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Assessing resource and infrastructure disparities to strengthen Indian dairy sector

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ABSTRACT

The present study reveals the resource and infrastructure disparities of dairy development in India. The relative progress of the states in dairying was measured by multitude of developmental indicators. To get a lucid picture, a composite Dairy Progressiveness Index (DPI) with 20 indicators was developed for 16 states of India. Principal Component Analysis (PCA) was employed for the construction of DPI. As per the indices score, Punjab, Kerala, Haryana, Goa and Gujarat were categorized as highly dairy progressive states. Tamil Nadu, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka and Uttar Pradesh were categorized as moderate dairy progressive states while West Bengal, Himachal Pradesh, Bihar, Madhya Pradesh and Odisha states were grouped as least dairy progressive states. The study implicates the strong need to develop organized marketing network along with reforms in dairy cooperatives as well as producer companies in Punjab, Haryana, Himachal Pradesh, Bihar, Madhya Pradesh and Odisha. Since fodder, pasture and irrigation resources in Himachal Pradesh, Andhra Pradesh, Madhya Pradesh, Odisha, Kerala and Gujarat are poor, policy intervention like restriction on export of oilseed cake and ban on harvesting using combine harvester without straw ripper, establishment of fodder bank network could address the fodder scarcity. Transfer of technologies such as hydroponics, azolla, silage, urea treatment, use of mineral mixtures to field in resource poor states need attention. Poor genetic potential in the low performing states demand proper breeding strategies, conservation and spread of elite indigenous breeds such as *Sahiwal, Gir* and *Tharparkar.* Improvement in veterinary infrastructure would reduce the imbalanced progress. The policy interventions on identified gaps would pave even development of dairy farming and reduce future demand gap.

Key words: Dairy progressiveness index, Principal component analysis, Regional disparities

India ranks first in milk production, constituting 17% of global production. During 2013–14, milk production peaked at 137.69 MT, thus becoming an important secondary source of income for 70 million rural households engaged in dairying (GOI 2014). Consequent to the white revolution, Indian dairy sector has witnessed significant structural changes over time especially changes in composition of dairy herd in favour of crossbred cows, expansion of dairy cooperatives and increased share of private sector in milk collection and processing (Rajendran and Mohanty 2004, Singh and Datta 2010, Kumar *et al*. 2010, Birthal and Negi 2012). However, major criticism post white revolution, is an increase in regional inequality (Jha 2004, Saikia and Kakaty 2007, Gupta and Purohit 2010, Kumar *et al*. 2013, Dadhich 2015). Emerging trends indicated that the demand for milk is likely to be about 150 million tonnes by 2016–17 and 200-210 million tonnes by 2021–22. To meet this demand, the average incremental increase in milk production will have to be about six million tonnes per annum compared to an average of about three million tonnes over the last 15 years (NDDB 2011). This demand can be fulfilled, only if inter-state disparities are addressed by proper analysis and planning. Moreover, inter-state disparities in dairying within India need to be analyzed mainly due to its potential drag effect on the food and nutritional security and ultimately socio-economic growth of the country as a whole.

Few studies have been carried out in the past to measure the regional or inter-state disparities (Raut *et al*. 2002, Jha 2004, Kumar *et al*. 2013) but these studies were based on the single or few individual indicators of milk production thus the holistic approach was lacking. Efforts in this direction have been made by Pawar (1983) and Sharma *et al.* (2008), but mostly based on production aspects whereas other aspects like milk marketing and veterinary infrastructure was not considered. Moreover, the recent studies revealed the current regional disparities with holistic

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approach are scanty. Keeping this in view, the present study reveals the overall progress of dairying in different states and their relative growth based on comprehensive indicators.

MATERIALS AND METHODS

To measure the regional resource and infrastructure disparities in India, the states have been taken as the unit of study as there is a growing consensus on state-wise dairy and animal husbandry policy planning. States (16) namely, Andhra Pradesh, Bihar, Gujarat, Goa, Haryana, Himachal Pradesh, Karnataka, Kerala, Odisha, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal were included in the study. The states were selected based on the availability of the secondary data on the common selected dairy progressiveness indicators as well as keeping in view the contribution in country's milk production. These states contribute more than 94% of India's milk production (GOI 2013). The analysis of the state-wise dairy progress would help in identifying relative position of their progressiveness in dairying.

Selection of dairy progressiveness indicators: Narain *et al.* (2007) contemplated that progress is not pre-determined, but a continuous process. It is multi-dimensional, hence, cannot be measured with a single indicator. Moreover, a number of indicators analysed separately do not give integrated and easily comprehensible picture of reality, thus need to analyse together. There are two approaches in the selection of indicators, data-driven and theory-driven (Vincent 2004). But, each approach has its own limitations. Therefore, the best option is to verify the representativeness of the theory-based indicators, with data availability from authentic sources (Maiti *et al.* 2015). Both theory and data driven approaches were adopted to select the indicators used in this study. Keeping this in view, twenty common indicators which measure the dairy progress across the 16 states were identified based on availability of secondary data, expert discussion and literature review.

Data resources: As the progress is the gradual process over the years, state-wise secondary data on 20 selected indicators have been collected from various published sources. Data on milk production, dairy animals and their yields, veterinary institutions, milk processing were compiled from the basic animal husbandry statistics for various years and population data of different species of bovine animals was taken from the livestock census reports (1997, 2003, 2007, 2012) published by the Department of Animal Husbandry, Dairying and Fisheries of the Ministry of Agriculture, Government of India. Data on irrigation and cultivated area under fodder and cereal crops were compiled from the agricultural statistics at a glance and land use statistics published by the Directorate of Economics and Statistics, Ministry of Agriculture. Data on membership, procurement, marketing of cooperative societies were taken from the annual reports published by the National Dairy Development Board. Surface road length data were collected from the Ministry of Road Transport and Highways, Government of India. Rainfall data were compiled from the website of Indian Meteorological Organization as well as statistical abstract published by Department of Agriculture of concern states. To measure the temporal progress, data were collected for the years 2001 to 2011 and the mean value for each indicator was taken for calculation of the index. Missing observations were interpolated or extrapolated based on the trend of selected indicator variables.

Development of dairy progressiveness index: The indicators were taken from the different population distribution and they were recorded in different units of measurement. Therefore, to bring the values of the indicators within the comparable range, these needed to be normalized. Normalization was done by subtracting the minimum value from the observed value and dividing by range (Maiti *et al*. 2015, Ayyoob *et al.* 2013). Next step was the testing suitability of indicators. Ravindranath *et al.* (2011) and Maiti *et al*. (2015) used Principal Component Analysis (PCA) to identify the significant indicators and eliminate non-significant indicators. PCA was employed on transformed data after normalization with 'varimax method' for rotation of the factors in Statistical Software for Social Sciences 20 (SPSS 20). The result of communalities derived through the PCA explained the amount of variance contributed by all the indicators. Mohanty *et al.* (2009) used a thumb rule of communality, indicating that the value more than 0.6 as a sufficient condition to keep the indicator in the PCA. As all communality values were above 0.6, no indicator was dropped from the factor analysis model and each indicator was considered for next step i.e., assignment of weights to the indicators. The method followed by Ayyoob *et al*. (2013) and Feroze and Chauhan (2010) was adopted for this study to assign the weights to the indicators for the construction of the Dairy Progressiveness Index (DPI). The index was computed with the help of following formula:

$$I = \frac{\sum_{i=1} XiWi}{\sum_{i} Wi}$$

where, I, index for each state; Xi, normalised value of i^{th} indicator; W_i, weight of the i^{th} Indicator $= \Sigma \left| L_{ij} \right| E_j$; L_{ij}, factor loading value of the i^{th} state on the j^{th} factor; E_j, Eigen value of the j^{th} factor; i,1, 2, 3,….20 indicators; j, 1,2,3 …factors.

The states were then divided into three categories based on the calculated index score.

Highly dairy progressive states = Ij> Mean $+^1/_2$ SD

Moderate dairy progressive states = Mean $-^1/_2$ SD <Ij< Mean $+^1/_2$ SD

Least dairy progressive states = Ij< Mean $-^1/_2$ SD

RESULTS AND DISCUSSION

The results of the PCA produced 6 principal components (PC) with eigen value more than 1 as shown in scree plot with bars in primary axis (Fig 1). The 6 PCs together account

nearly 91% of variability present in the transformed data as indicated by the line graph represented in secondary axis of the scree plot (Table 1). The weights assigned to each indicator for construction of index were represented by eigen values and factor loadings.

The index values of dairy progressiveness indicators for each state are presented in Table 2. Component wise as well as overall dairy progressiveness index values for each state are given in Table 3.

Livestock potential and milk availability: It was found that (Table 3) in the livestock potential and milk availability, Punjab state scored highest followed by Haryana and Gujarat in second and third position respectively. Under this component Punjab scored highest for milk yield of crossbred and buffalo as well as per capita milk availability, whereas for milk yield of indigenous cattle and share of breedable buffalos in total, buffalos scored second highest after Haryana. Odisha, West Bengal, Karnataka and Himachal Pradesh scored lowest which shows low herd quality of bovine animal and milk availability. There are some 'zero values' in Table 2, however this did not imply that indicators were worthless for the respective states. It happened because of consideration of normalized value of those particular indicators. It only shows the relative position of the state. National Commission on cattle reported that past programmes for genetic improvement were not successful, particularly up-gradation of indigenous breeds through continuous crossbreeding in the states where backup support of the feed and fodder resources was absent. Therefore, reorientation of cattle and buffalo breeding policy need to be attempted with area specific approach focused on conservation of elite indigenous breeds in rainfed areas lacking in feed and fodder resources. Population of pure indigenous breeds such as Gir in Gujarat, Ongole and Punganur breed in Andhra Pradesh, Sahiwal and Tharparkar in Haryana, Amritmahal in Karnataka, Vechoor in Kerala have decreased because of indiscriminate cross-breeding added to lack of grazing facilities. Thus, cross-breeding with exotic strains should be totally banned in the home tracts of the important cattle breeds. Formation of breed associations for improvement of pure indigenous breeds shall be encouraged to produce disease free superior quality male stock (Sreenivas 2013).

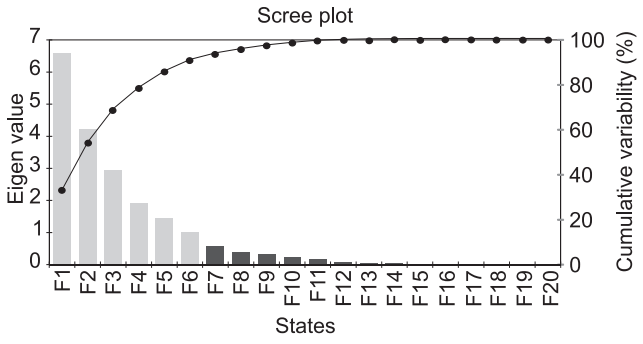

Fig. 1. Scree plot of eigen value and cumulative variability.

Table 1. Eigen values and extraction of variability

PC No.	Extraction sums of squared loadings		
	Eigen value	% of variance	cumulative%
1	6.591	32.96	32.96
2	4.229	21.15	54.10
3	2.939	14.70	68.80
4	1.918	9.59	78.39
5	1.445	7.23	85.62
6	1.020	5.10	90.72

Resources availability: Availability of collective resources that are fodder, pasture, cereals, irrigation and rainfall in assistance for the milk production was found highest in Punjab state, followed by Haryana and Goa. Punjab scored highest in area under cereals and irrigation. Area under fodder per 1000 adult female bovine was found to be higher in Rajasthan. In the states like Himachal Pradesh and Andhra Pradesh, availability of resources was scarce. Though Himachal Pradesh scored highest in area under permanent pasture, it is deprived in other resources. There should be restriction on export of oilseed cake and ban on harvesting of wheat and other fodder crop using combine harvester without attachment of straw ripper, so that wheat straw can be available in adequate quantity. There is no feed and fodder resource management system for animals in the country. Establishment of a nationwide fodder bank network can reduce the fodder scarcity in the deprived areas. More emphasis should be given for transfer of improved feed and fodder technologies to the farms such as hydroponics, azolla, silage, urea treatment, use of mineral mixtures in the resource poor states.

Veterinary infrastructure: The infrastructure level of Kerala, Goa, Himachal Pradesh, Tamil Nadu and Punjab was found better whereas, Bihar, Madhya Pradesh, Uttar Pradesh and Rajasthan were the poor states. These findings are corroborated with Yadav *et al.* (2014), who also reported that access to information on animal husbandry by farmers was highest in Kerala and Tamil Nadu and lowest in Rajasthan, Madhya Pradesh and Uttar Pradesh. Inadequate manpower along with poor veterinary infrastructure was also likely causes of imbalanced progress. As per current livestock census, the country needed about 1.16 lakh veterinarians and only 63,000 veterinarians are registered with Indian veterinary council which means almost 50% deficit in manpower.

Milk marketing structure: A strong organized milk marketing structure was found in the case of Gujarat followed by Goa, Maharashtra, Karnataka and Tamil Nadu. Milk procurement per dairy cooperative society was found to be highest in Gujarat, while number of dairy cooperatives in proportion to milk production and marketing of milk per dairy cooperative was scored highest by Goa. In terms of membership in dairy cooperatives, Tamil Nadu secured first position. Maharashtra was having a good capacity milk processing plant and road infrastructure. Himachal Pradesh was having a weak structure of the organized milk marketing followed by Haryana, Bihar, Madhya Pradesh,

Table 2. Index values of indicators wise dairy progress across the states

States	Indicators of dairy progressiveness																			
	Livestock potential and milk availability						Resources availability					Veterinary infrastructure			Milk marketing structure					
	YCB	YI	YB	PCM	SBC	SBB	FOD	PAST	CER	RAIN	IRR	AI	AIC	VET	DC	MDC	MPDC	MMDC	MPROC	ROD
Andhra Pradesh	3.89	1.78	1.80	1.58	0.39	6.10	0.39	0.12	1.03	1.25	2.39	1.58	1.22	1.21	0.07	3.30	0.98	2.87	0.57	2.83
Bihar	2.44	2.73	1.67	0.42	0.61	3.82	0.04	*0.00*	2.07	1.99	3.67	0.03	*0.00*	0.39	1.30	0.19	0.25	0.50	*0.00*	0.78
Goa	3.83	1.15	0.68	0.03	1.02	3.65	*0.00*	0.04	4.59	**7.91**	0.58	1.39	3.53	**5.10**	**4.60**	1.76	0.99	**6.09**	1.40	*0.00*
Gujarat	5.16	4.71	2.60	2.29	0.30	5.64	3.23	0.22	0.63	1.14	2.12	1.59	0.97	*0.00*	1.98	4.44	**2.48**	2.31	1.48	2.42
Haryana	3.56	**7.15**	5.82	4.56	0.43	**7.49**	5.97	0.01	4.51	0.23	5.79	1.76	0.59	1.95	0.80	0.07	0.20	0.24	0.78	0.42
Himachal Pradesh	*0.00*	1.71	0.61	2.42	1.67	3.09	0.16	**1.99**	1.18	1.55	0.28	1.48	2.02	4.16	*0.00*	0.20	0.18	0.30	0.45	0.29
Karnataka	2.44	2.41	*0.00*	0.99	0.72	2.61	0.15	0.28	2.59	3.58	1.05	1.60	1.17	1.50	3.19	3.70	1.15	2.07	0.94	2.68
Kerala	4.58	2.94	4.93	0.81	**5.16**	*0.00*	0.13	*0.00*	*0.00*	7.11	*0.00*	**5.94**	**6.70**	4.12	1.57	4.87	0.85	3.09	0.44	1.66
Madhya Pradesh	2.60	1.68	1.23	1.36	*0.00*	3.52	1.60	0.20	1.41	1.27	1.24	*0.00*	0.08	0.19	0.52	0.06	0.22	0.54	0.46	1.58
Maharashtra	3.32	1.12	1.62	0.72	1.02	3.62	3.02	0.23	2.85	1.60	0.19	1.08	0.58	0.80	4.02	1.05	0.52	1.52	**3.11**	**4.33**
Odisha	1.97	*0.00*	0.02	*0.00*	0.59	0.66	0.06	0.14	2.03	2.96	1.21	0.68	1.77	1.38	2.05	0.57	0.22	0.69	0.01	0.59
Punjab	**6.48**	6.12	**7.69**	**6.87**	1.11	6.97	3.99	*0.00*	**7.79**	0.17	**6.81**	2.95	0.68	2.45	0.40	0.33	0.44	0.79	0.60	0.81
Rajasthan	3.30	4.30	3.31	2.88	0.10	4.78	**6.97**	0.31	2.89	*0.00*	1.54	0.35	0.22	0.56	1.16	0.12	0.38	0.77	0.17	2.22
Tamil Nadu	2.91	3.31	2.37	1.22	3.30	1.33	0.87	0.04	0.90	1.52	3.26	3.55	1.58	1.72	1.69	**5.21**	0.90	2.08	1.27	2.60
Uttar Pradesh	3.60	2.93	2.64	1.42	0.18	5.80	1.04	0.01	2.78	0.96	4.92	0.39	0.02	0.17	0.92	*0.00*	*0.00*	*0.00*	1.01	2.64
West Bengal	2.17	1.90	3.72	0.26	0.69	0.13	0.01	*0.00*	1.93	3.57	3.43	1.03	1.22	1.06	0.14	0.77	0.36	3.83	0.31	1.09

Italics, lowest value; bold, highest value; YCB, average per day milk yield of crossbred cattle (kg/day); YI, average per day milk yield of indigenous cattle (kg/day); YB, average per day milk yield of buffalo (kg/day); PCM, per capita milk availability (g/day); SBC, share of breedable crossbred in breedable bovine stock (%); SBB, share of breedable buffalo in breedable bovine stock (%); FOD, area under fodder per 1000 adult female bovine (ha); PAST, area under pasture per 1000 adult female bovine; CER, area under cereals per 1000 adult female bovine; AI, number of AI performed per 1000 breedable bovines; AIC, number of AI centers per 1000 breedable bovine; VET, number of veterinary hospitals per 1000 bovine female; DCnNumber of dairy co-operative societies per 1000 tonnes milk production; MDC, number of members per dairy cooperative society; MPDC, milk procurement per day per dairy cooperative society; MMDC, marketing of milk per day per dairy cooperative society; MPROC, capacity of milk processing facilities to the total milk production; RAIN, rainfall; ROAD, surface road length; IRR, percentage of gross irrigated area to total cropped area.

and Punjab. Though the states like Punjab and Haryana are considered to be highly developed in milk productivity and production, the existing organized milk marketing structure is very poor. To promote the more organized marketing new generation cooperatives in the form of milk producer, companies need to be promoted in these states.

Overall dairy progressiveness: Considering the mean +1/2 standard deviation as a yard stick, the overall dairy progressiveness indices calculated for the states were classified into 3 categories (Fig. 2). From the Fig 2, it is explicit that Punjab, Kerala, Haryana, Goa, and Gujarat fall under 'highly dairy progressive states' in terms of progressiveness. The states viz., Tamil Nadu, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka and Uttar Pradesh are grouped under 'moderately dairy progressive states'. West Bengal, Himachal Pradesh, Bihar, Madhya Pradesh and Odisha are the 'least dairy progressive states'.

The study concluded that the vast differences in dairy progressiveness based on the analysis of 16 selected states provided inputs for planners and policy makers. Development of organized marketing network would further strengthen both the highly dairy progressive states namely Punjab and Haryana as well as poor states like Himachal Pradesh, Bihar, Madhya Pradesh and Odisha. Fodder, pasture and irrigation resources need to be improved in Kerala and Gujarat. Quality improvement through cross

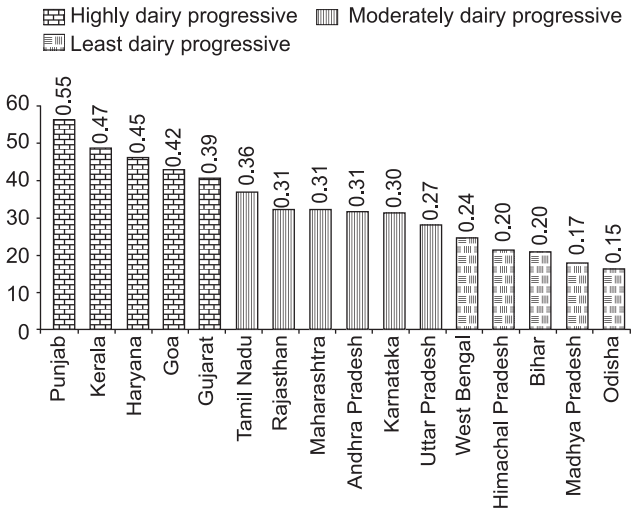

Fig. 2. Categories of states based on dairy progressiveness index.

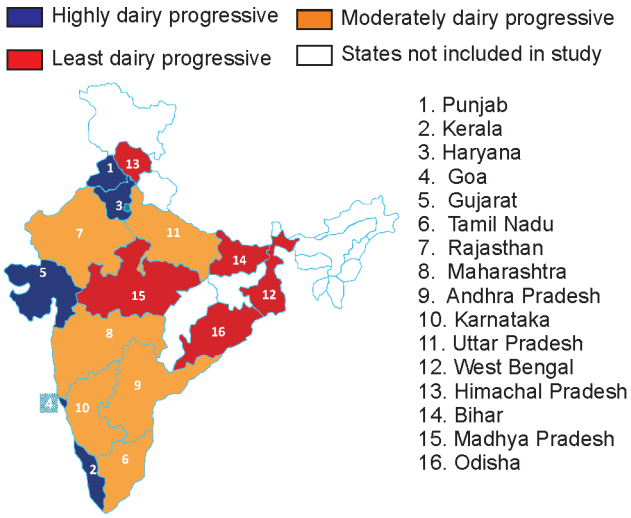

Fig. 3. Regional or inter-state disparity of dairy development in India.

Table 3. State-wise index values of overall dairy progressiveness and its components

States	Livestock potential and milk availability		Resources availability		Veterinary infrastructure		Milk marketing structure		Overall dairy progressiveness index	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Andhra Pradesh	0.38	7	*0.16*	15	0.23	8	0.41	7	**0.31**	9
Bihar	0.29	9	0.25	7	*0.02*	15	0.12	14	**0.2**	14
Goa	0.25	11	0.42	3	0.56	2	0.57	2	**0.42**	4
Gujarat	0.51	3	0.23	10	0.14	12	**0.59**	1	**0.39**	5
Haryana	0.71	2	0.52	2	0.24	6	0.1	15	**0.45**	3
Himachal Pradesh	0.23	13	*0.16*	16	0.43	3	*0.05*	16	**0.2**	13
Karnataka	0.22	14	0.24	9	0.24	7	0.53	5	**0.3**	10
Kerala	0.45	5	0.23	11	**0.94**	1	0.48	6	**0.47**	2
Madhya Pradesh	0.25	12	0.18	14	*0.02*	16	0.13	13	**0.17**	15
Maharashtra	0.28	10	0.25	8	0.14	11	0.56	3	**0.31**	8
Odisha	*0.08*	16	0.2	13	0.22	9	0.16	11	***0.15***	16
Punjab	**0.86**	1	**0.6**	1	0.34	5	0.13	12	**0.55**	1
Rajasthan	0.46	4	0.37	4	0.06	13	0.19	9	**0.31**	7
Tamil Nadu	0.35	8	0.21	12	0.39	4	0.53	4	**0.36**	6
Uttar Pradesh	0.41	6	0.31	5	0.03	14	0.18	10	**0.27**	11
West Bengal	0.22	15	0.28	6	0.19	10	0.25	8	**0.24**	12

Italics, lowest value; Bold, highest value; Underline, highest value in overall DPI.

breeding or selective breeding would improve the genetic potential of dairy animals in Odisha, West Bengal, Karnataka, Himachal Pradesh and Madhya Pradesh. More conservation focus should be given for elite indigenous dairy animals such as Sahiwal, Gir and Tharparkar in such states where the intensive cross-breeding is not possible because of climatic and agro-ecological reasons. The states viz., Himachal Pradesh, Andhra Pradesh, Madhya Pradesh and Odisha need to improve the resources for dairy farming. Madhya Pradesh, Bihar, Uttar Pradesh and Rajasthan need to improve veterinary infrastructure. The policy interventions on identified major gaps would pave way for even development of dairy farming benefitting around 70 million farm families ultimately resulting in economic development of the country.

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