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# A Review on "Bovine Sub-Clinical Mastitis in Nepal: Sustainable Management Strategy."

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## Abstract

Nepalese bovine farming is crucial yet underperforming enterprise in Nepal. Inadequate husbandry, lack of proper nutrition and increasing cost of inputs in relationship with the price of outputs makes it a risky business. Diseases and reproductive pathologies tops the list and mastitis is one among top three threats found by farmers of Nepal. Sub-clinical mastitis is characterized by no visible changes in the appearance of the milk and udder but milk production decreases and if timely detected saves lots of trouble to the animal, farmer and the veterinarian. The aim of this paper is to review reported information on status, associated risks and preventive measures of sub-clinical mastitis in bovines of Nepal. A systematic review of available papers published in Nepalese and International magazines, journals, conference souvenirs through hard copy and online search from Google Scholar, Research Gate was done. The obtained information was thoroughly reviewed and the prevalence rate, microbes involved, treatment approach adopted was reanalyzed and summarized. Sub clinical mastitis is serious problem from both farmers and consumers' point of view. Given the era of antimicrobial resistance, consumer concerns, cost of treatment and stress of high production-sustainable management is likely the best approach.

## Keywords

Sub-Clinical Mastitis, Nepal, Sustainable Management

## 1. Introduction

Mastitis is the affection of the mammary gland and usually accompanied by physical, chemical and bacteriological changes in milk and pathological changes in glandular tissue (Cressier & Bissonnette, 2011). Mastitis remains the most costly disease for dairy farmers worldwide. Mastitis is assumed to be the top three threats faced by farmer in terms of financial losses (Khanal & Pandit, 2013). Mastitis in bovines can be broadly classified as: clinical mastitis and sub-clinical mastitis. Clinical cases of mastitis are usually characterized by abnormal milk, visible infection of mammary glands and some systemic signs. Sub-clinical mastitis shows no visible changes in appearance of milk and mammary gland but milk production subsequently decreases, composition is altered and various pathogens are present in milk. Sub-clinical mastitis directly or indirectly affects the farmers by decreasing milk production, increasing drug and veterinary expenses and also increasing time and labor. Sub-clinical mastitis is usually unnoticed but it is highly prevalent than clinical mastitis and decreases the production and can easily advance into clinical mastitis under adverse conditions so identification and control of sub-clinical mastitis is very important from farmers' point of view (Islam, Islam, Islam, Rahman, & Islam, 2012). It is a very difficult task for the farmers to detect sub-clinical mastitis, but its detection is crucial to save a lots of troubles to farmers as well as animals (Kabir et al., 2017). In Nepal, sub-clinical mastitis is highly prevalent in bovines due to lack of knowledge among farmers, poor management practices, and lack of facilities for early detection. The prevalence of bovine subclinical mastitis was reported 30-40 times more than

clinical mastitis in cattle (Bhanderi and Garg, 2012). Sub-clinical mastitis has zoonotic importance as themilk from infected animal contains harmful pathogens like Staphylococcal aureus, Streptococcus agalactiae, Escherichia coli, Mycobacterium bovis, Mycoplasma spp., etc. so early detection and control of sub-clinical mastitis is very important from consumers' point of view as well (Dhakal et al., 2007). Similarly, there are issues of antibiotic resistance due to prolonged and haphazard use of antibiotic to control mastitis. The aim of this paper is to review reported information on status, associated risk, treatment and sustainable management strategy for prevention and control of sub-clinical mastitis in Nepal.

The concept of mastitis is customized to address its social and clinical impact in the case of humans and the health, welfare, and economic consequences for other mammals. There are many microbial, host, and environmental factors that influence the development of mastitis. Some are common to all mammals as well as inherent to each species. Together these factors influence the most prevalent etiological agents for each species and might determine the possibility of interspecies transmission with its consequences to public health. The present review will summarize and compare reports on mastitis etiology and its epidemiology in humans and food animal species."

## 2. Etiology

Pathogens causing mastitis in bovines are broadly classified into contagious and environmental bacteria in which contagious bacteria are transmitted from infected quarters to uninfected quarters during milking or other process whereas environment bacteria are found in the environmental and transmitted from various sources and poor management practices (Risco, Donovan, & Hernandez, 2010).

**Contagious bacteria** includes Staphylococcus aureus,Streptococci aglactiae, Streptococci zooepidemicus, Streptococci faecalis, Streptococci pyogenes, Corynebacterium pyogenes, Mycobacterium bovis, Brucella abortus, Pseudomonas pyocyaneus, Pasturella multocida, Mycoplasma bovis, etc.

**Environmental bacteria** includes Escherichia coli, Klebsiella spp., Enterobacter spp., Citrobacter spp., Seratia, Pseudomonas spp., Proteus and Actinomyces Pyogenes, Streptococci uberis, Streptococci dysgaladiae, etc.

In Nepal, the major organism for causing sub-clinical mastitis is Streptococcus which is followed by E. coli which is then followed by Staphylococcus (Khanal & Pandit, 2013). But, Staphylococcus are found to be the major organisms followed by Streptococci which is then followed by E. coli for causing sub-clinical mastitis in cows in India (Patel et al., 2012). Besides bacteria, fungal pathogens to cause mastitis in bovines are Candida Spp., Aspergillus and Fusarium spp.

## 3. Factors Affecting Susceptibility

Factors which increase the risk of occurrence of sub-clinical mastitis are management aspects like hygiene, husbandry, ventilation and milking methods (Fagiolo & Lai, 2007). Various factors affecting the susceptibility of sub-clinical mastitis in bovines are explained below:

### Breed

High yielding breeds are more susceptible to sub-clinical mastitis as compared to low yielding breeds.

### Age and Stage of Lactation

Bovines with old age and late lactation period were found more susceptible to sub-clinical mastitis (Ottalwar Tanmay et al., 2017).

### Species

Cows are supposed to be more prone to sub-clinical mastitis than buffaloes which may be due to tight closure of teat orifice in buffaloes as a result of presence of well-developed circular muscles in buffaloes and also due to presence of thicker stratified squamous keratinized epithelium of streak canal lining in buffaloes which serve as barrier to pathogens from epithelium (Sharma et al; 2012).

### Milking Methods

Improper milking methods and irregular milking intervals increases risk of sub-clinical mastitis in bovines (Sharma et al; 2012).

### Size of Herd

There is increased risk of sub-clinical mastitis with increase in size of herd.

### Nutrition

Deficiency Copper, Cobalt, Zinc, Selenium and Vitamin E is thought to be the risk factor of sub-clinical mastitis in bovines. Similarly, increase in protein diet also increases risk of sub-clinical mastitis (Chakrabarti, 2014).

### Management Practices

Inadequate sanitation, poor hygiene, poor ventilation, etc. are poor management practices that increases susceptibility for sub-clinical mastitis in bovines.

### Trauma

Teat and udder injuries make bovines highly susceptible to sub-clinical mastitis.

### Blood Group

High prevalence of sub-clinical mastitis was found in bovines with M Group System (M & HA, 2016).

## 4. Effects of Sub-Clinical Mastitis

### Effects on Dairy Industry

Sub-clinical mastitis is consideredas one of the threat to the dairy industry. The incidence of sub-clinical mastitis may remain unnoticed but it may cause a huge economic loss by reducing milk production and increasing treatment cost. Dhakal and Thapa (2003) assumed a loss of Rs.4287 or $63 per buffaloes per lactation due to mastitis in Nepal. In India, Dua (2001) has assumed annual losses as a result of mastitis to the tune of Rs.60.5321 billion of which, Rs.43.6532 billion has been assumed to be due to sub-clinical mastitis. The economic losses as a result of sub-clinical mastitis are due to decrease in milk production, medicine and veterinary expenses and increased labor (Sinha, Thombare, & Mondal, 2014) clinical expenses, and additional resources used were quantified and aggregated. The losses due to mastitis in monetary terms were estimated to be INR1390 per lactation, among which around 49% was owing to loss of value from milk and 37% on account of veterinary expenses. Higher losses were observed in crossbred cows due to their high production potential that was affected during mastitis period. The cost of treating an animal was estimated to be INR509 which includes cost of medicine 31.10%. Furthermore, there is high risk of sub-clinical mastitis to develop into clinical mastitis which increases expenses by discarded milk and extra treatment and veterinary expenses. It is assumed that sub-clinical mastitis causes impairment of follicular response in cows which reduces fertility as well as decreases conception rate in bovines (Wolfenson, Leitner, & Lavon, 2015). There is a marked increase in pH and acidity of milk whereas there is a marked decrease in protein, lactose, fat, Solid-Not-Fat (SNF) due to sub-clinical mastitis in bovines (Horváth, Mohamed, Varga, Szemerédi, & Quarini, 1981).

### Effects on Human Health

Subclinical mastitis (SCM) remains one of the zoonotic potential disease for consumers worldwide (Ottalwar Tanmay et al., 2017). Milk zoonosis are very important in developing countries where there is consumption of untreated milk (M & HA, 2016). Milk from infected animal may contain harmful pathogens like Staphylococcus aureus, Streptococci pyogenes, Corynebacterium pyogenes, Mycobacterium bovis, Brucella abortus,Pseudomonas pyocyaneus, Pasturella multocida, Mycoplasma bovis, Escherichia coli, Klebsiella spp., Enterobacter spp., Pseudomonas spp., etc. which are considered as a threat to human health. For instance, ingestion of Staphylococal and Streptococal endotoxin from infected milk may cause serious illness. Similarly, Pseudomonas spp. may be life-threatening to immunocompromised patients. Likewise, Mycobacterium bovis causes tuberculosis and E. coli causes severe gastrointestinal problems and so on. Antibiotic residue is as also a mastitis related public health concern when antibiotics are used haphazardly in the treatment and control of disease without following withdrawal period because these antibiotic residues can cause adverse effects in people allergic to these antibiotics along with the development of antibiotic resistant strains of bacteria (Galal, Hameed, Sender, & Korwin-kossakowska, 2007).

## 5. Seroprevalence

The seroprevalence of sub-clinical mastitis in various places of Nepal are listed below:

| S.N. | Area of research | Species | Number of animals tested | Percentage of positive results | Method of diagnosis | Reference |
|---|---|---|---|---|---|---|
| 1. | Bhaktapur District | Cattle | 50 | 52% | CMT | (Shrestha & Bindari, 2012) |
| 2. | Chitwan District | Cattle | 211 | 69% | CMT | (Lamsal, 2018) |
| 3. | Chitwan District | Buffalo | 60 | 21.7% | CMT | (Dhakal, 2006) |
| 4. | Lamjung District | Cattle and Buffalo | 63 | 46.1% | CMT | (Khanal & Pandit, 2013) |
| 5. | Kathmandu District | Cattle | 186 | 17.20% | CMT | (Khakural GP, 1996) |
| 6. | Chitwan | Cattle | 30 | 30% | CMT | (Dhakal & Tiwari, 1993) |
| | | Buffalo | 70 | 35.71% | | |
| 7. | Western Hills of Nepal | Cattle | 85 | 30.6% | Sodium Lauryl Sulphate Test and Whiteside test in field | (Joshi HD & Joshi BR 1997) |
| | | Buffalo | 363 | 32.2% | | |
| 8. | Eastern Terai of Nepal | Cattle | 190 | 13.6% | CMT and modified Whiteside Test | (Yadav S & Deo SN, 2010) |
| 9. | Eastern Hills of Nepal | Cattle | 388 | 18.8% | Sodium Lauryl Sulphate and Teepol Test (SLST) | (Jha et al; 1993) |
| | | Buffalo | 150 | 21.3% | | |
| 10. | Chitwan District | Catle | 219 | 35.16% | CMT | (Subedi, 2018) |
| 11. | Ratnanagar, Chitwan District | Cattle | 202 | 31.68% | CMT | (Pandit, 2018) |

## 6. Different Methods of Diagnosis

Sub-clinical mastitis is difficult to diagnose due to lack of visible changes in mammary gland and milk. But the early diagnosis of sub-clinical mastitis is crucial to protect farmers from economic loss and to relief animals from stress and discomfort. Following are the most commonly usedmethods for identification of sub-clinical mastitis in bovines:

### California Mastitis Test (CMT)

In this method, 3ml of milk sample and 3ml of CMT reagent is placed in CMT paddle and mixed properly. Then, results were interpreted as 0 (negative/trace), +1 (weak positive), +2 (distinct positive) and +3 (strong positive). It is one of the most used method for diagnosis of sub-clinical mastitis in bovines.

### Mastrip Test

In this method, bromothymol blue is dipped into milk sample. Results are interpreted as yellow color of bromothymol blue denoting healthy milk, green color denoting sub-clinical mastitis and blue color denoting clinical mastitis.

### Somatic Cell Count

Somatic cell count refers to PMN and other cells that are found at mammary gland during an infection. It includes macrophages, leukocytes and neutrophils. In dairy cattle and buffaloes, if SCC is greater than 2,00,000 cells/ml then it

denotes Sub-clinical mastitis (Contreras & Rodríguez, 2011) .

### Cultural Examination

Milk samples can be collected from suspected animals and cultured in a suitable culture media for diagnosis of pathogens.

### Sodium Lauryl Sulphate Test

In this method, 2ml of milk sample is mixed with 2 ml of reagent in a plastic paddle. Results are interpreted by 0, trace, 1, 2 and 3 on the basis of formation of gel.

## 7. Strategies for Thepary and Prevention of Sub-Clinical Mastitis

### Therapeutic Strategy

Antibiotics are widely used in the treatment of bovine sub-clinical mastitis. However, issues of antibiotic resistance are emerging nowadays due to improper use of antibiotics and lack of sensitivity test which ultimately reduces the effectiveness of a particular antibiotic. Sub-clinical mastitis can be treated with either systemic antibiotic therapy or intra-mammary antibiotic therapy.

Drugs used as intra-mammary routes are Pendistrin, Aureomycin intra-mammary, Nefuran intra-mammary, Cloxacillin, Ampicillin, Cephalosporin, etc. (Chakrabarti, 2014).

Drugs used as parenterally are Chloramphenicol, Gentamicin, Enrofloxacin, Amoxicillin, Procaine Penicillin G, Strepto-Penicillin, Ceftriaxone, Oxytetracycline, Lincomycin, Neomycin, Erythromycin, Tetracycline, etc.

Chloramphenicol is assumed to be more effective for treatment of bovine mastitis as compared to Gentamicin, Enrofloxacin, and Amoxicillin but we should follow strictly the withdrawal period of at least 3 days due to direct effect of Chloramphenicol on consumers health and; following things should be considered before starting antibiotic therapy (M & HA, 2016) :

- Type of mastitis
- Pathological changes in mammary gland
- Causative agent
- Drug sensitivity test
- Route, dose and dosing interval of drug
- Withdrawal period of drug

Similarly, effective treatment and control of bovine sub-clinical mastitis requires antibiotic sensitivity test (Bindari, 2012) Botryosphaeria dothiorella (18.52%).

### Sustainable Management Strategy

Livestock sector in South Asian countries like Nepal is characterized by the dominance of small scale dairy farmers possessing only one or two cattle or buffalo with low capital, little knowledge, low productivity, lack of proper feeding, poor management practices and inadequate infrastructure for veterinary services, processing, storage, transport and marketing of milk (Singh & Pundir, 2001). Small scale dairy industry constitute the core of dairy industry in Nepal and is one of the most important source of income in rural and sub-urban areas. Sub-clinical mastitis has important impact in developing countries like Nepal where dairy industries has crucial role in the livelihood of people. Thus, mastitis is a serious problem not only at farm level but also at national level. Mastitis is a complex disease so it does not have easy and simple solution. A sustainable management strategy is required to solve the problem from farm levels. To develop a sustainable strategy, it is very essential to understand its causes, risk factors, economic importance, treatment and methods of prevention.

Many antibiotics are widely used in the prevention and control of sub-clinical mastitis but the use of antibiotics are of great concern due to issues of antibiotic resistance as well as effects of antibiotic residue on human health. So, sustainable management strategy should be focused. These sustainable strategies should focus on creating awareness

by educating people with the economics of the disease at first which will then motivate farmers to follow preventive measures. But, the cost of mastitis in Nepal is still difficult to calculate due to lack of sufficient research at farm levels and national levels. A nationwide prevention and control program, able to reach marginal geographical area is required for effective disease control. Sustainable management strategy should focus on prevention and control of sub-clinical mastitis by following ways:

### A) Shed Management

Shed management is one of the most important factor affecting the health and performance of animal. Shed management is directly affected by the knowledge and skills of farmers. Improper shed management like lack of sanitation, improper ventilation can increase the chance of sub-clinical mastitis. Following things are essential for a good shed management:

- Shed should be constructed in such a way that there is enough sunlight and good ventilation.
- Floor should be made from concrete which prevents it from being damp.
- Shed should be cleaned regularly.
- Floor of shed should be sloped which helps to clean the urine and feces easily and properly.
- There must be a separate place for collection of dung and urine which should be little far from the shed.
- There should be provision for clean drinking water.
- A separate place is required for the storage of feeds and fodder.

### B) Routine Examination

Farmers should be aware about examining their animals routinely which will help in early diagnosis of sub-clinical mastitis. As we can diagnose it earlier, therapeutic measures could be applied early which will decrease the severity of infection and treatment cost as well. Farmers should be aware about collection and transport of milk sample which is very important for proper diagnosis.

### C) Biosecurity

Biosecurity is very essential to prevent the entry of contagious and environmental pathogens in farm. Following things should be considered for a proper biosecurity practices:

- When new animals is to be brought to farm, only healthy and vaccinated animals should be chosen.
- New animal should be placed in isolation for a week while introducing the farm. After proper testing, the animals should be introduced into the herd.
- Unauthorized animals should not be allowed to enter the farm.
- Sick animals should be separated from herd and treated.
- Calcium oxide should be used to disinfect the area around the shed.

### D) Nutrition

There is a crucial role of vitamins and minerals for prevention of sub-clinical mastitis in bovines. Vitamin A increases immunity and creates resistance against disease, Zinc creates skin integrity and thus prevents infection, Vitamin E and Selenium acts as antioxidants (Chakrabarti, 2014).

### E) Hygiene of Milking Person

Hygiene of milking person also affects the incidence of sub-clinical mastitis. If the hands are dirty and contaminated then it may be a source of pathogens for mammary gland which may cause sub-clinical mastitis. So, milking person should wash hands properly with soap and water before and after milking. Similarly, person suffering from zoonotic disease like tuberculosis, cough, etc. should not be allowed for milking.

### F) Hygiene of the Animal

We should also focus on the hygiene of animals to protect them from sub-clinical mastitis. Timely grooming and bathing in clean water on farm animals should be done to make them hygienic and prevent from incidence of various disease like sub-clinical mastitis.

### G) Milking Methods

Milking methods should be proper which will decrease the chances of occurrence of sub-clinical mastitis in bovines. Improper milking method will cause injury to mammary glands that will predispose to sub-clinical mastitis. Healthy animals should be milked first and the unhealthy animals which will prevent healthier animals from infection. In an infected animal also, healthy quarter should be milked first and then unhealthy quarter.

### H) Teat Dipping

Teat dipping is very useful for prevention from streptococci and staphylococci which are regarded as the most common organisms causing sub-clinical mastitis in bovines. Teats of all cows/buffaloes should be dipped in a solution containing 9 parts of povidine iodine and one part of glycerin after each milking to prevent infection by pathogens.

### I) Teat Sealing

Teat sealing can be done by dipping the teats in acrylic solution (Chakrabarti, 2014). It is done in susceptible bovines to create barrier for entry of harmful pathogens.

### J) Dry Therapy

The treatment of animals in dry period to prevent the occurrence of mastitis in next lactation period is known as dry therapy. Vitamin A, Vitamin e, Copper, etc. can be used in dry therapy (Chakrabarti, 2014).

### Implementation of Sustainable Management Strategy

Following things should be done for proper implementation of sustainable management strategy for prevention and control of sub-clinical mastitis in Nepal:

- First of all, overall survey should be done to explore the overall status of dairy industry and status of sub-clinical mastitis in Nepal.
- After that, root causes of sub-clinical mastitis in small scale as well as large scale dairy farming should be understood.
- Mastitis control program which is able to reach marginal geographical areas and small scale farmers should be made by keeping in mind the financial sustainability of the project.
- A national level extension program is needed to create awareness about sub-clinical mastitis and its impacts on dairy industry.
- Mastitis control program should be implemented in all 77 districts which should be monitored by "Veterinary Hospital and Livestock Services Expert Centre" of each districts.
- Local veterinary officers and local leaders should be selected and trained to motivate farmers to follow mastitis control programs.
- Regular meetings, workshops and seminars should be conducted under veterinarians or local leaders to create awareness among farmers.
- Some farms with best management practices should be rewarded and also declared as "Model Farms". Others farmers should be taken to visit those farms to learn ideas about good management practices.
- Veterinary Hospital and Livestock Services Expert Centre of each districts should facilitate farmers with rapid diagnosis of sub-clinical mastitis and proper treatment.
- Local agro vets should provide essential medicines at reasonable price.
- Farmers should be made aware about proper use of antibiotics and issues of antibiotic resistance and antibiotic residues.
- Farmers should be motivated to practice ethno-veterinary medicines.

## 8. Ethno-Veterinary Practices

The use of ethno-veterinary practices can produce sustainable and cheaper effect as compared to antibiotics (Rehman et al; 2009). WHO stated that about 80% people in developing countries are still dependent on ethno-veterinary practices due to their cheaper price, traditional belief and easy accessibility. Considering the economic aspects of sub-clinical

mastitis, issues of antibiotic resistance and harmful effects of antibiotic residues on human health, the use of ethno-veterinary medicine can be considered as blessing to dairy industry. Ethno-veterinary practice is based on farmer's knowledge, skill, belief and tradition.

- In India, people use the mixture of *Benachu kallu*, Desi butter, abetel leaf (*Piper betel*) and Sambrani (*Benzoin resin*) as a treatment protocol of mastitis (Mooventhan, Manimaran, Kumar, Selvan, & Prakash, 2016).
- Some eople also using thepaste of turmeric powder (*Curcuma longa*), Drumstick leaves (*Moringa oleifera*) & common salt (Sodium Chloride) for treatment of mastitis (Mooventhan et al., 2016).
- Similarly, mixture of Aloe vera (250 g), Turmeric (50 g) & CaO (10 g) could be applied to entire udder for treatment of mastitis (Priya & Mohan, 2018).
- Freshly prepared mixture of Aloe vera leaves, *Curcuma longa* rhizome and calcium hydroxide can be applied externally over udder 10 times per day for 5 days and the affected animals are feed with 2 lemon fruits per day (Mn, Punniamurthy, Mekala, Ramakrishnan, & Sk, 2017).

Some traditional ethno-veterinary practices are not use nowadays but we can also hear from memory of eldest population of community. Adecrease on circulation of ethno-veterinary practices from one generation to another was found which may be due to easy availability of antibiotics. Lack of proper documentation of hidden ethno-veterinary practices is one of the major problem in Nepal.

## 9. Vaccination

It is beyond the scope of this study to present the detail information about vaccination for sub-clinical mastitis but some information about the vaccination is presented. In general, vaccination against mastitis is not effective due to diversity of bacterial pathogens causing mastitis. Vaccine for Streptococcus agalactiae, Streptococcus dylagalactine, Streptococcus aboris, Staphylococcus pyogenes, Staphylococcus aureus, E. coli, Pseudomonas aeruginosa and Corynebacterium is available in Indian market (Chakrabarti, 2014).

However, various research has shown that these vaccines reduces the clinical severity of the disease but cannot prevent new infections (Tiwari et al., 2013). The efficacy of mastitis vaccine is controversial so, further studies are required to test the effectiveness of vaccines. Sustainable management strategy should also focus on vaccination for mastitis.

## 10. Conclusion

Sub-clinical mastitis is highly prevalent in dairy cattle and buffaloes of Nepal which is causing high economic losses in terms of decreasing milk yield, high medical expenses, and increasing additional labor. The main reasons for high prevalence of sub-clinical mastitis is found to be poor hygiene, inadequate sanitation, lack of early diagnosis, lack of proper veterinary service and most importantly lack of awareness among farmers. Sub-clinical mastitis has zoonotic potential as infected milk causes health hazards in humans. So, problem of sub-clinical mastitis in bovines is significant from consumers' point of view as well.

Prevention and control could be the most important aspect to reduce the incidence of sub-clinical mastitis in developing countries like Nepal where early detection by laboratory diagnosis and proper treatment by antibiotic sensitivity test is still a difficult task due to uneducated farmers, subsistence farming and lack of effective efforts from government. It is important to realize that production related diseaselike mastitis are given little attention in national program although they have been reported to be highly prevalent in small scale dairy sectors. For this, government, NGO's, INGO's, and all other related stakeholders should be committed to bring mastitis control programs. These programs must focus on prevention and control strategy by good management practices and education about sub-clinical mastitis through training, seminars and workshops. An effective extension program is needed to create awareness among farmers for prevention and control of sub-clinical mastitis. Similarly, rapid test kit should be easily accessible to farmers for early diagnosis of mastitis. Government offices must provide effective veterinary services to farmers for early diagnosis and treatment of sub-clinical mastitis. Further studies are required about the status, economic aspects, prevention and control strategy of sub-clinical mastitis in bovines of Nepal which will aid in planning and implementation of various mastitis control programs in Nepal.

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