

Buffalo Healthcare Management Practices in India

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Abstract: *Background and Aim:* Dairy farming is one of the most important sub-sectors of the Indian farming system. Healthcare management practices play a crucial role in realising the full potential of dairying. Hence, the present study aims to analyse the adaptation of healthcare management practices by the buffalo farmers in the Punjab state of India.

Materials and Methods: A sample size of 397 buffalo farmers from three different agro-climatic zones —i.e., Shivalik Foothills, South-West Dry, and Central Plains—was selected using a multistage sampling technique for the year 2019. Descriptive statistics and the Chi-Square test are used for analysis.

Results: Most buffalo farmers adopt general healthcare management practices such as vaccinating their buffaloes against Foot and Mouth Disease and use of anti-parasites for tick eradication, but they are not disinfecting the dairy shed at all. The farmers follow calf and udder healthcare management practices, such as providing bedding material to newborn calves, deworming calves, and udder cleaning. The chi-square test indicates a significant difference across categories regarding the adaptation or non-adoption of certain healthcare practices, such as the source of vaccination, tick solution, bedding material for calves, and deworming of calves.

Conclusion: Buffalo health is not only a veterinary concern but also a socio-economic imperative. While certain healthcare management practices are universally embedded among the farmers, others are constrained by access, awareness, and resource availability, thereby introducing important equity considerations.

Keywords: Calves, Foot and Mouth Disease, Deworming, Disinfection, Udder, Vaccination.

INTRODUCTION

Dairy farming is one of the most important sub-sectors of the Indian farming system. Dairying has played an essential role in the economy of Punjab as it involves a majority of the marginal and small farmers. In India, most farmers rear indigenous breeds, which are generally disease-resistant. These breeds can live and reproduce with minimum feed and fodder. With population growth, the enhancement of milk production is required to meet high demand. This could be possible by adopting a crossbreeding programme. But, in cross-bred buffaloes, the chances of transmission of disease infections are higher than in indigenous buffaloes. Indigenous buffalo breeds, having evolved in local agro-climatic conditions, possess the adaptability and inherent resistance to infections, making them more sustainable in the long run. Whether this sector has attained its full potential or not depends on the availability of animal health services/veterinary services. These services can reduce the risk of diseases affecting buffaloes' health, growth, and productivity. Buffalo production has experienced economies of scale in the veterinary services as size increases, but shows diseconomies of scale in the

costs of animal health products [1]. Treating infections in buffaloes requires careful therapeutic decisions, not only by reducing antimicrobial use but also by improving farm management practices [2]. The adoption of scientific buffalo husbandry practices plays a significant role in improving livestock productivity [3]. Breeding, feeding, housing, and healthcare management practices play a crucial role in maximizing the potential of dairying [4], as these practices can enhance the sustainability of dairy farms [5].

According to the 20th Livestock Census, the buffalo population in Punjab was 40.15 lakh. Talking about the veterinary infrastructure of the state, there are 1367 civil veterinary hospitals and 1489 civil veterinary dispensaries in Punjab in 2023-24. Each veterinary institution serves an area of around 18 square kilometers [6]. Several studies have been conducted to discuss the scenario of veterinary health, buffalo health issues, and healthcare management practices followed by dairy farmers [7-11]. However, little work has been done on this aspect in the state of Punjab. Hence, the present study aims to analyse the adaptation of buffalo healthcare management practices by farmers in Punjab.

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MATERIALS AND METHODS

Research Design

The present study has used quantitative data analysis to provide a comprehensive understanding of the objective.

Sampling

A five-stage stratified sampling approach has been employed. In the first stage, the Punjab state has been selected as it is one of the highest milk-producing states in India. In the second stage, three districts have been selected based on milk production in the state, viz. Gurdaspur, Mansa, and S.B.S. Nagar have been selected from the highest, medium, and lowest milk-producing districts in Punjab. In a way, the selected districts also represent the three agro-climatic zones of the state, viz. the Shivalik-Foothills (Gurdaspur), South-West Dry (Mansa), and Central Plains (S.B.S. Nagar) regions. In the third stage of sampling, all development blocks have been selected from the selected districts. Altogether, 21 development blocks (11 from Gurdaspur, 5 from Mansa, and 5 from S.B.S. Nagar) have been selected. In the fourth stage, one village from all the blocks has been selected randomly. Thus, in all, twenty-one villages have been selected for the survey. In the fifth stage of sampling, a list of households involved in dairying from all twenty-one selected villages was prepared, and households were

categorised into five categories, viz. landless households, marginal farm households, small farm households, medium farm households, and large farm households. Four dairy farm households from each household category have been selected randomly from the selected villages. Thus, a sample of twenty dairy farmers has been selected randomly from each selected village, making a sample of 420 dairy farm households (cow-buffalo mix) from the selected categories from all selected villages. Because in this study, the primary focus is on buffalo husbandry, the analytical sample comprises 397 households that rear buffaloes. Households without buffaloes are excluded from the buffalo-specific analysis.

Data Collection

The study is based on the primary data collected through the pre-tested schedule for the year 2019. The schedule contains information about the demographic profile of respondents, the healthcare management practices they adopt, and other economic aspects of buffalo farming.

Statistical Analysis

Descriptive statistics and the Chi-Square test are used for analysis.

The chi-square test (χ^2) is calculated by using the following formula:



Figure 1: Selected areas for sampling.

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Where χ^2 is the chi-square test, O is the observed frequency, and E is the expected frequency.

RESULTS AND DISCUSSION

Adaptation of General Buffalo Healthcare Management Practices

The general healthcare practices include the provision of veterinary aid, vaccination against Foot-and-Mouth disease, sources of vaccination, tick problems and their solution, and the disinfection of sheds. Table 1 depicts data on the adaptation of general healthcare management practices by buffalo farmers in Punjab. There is a growing demand among producers and consumers for veterinary services to protect the health of buffaloes and the safety of the products for both domestic and international markets. As livestock services have changed after liberalisation, livestock producers are faced with a range of service delivery organisations, both public and private. Out of all, 317 (79.85 per cent) buffalo farmers prefer private practitioners for veterinary aid, as these practitioners reach the farmers' doorsteps at any time whenever the farmers call them. Quick treatment reduces mortality and morbidity among buffaloes, which directly impacts milk yield and reproductive efficiency of buffaloes. The lack of adequate government veterinary services is also reflected in heavy dependence on private practitioners. Another 67 (16.88 per cent) farmers prefer veterinary hospitals/dispensaries for veterinary services because the veterinary charges by the veterinary hospitals are less than those of private practitioners. The other 10 (2.53 per cent) farmers are self-trained in the veterinary services, and only 3 (0.75 per cent) approach local healers for these services. The study's findings do not support the results, which indicate that more than half of the dairy farmers in western Maharashtra receive veterinary aid from veterinary doctors [12].

Livestock diseases can cause heavy losses in Punjab, including productivity losses resulting from the morbidity (illness) and loss of livestock. The central and state governments are making efforts to implement the disease control programmes that also include livestock vaccination. But the farmers vaccinate their livestock only when a veterinarian visits their villages under the government schemes like the Foot & Mouth Disease Control Programme (FMD-CP). Almost all 394 (99.24

per cent) farmers vaccinate their buffaloes against Foot & Mouth Disease as this vaccination reduces the chances of disease outbreak, enhances buffalo immunity, and contributes to the overall productivity of buffaloes. At the same time, only 3 (0.76 per cent) of them do not vaccinate their buffaloes against Foot-and-Mouth Disease because of a lack of awareness about the vaccination, or due to the perception that the vaccination reduces milk production and results in infertility. These findings confirm with the results that have found most of the farmers have vaccinated their dairy animals against Foot & Mouth Disease in Gujarat and Andhra Pradesh [13, 14]. However, the results are in contrast with another study, which shows that more than half of the dairy farmers in Maharashtra do not vaccinate their animals [15]. Across the categories, the highest number (2, 2.50 per cent) of the dairy farmers who do not vaccinate their dairy animals against Foot & Mouth Disease belonged to the marginal farm size category, and neither from the large, medium, nor the small farm size category. The results of the chi-square test are non-significant, revealing that there is not much difference in vaccination against Foot & Mouth Disease across various categories.

Although livestock vaccination is considered an emerging innovation of socio-economic importance in the Indian Dairy industry, the rate of adoption and diffusion of vaccination technology is inadequate at the field level. Most prior studies highlight the role of public veterinary services in maintaining herd health. However, the findings show that more than 90 per cent of farmers depend on private chemists instead of government veterinary hospitals. This challenges the belief of a strong government role in vaccine distribution and reveals a market-driven diffusion process. The insignificant chi-square value indicates that there is no difference in the source of vaccination across various categories. This uniformity could be attributed to Punjab's well-developed private veterinary network and easy accessibility of medicines through chemists in both rural areas, making farmers across all farm size categories equally likely to rely on private sources.

The buffalo tick is an essential external parasite that severely affects the productivity of the buffaloes. Tick causes disease and death due to anemia from loss of blood. The prevalence of tick infestation is reported by 317 (79.85 per cent) farmers. The remaining 80 (20.15 per cent) farmers have not reported tick infestation among their buffaloes. Tick bites create wounds on the skin and udder area, and these wounds act as entry

Table 1: Adaptation of General Buffalo Healthcare Practices

Description	Large farm Househ.	Medium farm Househ.	Small farm Househ.	Marginal farm Househ.	Landless Househ.	Overall	Chi-square value
Veterinary Aid							
Veterinary Hospitals/Dispensaries	5	12	9	16	25	67	31.51 [*]
	(6.10)	(14.81)	(11.11)	(20.00)	(34.25)	(16.88)	
Private Hospitals	75	68	67	61	46	317	
	(91.46)	(83.95)	(82.72)	(76.25)	(63.01)	(79.85)	
Self-Trained	2	1	3	2	2	10	
	(2.44)	(1.24)	(3.70)	(2.50)	(2.74)	(2.52)	
Quacks	0	0	2	1	0	3	
	(0.00)	(0.00)	(2.47)	(1.25)	(0.00)	(0.75)	
Total	82	81	81	80	73	397	
Vaccination against Foot and Mouth Disease (FMD)							
Yes	82	81	81	78	72	394	5.47
	(100)	(100)	(100)	(97.50)	(98.63)	(99.24)	
No	0	0	0	2	1	3	
	(0.00)	(0.00)	(0.00)	(2.50)	(1.37)	(0.76)	
Total	82	81	81	80	73	397	
Source of Vaccination							
Veterinary Hospitals/Dispensaries	2	2	5	3	7	19	6.17
	(2.44)	(2.47)	(6.17)	(3.75)	(9.59)	(4.79)	
Private chemists	80	79	76	77	66	378	
	(97.56)	(97.53)	(93.83)	(96.25)	(90.41)	(95.21)	
Total	82	81	81	80	73	397	
Tick Problem							
Yes	66	67	66	65	53	317	3.05
	(80.48)	(82.72)	(81.48)	(81.25)	(72.60)	(79.85)	
No	16	14	15	15	20	80	
	(19.52)	(17.28)	(18.52)	(18.75)	(27.40)	(20.15)	
Total	82	81	81	80	73	397	
Solution for tick infestation							
Anti-parasites	66	58	55	57	43	279	22.81 [*]
	(100.00)	(86.57)	(83.33)	(87.70)	(81.13)	(88.01)	
Ethno-veterinary practices	0	3	5	4	0	12	
	(0.00)	(4.48)	(7.57)	(6.15)	(0.00)	(3.79)	
Manual Removal	0	6	6	4	10	26	
	(0.00)	(8.95)	(9.10)	(6.15)	(18.87)	(8.20)	
Total	66	67	66	65	53	317 [#]	
Shed disinfection							
Yes	23	14	13	11	1	62	21.25 [*]
	(28.05)	(17.28)	(16.05)	(13.75)	(1.37)	(15.62)	
No	59	67	68	69	72	335	
	(71.95)	(82.72)	(83.95)	(86.25)	(98.63)	(84.38)	
Total	82	81	81	80	73	397	

Source: Field Survey, 2019.

^{*}statistically significant at 5 per cent level of significance.[#]only those dairy households are included who have reported the tick infestation of their dairy animals.

points for mastitis pathogens. Tick infestation is a widespread and non-discriminatory threat to buffalo productivity, requiring collective preventive and management efforts rather than targeted ones. Across the categories, tick infestation on buffaloes is reported in large numbers (67, 82.72 per cent) by the farmers of the medium farm size category and in small numbers (53, 72.60 per cent) by the farmers of the landless household category. One possible reason for this difference could be that medium farm size category farmers usually maintain a large herd size as compared to landless farmers. There is a high chance of tick transmission due to closer contact with buffalo. Tick infestation does not indicate significant differences across the farm size categories, as the chi-square value is found to be non-significant. This suggests that, although numerically there appears to be a higher prevalence of ticks in medium farm size households, this difference is not statistically strong enough to conclude that farm size is a determining factor for tick infestation in the sample studied.

Farmers in developing countries are significant users of antibiotics and antiparasitic agents [16]. Out of 317 farmers facing the problem of tick infestation on their buffaloes, 279 (88.01 per cent) farmers treat tick infestation with anti-parasites (acaricides), followed by 12 (3.79 per cent) using ethno-veterinary practices (using mustard oil, apple cider vinegar, garlic, etc.), and 26 (8.20 per cent) manually remove the ticks. Acaricides do not directly cause antimicrobial resistance (AMR), but they can indirectly influence bacterial ecosystems and lead to increased antibiotic use if mismanaged. The overall impact depends on whether they are used strategically or overused. Strategic use of anti-parasites, integrated tick management, and farmer awareness programs is critical to safeguarding both buffalo productivity and human health. The buffalo farmers prefer ethno-veterinary practices as these are accessible and easy to prepare, and almost at no cost to the farmers [17]. The value of chi-square indicates the significant differences in solutions for tick infestation are adopted across the farm size categories, which shows that tick control is not standardised in Punjab, as different farm categories use various methods to control tick among their buffaloes.

Effective control of infectious diseases is essential for animal health. This mainly relies on the maintenance of a healthy environment involving cleaning and disinfection. Cleaning is the process of

removing dust, dirt, and undesirable material from the shed. Disinfection is the process of eliminating infectious organisms by using chemical agents. The selection of disinfectants depends upon cost and efficiency. Potassium permanganate (KMnO_4) is a commonly used disinfectant in dairy farms because it is less expensive. Phenyl (carbolic acid) is also an effective disinfectant against bacteria and viruses. Altogether, 335 (84.38 per cent) farmers do not disinfect the buffalo shed at all. This reflects a serious gap in awareness and adoption of hygienic farm management practices. This neglect exposes buffaloes to disease-causing pathogens and parasites, leading to reduced milk yield, poor reproductive performance, and increased veterinary costs. It implies that buffalo productivity in Punjab is being undermined not only by biological factors, such as ticks, lice, bacteria, FMD, reproductive disorders, and heat stress, but also by preventable management lapses, underscoring the need for awareness campaigns and low-cost hygiene interventions. The remaining 62 (15.62 per cent) dairy farmers disinfect the shed by using an acaricide spray, phenyl, and potassium permanganate. One such study has revealed that most of the farmers do shed cleaning in north Gujarat [18]. In other words, there is a significant difference regarding the disinfection of sheds across various categories as indicated by the chi-square value. Larger or medium-sized farmers may be more likely to invest in disinfectants and regular cleaning routines due to better awareness, higher economic capacity, and greater concern for disease prevention. In contrast, small or landless farmers might follow these practices less consistently.

Adaptation of Buffalo Calf Healthcare Practices

The calf healthcare practices include the provision of bedding material for new born calves and deworming of calves. Table 2 provides information about the adaptation of buffalo calf healthcare practices by the buffalo farmers in Punjab. The early pre-weaning stage of a calf's life is essential. The use of bedding material for calves can provide comfort, decrease the risk of contracting disease, and reduce stress. Generally, straw is used for making bedding material for young calves in the study area. All 372 (93.70 per cent) dairy farmers provide bedding material for calves, demonstrating a high adoption rate of calf welfare practices in Punjab, and 25 (6.30 per cent) do not provide bedding material for calves. The results confirm the findings of one study, which shows that more than half of the farmers offer paddy straw bedding to young

Table 2: Adaptation of Buffalo Calf Healthcare Practices

Description	Large farm Househ.	Medium farm Househ.	Small farm Househ.	Marginal farm Househ.	Landless Househ.	Overall	Chi-square value
Bedding material for new born calves							
Yes	81	79	78	76	58	372	31.87*
	(98.78)	(97.53)	(96.30)	(95.00)	(79.45)	(93.70)	
No	1	2	3	4	15	25	
	(1.22)	(2.47)	(3.70)	(5.00)	(20.55)	(6.30)	
Total	82	81	81	80	73	397	
Deworming of calves							
Yes	73	78	70	65	55	341	16.05*
	(89.02)	(96.30)	(86.42)	(81.25)	(75.34)	(85.89)	
No	9	3	11	15	18	56	
	(10.98)	(3.70)	(13.58)	(18.75)	(24.66)	(14.11)	
Total	82	81	81	80	73	397	

Source: Field Survey, 2019.

*statistically significant at 5 per cent level of significance

calves [19]. Across the categories, a vast majority of dairy farmers (more than 95 per cent) from all farm size categories, except the landless category, provide bedding material to newborn calves. The chi-square value indicates that significant differences are found in the preferences of dairy farmers regarding the bedding material for newborn calves across the farm size categories. This adds nuance to the literature by showing that even for widely accepted practices, resource constraints still matter, creating disparities in calf healthcare.

Deworming plays an essential role in reducing internal parasites. Buffaloes are not only attacked by outside pests, such as ticks, lice, and flies, but also by internal parasites like lungworms. This, in turn, demands efficient and timely deworming of calves. Ideally, deworming should start from the first week after a calf is born. All 341 (85.89 per cent) dairy farmers deworm their calves, providing strong evidence for the adoption of this preventive health measure to control internal parasites in calves. Deworming leads to better body weight and early maturity of calves by utilising feed efficiently. Healthy calves grow into stronger buffaloes with higher future milk yields. It reduces the veterinary expenses, leading to economic benefits for the farmers. Some studies have found similar results, indicating that most dairy farmers have occasionally practiced deworming of their calves [20, 21]. However, the results are in contrast with the study that shows that 76 per cent of the dairy farmers have not practised the deworming of calves in Mizoram [22]. This highlights

the regional variations in livestock health management practices in India. The significant differences across the categories regarding the deworming of calves are evident, as the chi-square value is found to be statistically significant, suggesting a notable awareness level among farmers regarding this practice.

Adaptation of Buffalo Udder Healthcare Practices

The adaptation of udder healthcare practices, such as udder cleaning and the method of milking, is discussed in Table 3. One of the significant constraints in dairying is the occurrence of sub-clinical mastitis. Sub-clinical mastitis is the inflammation of the mammary gland that does not create visible changes in milk or the udder. It reduces milk production. Mastitis puts a significant economic burden on global milk production [23]. The primary sources of mastitis pathogens are infected quarters, sore teat ends, and the environment. Udder cleaning is the most effective method of disinfecting the udder and teats, as well as preventing sub-clinical mastitis. All 396 (99.75 per cent) dairy farmers do udder cleaning with water, confirming that preventive hygiene practices are widely adopted at the field level in Punjab. Cleaning the udder with water removes dirt and pathogens that cause mastitis. Lower bacterial load on teat skin reduces the chances of infections entering the udder during milking. It also reduces cross-contamination from one buffalo to another via the milker's hand. It also enhances buffalo sustainability as healthier buffaloes stay productive for more lactations. The distribution of dairy farmers

Table 3: Adaptation of Buffalo Udder Healthcare Practices

Description	Large farm Househ.	Medium farm Househ.	Small farm Househ.	Marginal farm Househ.	Landless Househ.	Overall	Chi-square value
Udder cleaning							
Yes	82	81	81	80	72	396	4.45
	(100.00)	(100.00)	(100.00)	(100.00)	(98.63)	(99.75)	
No	0	0	0	0	1	1	
	(0.00)	(0.00)	(0.00)	(0.00)	(1.37)	(0.25)	
Total	82	81	81	80	73	397	
Method of milking							
Full hand	23	27	24	18	10	102	13.23
	(28.05)	(33.33)	(29.63)	(22.50)	(13.70)	(25.70)	
Knuckling	58	54	57	62	63	294	
	(70.73)	(66.67)	(70.37)	(77.50)	(86.30)	(74.06)	
Machine Milking	1	0	0	0	0	1	
	(1.22)	(0.00)	(0.00)	(0.00)	(0.00)	(0.24)	
Total	82	81	81	80	73	397	

Source: Field Survey, 2019.
 statistically significant at 5% level of significance.

regarding udder cleaning across various categories reveals the state pattern with minor changes. The chi-square value across the categories is found to be non-significant regarding udder cleaning. This indicates that udder cleaning practices are largely uniform across all farm size categories, suggesting that farmers—irrespective of herd size or landholding—recognise the importance of udder hygiene and follow similar routines before milking.

Milking is the act of removing milk from the udder. Methods of milking influence the quantity and quality of milk production. Hand milking, including full hand and knuckling, and machine milking are two methods of milking. The whole hand milking method is grasping the teat with all five fingers and pressing it against the palm. Knuckling is the milking method in which the thumb is bent against the teat. Knuckling should always be avoided to prevent teat tissue-related injuries. Out of all, 294 (74.06 per cent) dairy farmers milk by knuckling, followed by 102 (25.70 per cent) by full hand. Knuckling has been observed in Punjab for generations, and farmers often adopt the same method their elders used. Farmers believe that knuckling requires less hand strength than the whole hand method, especially for buffaloes with smaller teats. But knuckling damages teat tissues, creating entry points for mastitis pathogens. The incidence of mastitis causes milk loss, shortening the lactation span and reducing the overall productivity of buffaloes. The

farmers continue with these local practices as they are not receiving extensive training for the scientific milking method (complete hand method). Similar results are reported in the study conducted in Andhra Pradesh and Surat, respectively, where most farmers prefer the knuckling method, which is not recommended [24, 25]. Less than one percent of farmers use milking machines, as these machines are costlier. The results are in the opposite direction of the findings, which have shown that more than three-fifths of the farmers practice the correct practice of full-hand milking in south-western Punjab [26]. Across the categories, the pattern regarding milking method is like the state level, except that only one farmer of the large farm size category uses machine milking.

CONCLUSIONS

The present study aims to investigate the adaptation of healthcare management practices among buffalo farmers in Punjab, with a specific focus on general buffalo health, calf health, and udder health. Using a five-stage stratified sampling framework and primary data collected from 397 buffalo farm households across three representative agro-climatic regions, the research employed descriptive statistics and the Chi-square test to systematically analyse the patterns of adoption across different categories of farmers. The study contributes to the growing body of literature that emphasises the importance of livestock

healthcare as a cornerstone of sustainable dairying in India. Work underscores that buffalo health is not only a veterinary concern but also a socio-economic imperative. Practices such as vaccination, tick and parasite control, calf welfare management, and udder hygiene are integral for maintaining buffalo productivity, reducing disease burden, and ensuring the safety of milk for consumers. While certain healthcare management practices are universally embedded among the farmers, others are constrained by access, awareness, and resource availability, thereby introducing important equity considerations. Strengthening veterinary infrastructure, promoting awareness campaigns, and designing inclusive interventions are crucial steps for ensuring that healthcare innovations reach all categories of buffalo farmers. As dairy farming is vital for rural livelihoods, particularly in Punjab, improving buffalo healthcare practices is necessary. This not only boosts buffalo productivity but also protects public health and supports India's dairy economy in a more competitive and global market.

DATA AVAILABILITY STATEMENT

The data will be shared upon request by the authors.

CONFLICTS OF INTEREST STATEMENT

We declare no conflicts of interest.

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This research received no specific grant from any funding agency.

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