.95	51.37	7.78	33.92	41.94	9.09	7.65
Chhindwara	XI	44.23	54.80	54.33	95.59	66.33	86.27	73.26
	XII	29.86	55.48	32.87	26.35	42.40	12.26	23.40
Dindori	XI	0.00	30.49	18.13	63.19	63.19	68.94	46.17
	XII	39.70	55.48	82.12	30.14	52.94	38.33	33.75
Hoshangabad	XI	47.08	74.69	57.08	53.67	58.74	60.52	58.77
	XII	54.09	48.33	87.91	22.60	39.35	16.20	61.62
Mandla	XI	64.89	44.82	61.37	107.59	100.83	111.94	83.72
	XII	41.69	24.12	27.28	33.04	43.85	32.39	27.13
Narsinghpur	XI	37.27	30.43	33.30	130.73	119.09	126.11	97.97
	XII	77.17	105.71	34.57	68.13	62.92	57.50	31.68
Seoni	XI	66.20	67.24	65.09	34.23	0.00	27.39	64.12
	XII	28.54	52.63	14.78	46.44	34.13	16.06	14.52
Others	XI	29.61	58.74	34.86	102.77	73.55	84.33	49.09
	XII	32.78	50.21	26.92	33.78	26.25	27.78	22.76

Table 3. The compound annual growth rate for lac production during XII *vis-a-vis* XI plan in Madhya Pradesh

Districts	Plan period	<i>Rangeeni</i>			<i>Kusmi</i>			Grand total
		Summer	Rainy	Total	Summer	Winter	Total	
Whole State	XI	-32.09	-24.52	-29.43	-34.92	-34.53	-34.77	-30.15
	XII	-11.82	18.44	-3.53	12.45	-4.60	3.35	-3.20
Anooppur-Sahadol	XI	-10.77	-10.77	-10.77	3.05	-26.75	-10.77	-10.77
	XII	-27.52	-0.24	-14.21	10.31	0.00	7.62	-8.39
Balaghat	XI	-27.61	-29.48	-31.17	37.97	25.89	33.14	-30.74
	XII	-12.50	18.87	-3.50	18.80	-18.58	4.71	-3.40
Chhindwara	XI	-22.82	-25.89	-24.21	-47.59	-38.44	-43.90	-39.79
	XII	4.14	36.74	17.34	18.22	-20.57	2.95	12.47
Dindori	XI	0.00	0.00	0.00	-34.02	-34.02	-34.02	-24.03
	XII	26.15	36.74	28.14	14.87	-29.12	1.11	23.77
Hoshangabad	XI	-25.10	-34.02	-28.74	-26.72	-30.48	-28.12	-28.19
	XII	-22.92	47.88	0.00	6.49	-36.90	-7.36	-1.64
Mandla	XI	-26.66	-14.41	-22.29	-43.83	-39.80	-41.51	-30.23
	XII	22.48	9.90	17.74	11.61	14.87	13.12	17.06
Narsinghpur	XI	14.87	-4.98	6.05	-61.37	-44.06	-54.43	-36.66
	XII	-48.75	60.17	-3.58	-12.94	-27.52	-22.16	-6.43
Seoni	XI	-35.35	-17.65	-31.68	23.11	0.00	12.93	-30.95
	XII	-16.81	19.92	-7.69	23.11	-12.94	2.92	-7.53
Others	XI	-4.17	-8.16	-4.44	-44.96	-42.43	-43.90	-23.63
	XII	21.73	-33.99	5.22	10.84	11.61	11.36	6.45

growth. Mandla district (13.12%) had the highest growth rate, followed by Anooppur-Sahadol, Balaghat, Chhindwara, Seoni, and Dindori. During the XI plan, the state experienced negative growth totaling (-) 34.77 per cent, but after that, it saw growth totaling (-) 3.35 per cent year. Anooppur-Sahadol, Chhindwara, Dindori and Mandla are some of the districts whose growth rates were negative during the XI plan but turned positive during the XII plan. Although the rate of growth slowed down during the XII

plan, Balaghat and Seoni districts experienced growth rates during both plans (Table 3).

CONCLUSION

The study indicated that in Madhya Pradesh, the declining trend in lac production which was visible during the XI plan continued during the XII plan period also. But it slowed down during the XII plan period substantially. Seoni and Balaghat districts

are the two most potential area for *rangeeni* lac production and the bulk of production start reaching to market in April and May from trees of *B. monosperma* and *Z. mauritiana*. In many areas, both of these tree species also occur on the border of paddy fields and simultaneously pruned for inoculation of the next crop. Both districts showed considerable improvement during the XII plan in respect of increased mean value as well as a reduction in negative growth value in comparison to the XI plan. This model of lac cultivation on trees planted on borders of paddy fields may be replicated in other areas of the state.

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