



Dairy cooperatives in India: Trends of its coverage and determinants

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ABSTRACT

Dairy cooperatives is a promising rural producing organization which accounted for the milk revolution and improved livelihood of the rural population of India. However, its coverage has remain largely non-uniform across the nation. Hence, this paper studied its coverage over last two decades (1999-19) in different parts of India. Growth analysis, principal component analysis based index calculation and multiple regression analysis aids in studying the variation in cooperative coverage across zones and states, and its nature and degree of relation with other internal and external factors. The results showed that dairy cooperatives has increased over time in all the states of India, especially in eastern states. Nonetheless, the slow or negative growth in milk procurement and membership over time concludes that milk procurement by cooperatives has not commensurate with milk production, specifically in east zone. Conversely, the slow growth in membership and high growth in milk procurement per member points towards mounting dairy commercialization, especially in western and southern states of the country. The study also suggests agricultural promotion and diversifying the services offered by cooperative at village level might help in increasing membership and milk procurement, simultaneously would also improve dairy farming in the region.

Keywords: Coverage, Dairy cooperatives, DCCI, India

India is primarily a smallholder milk production system. Dairy and Animal Husbandry sector, which contributes nearly 4.2% in the Indian GDP, has emerged as a primary source of income for livelihood of about 70 million rural households. It is recognized as an important activity for employment generation and value addition in the agricultural sector of the Indian economy. As an example of production by the masses, India ranks first among the world's milk producing nations since 1998 and registered an annual growth rate of 4.5% to produce 187.7 Million tonnes of milk in 2018-19 (NDDB 2020). This has been possible because of dependable marketing system provided by the dairy cooperatives in the country. Dairy cooperatives have proved not only one of effective milk marketing channels but have improved the livelihood of the small milk producers by reducing their transactions costs in realizing the benefits of the market.

The cooperative milk revolution was started in 1946 in a small town of Anand in Gujarat. In 1965, National Dairy Development Board (NDDB) was set up with the object of meeting the increasing demand of milk especially in urban areas as well as developing the rural economy through the enhancement of the milk production of the country. In 1970, NDDB took up Operation Flood Programme in order to organize Milk Producers' Cooperative in several probable places of India taking the Kaira District (Anand) Cooperative Milk Producers' Union Limited (AMUL) of

Anand, as a model with the above objective in view. As a part of Operation Flood programme, many Milk Producers' Cooperative has been formed in this country. The progress of the Operation Flood programme all over India has been quite commendable. Apart from the increase of milk production and its per capita consumption, a great number of Village Milk Cooperative Societies have come up. The trend of keeping milk animals in a scientific method has registered an increase too. As a result, import of milk powder from foreign countries substantially dropped and after 1976, its import on a commercial basis stopped totally. However, the country got little amount of milk powder after that as a gift. This testified to the fact that, with the inception of the Operation Flood programme, the dairy development movement in India and also the dairy industry has made a remarkable progress.

Nevertheless, the marketing of milk and milk products in the country remained largely traditional, fragmented and unorganised because 34% of the total milk produced is sold to unorganised sector while organised sector accounts only 20% of total milk production and rest 46% of milk is consumed locally. In organised sector, cooperatives and producer companies are the major players where cooperatives dominate with 80% share in the total revenue (Kulkarni and Jain 2015). At present, around 35% of villages are covered under dairy cooperative network and the organised dairy sector is growing at nearly 10-12% per annum (AMUL 2019). In spite of the fact, the coverage of dairy cooperatives has not been uniform across the country. A study by Kale *et al.* (2016) concluded that a

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strong marketing structure in the form of cooperatives exist in Gujarat followed by Goa, Maharashtra, Karnataka and Tamil Nadu. The weakest structure was found in Himachal Pradesh followed by Haryana, Bihar, Madhya Pradesh and Punjab. The trends and discrepancies in the cooperatives coverage can be seen as an effect of internal and external factors to the cooperatives and dairy development. Hence, this paper determined the factors affecting the cooperatives' coverage as measured through dairy cooperatives coverage index for the various states of India.

MATERIALS AND METHODS

The dairy cooperatives coverage index (DCCI) was estimated for 26 major states of India by considering 8 indicators related with cooperatives such as membership per DCS ('000/DCS), milk procurement per member (kg/day), milk procurement per DCS (kg/day), percentage share of milk procured to production (%), DCS's density per 100 km² or per ha, percentage share of liquid milk marketed to milk procured (%), chilling centre facility per kg of milk procured per day (kg/day) and dairy plant facility per kg of milk procured per day (kg/day). The index was calculated by determining weights through Principal Component Analysis (PCA). The index calculation procedure includes three steps, first, normalization, where all the variables were made unit free or comparable. It was done by subtracting the minimum value from the observed value and then dividing it by the range of corresponding variable. Second step was weights calculation through PCA approach by following the formula as given below.

$$W_i = \sum |L_{ij}| E_j$$

where W_i is the weight of the i^{th} indicator; E_j is the Eigen value of the j^{th} factor; L_{ij} is the loading value of the i^{th} state on j^{th} factor.

The third step was composite index calculation for all the states using following formula

$$DCCI_{\text{State}} = \frac{\sum_{i=1}^n X_i W_i}{\sum_i W_i}$$

$$\text{where } W_i = \sum |L_{ij}| E_j$$

$DCCI_{\text{state}_i}$ is the dairy cooperatives coverage index value of each State; X_i is the normalized value of i^{th} indicator.

The weights used for the calculation of composite dairy cooperatives coverage index (DCCI) are given in the Table 1. Three principal components with Eigen value greater than one were used for weights calculation and they together explained about 75% of variation in the sample data. Among all the considered variables for the index calculation, milk procurement per DCS (kg/day) carried the highest weight followed by milk procurement to milk production share (%) and membership per DCS. While chilling centre facility per kg of milk procured per day carried least weight which implies that in general the milk procurement by and membership in DCSs are the major contributing parameters for the difference in the coverage

of dairy cooperatives across the states. The states were also categorized into three groups using means and standard deviation (SD) approach. The states having DCCI value greater than its Mean+0.5 SD were in high category and states with DCCI value less than its Mean-0.5SD were grouped into low category. The rest states were grouped into moderate category.

The current value of indicators of cooperatives coverage are discussed zone-wise namely north, south, east and west. National Dairy Development Board has categorized four zones of milk production, namely, north, south, east and west. North zone comprises Haryana (HR), Himachal Pradesh (HP), Punjab (PJ), Rajasthan (RJ) and Uttar Pradesh (UP). East zone comprises Assam, Bihar, Nagaland, Odisha, Sikkim, Tripura and West Bengal (WB). West zone comprises Goa, Gujarat (GJ), Madhya Pradesh (MP) and Maharashtra (MH). South zone comprises Andhra Pradesh (AP) (including Telangana), Karnataka (KT), Kerala and Tamil Nadu (TN).

Table 1. Weights allotted to the variables in calculating DCCI

Variable name	Weights
Membership per DCS ('000/DCS)	2.562
Milk procurement per member (kg/day)	2.325
Milk procurement per DCS (kg/day)	3.183
Percentage share of milk procured to production (%)	2.783
DCS's density per 100 km ² / ha	2.481
Percentage share of liquid milk marketed to milk procured (%)	2.362
Chilling centre facility per kg of milk procured per day (kg/day)	1.577
Dairy plant capacity per kg of milk procured per day (kg/day)	2.378

Data on indicators of cooperatives coverage for above mentioned states were collected for last 20 years (1999-2000 to 2018-19) from Annual Reports of National Dairy Development Board (NDDB) and converted to comparable parameters like village level DCSs density, membership per DCS, milk procurement per member as well as per DCS, milk procurement to production ratio and liquid milk marketing to procurement ratio. The states with incomplete time series on various parameters were eliminated from the study. The temporal change of all these indicators was estimated by the annual compound growth rate for four time intervals i.e first quinquennial ending (QE) 2003-04, second QE 2008-09, third QE 2013-14 and fourth SE 2018-19.

In order to identify the possible factors affecting the progress of cooperatives, the multivariable log-linear regression analysis was conducted. The analytical structure of the Log-linear model is represented below:

$$\ln(Y_j) = f(\beta_0, \beta_1 X_1, \beta_2 X_2 \dots \beta_n X_n)$$

where Y_j is the Dairy cooperatives coverage index (DCCI) of i^{th} state; β_0 is the intercept; β_1 to β_n are the partial regression coefficients.

The explanatory variables included in regression were rural literacy rate (%) which indicates the % age share of literate population in total rural population of the state. The % age share of crossbred bovine population in the total dairy bovine population represents the adoption intensity of high yielding animal breed or improved technologies. The agricultural production per hectare of net sown area ('000 tones/ha) was calculated by dividing the total food grains production by total net sown area of state, while the average milk productivity of crossbred cow, indigenous cow and buffaloes (kg/day) represents the production potential in the state. The rural income (₹/household) indicates the economic welfare of rural people in the state. The %age share of urban population in the total population of state represents the consumption demand or the dependent population for milk in the state. The veterinary institutes per adult female bovine shows the status of veterinary infrastructure in the state and it includes veterinary hospitals/Poly clinics, veterinary dispensaries and veterinary Aid Centre such as Stockmen Centres and Mobile Dispensaries. The variable on agency preference for milk sale is measured as the %age share of total sample of rural households who prefer cooperatives as a primary outlet for the sale of their milk surplus. The data on the rural income and agency preference for milk sale was taken from the 70th round of National Sample Survey (NSSO 2015). The data on bovine population, animal productivity were collected from the annual report or site of NDDDB (2019). The data on rural literacy rate, urban population, total food grain production and net sown area were collected from the site of Reserve Bank of India. The veterinary institute's data was retrieved from the Annual Report of Department of Animal husbandry and Dairying (2018). After fitting various combinations of variables on different functional form, the best fit model was selected.

RESULTS AND DISCUSSION

Zone wise coverage of dairy cooperatives: Overall in India about 10% of total milk production is procured by dairy cooperatives of considered states. It is evident from Table 2 that the west and south zones of India performed better in terms of membership and milk procurement than their counterparts. The western zone dairy cooperatives procure about 24% of zonal milk production while eastern zone dairy cooperatives procure only around 5% of its milk production. However, the proportion of liquid milk marketed out of total milk procured by dairy cooperatives is higher for the east zone followed by north, south and west zones, respectively. This may be because the quantity of milk procured in the eastern zone by cooperatives is smaller than the liquid milk marketed in the zone. It may be noted that the milk procurement and liquid milk marketed by cooperatives in the states of different zones also includes the milk procured from and marketed in the states of other zones. For instance, in the year 2018-19, Gujarat procured around 2,861 thousand kg milk per day from outside the state and marketed around 12,502 thousand litres liquid

milk per day to the other states (NDDDB 2019). Overall in India, around 56% of total milk procured by dairy cooperatives is marketed as liquid milk. The concentration of DCSs is almost equal in all the zones with north zone having marginally high density of DCSs (6.2 per 100 km²).

Table 2. Current status (2018-19) of dairy cooperatives in four zones of India

Particular	North	West	East	South	India
Members per DCS ('000 no./DCS)	0.05	0.12	0.05	0.16	0.1
Procurement per member (kg/day/member)	1.82	4.86	1.56	2.27	3.01
Procurement per DCS (tonnes/day/DCS)	0.09	0.56	0.08	0.37	0.31
Liquid milk marketed to procured ('000 litre/day)	0.86	0.39	1.03	0.69	0.56
DCS density (No/km ²)	0.06	0.05	0.06	0.06	0.05
Milk procured to milk production (tonnes/day)	0.02	0.24	0.05	0.13	0.1

Note: North—Haryana, HP, Punjab, UP, Rajasthan; South—AP, Karnataka (including Telangana), Kerala, TN; West—Goa, Gujarat, Maharashtra, MP; East—WB, Bihar, Odisha and North-eastern states (Assam, Nagaland, Sikkim, Tripura).

The current growth in dairy cooperatives is the result of its progress over the period of time and hence, to study the progress of various related parameters over the nearly last two decades (1999-2000 to 2018-19), growth rate analysis was done. Table 3 represents the growth in each parameters over four different time interval of last two decades. The results indicate that the number of village level DCSs have increased over time and in each time interval, DCSs density showed positive growth across all the zones. This growth is relatively high in eastern part of the country than other in all time intervals. In India, on an average, the DCSs density showed around 3.5% point growth in each time interval. Although, the membership has increased over time, but relatively slower than that of increase in DCSs and quantity of milk procured. It can be noted that earlier (1999-2004) the milk procurement was increased by bringing more of the producers under cooperatives network as indicated by positive growth rate of membership per DCS. But later since the interval of 2004-09, the membership per DCS has shown continuous negative or low growth with increasing milk procurement per member, especially in west and south zones of the country. This indicates that over the period the increase in productivity of dairy animals and the herd size per member or increased dairy commercialization might have also contributed to the rise in the quantity of milk procured by cooperatives. The milk

procurement per DCS showed high and positive growth in west zone, however the same was either low or negative in the rest of the zones. This can be accounted to the relatively higher growth of DCSs formation in those zones than the growth in quantity of milk procured by them. Liquid milk marketed out of the total milk procured showed positive but declining growth trend over period in north part which indicate that with increase in milk procurement, more of milk is being diverted towards milk products after meeting the demand for liquid milk. On the contrary, in west part of the country, the growth in liquid milk marketed out of total procured milk was negative for all periods except 1999-2004, which might be the result of high milk procurement by cooperatives, since the demand for liquid milk is limited due to its high perishability. In the east part of India, the milk marketed to procured ratio showed high and positive growth during 2004 to 2014, since the demand of milk in states was met by procuring the milk from other states. The milk procurement to milk production ratio showed positive and high growth rate during the period of 2009-14 among all time intervals, across all the zones except north zone because in that time interval, there was consistent increase in the milk procurement with rise in the milk production was seen, especially in the west part of India (Fig. 1). In the eastern zone, the milk procurement increased with more than 10% rise in each year except in 2011-12, with an average rise of around 3% in the milk production each year during 2009-14. In past years, the eastern states like Jharkhand, Assam, Sikkim, Tripura has made significant progress in developing dairy cooperatives network with the help of NDDB. Also states like Gujarat and Madhya

Pradesh had also shown consistent positive growth on all considered parameters. While the states like Uttar Pradesh and Bihar had huge increase in density of DCSs but the other parameters had shown consistent negative growth.

The scatter plot drawn between milk procurement and milk production over period for all zones shows huge positive correlation between them, especially in the western part of India as indicated by the linear shape of the curve (Fig. 1). The linear shape of the curve indicate that the milk procurement has increased more or less proportionally with the increase in the milk production. The curves for north and south zones also showed that the milk procurement increased with increase in milk production but disproportionally. Conversely, in the east zone, the milk procurement has not picked up much even with the huge rise in the milk production in the zone as indicated by the steep slope of the curve. It suggests the need to emphase the cooperative structure in the east zone.

State-wise dairy cooperatives progress across India:

The five years average value of different indicators from year 2014-15 to 2018-19 across zones gives idea about the strength and weaknesses on different aspect of dairy cooperatives in different areas (Supplementary Table 1). The dairy cooperatives coverage of the states measured through a DCCI index is shown in Fig. 2. The results shows that the Gujarat, Jharkhand, Karnataka, Kerala and Uttar Pradesh are the states with most dairy cooperatives coverage while Jammu & Kashmir, Himachal Pradesh, Assam, Meghalaya, Uttarakhand are having least dairy cooperatives network coverage. Ranking of the states based on the DCCI values clearly indicates that the most of the states who showed the

Table 3. Growth rates of different dairy cooperatives parameter over period (1999-2000 to 2018-19)

Zone	Time interval	Members per DCS	Procurement per member	Procurement per DCS	Liquid milk marketed to procured	DCS density	Milk procured to milk production
North	1999-2004	-0.05	-1.52	-1.57	1.98	5.97	1.44
	2004-2009	-0.44	-1.85	-2.29	5.23	3.70	-3.49
	2009-2014	-1.17	3.00	1.79	3.71	1.82	-0.39
	2014-2019	1.33	-2.20	-0.90	-0.08	5.02	-2.28
West	1999-2004	0.48	-0.99	-0.51	1.23	2.04	-1.40
	2004-2009	0.24	4.86	5.11	-3.56	3.12	3.56
	2009-2014	-0.88	7.95	7.00	-0.25	2.56	3.63
	2014-2019	0.21	7.71	7.94	-5.07	0.91	1.79
East	1999-2004	1.37	4.07	5.50	-11.87	7.08	11.61
	2004-2009	-1.59	-8.26	-9.72	3.85	8.87	-5.79
	2009-2014	-1.01	-1.17	-2.17	4.82	14.02	7.82
	2014-2019	-0.89	-1.53	-2.40	-0.22	5.14	-2.00
South	1999-2004	1.19	0.97	2.18	-1.66	0.93	1.67
	2004-2009	-1.46	1.13	-0.34	5.01	4.10	-2.74
	2009-2014	-1.39	5.78	4.31	-3.68	3.22	3.40
	2014-2019	-1.67	4.57	2.83	-1.72	2.76	-1.36
India	1999-2004	-0.35	-0.19	-0.54	-0.48	3.50	0.56
	2004-2009	-0.84	1.99	1.13	1.01	4.08	0.06
	2009-2014	-1.46	5.89	4.35	-0.67	3.85	3.79
	2014-2019	-1.10	4.69	6.29	-3.27	3.39	0.46

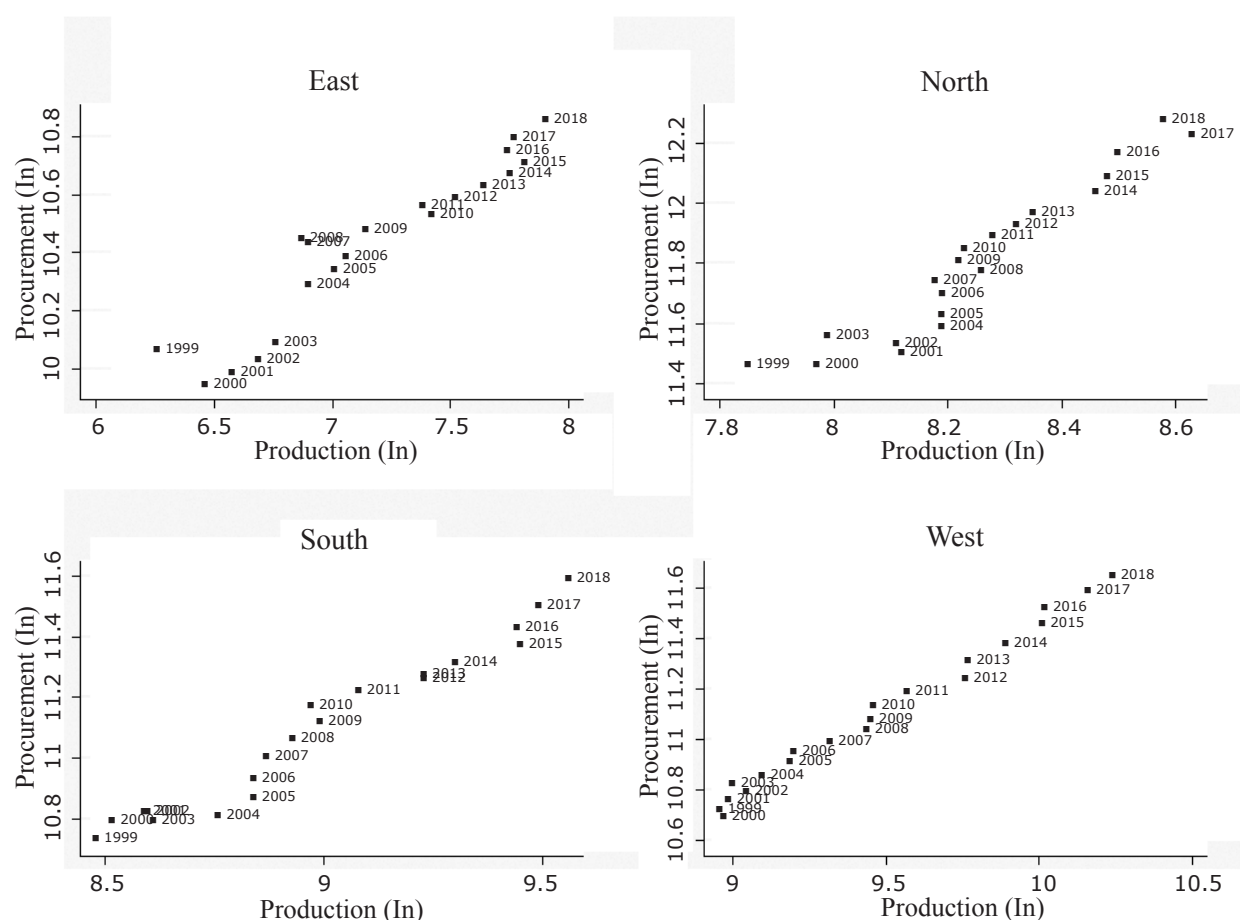


Fig. 1. Scatter plots showing correlation between milk procured v/s milk production.

least progress in terms of dairy cooperatives network are from eastern part of the nation. The averages of DCCI value of states falling in the four different zones shows that the south Indian states have higher overall dairy cooperatives coverage with an average DCCI value of 0.236, followed by west India (0.186), north India (0.148) and east India (0.144). However, the variability in the DCCI for various zones measured through coefficient of variance indicates that the western zone had huge variation among the states (around 89%) followed by northern zone (63%) and eastern zone (59%), while the southern zone had least variability across the states (29%). The states were categorized into three categories i.e. high, moderate and low on the basis of DCCI value (Fig. 2).

Factors influencing the coverage of dairy cooperatives in India: In order to find the determinants of the dairy cooperatives coverage across states, different factors that may theoretically contribute were considered and the best fit model was selected. The results are presented in Table 4. The factors significantly influencing the dairy cooperative coverage in the states were share of crossbred cow to total bovine population, agricultural production per unit of net sown area (NSA), share of urban population and share of producers choosing cooperatives as a prime agency.

Among these factors, the value of coefficient of agricultural production per unit of area was the highest and positive which means with increase in the agricultural production by one tonne per hectare of net sown area, the DCCI increased by around 43%. This indicates that agricultural growth highly supports the progress of dairy cooperatives.

The higher crossbred cow population was negatively contributing in cooperatives coverage. It indicates that adoption of crossbred technology has not promoted dairy cooperatives which may be due to the reason that small scale production fits well with cooperative network and the large scale production as a result of adoption of crossbred technology encourage the farmer to follow alternative and more lucrative channel of marketing. Similarly, the productivity of indigenous cow had negative but insignificant effect on the coverage of dairy cooperatives. These results indicate that the states which have higher population and productivity of cattle, have lower dairy cooperative coverage. The urbanization also had significant positive effect on the cooperatives progress which means that with increase in the share of urban population by 1%, the DCCI value increases by 2%. However, this results might get reversed in case of extreme urbanisation where the producers becomes short for meeting the demand of

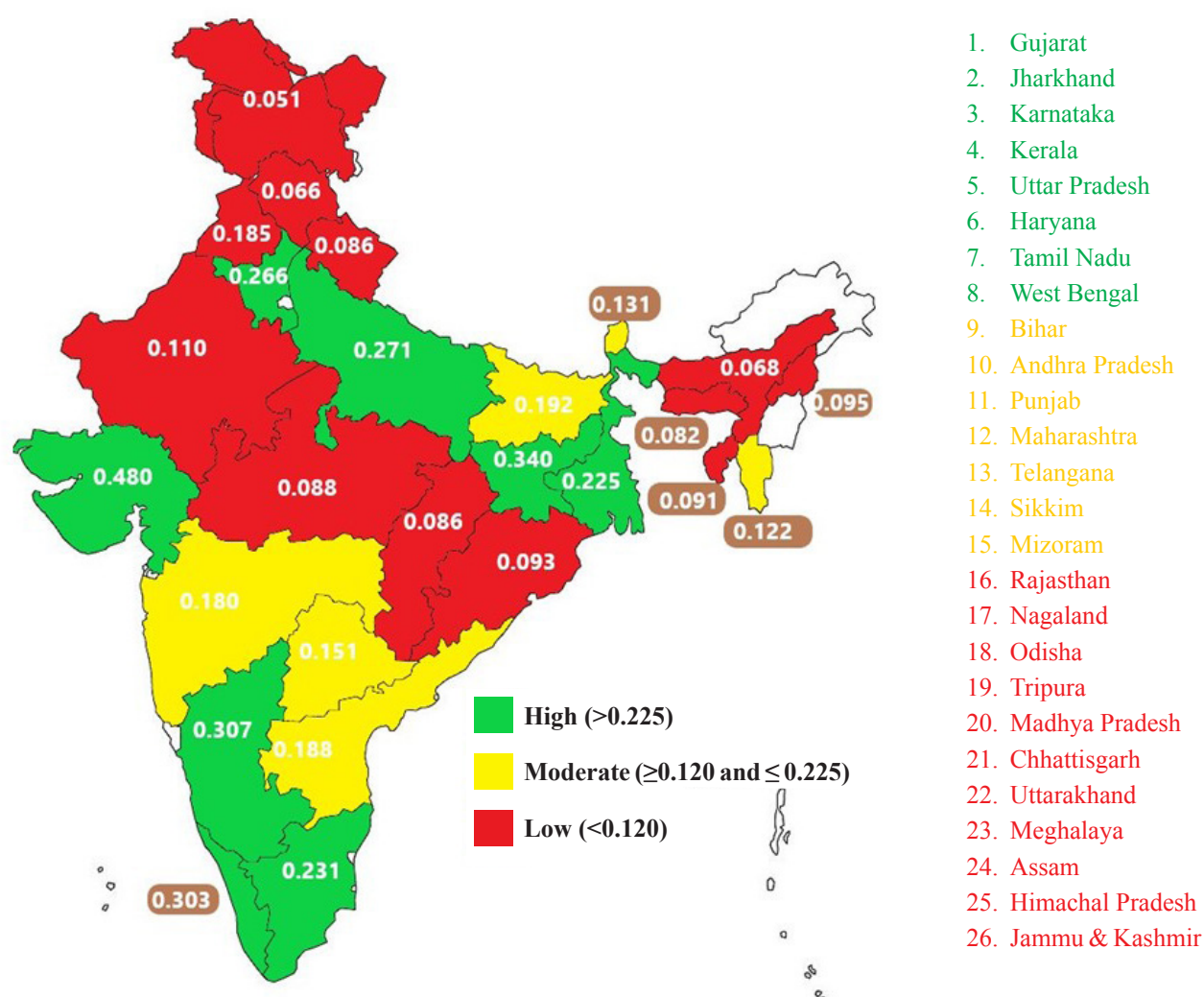


Fig. 2. Mapping of states based on the dairy cooperatives coverage index.

the consumers. The other factors included in the study, viz. rural literacy rate, animal density and average operational land holding had negative influence on the cooperatives coverage. Although, the productivity of buffalo, annual rural income per household and veterinary institute availability per adult female bovine showed positive influence on cooperatives coverage. Further, the variables included in the model explained about 77% of variations in the coverage of dairy cooperatives.

This study limits its search in the coverage of dairy cooperatives to its density, membership, milk procurement and processing facility. However, the literature suggests significant role of DCS's integration with dairy inputs and output production, distribution and processing and marketing of milk and milk based products which aids in making better returns and lower their costs (Gupta and Murthy 1985). This will not only increase the reach of DCSs to the producers i.e. increase in membership but will also facilitate adoption of improved package of practices of dairying by the producers. Also, the study also recommends the need to identify area specific factors effecting the

progress of dairy cooperatives through micro-level studies.

Beyond doubt, the dairy cooperatives has played an important role in improving the dairy farming in India and making the enterprise sustainable, not only economically but also socially by providing outlet to smallholder's produce. Among the four geographic zones in the country, the east zone had shown maximum growth in a density of dairy cooperative societies and in milk procurement showing that improvement in dairying has picked up in the region. Still, there exist lot of variation in progress within and across the zones, especially in the western part of the country. The negative growth of milk procurement to production ratio in the north zone indicated that the milk procurement by cooperatives has not commensurate with milk production in the zone. This may be due to development of alternatives milk marketing channels like milk producer companies or Farmer Producer Organization (FPO) and private dairy companies. Conversely, the slow growth in membership and high growth in milk procurement per member points towards increasing dairy commercialization, especially in west and south part of the country.

Table 4. Factors determining coverage of dairy cooperatives across states

Variable	Coefficient	Standard error
Constant	-2.790**	1.142
X ₁ = Share of crossbred to total bovine population (%)	-0.012***	0.006
X ₂ = Rural literacy rate (%)	-0.004	0.016
X ₃ = Animal density ('000 bovine/km ²)	-0.259	0.172
X ₄ = Average productivity of crossbred cow (kg/day/animal)	-0.047	0.075
X ₅ = Average productivity of indigenous cow (kg/day/animal)	-0.008	0.128
X ₆ = Average productivity of buffalo (kg/day/animal)	0.027	0.093
X ₇ = Rural income (₹/HH/annum)	0.000	0.000
X ₈ = Agricultural production per unit net area sown (tonnes/ha)	0.431*	0.124
X ₉ = Average operational land holding of the state (ha)	-0.196	0.127
X ₁₀ = Veterinary institutes per adult female bovine	0.104	0.097
X ₁₁ = Share of urban population to total population (%)	0.022***	0.011
X ₁₂ = Share of population choosing co-operatives as a primary outlet (%)	0.021*	0.005
R ²		0.77
F statistics		3.53
Number of observations		26

***Significant (p<0.1); **significant (p<0.05); *significant (p<0.01).

Increasing the number of cooperatives milk collection centres and provision of various dairy input services to the farmers at their door steps through cooperatives, like

artificial insemination, sale of cattle feed and fodder and other veterinary services will help to maximize the outreach to milk producing community (increase in membership) and also increasing the milk production. The study also suggests that the promoting crop production in the states with poor dairy cooperatives network, keeping dairying in the consideration would complement DCSs growth.

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