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Mastitis: A challenge in doubling the farmer's income by 2022

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The livestock sector being a major contributor to the Gross Domestic Product (GDP) of the country is still facing many challenges like mastitis. Mastitis causes large economic losses to farmers in terms of loss of milk yield, veterinary care, decreased value of animals and many more. It is a big hurdle in the dream of 'Doubling farmer's income by 2022' for the livestock farmers. It needs urgent attention in terms of early and better diagnosis, proper treatment and post-treatment management and most importantly, the prevention and control.

Keywords: Farmers, Income, Mastitis, Milk

INDIA is world's 5th largest economy with GDP of $2.936 trillion and growing rapidly. The livestock sector contributes 4% of India's GDP and dairy sector comprises majority of share. India is leading the whole world in milk production by producing 176.30 million tonnes of milk every year but average daily production of milk of a animal in India (7.1 kg) is very less as compared to other countries like UK (25.6 kg) and Israel (38.6 kg). The major causes of low productivity in India are both intrinsic (low genetic potential) and extrinsic (poor nutrition/feed management, inferior farm management practices, ineffective veterinary care and disease control). Mastitis is one of the important facets which directly or indirectly affect the economy of the farmers and ultimately affect the economy of the country.

Mastitis is characterized by inflammation of mammary glands and physical, chemical and, usually, bacteriological changes in milk. It is a multi-etiological disease and is a result of interaction between infectious agents, host resistance, and environmental factors. Mastitis is the most widespread and most economically damaging disease in dairy milk production in India.

Economic cost of mastitis

Economic cost associated with mastitis is due to direct losses (a reduction of milk quality, quantity and culling of animal) and treatment cost. In addition, it can also cause irreversible damage to the udder tissue by destroying milk secreting cells and replacing them with scar tissue resulting in a permanent loss of productive ability. Mastitis hinders the goal of one calf a year by reducing reproductive ability of the animal. Occasionally can also cause fatalities.

On an average, it 50% of all dairy animals in India are affected by mastitis and loss is on the increase. It accounts for annual loss of more than ₹ 50 crores. Out of this huge amount, reduced milk yields (up to 70%), milk discard after treatment (9%), cost of veterinary services (7%) and premature culling (14%) are major. Economic loss per animal is estimated in the range of ₹ 21,677 to ₹ 88,340 for one lactation period.

Etiology

Variety of pathogens are responsible for occurrence of mastitis like bacteria, fungi, virus, yeast and algae. They can be divided into contagious and environmental pathogens. Contagious pathogens live on the cow's udder and teat skin, and transfer from affected cow to unaffected cow during milking. Environmental pathogens are present in the housing and bedding, can transfer during milking or between milking, when the cow is loafing, eating or lying down, mainly after milking because teat canal remains open for sometime after milking. The main mastitis causing pathogens are bacteria like *Escherichia coli (E. coli)*, *Streptococcus uberis* and *Staphylococcus aureus*.

Forms of mastitis

Two different form of mastitis occurs in dairy animals' i.e clinical and subclinical mastitis. Clinical mastitis results in apparent change in appearance and size of mammary glands due to inflammation which is characterized by pain, swelling and redness. Also there will be change in milk composition and appearance with decreased milk production. It can be detected easily. Clinical mastitis can be further divided on the basis of severity into per acute, acute, sub acute and chronic. In contrast, detection of sub-clinical mastitis is

more difficult because signs like change in appearance of mammary glands and milk appearance are not readily apparent. Thus, its diagnosis is a challenge in dairy animal management and sub-clinical form is 15-40 times more prevalent than the clinical form and accounts for larger (approx 60%) economic losses as compared to clinical form. Also the sub-clinically affected animals remain a continuing source of infection for herd mates.

Sign and symptoms

Abnormal milk, abnormal mammary gland and abnormal animal are characteristic of mastitis and extent of abnormality depends upon the form of mastitis.

Table 1. Clinical signs and symptoms of mastitis in dairy animals

Changes	Sign and Symptoms	Form of mastitis
Abnormal milk	• Discolouration of milk • Presence of flakes, blood clots, pus in milk	• In all forms except sub-clinical mastitis
Abnormal gland	• Painful inflammatory swelling • Redness • May be hot to touch • Fibrosis and atrophy	• Only in per acute and acute· • Mild in sub acute • Chronic (infection more than 2 months)
Abnormal animal	• Fever, anorexia, depression	• Marked in per acute, can be there in acute form also

Diagnosis

Diagnosis of mastitis is the most important before arriving at the treatment because all forms of mastitis can not be treated by a single mean of therapy. Diagnosis of mastitis can be done by following approaches:

Physical examination of udder: Swelling, redness and pain in the mammary gland which could be ascertained from distant or by physically palpating the mammary gland of the animal are a good indicator of the clinical mastitis as shown in the figure below. It should not be confused with udder edema in the peri-parturient animals especially in the primiparous (first calvers).

Strip cup test: It is the most basic field level test to detect mastitis but can not detect sub-clinical form. Squirt first stream of milk from each teat into strip cup. Inspect for flakes, lumps, and other signs of abnormal milk. Absence of abnormality can not rule out mastitis.

California mastitis test (CMT): It is the most promising field level test to detect mastitis. Both forms of mastitis i.e clinical as well as sub-clinical could be diagnosed with CMT. It detects increased number of somatic cells (normal d" 2 Lakh/mL) in case of mastitis. Problem in each quarter can be analyzed separately and also give a estimation of somatic cells at field level. Pooled bulk milk samples can be used to determine herd status. A four-well plastic paddle is used, one well being used for each quarter of the cow to be tested. The foremilk is discarded, and then a little milk drawn into each well. An equal volume of test reagent (CMT reagent) or any detergent at home can be added and then the sample is gently agitated and result is interpreted in Table 2.

Table 2. California mastitis test (CMT) and its interpretation

CMT Score	Reaction	Interpretation	Somatic cell count (Lakh/mL milk)	Form of mastitis
0	Fluidy milk	Negative	0-2	No mastitis
1	Slight precipitation	Trace	1.5-5	Subclinical
2	Distinct precipitation with no gel formation	Weak positive	4-15	Subclinical
3	Precipitation with gel formation	Distinct positive	8-50	Clinical
4	Complete gel formation	Strong positive	> 50	Clinical

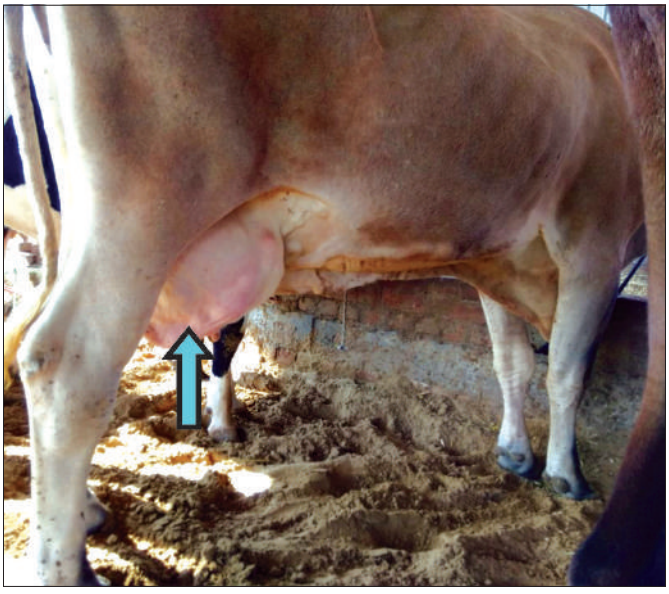
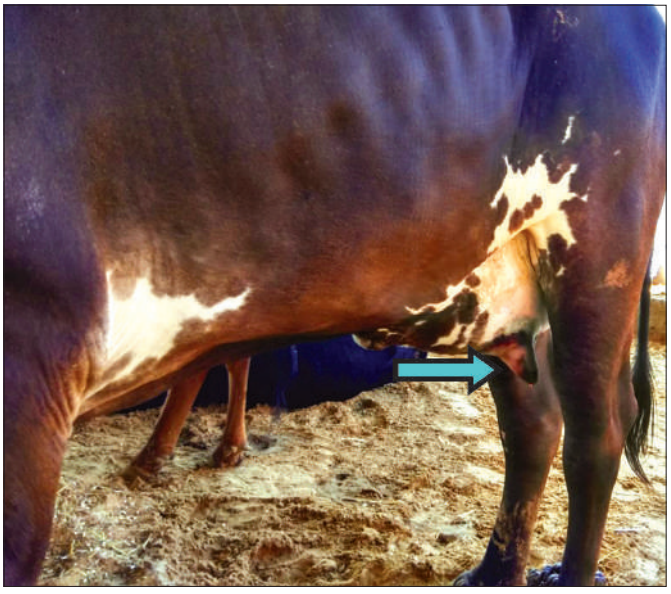


Fig. (a) Swollen and red udder of the cow affected with clinical mastitis (arrow)



(b) Swollen teat of the cow affected with clinical mastitis (arrow)

pH of milk: pH of milk from affected animal is higher than normal milk (6.4-6.8) due to inflammatory condition in the udder tissue leading to alkalinity. It can be detected at farm level with help of pH paper strips and the colour obtained could be matched with the standard for interpretation.

Electrical conductivity measurement: Due to damage to cells of mammary glands in mastitis, concentration of Na^+ and K^+ increases in milk which results in increased electrical conductance of milk. Conductance of milk is determined with help of special instruments called conductivity meter. The normal conductance values are 2.5-5.0 and 4.0-6.0 mS/cm (18°C) for buffalo and cattle milk, respectively.

Somatic cell count (SCC): It is the indicator of milk quality. Majority of somatic cells are *leukocytes* (white blood cells), which become present in increasing numbers in milk when an immune response is elicited against a mastitis causing pathogen and a small number of normal milk-producing epithelial cells which shed from inside of the udder in increased numbers when mastitis occurs. CMT gives an estimate to SCC, whereas, specialized instruments like somatic cell counter at farm level and special staining techniques like Modified lamport's stain in specialised laboratries can be performed to detect exact number of somatic cells in milk. Individual animal cell count to determine individual animal status or cell count in pooled milk sample can be done to access the herd status.

Cultural sensitivity examination of milk (CST): It is the gold standard laboratory method to definitively diagnose the causative bacteria behind cases of clinical and sub-clinical mastitis. After culturing, further sensitivity test can be done to determine the most appropriate antimicrobial against cultured agent and to decide most appropriate course of action. Sampling is the most critical step in the milk culture examination. Contamination from the hands of the individual taking samples, from contaminated sample containers or from environment renders the test results meaningless. Underlying procedure is to be followed during sampling:

- Use sterile containers to collect samples and kept sealed until collection start.
- Whole udder should be thoroughly cleaned with wet clean cloth and after drying the udder properly, teats should be disinfected with the help of disinfectants like 70% alcohol.
- Individual collecting samples should thoroughly clean his hand with help of disinfectant.
- After discarding one or two streaks of milk, sample is collected directly into container and labeled properly.

Milk NAGase (N-acetyl-β-D-glucosaminidase) test: It is a specialized laboratory test and an accurate indicator of sub-clinical and clinical mastitis.

Catalase test: It is a laboratory screening test used to detect clinical and sub-clinical mastitis. Amount of catalase present is measured in milk and this is an indirect measure of the somatic cell count of raw milk.

Chloride test: Normal milk consists of 0.07% chloride and the amount of chloride is increased in case of mastitis. This test detects increased chloride content of milk. Milk sample (1ml) is taken in test tube and small amount of silver nitrate (0.1341%) solution is added. Two drops of 10% potassium chromate is added to this, appearance of yellow colour indicates positive cases of mastitis and blue colour will indicates negative cases.

Bromothymol blue (BTB) and bromocresol purple test (BCP): Cheap, field level test uses indicator dyes which changes colour on pH change (affected milk has higher pH). Milk samples (5 ml) are taken in two different test tubes. In first tube, add 1.6 g of BTB reagent and in second add 1.6 g of BCP reagent. In BTB, mastitis case is positive only when colour changes from green to dark blue-green colour, whereas in case of BCP, dark blue or purple colour reaction will appear. Specially marketed strips like Mastrip® (Ayurvet Limited) can be used at field level.

White side test: It is a rapid field level test and sub-clinical mastitis can also be diagnosed using white side test. This test is indirect measure of increased somatic cell in mastitis affected milk. 5 drops of milk is taken on a slide and 2 drops of 4% NaOH are added and is observed for precipitate formation which indicates positive results.

Table 3. Wisconsin Mastitis test (WMT) and its interpretation

WMT value	Somatic cell count (Lakh/mL)	Interpretation
d"11	d"2	Negative sample
12 to d"30	d"15	Sub-clinical mastitis
e"30	e"15	Clinical mastitis

Wisconsin mastitis test (WMT): It is a simple, rapid screening test for sub-clinical as well as clinical mastitis in bulk samples. This test is also an indirect indicat of somatic cell count. An increase in leucocytes is accompanied by an increase in viscosity when a detergent reagent is mixed with a milk sample. The viscosity is determined by measuring the height of a column of milk-reagent mixture remaining in a test tube after a 15 sec outflow through a cap having an orifice 1.2 mm diameter and could be interpreted as per Table 3.

Treatment and control

The treatment and control of mastitis is an intermingled phenomenon as treatment of one positive case will control the spread of mastitis to uninfected animal. Thus it can be categorized in 3 basic strategies i.e elimination of existing infection, prevention of new infection and monitoring udder health status.

Elimination of existing infection

a) Therapy during lactation:

i. Antimicrobial therapy as per CST report and intra-mammary infusion is preferred if only one or 2 teat are affected while systemic route is preferred in case both quarters are affected.

ii. Anti-inflammatory agents like Ketoprofen (2-4 mg/kg OD IM) or Meloxicam (0.5 mg/kg OD/BD IM) to control the inflammation.

iii. Antioxidant therapy like ascorbic acid (20 mg/kg OD IM) or

selenium plus vitamin E preparations could be used to counter the alkaline changes in the milk due to inflammatory condition as well as to increase the power of udder tissue to fight the infection.

iv. Supportive therapy consisting of trisodium citrate to counter pH change (30 g), vitamin A, D_3 and ethno veterinary practices like feeding of sodium bicarbonate and lemon juice mixture.

b) Dry cow therapy

- Intra-mammary infusion of antibiotics after cessation of lactation period to control the existing infection in addition to preventing new infection in early lactation. It consists of three basic approaches.
  - **Blanket strategy:** Infusion of intra-mammary preparations in all teats of all animals whether affected or not.
  - **Selective animal therapy:** Infusion of intra-mammary preparations only in all quarters of the affected animals.
  - **Selective quarter therapy:** Infusion of intra-mammary preparations only in the affected quarter of the dry animals.

c) Culling of chronically affected animal

i. Animal that has three or more episodes of reoccurring mastitis or fibrosed udder due to chronic course of mastitis should be culled.

ii. It serves as measure to control the spread of infection in healthy animals in addition to improving economics due to high treatment cost.

Prevention of new infection

a) Udder hygiene and proper milking method:

i. Pre milking udder hygiene:

- Proper cleaning of udder before milking with the help of a dry clean cloth helps in prevention of the spread of mastitis and also stimulates milk let down and efficient milk removal.
- The milking individual should disinfect hands before milking each animal.
- Milking equipments like teat cups should be disinfected before and in between every milking.

ii. Proper milking:

- Complete milking should be done as the milk remaining in the udder tissue could be a better media for bacterial growth and mastitis could develop.
- Proper full hand milking should be practiced and remaining milk should be removed with the help of stripping.
- Knuckling method should not be practiced for milking.

iii. Post milking consideration

- Teat disinfection in disinfectant like 70% alcohol after the milking prevents establishment of infection due to environmental pathogens.
- Do not allow the animal to sit at least for 30 min after milking as the teat canal remains open for some period after the milking and environmental pathogens could enter in the teat leading to mastitis.

b) Maintenance of appropriate environment:

- Proper temperature, humidity and air quality should be maintained inside the animal house.
- Milking should be done in separated well cleaned area.
- Proper waste disposal should be ascertained.

c) Nutritional management:

- Proper inclusion of trace minerals like Copper, Manganese, Zinc, Selenium and vitamins like E, A and beta carotene in animal feed as these micronutrients helps the animal to combat infection and also maintains proper udder health.

d) Bio-security for herd replacement:

- Proper testing and milk culture examination of animal should be done before incorporating of the new animal in the herd as the affected animal could be a source of infection to healthy animals.

e) Vaccination:

- Vaccination of animals for prevention and control of mastitis in dairy animals in India but various vaccines are available against the pathogens causing mastitis in the western world. These vaccines could be used for the prevention and control of mastitis in animals on India too to prevent the economic losses occurring due to mastitis as well as to increase the milk production and income of the dairy farmers. The commonly available vaccines to control mastitis in the foreign countries are:

i. Lysigen® (Boehringer):

- This vaccine is against *Staphylococcus aureus* infection.
- It is recommended at 6 month of age, repeat in 2 weeks and then booster dose every 6 months.

ii. ENVIRACOR J-5® (Zoetis):

- This vaccine is against *E. coli*.
- First two doses are given to dry animal and one dose after calving.

iii. J-VAC® (Boehringer):

- This vaccine is against *E. coli* and can be given at any stage of lactation.
- Two doses are to be given with booster dose after 2-4 weeks of first dose.

iv. ENDOVAC- Bovi® (IMMVAC):

- This vaccine is against *Salmonella typhimurium*.
- First dose is given at dry off stage and then booster dose 2-3 weeks later.

Monitoring herd health status

a) Herd level:

- Pooled milk somatic cell count.
- Pooled milk CMT.

b) Individual level:

- CMT at seven day interval.
- Culture examination of composite quarter milk samples at regular interval of three months.

Conclusion

Diary sector contributes at a large extent to India's economy. It is a source of livelihood for large section of society and contribution of dairy sector is increasing as compared to the agriculture sector. Diary sector shows the most promising potential in achieving the goal of 'Doubling farmer's income by 2022' of Government of India but constraints like Mastitis are one of the biggest hurdles in achieving this goal. So, proper steps at each level should be taken to prevent losses from mastitis so that economics of dairy sector and farmers grows at a rate that farmer's income can be doubled by 2022.

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