

Reproductive Efficiency of Dairy Animals in Different Dairy Production Systems under Field Conditions

Diksha Patel^{1*} K. Ponnusamy² and Arjun Prasad Verma³

¹Subject Matter Specialist, Agriculture Extension, KVK-Banda, Banda University of Agriculture and Technology, Banda, Uttar Pradesh, INDIA

²Principal Scientist, Agricultural Extension, Dairy Extension Division, ICAR-National Dairy Research Institute, Karnal, Haryana, INDIA

³Subject Matter Specialist, Agriculture Extension, KVK-Jhansi, Banda University of Agriculture and Technology, Banda, Uttar Pradesh, INDIA

*Corresponding Author: pateldiksha279@gmail.com

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Abstract

Economic viability of dairy farming primarily depends on the reproductive efficiency of dairy animals. The present study was undertaken in Haryana, Madhya Pradesh and Chhattisgarh representing three different dairy production systems namely; dynamic, transient and subsistence dairy production systems in 2018 to assess the productive and reproductive performance as well as adoption of various aspects of reproduction management. A sample of 240 respondents comprising 80 from each state was selected using simple random sampling. Data on productive and reproductive performance of dairy animals indicated that performance in Haryana state was found to be better than Madhya Pradesh and Chhattisgarh. Reproductive management adoption index was found to be 0.56, 0.42 and 0.35 in Haryana, Madhya Pradesh and Chhattisgarh respectively. Therefore, the study warranted to educate farmers on various aspects of reproduction management and their associated problems. In this context, a booklet has been developed which was tested for its effectiveness. The overall mean knowledge gain through booklet was 12.76 per cent in Haryana, 15.08 per cent in Madhya Pradesh and 19.66 per cent in Chhattisgarh, therefore the booklet has to be used by extension functionaries of different line department for knowledge enhancement of farmers.

Keywords: Adoption, Booklet, Dairy Production Systems, Productive and Reproductive Parameters, Reproductive Efficiency

Introduction

Dairying is an important sub-sector of agriculture where dairying occupies a preeminent position in crop-livestock mixed farming system in India. Moreover, dairying has huge potential to promote rural welfare and to reduce poverty. This sector alone involves more than 70 million producers, each raising one or two cows/ buffaloes primarily for milk production (Ponnusamy *et al.*, 2017). Since agriculture is mostly seasonal, this sector plays significant role in constant and assured family income, nutrition and generating gainful employment to rural masses particularly among landless labourers, small and marginal farmers and farm women. Demand for milk and milk products keeps on increasing as a result of the growing population, higher income and more health consciousness of consumers. Emerging trends indicate that milk demand is likely to be in the range of 200 to 210 million tonnes by 2021-22. To meet the growing demand, there is a need to increase the annual incremental milk production from 4 million tonnes per year in past 10 years to 7.8 million tonnes in the next eight years (NDDB, 2015). The Government has given a highest development priority to the dairy sector since the inception of white revolution until today by ensuring policy supports and allocating substantial resources and considering its importance to rural populace. Although, the annual growth of dairy industry if analyzed in terms of milk production is commendable but the average milk productivity of Indian bovines are very low. The average milk productivity of Indian dairy animals is only 1214 Kg per lactation which is nearly half of the world average of 2104 Kg per lactation (Planning Commission, 2012). There is inter-state and inter-regional disparity in milk production and productivity of dairy animals (Kale *et al.*, 2016). There is urgent need to increase the average productivity of Indian bovines. This could only be achieved through exploitation of full genetic potential of the existing dairy animal resources, for this it is essential to understand the reproductive efficiency of the dairy animals. Productive and reproductive performance of the herd is a key indicator of sustainability of a dairy farming system. The important parameters that determine productive and reproductive efficiency of bovines are age at first calving, age at first service, birth weight, total milk yield, average milk yield per day, calving to conception and calving interval (Dematawawa and Beger, 1998). Biologically, potential for milk production also depends on age at puberty, early first calving, number of parity and shorter calving interval (Islam *et al.*, 2006). These parameters are important in terms of economics of dairy farming. At field level, animals were suffering from many productive and reproductive problems which render the animal with losses of reproductive function. This is mainly due to unawareness and non-adoption of scientific reproductive management practices among farmers. Therefore, it is important to educate the farmers on different aspects of managing reproductive problems in dairy animals. The present study highlighted the productive and reproductive performances of dairy animals in three different dairy production systems with the specific objectives:

1. To assess the productive and reproductive performances of the dairy animals under different dairying production systems.
2. To study adoption of reproductive management practices among farmers and
3. To assess the effectiveness of booklet on knowledge regarding reproductive management of dairy animals.

Materials and Methods

The present study was conducted in Haryana, Madhya Pradesh and Chhattisgarh during 2018 which represented three different dairy production systems namely; dynamic, transient and subsistence dairy production systems. A composite dairy production system index was developed to classify 20 Indian states into three categories dynamic, transient and subsistence dairy production systems based on their functional dynamism. A detailed classification of states is given in (Table 1) (Patel, 2018).

Table 1: Classification of dairy production systems of India based on their functional dynamism

Dynamic dairy production systems	Transient dairy production systems	Subsistence dairy production systems
Kerala	Tamil Nadu	Uttar Pradesh
Punjab	Karnataka	Uttarakhand
Goa	Himachal Pradesh	Jammu & Kashmir
Haryana	Andhra Pradesh	Odisha
Gujarat	Maharashtra	West Bengal
Rajasthan	Madhya Pradesh	Bihar, Chhattisgarh, Jharkhand

From each selected state, two districts which were having highest bovine population were selected. Hissar and

Bhiwani from Haryana, Rewa and Satna district from Madhya Pradesh, and Raipur and Durg district from Chhattisgarh were selected purposively (19th Livestock census). Eighty respondents from each selected states who had at least one adult milch animal were selected through simple random sampling. The ex-post facto research design was applied in this study. Productive and reproductive parameters have been assessed by calculating (Mean $\pm$ SD) values of different parameters. For assessing adoption of reproductive management practices, Reproductive management adoption index (RMAI) was developed.

Effectiveness of developed booklet was assessed through knowledge gain. "Knowledge gain is operationalized as the amount of information and understanding, which gained by the respondents after exposure to booklet for reproductive management of dairy animals". For this purpose, 20 respondents from each selected state were identified and booklet was given for their knowledge enhancement regarding management of reproductive problems. Pre and post knowledge test were conducted with lapse of 15 days and knowledge gain was assessed by using the following formula:

$$\text{Knowledge Gain} = \text{Post-Test Score} - \text{Pre-Test Score}$$

Pearson's correlation coefficient was used for predicting the relationship between knowledge gain with independent variables viz. age, educational qualification, experience, herd size, milk production, income from dairying, extension agency contact, mass media exposure and reproductive management adoption index.

Results and Discussion

In Haryana state, out of 80 respondents, 26; 18 and 62 dairy farmers possessed 95 indigenous cattle; 82 crossbred cattle and 393 buffaloes respectively whereas in case of Madhya Pradesh 74; 14 and 31 farmers possessed 309 indigenous cattle; 49 crossbred cattle and 106 buffaloes respectively. In case of Chhattisgarh 73; 11 and 21 farmers possessed 202 indigenous cattle; 38 crossbred cattle and 65 buffaloes respectively. Farmers of Haryana were practicing buffalo based dairy farming where in case of Madhya Pradesh and Chhattisgarh dairy farming is mixed indigenous cattle and buffalo based.

Productive Parameters of Dairy Animals

Average Daily Milk Yield (ADMY)

The data pertaining to the productive traits of the animals were assessed and presented in (Table 2) which indicated that the average daily milk yield of indigenous cow, crossbred cow and buffaloes were 4.62 $\pm$ 0.84, 11.03 $\pm$ 1.91, and 7.12 $\pm$ 1.92; 3.16 $\pm$ 0.74, 8.88 $\pm$ 2.69 and 4.99 $\pm$ 1.32; 2.36 $\pm$ 0.54, 6.02 $\pm$ 1.01 and 3.87 $\pm$ 0.95 liters/day/animal respectively in Haryana, Madhya Pradesh and Chhattisgarh states. Haryana is well known for its Murrah breed of buffaloes and Hariana breed of indigenous cow. Moreover, extensive irrigation facilities helped farmers to cultivate green fodder. Round the year availability of green fodder which could be the reason for high milk yield of Haryana bovines. The findings were in correspondence with the results of Kale *et al.* (2018) who found more or less comparable results of average dairy milk yield in highly progressive, moderately progressive and low progressive dairy states of India.

Lactation Length

The optimum lactation length of the dairy animals is one of the best indicators in the performances of the dairy animals. The data related to lactation length of indigenous cow, crossbred cow and buffaloes were 250.71 $\pm$ 18.46, 290.25 $\pm$ 24.47 and 263.07 $\pm$ 34.89; 215.63 $\pm$ 31.82, 265.43 $\pm$ 23.25 and 255.00 $\pm$ 41.08; 242.8 $\pm$ 30.33, 244.29 $\pm$ 18.07 and 251.25 $\pm$ 28.75 in days respectively in Haryana, Madhya Pradesh and Chhattisgarh states. However, lactation length of 305 days is optimum for profitability of any herd. But in study area none of the animal was found to be having lactation length of 305 days. Only the crossbred cow of Haryana was found near to the optimum lactation length. The results are in agreement with results of Sachan *et al.* (2015) who reported that lactation length of buffalo is 293.5 $\pm$ 27.1 days in Unnao district of Uttar Pradesh.

Table 2: Species wise productive and reproductive parameters of dairy animals

Parameters	Indigenous cattle			Crossbred cattle			Buffaloes		
a. Productive parameters of dairy animals									
	Haryana	Madhya Pradesh	Chhattisgarh	Haryana	Madhya Pradesh	Chhattisgarh	Haryana	Madhya Pradesh	Chhattisgarh
Farmers*	26	74	73	18	14	11	62	31	21
Animals	95	309	202	82	49	38	393	106	65
Average daily milk yield (Lit)	4.62±0.84	3.16±0.74	2.36±0.54	11.03±1.91	8.87±2.69	6.02±1.01	7.12±1.92	4.99±1.32	3.87±0.95
Lactation Length (D)	250.71±18.46	215.63±31.82	242.8±30.33	290.25±24.47	265.43±23.25	244.29±18.07	263.07±34.89	255.00±41.08	251.25±28.75
Lactation milk yield (Lit)	1409.52±258.66	965.62±228.04	721.21±229.29	3365±583.34	2708.70±820.71	1835.71±310.36	2174.36±585.67	1522.72±402.16	1183.33±291.42
Peak yield (Lit)	7.04±1.29	4.82±1.14	3.60±0.82	16.825±2.91	13.87±3.85	9.18±1.55	10.87±2.92	7.62±1.98	5.91±1.45
Dry period (D)	138.57±18.31	171.56±34.91	159.54±29.48	104.25±15.75	128.48±24.7	136.07±23.87	152.30±18.7	186.36±51.97	178.75±39.04
b. Reproductive parameters of dairy animals									
Age at first calving (month)	39.25±3.021	44.16±5.81	44.36±4.22	34.5±3.44	34.26±6.05	41.36±5.79	41.65±5.051	50.18±7.05	53.25±4.78
Service period (D)	116.43±17.47	110.00±31.65	122.27±30.33	114.5±24.38	113.91±24.46	100.36±18.17	105.38±29.43	116.81±39.7	120.00±58.29
Calving interval (D)	396.43±17.47	390.00±31.65	402.27±30.33	394.5±24.38	393.91±24.46	380.36±18.17	415.38±29.43	426.81±39.7	430.00±58.29
Service per Conception(n umber)	1.91±0.34	1.69±0.44	1.7±0.35	2.24±0.33	2.02±0.6	1.63±0.34	2.37±0.51	1.80±0.42	1.76±0.41

*certain respondents were possessing more than one species

Lactation Milk Yield

The lactation milk yield of indigenous cow, crossbred cow and buffaloes were 1409.52±258.66, 3365±583.34 and 2174.36±585.67; 965.62±228.04, 2708.70±820.71 and 1522.72±402.16; 721.21±165.37, 1835.71±310.35 and 1183.33±291.42 in liters respectively in Haryana, Madhya Pradesh and Chhattisgarh states. The lower lactation milk yield in Madhya Pradesh and Chhattisgarh was primarily attributed to provision of poor quality and quantity of feed and fodders fed to animals. It was also found farmers did not provide adequate quantity of green fodder and concentrate to their animals.

Peak Yield

The data pertaining to the peak yield of indigenous cow, crossbred cow and buffaloes were 6.76±1.48, 16.825±2.91 and 10.87±2.92; 4.82±1.14, 13.87±3.85 and 7.62±1.98; 3.61±0.82, 9.18±1.55 and 5.91±1.45 in litres respectively in Haryana, Madhya Pradesh and Chhattisgarh states. The findings were in accordance with results of Meena *et al.* (2013) who revealed that average peak milk yield of Buffaloes, CB cow, Indigenous cow was 8.87±0.98, 10.26±1.05, 5.58±0.54 litre/animal respectively in Ayodhya district of Uttar Pradesh.

Dry Period

The result indicates that the dry period of indigenous cow, crossbred cow and buffaloes were 138.57±18.31, 104.25±15.75 and 152.30±18.70; 171.56±34.91, 128.48±24.70 and 186.36±51.97; 159.54±29.48, 136.07±23.87 and 178.75±39.04 in days respectively in Haryana, Madhya Pradesh and Chhattisgarh states. Dry period of 60-90 days was optimum in terms of getting good lactation milk yield. Long dry periods of animals were also a reflection of short lactation length which results in less income from the dairy animals. Dry period was found to be more in all

three states but condition of Haryana bovines were found quite better as compared to the Madhya Pradesh and Chhattisgarh. The respondents of Chhattisgarh expressed that, as soon as animal conceive, they stop milking. Same results were found by Kale *et al* (2018) who reported that dry period of indigenous cow, crossbred cow and buffaloes were 125.56 ± 10.86 , 108.07 ± 20.35 and 156.35 ± 30.04 ; 130.50 ± 14.66 , 113.07 ± 20.22 and 184.06 ± 16.56 ; 131.09 ± 14.40 , 124.95 ± 16.50 and 183.38 ± 16.95 in Haryana, Maharashtra and Odisha respectively.

Reproductive Parameters of Dairy Animals

Age at First Calving

In the present study it was observed that the age at first calving of indigenous cow, crossbred cow and buffaloes were 39.25 ± 3.021 , 34.5 ± 3.44 and 41.65 ± 5.051 ; 44.16 ± 5.81 , 34.26 ± 6.05 and 50.18 ± 7.05 ; 44.36 ± 4.22 , 41.36 ± 5.79 and 53.25 ± 4.78 in months respectively in Haryana, Madhya Pradesh and Chhattisgarh states. The dairy animal of Madhya Pradesh and Chhattisgarh were mainly suffered by late sexual maturity as given in (Patel and Ponnusamy, 2019). It is well known fact that the animals who attain sexual maturity late will be usually having delayed age at first calving. Increase in age at first calving reflects the poor maintenance of heifer by the farmers and thus it affected the profitability of dairy enterprise considerably.

Service Period

The service period of indigenous cow, crossbred cow and buffaloes were 116.43 ± 17.47 , 114.5 ± 24.38 and 105.38 ± 29.43 ; 110.00 ± 31.65 , 113.91 ± 24.46 and 116.81 ± 39.70 ; 122.27 ± 30.33 , 100.36 ± 18.17 and 120.00 ± 58.29 in days respectively in Haryana, Madhya Pradesh and Chhattisgarh states. The service period is the period from calving to successful conception. The ideal service period of dairy animal should 60-90 days for getting one calf per year in cow and one calf in 13-14 months in buffaloes (TNAU agritech portal, 2019). Poor maintenance of animals, inability to properly identify post-partum estrus symptoms or poor maintenance of breeding records of animals could have been the possible reasons.

Calving Interval

The calving interval of indigenous cow, crossbred cow and buffaloes was 396.43 ± 17.47 , 394.5 ± 24.38 and 415.38 ± 29.43 ; 390.00 ± 31.65 , 393.91 ± 24.46 and 426.81 ± 39.70 ; 402.27 ± 30.33 , 380.36 ± 18.17 and 430.00 ± 58.29 in days respectively in Haryana, Madhya Pradesh and Chhattisgarh states. However, the calving interval of Haryana bovine was fairly near to the optimum than Madhya Pradesh and Chhattisgarh. A longer calving interval in buffaloes might be higher due to summer stress, silent heat problems and low conception rates (Dhami *et al.*, 2018).

Service per Conception

The data revealed that the service per conception of indigenous cow, crossbred cow and buffaloes was 1.91 ± 0.34 , 2.24 ± 0.33 and 2.37 ± 0.51 ; 1.69 ± 0.44 , 2.02 ± 0.60 and 1.80 ± 0.42 ; 1.7 ± 0.35 , 1.63 ± 0.34 and 1.76 ± 0.41 in numbers respectively in Haryana, Madhya Pradesh and Chhattisgarh states. Lower the service per conception indicate the better reproductive efficiency of animals and also less cost incurred by farmers for extra services. The service per conception was quite higher in Haryana than Madhya Pradesh and Chhattisgarh because majority of farmers of Haryana were using AI as a method of breeding for their animals whereas in case of Madhya Pradesh and Chhattisgarh, most of the farmers were using natural service as breeding method. So, this could be the possible cause of higher service per conception in Haryana because conception rate is about 40-50 per cent only in first AI and 80 per cent in second AI. In addition, during survey, the farmers from Haryana stated that, at least two services were needed for getting a successful conception.

Adoption Index of Reproductive Management Practices Under Different Dairy Production Systems

Reproduction management adoption index has five indicators viz. heat detection, method of breeding, maintenance of record, feeding & nutrition and health care & housing. Under these indicators, various management practices have been studied. It is clearly visible from the (Table 3) that in Haryana, respondents provided major emphasis on feeding and nutrition practices with index value (0.64) followed by method of breeding (0.61), health care and housing (0.60) heat detection (0.56) and maintenance of record (0.41). It might be due to the fact that in dairy

farming 60-70 per-cent of the cost is due to the feeding of animals so by investing more in feeding Haryana, farmers are getting more income from milk.

Table 3: Reproduction management adoption index scores in study area

S. No.	Major Indicator	Index value		
		Haryana (n=80)	Madhya Pradesh (n=80)	Chhattisgarh (n=80)
1	Heat detection	0.56	0.42	0.36
2	Method of breeding	0.61	0.36	0.24
3	Maintenance of record	0.41	0.32	0.2
4	Feeding and Nutrition	0.64	0.43	0.4
5	Health care and housing	0.6	0.52	0.47
	Overall	0.56	0.42	0.35

In Haryana, relatively better availability of irrigation facilities supports the green fodder cultivation and farmers are more aware about the balance feeding of dairy animals. Secondly, farmers were using more A.I. services so they gained more knowledge about its importance. In Madhya Pradesh, respondents mainly followed the healthcare and housing (0.52) followed by feeding and nutrition (0.43), heat detection (0.42), method of breeding (0.36) and maintenance of record (0.32). In case of Chhattisgarh, healthcare and housing (0.47) has got first rank followed by feeding and nutrition (0.40), heat detection (0.36), method of breeding (0.24) and maintenance of record (0.20). It was seen from (Table 3) that the practices related to maintenance of record were least adopted by respondents in all three states, hence there is need to create awareness among farmers about importance of record keeping so that farmers will know and adopt efficient way of heat identification, time of insemination and other relevant management practices which will ultimately improve the reproductive management. Moreover, past history of disease occurrence will ably help the extension functionaries and farmers for better planning and management at field level.

Effectiveness of Booklet on Managing Reproductive Problems

The prepared booklet was tested in selected respondents in all three states. It was clearly depicted from (Table 4) that all the respondents from each states had gained knowledge by exposure to booklet.

Table 4: Knowledge gain of respondents after exposure to booklet in Haryana, Madhya Pradesh and Chhattisgarh

S. No.	States	% Knowledge			t-value
		Pre-test	Post-test	Knowledge gain	
1	Haryana (n=20)	52.7	65.46	12.76	6.40**
2	Madhya Pradesh (n=20)	42.87	57.95	15.08	16.54**
3	Chhattisgarh (n=20)	40.46	60.11	19.66	29.25**

**significant at 1 percent level of significance

It was reported that booklet was found significant for imparting knowledge regarding reproductive management of dairy animals. The overall mean knowledge gain through booklet was found to be 12.76 per cent in Haryana, 15.08 per cent in Madhya Pradesh and 19.66 per cent in Chhattisgarh. It was interesting to note that the highest knowledge gain was found in Chhattisgarh followed by Madhya Pradesh and Haryana. The possible reasons might be that the awareness of the farmers was limited on different aspects of reproductive management and reproductive problems. However, when they were exposed to treatments, their interest and enthusiasm might have enhanced and this might have prompted them to read the booklet carefully. The findings are in agreement with findings of Vidya *et al.* (2010) who found that interactive DVD effective in achieving higher knowledge gain on dairy health management practices among the respondents. Similar findings were reported by Ponnusamy *et al.* (2016) and Ponnusamy *et al.* (2017) who found the effectiveness of Cattle and Buffalo Expert System and Pashu Sakhi model among farmers respectively.

Relationship Between Knowledge Gain of Respondents with Independent Variables

The results of correlation between independent variables and knowledge gain through booklet were presented in

(Table 5) which reported that herd size ($p<0.05$), income from dairying ($p<0.01$) and reproductive management adoption index ($p<0.05$) was significantly correlated with knowledge gain of respondent among Haryana. Whereas in case of Madhya Pradesh experience, extension agency contact and reproductive management adoption index ($p<0.05$) were found to be significant relationship with knowledge gain and in Chhattisgarh knowledge gain of respondents were found significantly associated with extension agency contact and reproductive management adoption index at 5.00 per cent level of significance.

Table 5: Correlation analysis between independent variable and knowledge gain of respondents

S. No.	Independent Variables	'r' value		
		Haryana (n=20)	Madhya Pradesh (n=20)	Chhattisgarh (n=20)
1	Age	0.343	0.412	0.265
2	Education	-0.112	0.121	-0.234
3	Experience	0.406	0.492*	0.235
4	Herd size	0.512*	0.326	-0.217
5	Milk production	0.392	0.262	0.023
6	Income from dairying	0.576**	0.374	0.179
7	Extension agency contact	0.128	0.482*	0.445*
8	Mass media exposure	-0.032	0.247	0.146
9	Reproduction management adoption index	0.451*	0.479*	0.485*

(*Significant at 0.05 level of significance and **Significant at 0.01 level of significance)

Income from dairying is one of the important economic variables of the respondents which have shown positive correlation with the knowledge gain of respondents in Haryana. Higher income from dairying drives the farmers to expend more money for availing the latest technologies. Farmers experience in Madhya Pradesh had significant relationship with knowledge gain as experience helps in developing maturity and ability to face difficult situations. Extension agency contact in Madhya Pradesh and Chhattisgarh had shown significant relationship with knowledge gain of respondents, as extension contact helps the farmers not only to acquire technical knowledge about latest farm innovations. Extension agency can also directly help them to solve their problems. Reproductive management adoption index was found to have significant relationship with knowledge gain of respondents in all the three states as it plays critical role in overall milk productivity of dairy cattle. Farmers who are adopting good reproductive management practices had good knowledge about scientific dairy management.

Conclusion

Productive and reproductive parameters are the key indicators of reproductive efficiency of animals. The study highlighted the difference between the three geographically and economically different states corresponding to different dairy production systems having varying level of productive, reproductive parameters, adoption of reproductive management practices and also varying level of knowledge gain regarding reproductive management. Productive and reproductive parameters of dairy animals and adoption of reproductive management practices of Haryana state is better than Madhya Pradesh and Chhattisgarh. Therefore breed improvement programme, better veterinary structure, training to inculcate the habit of keeping record among the farmers and mass awareness programme on feeding balance diet and mineral mixture should be organized to improve the reproductive efficiency of dairy animals of Madhya Pradesh and Chhattisgarh states. The study find the knowledge gain of respondents after exposure to Booklet across all three states, which could be further improved after subsequent exposure and providing detailed information to the farmers.

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Conflict of Interests

There is no conflict of interest.

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