Published in final edited form as:
Prev Vet Med. 2010 September 1; 96(3-4): 179–185. doi:10.1016/j.prevetmed.2010.06.012.

Impact of Livestock Hygiene Education Programs on Mastitis in Smallholder Water Buffalo (*Bubalus bubalis*) in Chitwan, Nepal

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Abstract

A project implemented from 2003–2005 trained women in Chitwan District, Nepal, in hygienic dairy production using a process of social mobilization. The aim of this research was to assess if the prevalence of mastitis in water buffalo in the households of women who were trained was lower one year after training than in untrained households, if the training influenced knowledge and practices for the prevention or control of mastitis, and if these practices and knowledge were associated with a lower prevalence of mastitis. A total of 202 households from Eastern and Western Chitwan District were included in the study. Of these, 60 households had participated in the project and 142 had not. Milk samples were collected from 129 households (33 project households and 96 non-project households). Clinical mastitis was determined using visual inspection of udders and detection of macroscopic clots and flakes in milk. The California Mastitis Test was used to diagnose sub-clinical mastitis from milk samples, and the IDEXX SNAP test to identify the presence of tetracycline residues. The prevalence of mastitis in trained households (39.4%) was 43.78% of that in untrained households (60.4%), lower but not significantly so (p = 0.08, 95% CI 0.17–1.12). Thirteen indicators of knowledge or practice for the control or prevention of mastitis were more likely to occur in trained households, four significantly so (not consuming milk from sick buffalo (p=0.001), using soap to wash hands before milking (p=0.001), discarding milk after antibiotic usage (p=0.01), and choosing appropriate flooring for their livestock (p=0.03)). Trained households that discarded milk from sick buffalo were 2.96 times more likely to have at least one animal with mastitis in the household (p=0.03, 95% CI 1.15–7.65). Trained households that knew to wash buffalos teats after milking were less likely (OR 0.25) to have mastitis in their herd ((p=0.02, 95% CI 0.08–0.80). Of the 138 buffalos tested, only one tested positive for tetracycline residues.

Keywords

Bubalus bubalis; Water Buffalo; Mastitis; Antibiotics; Nepal; Training; Education

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1. Introduction

From 2003–2005, a program of social mobilization was implemented in Chitwan, Nepal to educate women about animal hygiene and safe food handling. Social mobilization encourages community organizations such as women s groups, and emphasizes sharing the benefits of new ideas and skills between group members and the remaining community. This particular social mobilization program for women concentrated on minimizing public health risks by preventing and controlling transmission of livestock diseases through improved animal care and dairy production at the farm level (Jost et al., 2005). The project specifically targeted women for two reasons. Women in the project communities were already members of Heifer International women s groups, which provided easy and organized access to the communities. Secondly, women are the primary food preparers and are often the main caretakers of livestock in Nepal. Members of women s groups organized by Heifer International Nepal were given informational handouts and public health social mobilization training by IAAS Veterinary School faculty and students. An end of project qualitative evaluation in 2005 documented changes in women s food production and preparation, including hand washing before and after milking, safe food storage, proper boiling of milk, and changes in water supply to improve livestock and human hygiene (Jost et al., 2005).

Mastitis is a bacterial disease that causes economic losses in dairy buffalo in Nepal. A 2002 study in Nepal found the economic impact of clinical mastitis in buffalo to be $63 (US) per buffalo per lactation due to lower milk yield, quality, shelf life and fat content, and $30 for treatments, veterinary services and extra labor to care for sick livestock (Dhakal et al., 2002). In a previous study of mastitis in Chitwan District, researchers using the California Mastitis Test (CMT) found the prevalence of mastitis to be 21.4% in cows and 38.5% in buffalo (Knox et al., 2000). In addition to economic effects, the direct human health effects of ingesting improperly pasteurized mastitic milk involve the consumption of heat stable toxins and microorganisms (National Mastitis Council, 2005). Little research has been done on normal SCC in water buffalo, however Dhakal (2006) recommends an SCC threshold of 200,000 per milliliter for tropical dairy farm buffalo. The California mastitis test (CMT) is a commonly used rapid test for sub-clinical mastitis that detects somatic cell nuclear material, relying on a threshold of 300,000 SCC per milliliter (Radostits et al., 1994).

The economic impact of therapeutic failure with inexpensive broad spectrum antibiotics in developing countries is an increasing reliance on newer, expensive drugs unaffordable to the general population (World Health Organization, 2001). There is currently no data available on the presence of antibiotic residues in milk in Chitwan District, although a previous study found that most people are not aware of the need to withhold milk following treatment. That study attempted to quantify the presence of β-lactam antibiotic residues in milk, but did not find any cattle or buffalo with detectable residues (Turnbull, 2003). This may be because of reduced use due to injectable ampicillin and penicillin treatment failure in the area. A recent study has found that coagulase negative Staphylococci were predominantly associated with cases of clinical and sub-clinical mastitis in Chitwan District, followed by Coliforms (Dhakal et al., 2007). Ampicillin was found to be the least effective antibiotic against these organisms, with the sensitivity of the drug decreasing from 70.7% in 2002 to 53.3% in 2005. The same study found that tetracyclines, a popular antibiotic amongst smallholders and veterinary technicians in the area, was 79.0% effective in 2002, but only 57.0% effective in 2005. Enrofloxacin is now widely used as an antibiotic of first choice for mastitis treatment in Nepal (Dhakal et al., 2007).

Buffalo are important assets in small-holder farming communities in Chitwan District. They provide a critical source of protein for household consumption, and excess milk can be sold. In Chitwan District, 43.5% of households are dependant on animal and crop production for food and income, while 74.8% of households consume milk from their own herd and sell the extra for income (Turnbull, 2003). It was anticipated that social and economic factors might prevent households from treating or removing animals affected by mastitis from their herd, particularly sub-clinical mastitis, and that a short-term impact of the training one year after the project might not be measurable. However, it was anticipated that knowledge and practices associated with safe household milk production and consumption would be more common in trained households. The aim of this research was to measure the impact of the project one year after implementation by assessing if the prevalence of mastitis in water buffalo (*Bubalus bubalis*) in the households of women who were trained was lower than in untrained households, if the training influenced knowledge and practices for the prevention or control of mastitis, and if these practices and knowledge were associated with a lower prevalence of mastitis.

2. Materials and Methods

2.1 Population Surveyed

A region of Nepal s tropical Terai from longitude 27.66421° to 27.54935° and latitude 84.90842° to 84.34019° was surveyed, covering parts of Western and Eastern Chitwan District near the Chitwan National Park and Tribhuvan University.

At the time of study design, the mastitis status of buffalo in the households was unknown. Therefore, the study was designed to include several untrained (control) households per trained (case) household based on proximity to the trained household (Dohoo et al., 2003). A total of 202 households were included in the study with a ratio of 2.3:1 control to case households. The local head of Heifer International in Chitwan developed lists of eligible case and control households. Case households included all possible households that were members of a Heifer International women s group in the study area, had participated in the "Training Communities" project and that had at least one buffalo, for a total of 60 case or project households. All eligible case households were interviewed and included in the study. Control households were identified as those buffalo-owning households with at least one buffalo and near case households, which included some members of the Heifer women s groups that had not participated in the project. A number of eligible control households refused to participate and 142 control households were included in the study. Case-control groups were created by stratifying households within each training group, and then randomly assigning control households from each training group area to case households. In this way case-control pairs were created, ranging from 1 to 4 control households per single case household.

2.2 Survey Design

The 15 women s groups were initially visited by members of the research team to introduce the research team, explain the goals of the study, and obtain permission to visit the communities. Over the course of 35 days, two interviewers interviewed 202 households. Each interviewer was assigned to a household based on ease, time and distance to the next household to interview. Interviewers were not randomly assigned to households and were aware of the training status of each household. The family member who had the most contact with buffalo was requested for the interview. In 93.1% of the interviews, the main handler or milker was available for surveying and 70.0% of those interviewed were women. The family member was asked 30 open-ended questions in Nepali and his or her answers were translated into English and recorded on individual printed surveys. The questionnaire was first tested in two households. These surveys were conducted to evaluate the amount of preventive behaviors performed by households in livestock management and to evaluate their knowledge of zoonoses related to dairy production; including information concerning selling and household consumption of milk, preparation of milk before consumption, an overview of the household s entire milking procedure, antibiotic usage, milk withdrawal times, livestock feeding and grazing, and previous training in livestock care. The survey included a series of open ended questions that were discussed and narrowed with each interviewee until the topic was completed. Each interview was approximately one hour long.

The same two interviewers also performed barn-walkthroughs to directly observe barn cleanliness and other livestock management practices through inspection of overall cleanliness, disposal of feces, ventilation quality, presence of obviously sick animals and their separation from the remaining herd, setup of water and feeds, crowding of animals, type of bedding, type of flooring, and presence of stagnant water.

2.3 Mastitis Testing

At each household with lactating buffalo, flip-top vials for each quarter of each lactating buffalo were distributed to primary caretakers on the day the questionnaire was given. The vials, containing approximately 10ml of milk each, were then picked up on the day of milking and kept chilled with ice packs until they were analyzed. Clinical mastitis in the buffalo was determined using visual inspection of udders and detection of macroscopic clots and flakes in milk, while subclinical mastitis was determined using the CMT (Jorgensen Laboratories). All samples were tested within 16 hours of milking, except for one sample that was tested within 44 hours and 30 minutes. Milk from individual quarters was tested in a four-well reagent paddle with a 2:3 proportion of milk to CMT reagent as per the instructions of the manufacturer. Results were read within 10 seconds of gentle swirling of the reagent paddle and scored as negative, +1, +2 or +3 based on formation of a gel and pH indicators. Positive animals were scored as a household positive for sub-clinical mastitis. Previous studies have found that the CMT produces 10.87% false negatives but no false positives in Indian buffalo on smallholder farms (Kumar, 2001, Reddy et al., 2001). Jorge et al. (2005) found a positive correlation between SCC in buffalo in Brazil and the CMT. Dhakal (2006) found that 94% of CMT negative quarter samples from buffalo in Nepal and India had SCC of less than 200,000. Despite its limitations, CMT is an inexpensive, rapid and relatively easy buffalo-side test recommended for detecting subclinical mastitis.

2.4 Tetracycline Residue Testing

Oxytetracycline was reported to be the most widely used antibiotic for mastitis treatment in Chitwan at the time of the study in 2006 (I.P. Dhakal, personal communication). After testing for mastitis, testing for tetracycline residues was done on milk from individual animals. The SNAP Tetracycline Test from IDEXX laboratories, an enzyme-linked receptor-binding assay, was used to detect residues, including tetracycline, chlortetracycline, and oxytetracycline at a sensitivity of 20–30 ppb. Until the day of use, the SNAP test was refrigerated at 0°–7°C. A milk sample of 450μL ± 50μL was drawn from each vial containing an individual animal s quarter milk sample, and added to another vial to make a common vial containing equal amounts of milk from each quarter. From that common vial, a milk sample of 450μL ± 50μL was drawn and incubated at 45°C ± 5°C in the SNAP Portable Heater Block for two minutes before being added to the sample well. After further incubation for seven minutes, a sample spot lighter than the control spot indicated positive results while negative samples had a darker sample spot. A positive sample was recorded as a household positive for residues.

2.5 Analysis

One household with only a single bull and four distant control households were omitted for analysis. A scale was created for the answers to each survey question. Each answer was assigned a number based on appropriateness for preventing mastitis or for protecting human health, with zero assigned to the answer that would have the most negative impact on animal and human health and each increasing number (1–4) corresponding to a more appropriate answer. A database was created in Microsoft Excel 2007 to record these results. The data was then imported into STATA 10.0 for analysis.

Pearson s chi-square test or Fisher exact probability test were performed to test for significant differences in gender of primary caretaker, selling buffalo milk, antibiotic knowledge and vaccine status of buffalo between trained and untrained households.

To determine the effect of training on prevalence of mastitis, a multivariable logistic regression model was used with mastitis as outcome of interest, and village, interviewer, gender of interviewee and training status of household serving as independent variables – village to account for geographic clustering of households, and interviewee gender, and interviewer as potentially biasing influences.

For each survey answer, the frequency and percent of households scoring at each point on the measured scale were tabulated. Those answers in which fewer than eight households scored zero, or scored above zero, were dropped. For each of the remaining answers (15 in total), the scale was collapsed to two dummy variables, with scores combined as appropriate, and for each answer the odds that a score of one was obtained in case versus control households was determined using a simple logistic regression model for each answer, with the answer as outcome of interest and village, interviewer, gender of interviewee and training status of household serving as independent variables.

Finally, to identify which practices and knowledge examined in the survey were associated with mastitis prevalence, a parsimonious multi-variable model was built with mastitis as the outcome of interest and each of the 15 answers plus village, interviewer, gender of interviewee and training status of household as independent variables. Backward and forward elimination of the fifteen answers as independent variables was executed to determine the significance of their association with a mastitis positive household.

For each model goodness of fit was determined with the Pearson chi square test, with a p value greater than 0.05 indicating that the model fit the data well. The Receiver Operating Characteristic (ROC) curve was determined where Pearson chi square indicated there was not a good fit for a model, and for the parsimonious multi-variable model.

3. Results

3.1 Mastitis Prevalence

A total of 136 animals were tested for mastitis from 129 households, 33 buffalo from 33 trained households and 103 buffalo from 96 untrained households. Mastitis prevalence in trained households was 39.4%, while prevalence in untrained households it was 60.4%. Thus prevalence in trained households was 43.78% of that in untrained households, lower but not significantly so (p = 0.08, 95% CI 0.17–1.12). The gender of the interviewee was not found to influence the outcome (p=0.09, CI 1.03–5.71). However, the interviewer was found to influence the outcome, with interviewer number two 2.42 times more likely to have worked in households with mastitis (p=0.04, 95% CI 1.03–5.71). Village four significantly influenced the outcome (p=0.003, CI 0.02–0.45). The model fit the data well (Pearson chi2 34.65, p=0.34).

3.2 Surveys

Sixty of 202 households surveyed (30.5%) had participated in project. The analysis was limited by this number due to the fixed number of buffalo-owning households. Of the households surveyed, 69.8% had at least some kind of livestock training, from either the project or another agency.

Between trained and untrained groups, there was no significant differences in the number of households where women played a part in caring for livestock (p=0.23, OR 2.9, 95% CI 0.53–13.39)), that knew what an antibiotic was or could distinguish antibiotics from other treatments (p=0.51, OR 1.25, 95% CI 0.65–2.42), (such as anthihelminthics or vaccines), and that depended on buffalo milk for income by either selling milk to a diary, in their own shop or directly to consumer homes (p=0.39, OR 1.65, 95% CI 0.53–5.21). Only vaccine status was significantly different between trained and untrained households (p=0.03, OR 2.00, 95% CI 1.07–3.75), where 66.7% (40/60) of trained households and 50.0% (71/142) of untrained households, respectively, had their buffalo vaccinated, with a majority of animals being vaccinated for hemorrhagic septicemia and black quarter by the District Livestock Services Office.

3.3 Relationship between Training and Knowledge and Practices

Out of 25 indicators, ten (40.0%) were commonly known or practiced in both trained and untrained households and were not included in further analysis (Table 1). Thirteen (52.0%) indicators were positively influenced by training, four (16.0%) significantly so (P<0.05) (Table 2). Trained households were 3.41 times (p=0.001, 95% CI 1.72–6.73) more likely to remove milk from sick buffalos from household consumption. Trained households were 2.35 times (p=0.01, 95% CI 1.21–4.48) more likely to remove the milk of antibiotic treated buffalos from household consumption. Trained households were 3.50 times (p=0.001, 95% CI 1.73–7.07) more likely to wash their hands with soap before milking. Finally, trained households were 4.19 times (p=0.03, 95% CI 1.15–15.24) more likely to have brick, wood or concrete flooring in their barn.

Two (8.0%) indicators were not positively influenced by training, and counter-intuitively one of these was significantly associated with untrained households. Trained households were significantly less likely (OR 0.28) to know to collect stripped milk in a container rather than to strip onto the ground (p=0.001, 95% CI 0.13–0.59).

Interviewer was found to be significantly associated (P<0.05) with five indicators (20.0%), and of these to interact with training status in one: likelihood that a trained household knew to dry their hands before milking (p=0.02, 95% CI 1.65–137.66). Gender of the interviewee was found to be significantly associated with likelihood that a trained household was observed to keep their manure away from the house and/or barn (p=0.04, 95% CI 1.03–4.98), but no interaction with training status was found.

Pearson chi2 (p>0.05) showed that the models for 13 of the indicators fit the data well (Table 2). For two indicators, likelihood that a trained household knew not to consume milk from sick buffalo (chi2=55.51, p=0.03) and likelihood that a trained household knew to dry their hands before milking (chi2=46.66, p=0.05), the Pearson chi2 indicates the models did not fit the data well. However, the area under the ROC curve (0.77 and 0.73, respectively) do indicate a good predictive ability.

3.4 Relationship between Knowledge and Practices and Mastitis

Two training indicators were significantly associated with the mastitis status. Trained households that knew not to use milk from sick buffalo were 2.96 times more likely to have at least one animal with mastitis in the household (p=0.03, 95% CI 1.15–7.65). Trained households that knew to wash buffalos teats after milking were less likely (OR 0.25) to have mastitis in their herd ((p=0.02, 95% CI 0.08–0.80). However, interviewer was found to bias result of the model (p=0.03, 95% CI 1.08–6.54). Villages three (p=0.04, CI 0.03–0.89) and four (p=0.003, CI 0.01–0.40) significantly influenced the result of the model. The model fit the data well (chi2=44.10, p=0.51), with good predictive ability (ROC=0.80).

3.5 Antibiotic Residues

Of the 138 buffalos tested, only one tested positive for tetracycline residues. This positive animal was from an untrained household.

4. Discussion

There are several limitations to the design of this study. By analyzing the data with the household as the unit of interest, the study assumes that animals within a household are a homogenous group, ignoring individual factors that affect animal health. The survey also assessed the presence of Western methods that control mastitis, such as washing and drying teats after milking or not using straw bedding. Western mastitis control methods can be impractical in subsistence farming where farmers have few resources. In addition, the impact of sub-clinical mastitis may not be readily appreciated by owners of low producing animals, thus control incentives may be low.

Trained households may have influenced control households by teaching hygiene measures to their neighbors. Some influence is assumed inevitable, as the idea behind social mobilization is that communities become empowered to diffuse knowledge. It would thus be expected that the measured differences between trained and untrained households would be even greater than measured in this study. Additionally, the ratio of 2.3:1 control to case households does not achieve a high level of efficiency. Therefore, the study may have not fully measured the difference between case and controls and the impact of the training may actually be higher than the study indicates.

Interviewer bias could not be avoided as a double blind study could not be designed logistically. Interviewers were aware of both case and control households. Interviewers also performed observational barn-walkthroughs, which may have been subject to bias. Although the barn-walkthrough observations were subjective, the interviewers had been fully trained in mastitis causes and control in the context under study and had been fully briefed in the trainings provided by the project. Selection of the case and control households by a third party may have reduced bias. Interviewer bias would be expected to inflate the differences between case and control households in the survey portion of the study, and analysis showed that interviewer was significantly associated with five indicators: likelihoods that a trained household s barn was observed to be clean or that straw was used as bedding, and likelihoods that a trained household knew to feed its buffalo separated from other herds, knew to dry their hands before milking, and knew to collect stripped milk in a container rather than dispose of it on the barn floor. However, analysis of interaction between interviewer and training status showed significant interaction in only one indicator: likelihood that a trained household knew to dry their hands before milking. Interviewer was found to bias the mastitis outcome between trained and untrained households. It may be that the two interviewers provided different instructions to the owners that collected the milk samples, and this resulted in the finding of interviewer bias regarding mastitis prevalence. Interviewer was also found to bias the results of the multivariable model testing the relationship between knowledge and practice indicators and mastitis status. However, the indicators found to be significantly associated with household mastitis status were not found to be biased by interviewer. Therefore, the interviewer bias in the multivariable model was likely associated with mastitis status and not the knowledge and behavior indicator.

This study found that trained households were significantly more likely to know not to consume milk from sick buffalo, to know not to consume milk from buffalo treated with antibiotics, to know to wash their hands with soap before milking, and to have a barn with concrete, brick or wood as flooring. Women in the training programs were specifically taught how to appropriately wash their hands, how disease is transmitted from animals to humans, not to consume milk from sick animals or after giving medications, and how to keep a clean barn. In interpreting the results from the analysis of knowledge and practices for the prevention and control of mastitis, one must keep in mind that training is likely not the only factor that influenced the results obtained. For example, the training program did not emphasize dirt as an inappropriate flooring. The fact that trained households were significantly less likely to use straw for bedding may indicate that households were exposed to disease control information from other sources, and that trained households may be more likely to have sought disease control information before or after the training. Trained households were not significantly more likely to dry hands before milking, dry teats after milking, and keep track of vaccination records. This may indicate the failure of the training to positively influence these behaviors and knowledge in trained households, or that information on these practices was commonly available to both trained and untrained households outside of the project. The study found that untrained households were significantly more likely to know to collect stripped milk in a container rather than dispose of it on the barn floor, even though women were taught in the training not to let milk from a mastitic animal contaminate the animal shed.

Selling milk from sick or antibiotic treated buffalo can be considered to be inappropriate behavior as it creates a public health threat. However, selling such milk may make economic sense for a family, as family members are protected from the danger of consuming such milk but the family recoups the cost of producing the milk. Households that knew to wash buffalos teats after milking were significantly less likely to have mastitis in their herd. Households that knew not to use milk from sick buffalo were significantly more likely to have at least one animal with mastitis in the household. The strategy to discard milk from sick animals for household consumption protects households from zoonotic diseases such as brucellosis and tuberculosis, as well as exposure to heat stable toxins and bacteria. During the project, the animals of all trained households were tested for brucellosis and tuberculosis diseases. It was found that only one household had brucellosis in the herd, but that 18% of households had animals that were positive to the tuberculin skin test (Turnbull, 2003). This result may indicate that since the trained households knew the disease status of their animals, and therefore were disposing the milk from those animals. It would be interesting to determine if there is an association between household tuberculosis and mastitis status, as thus if disposal of milk from sick animals also protects households from heat stable toxins and bacteria associated with mastitis.

During post survey information sessions, it was found that most participants believed mastitis was due to problems with the feed instead of invasion of microorganisms into the teat. To prevent mastitis and economic loss from lower milk production, future programs should involve focused training on proper milking procedures in addition to hygienic practices. Emphasis should be placed on why these procedures should be followed and their importance to animal health and food safety.

There was an insignificant number of households with tetracycline residues found in the milk of milking buffalo. While a number of households reported using antibiotics in their buffalo, only one household surveyed knew the specific antibiotic that was used for treatment. Typical of small holders in the area, the study participants did not keep record of their animals medical history. Future training programs should emphasize the importance of keeping medical records by owners and of understanding the treatments administered to their animals by technicians. A follow-up study to detect residues should be performed using the more highly prescribed gentamicin, a drug more commonly used by the technicians, as discovered through circumstantial evidence, and enrofloxacin.

This study found that over half of the mastitis prevention tips provided in the training were more commonly known and/or practiced in trained households, indicating that gender-focused social mobilization training can help small holder dairy households prevent or control diseases that harm production and public health in the Chitwan District of Nepal. Community education programs in animal care and husbandry, such as the women s social mobilization model used in the project, may help to reduce the risk of livestock diseases with economic or zoonotic impact in developing communities like those in Chitwan District, Nepal. Further research is necessary to compare the costs of such approaches to the overall economic and social benefits achieved, particularly when taking into consideration the effects of diffusion of learning through social networks.

Acknowledgments

The authors thank Rishi Maya Poudel of Heifer International Nepal Chitwan Office and Gretchen Kaufman, Louise Maranda and George Saperstein of Tufts Cummings School of Veterinary Medicine for support in logistics, and Jeffrey Mariner, Jane Poole and Amos Omore of the International Livestock Research Institute for help with data analysis. This study was supported by an NIH Short-term Training Grant (T35 DK07635). The Training Communities in Livestock-Derived Food Safety and Hygiene in Chitwan, Nepal project was supported by a grant from the United States Agency for International Development Association Liaison Office for University Cooperation in Development grant to Tufts University.

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Table 1

Indicators of knowledge and practice for the prevention and control of mastitis in buffalo in which fewer than 8 households scored 0, or scored above zero.

		Number (%) of households obtaining a score of:			
Indicator (n*)	**Scoring**	**0**	**1**	**2**	**3**
Milk Preparation for Household Consumption (201)	2=Boil; 1=Chill; 0=No prep	4 (2.0)	1 (0.5)	196 (97.5)	
Vaccinated in Past 4 years (202)	1=answer of ‘yes’ or ‘no’; 0=answer of ‘don’t know’	1 (0.5)	201 (99.5)		
Wash Hands Before Milking (202)	1= Yes; 0=No	3 (1.5)	199 (98.5)		
Wash Bucket Before Milking (202)	2 = Yes with soap; 1 = Yes but without soap; 0 = No	2 (1.0)	88 (43.6)	112 (55.5)	
Wash Hands After Milking (202)	2 = Yes with soap; 1 = Yes but without soap; 0 = No	3 (1.5)	58 (28.7)	141 (69.8)	
Manure in Barn (199)	2=Removed from barn; 1= removed from pen but left in barn; 0=remained in pen	3 (1.5)	105 (52.8)	91 (45.7)	
Barn Ventilation (199)	2=Good; 1=Satisfactory; 0=Poor	6 (3.0)	51 (25.6)	142 (71.4)	
Wash Teats Before Milking (202)	1=Yes; 0=No	0 (0)	202 (100.0)		
Dry Teats After Milking (126)	1=Yes; 0=No	122 (96.8)	4 (3.17)		
Barn Crowding (180)	3 = >3 meters; 2 = 1.5–3.meters; 1 = 0.3–1.5 meters; 0 = <0.3 meters	5 (2.8)	108 (60.0)	56 (31.1)	11 (6.1)

* n=number of households scored for each indicator; n varies because for each indicator not all households could be scored.

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Table 2

The influence of social mobilization on household practices and knowledge training for the prevention and control of mastitis in buffalo in 126 households in eastern and western Chitwan district, Nepal. Odds ratio (OR) is the likelihood that a trained household has the indicated knowledge or behavior.

Indicator	OR (SE)	P value	95% CI	Gender of Interviewee Bias (P value)	Interviewer Bias	Model Goodness of Fit Pearson Chi2 (p value)
Chilled or boiled milk before selling	2.41 (1.89)	0.26	0.52–11.18	no	no	14.08 (0.96)
Not consume milk from sick buffalo	3.41 (1.18)	<0.001*	1.72–6.73	no	no	55.51 (0.03)
Knew antibiotic treatment status of their buffalo	1.37 (0.47)	0.36	0.69–2.70	no	no	36.25 (0.55)
Not consume milk from buffalo treated with antibiotics	2.35 (0.80)	0.01*	1.21–4.58	no	no	43.91 (0.20)
Use soap when washing hands before milking	3.50 (1.25)	<0.001*	1.73–7.07	no	no	41.44 (0.32)
Kept their barns at least somewhat clean	1.30 (0.43)	0.44	0.68–2.49	no	Yes (OR*** 0.43, p=0.01, CI**** 0.24–0.80)	45.67 (0.18)
Kept manure away from the house and/or barn	1.76 (0.66)	0.13	0.85–3.68	Yes (OR***** 2.26, p=0.04, CI 1.03–4.98)	no	38.06 (0.42)
Not graze their animals with other herds	1.92 (1.01)	0.22	0.68–5.38	no	Yes (OR 0.39, p=0.04, CI 0.16–0.93)	40.35 (0.37)
Dry hands before milking	1.10 (0.57)	0.85	0.40–3.03	no	Yes (OR 0.26, p=0.01, CI 0.10–0.70)**	46.66 (0.05)
Not strip milk from the teats onto barn floor	0.28 (0.11)	0.001*	0.13–0.59	no	Yes (OR 2.75, p=0.01, CI 1.26–6.01)	29.96 (0.82)
Milk sick buffalo last	1.66 (0.65)	0.19	0.78–3.58	no	no	45.97 (0.18)
Wash the teats after milking	1.24 (0.49)	0.58	0.58–2.67	no	no	50.44 (0.09)
Not use straw as bedding	1.38 (0.52)	0.39	0.66–2.80	no	Yes (OR 0.44, p=0.02, CI 0.23–0.85)	35.67 (0.58)
Brick, wood or concrete flooring in the barn	4.19 (2.76)	0.03*	1.15–15.24	no	no	41.67 (0.31)
Free of stagnant water pools	0.94 (0.31)	0.85	0.50–1.78	no	no	47.16 (0.15)

* Significant result ($p \leq 0.05$)

** Variable (gender of interviewee or interviewer) was found to interact with indicator

*** OR = odds ratio for interviewer two

**** CI = 95% confidence interval

***** OR = odds ratio for men