# A Survey on the Prevalence of Mastitis and the Quality of Milk Among Malian Dairy Herds in the Bamako Area

## Trip Report, December 13 – 20, 2008

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*Preamble*: In August of 2006, Oumar Ibrahima Toure, Former Minister of Livestock and Fishery of Mali and J. Scott Angle, Dean of the College of Agricultural and Environmental Sciences at the University of Georgia signed a *Letter of Intent* to establish outreach, training, research, and scholarly cooperative projects of mutual interest for each institution. More specifically, the goal is to increase the knowledge, experience, and technology of people involved in livestock, poultry, and fish production that could affect our economies. Specific areas of collaboration include: animal and poultry nutrition, animal genetics, disease control, production and marketing of value-added products, aquaculture, enhancement of farmer organizations, and professional capacity building. In December of 2007, Dean Angle headed the December 2007 delegation of six professors, including Dr. Nickerson, who visited Mali at the invitation of the present Minister of Livestock and Fishery (Madame Diallo Madeleine Ba) to tour agricultural sectors of the country and identify areas of mutual interest for collaboration. It was during this trip that Dr. Nickerson identified the dairy industry as an area in which the two institutions could collaborate to enhance milk quality and mastitis control. The report of the December trip completed in January 2008, was forwarded to the Ministry of Livestock and Fishery, and included a series of recommendations offered by Dr. Nickerson for exploring collaboration in the dairy sector. (Attached is copy of January trip report). With a population of ~10 million dairy animals equaling the Malian human population, the potential exists for Mali to become self sufficient in milk production and less reliant on skim milk powder imports to feed its population. In addition, once Mali becomes self sufficient in producing its own dairy products, it can begin exporting surplus products as a prime source of revenue. However, milk quality must first meet international standards for export to other countries. The purpose of the present survey was to determine the level of mastitis (disease control) and to assess milk quality (production and marketing of value-added products) in order to identify areas that could be modified to enhance overall milk production as well as product safety for consumers. A project proposal had been developed previously by Glover and Nickerson in anticipation of conducting the present survey, and this document was shared with administrators at both UGA and the Malian Ministry of Livestock and Fishery.

*Introduction*: This report is presented as a daily log followed by results of the survey in paragraph and tabular form. Tables are also presented that contain the results of each herd studied so that at some point, the data can be translated into Bambara, Songhai, or Fulani for discussion with individual dairy herd owners. Finally, a section titled "Suggestions for Follow-up and Future Collaboration" (pg 17) is offered for consideration by the Ministry, which offers future studies as proposed by authors Glover, Cisse, and Nickerson.

**Saturday, December 13**

Glover and Nickerson departed Atlanta at 8:50 PM on flight Air France 385 to Paris, arriving at 11:10 AM December 14.

**Sunday, December 14**

We had a 5.5-hour layover in Paris, but enjoyed the company of Jean Harman (USAID Bamako), who we met at the Paris airport security line, and she was heading home to Bamako on our flight. Nickerson had met Jean 1 year earlier at the USAID Office in Bamako. We explained the purpose of our mission to Mali, and Jean suggested we consider submitting a proposal for possible USAID funding, which we will definitely consider.

We departed Paris on flight Air France 796 at 4:40 PM and arrived on schedule into Bamako at 9:20 PM, where we were greeted by Dr. Mamadou Coulibaly, Ismaila Alhassane Maiga, and Ramata Cisse. After visiting in the lounge, we collected our checked luggage, and Mamadou drove us to our lodging site in the Niarela section of Bamako at the home of Hassanatou (Sanna) Sissoko Konde and Baffal Konde, Ramata's sister and brother-in-law (Rue 461, Porte 26, Niarela, Bamako, Mali). This site would serve as our headquarters for the week, where we would not only lodge and have our meals, but it would also serve as our laboratory where we plated milk samples, cultured blood agar plates, conducted somatic cell counts, read cultured plates, and recorded results. After visiting with the Konde family, we turned in at about 1:00 AM.

Ramata had arrived into Bamako about a day earlier to set up a schedule for the group. She visited with individual dairy farmers, veterinarians, and acquaintances to locate representative dairy farms in areas northeast, northwest, west, and south of Bamako. She was also able to locate a guide for our first day's visit.

**Monday, December 15**

1. Bama Yara Herd

At 7:00 AM, Alex, Ramata, Alhassane Sissoko (Ramata's brother who has a background in agriculture), and Nickerson left our headquarters and were met by driver, Madou Diarra and guide Ali Barry (for Monday only). Our first stop was at the dairy of Bama Yara in the town of Moribabougou, which is northeast of Bamako. The cows (mainly Zebus) had already been milked, but one of the milkers caught one, hobbled it for sampling, and introduced the calf. The usual procedure for milking cows at this farm, which was standard practice at all dairies that we visited was as follows:

After grazing in the morning after milking, and in the afternoon on any available (usually uncultivated) forage within the vicinity of the farm, cows (typically Zebu or crossed with Montbeliards or Holsteins) are returned to the farm yard. This yard is about an acre in size enclosed in a mud block wall 5-6 ft high. The yard also contains a roofed, holding

area for calves of the milking herd that is also fenced with mud walls. In the figure below, cows have just arrived from pasture into the farm yard, and calves are held in the shed in the background left.

After cows are secured in the yard, a few calves (usually the number equals the number of milkers) are released from their holding pen. The calves head to their dams and begin to nurse, and at this time, the dam is hobbled by tying the hind legs together with rope. After a few seconds of nursing, calves are tied around the neck and secured tightly to the right front leg of their dam. The milker then milks the cow into a plastic bucket or gourd held between his legs, two teats at a time (see figure below).

The milk is expressed from teats (initially lubricated with calf saliva) using the pull method by grasping the teat at its base by the thumb and fore finger where it attaches to the udder, and forcing the milk out through the teat duct. Fingers are periodically dipped into the frothy portion (butterfat) of the collection vessel for lubrication of teats after saliva of calves is gone. When all quarters are milked out, the calf is released and allowed to nurse in order to harvest any residual milk in the udder for its own nutrition. Then, a few more calves are released from the holding area and the process is repeated until all cows are milked. After buckets or gourds become full after milking several cows, milk is poured into a larger collecting vessel for transport to the milking center with or without pouring through a sieve. The sieve is used to filter out flies and other materials. However,

not all milkers use a sieve, and flies remain in collection vessels (see figure below). Flies are a vector in the transmission of bacteria and probably add greatly to the bacteria count.

These milking practices are very energy intensive and involve capturing the cow, hobbling, allowing the calf to initiate milk let-down, milking, tying of the calf, the release of the calf, walking to the bulk tank to empty collection vessels, releasing of more calves, and repeating these processes until all cows are milked.

We also sampled three more cows at the Bama Yara Dairy. Our procedure was to perform a cow-side California Mastitis Test (CMT), which is used as an indicator of elevated leukocytes (white blood cells) in milk, which in turn, are associated with the presence of mastitis or intramammary bacterial infection. Leukocytes in milk are commonly referred to as somatic cells; thus, the CMT is used to determine the somatic cell count (SCC) in milk. To conduct a CMT, a paddle with four wells is held below the cow's udder, and several streams of milk from each mammary quarter are expressed into each of the four wells (see figure below).

The paddle is tilted to drain excess milk, allowing approximately 1 ml of fluid to remain in each well. Holding the paddle level again, an equal amount of blue CMT reagent (a detergent that coagulates or causes gelling of cellular DNA) is added (~1 ml), and the mixture is swirled for 10-15 seconds. If the SCC is elevated above a normal count of ~200,000 cells/ml, the detergent will cause coagulation or gelling of the DNA in the

leukocytes, and the degree of coagulation is dependent on the SCC; as the SCC increases, coagulation becomes more pronounced. Although a scale of 0 to 3 may be used to classify the degree of coagulation in each well, it was decided to grade the presence of mastitis as 1) positive: very high degree of coagulation or 2) negative: no or only slight coagulation. The CMT gave us an immediate idea of the level of mastitis within quarters of individual cows as well as within the milking herd. Among the four cows sampled in the Bama Yara Herd, mastitis was observed in at least one quarter of every cow.

After performing a CMT, each teat was sanitized with cotton swabs soaked in 70% ethanol and a sterile milk sample was collected aseptically into a plastic disposable test tube to: 1) culture for the presence of mastitis-causing bacteria and 2) determine SCC once we returned to our headquarters. Milk samples were kept cool during the time between farm collection and processing by placing them in a rack stored in a thermal cooler with freezer packs that had been frozen solid overnight. Upon return to headquarters, samples were placed in a standard refrigerator where they were stored until plating for culture. Prior to plating, culture tubes were brought to room temperature and mixed thoroughly. Disposable loops with a 0.01-ml holding capacity were used to plate samples; each quarter sample was plated onto one quadrant of a plastic disposable sheep blood agar plate. Plates were then incubated at room temperature (90-95°C) for 24-48 hours and organisms were presumptively identified based on bacterial organoleptic and colony characteristics, hemolytic patterns, coagulase (rabbit plasma), and catalase (hydrogen peroxide) production. The SCC were determined using a battery-operated DeLaval Direct Cell Counter (DCC). In several samples, insufficient quantities of milk precluded analysis of SCC. See Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

2. Moussa Ousoubi Sissoko Herd

The Sissoko Herd was our next stop in Moribabougou. This was the only operation we observed where the milkers (Gourro and Kassim) washed their hands and the milk collecting buckets in detergent prior to milking. Human hands naturally harbor typical skin bacteria such as staphylococci and serve as fomites for the transfer of mastitis-causing bacteria to the teats of cows. Thus, the washing and sanitation of milkers' hands both prior to and during milking could be an important step in 1) minimizing transfer of human bacteria to cows teats; 2) reducing the transfer of bacteria from infected quarters to uninfected quarters of the same cows as well as among cows; and 3) reducing the bacteria count of bucket or gourd milk, as milkers dip their fingers in this milk to provide lubrication for milking teats. We tested the milk of three Zebu cows, and CMT results indicated one cow with mastitis. Samples were then collected for bacteriological examination and SCC as mentioned above for the Bama Yara Herd. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

3. Mamadou Bathily Herd

Also in Moribabougou, we visited the Bathily Herd, which had eight cows in milk. Many of these cows were cross-breeds of Zebu, Montbeliards, and Holsteins. The two milkers,

Bourema and Ammah Bah, were very helpful in securing cows for sampling. Five of the eight cows were positive for the CMT. The milkers identified one cow (Woulesaye) who had lost her calf; they felt that she may have mastitis. The CMT confirmed that three of four quarters were mastitic, and culture results revealed that all three quarters were infected with *Staphylococcus aureus,* which is a very difficult infection to manage. After discussing results with Mr. Bathily, our collaborator from the Ministry of Livestock and Fishery (Bougadar Diarra) returned to the farm and treated Woulesaye. We had transported several infusion tubes of an intramammary infusion product commercially available in the US for just this purpose. The cow received an infusion of Pirlimicin (ceftiofur hydrochloride) into each quarter after each milking for three consecutive milkings. Subsequent communications from Mr. Diarra revealed that Woulesaye is now producing more milk as a result of treatment. We conducted a CMT test on a total of seven cows in this herd, and four cows were positive in one or more quarters. Mr. Bathily relayed that in his herd, the calf receives about 1/6 of the dam's milk. A concentrate containing millet was fed once a day. One of his cows (Woulil-Boulel) was a cross between a Montbeliard and Bodrogui (a Niger breed). This was an above average herd in terms of management. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

4. Alou Gambi Herd

Some of the cows in this herd were Zimbawe crossbreds. Mr. Gambi includes more local breeds in his herd because they are less expensive to purchase. Note: Aly Barry (our guide) and Mr. Gambi are cousins. We CMT paddle-tested eight cows in this herd, and four were positive for mastitis, one in all four quarters. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

5. Ficou Koita Herd

We were unable to sample cows in this herd, but we did obtain a bulk milk sample for processing.

**Tuesday, December 16**

In the morning, we started with a new guide who would assist us through the rest of the week (Bougader Diarra, Ministry of Livestock and Fishery), and drove to Kalabanbougou Park. This is a livestock and agricultural market place, where we sampled several cows from different Bambara and Fulani herds. Herds sampled are listed below by owner and include herds 6-8 below.

6. Mamadou Diallo (Livestock market)

We tested and sampled his 4-year-old cow (Woole), who was nursing her 2$^{nd}$ calf. She had mastitis in two quarters according to the CMT test. We also sampled Take, who also had mastitis in two quarters. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

7. Sidiki Traore (Livestock market)

Two cows were tested: Targuawe and Dake-Targuawe, both of which had all four quarters exhibiting positive reaction for mastitis with the CMT. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

8. Sidi Sissoko (Livestock market)

One unidentified cow was tested with the CMT and was found to have two quarters with mastitis. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

9. Sidiki Traore Herd

This gentlemen also had a dairy farm near Kalambanbougou Park at the following address: Bako Djikoroni Para, Domaine II, Rue 322, Porte 78. Six of his cows were tested, four of which tested positive for mastitis with the CMT. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

In the after noon of December 16, we visited the veterinary clinic of Dr. Oumar Diabate south of Bamako in Satinebougou in the Sanankoroba Community and had lunch with his family. Oumar runs a small vegetable and livestock operation as a training facility for individuals interested in gaining experience in these areas. The farm is equipped with a community boarding house for students. After lunch, Oumar accompanied us to the dairy farm of Seydou Toure.

*As an aside, Oumar grows an herb on his farm called Artemizia, which has been shown to successfully treat malaria. The active element is called Artemezine and it is mixed with another product called Cotexin (coartemizine) for use against malaria. Dr. Diabate is interested in talking to UGA malaria expert Dr. July Moore (Biomedical and Health Sciences Institute, Department of Infectious Diseases, Coverdell Building) about further development of this product. Benjamin Shute at Urgenci.net is currently working with Oumar in cultivationg this herb, and Oumar serves as the African Regional Coordinator for Urgenci.net.*

10. Seydou Toure Herd

This was a well-managed herd composed of Zebu, Montbeliard, and Holstein crosses that were on a good nutrition program including calcium in the ration in the form of crushed oyster shells. Cows were in good body condition and excellent health; only one of six cows tested was positive by the CMT. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

**Wednesday, December 17**

We drove to Kati on the northwest of Bamako and met with a guide, who accompanied us to two Fulani dairies.

11. Mamadou Djane Herd

This was a small Fulani dairy, and cows had already been milked by the time we arrived. According to the milker, Bouakar Barry, the cow we were to sample was to be sold at the market the next day. With the aid of Mr. Barry's 11-year-old son, Samba, we caught the cow and found her CMT test to be negative. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

12. Adama Amadou Boli Herd

This was also a small Fulani herd, and cows had already been milked. Two cows (Soume and Dague Tarkeye) were caught, but no milk could be obtained. However, the owner did save us a sample of bulk milk, which was processed.

At noon, we visited Medina Coura: The Association of Women Milk Resellers in Bamako, and met with the President of the Association, Mme. Danna Niangado, and the Vice President, Mme. Diop Fatoumata Tiam. They explained that milk is delivered to them daily between 9 and 11 AM after it has been pasteurized. The milk is received while it is hot, and they place it in cold water for a while to cool off and then refrigerate it prior to sale.

In the afternoon, we traveled to Kassela to visit a milk collection center, which serves the milk cooperative: Bagan Yiriwaton. We met with Abou Niangadou, President of the cooperative. He explained that farmers from the surrounding areas bring their milk to this collection center. Before accepting the milk, the center does an alcohol test on a sample of each farm's milk as a screen against high bacteria count milk. They also perform a density test. Average time between the end of milking and the time that the milk is collected for transport to the collecting center is between 1 and 2 hours, and it takes an average of 1hour via bicycle to deliver milk from the various farms to the milk collection center after that. The Central Veterinary Laboratory in Bamako tests the milk once a month or when they suspect problems in milk quality at the collection center. Abou Niangadou emphasized the need to improve milk quality, packaging, and labeling, as well as to develop a system of mobile milk refrigeration. This cooperative is part of a network of milk collection centers overseen by a non-government organization (NGO) called CAB DEMESO, the President of which is Moussa Diabate, who we would meet later in the week.

**Thursday, December 18**

This morning, we drove back to Kassela under the guidance of Aguibou Salle to sample cows at two dairies.

13. Souleymane Dembele Herd

This was a typical Fulani herd where we tested eight cows for the presence of mastitis. Six of the eight were found positive. See Appendix Tables 4, 5, and 6 for herd results on CMT, bacteriology, and SCC, respectively.

14. Aguibou Salle Herd

This was the small farm of our guide for that day, Aguibou. He had only one cow and she was nonlactating, so no samples were collected.

At 2:00 PM, we met with the Minister of Livestock and Fisheries, Mme. Diallo Madeleine Ba along with three of her councilors: Boubacar Diallo (Vice Director of the Central Veterinary Laboratory), Issa Toure (Technical Advisor of Veterinary Services), and Yaya Konate (Coordinator of Development Projects and Processing of Milk). Dr. Mamadou Coulibaly and Ismaila Alhassane Maiga were also in attendance. The Minister discussed a project that is currently underway in the area of milk production improvement. She also relayed that there are 200 extension offices in Mali, including 6 in the Bamako area, each of which is represented by an agent from the ministry working in the mayor's office.

**Friday, December 19**

In the morning, we visited the Central Veterinary Laboratory (LCV), and met with the Head of the Quality Control Department, Dr. Traore Halimatou Kone, and the Head of one of the branches of the Laboratory, Adama Fane. There are four departments in the LCV including diagnostic research, quality control, vaccine production, and administration. The Diagnostic Research Center is equipped with several laboratories including those for virology, bacteriology, entomology, anatomy, and pathology. In the quality control labs, food is tested for bacteria counts, and other activities include vaccine production control, environmental control, and seed control.

In the afternoon, we traveled to Hamdallaye ACI 2000 and visited the Conseil et Accompagnement des Initiatives a la Base (CAB). CAB DEMESO is a NGO where we met with Moussa Diabate (President) and Mme. Maiga Nana Toure. Here we observed a poster displaying the proper procedures of milking, collection, and distribution. Unfortunately, dairymen associated with this NGO are not following these procedures and the government has no method of implementation or enforcement. This NGO promotes the use of a product called Spiruline, an antimicrobial that reduces growth of bacteria in milk.

**Saturday, December 20**

After a day of souvenir shopping and visiting new acquaintances in the area, Glover and Nickerson departed Bamako at 11:45 PM on flight Air France 791 to Paris, arriving at 6:20 AM December 21.

**Sunday, December 21**

We had a 3-hour layover in Paris and departed Paris on flight Air France 8984 at 9:20 AM and arrived on schedule into Atlanta at 1:30 PM.

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Ramata remained in Bamako for another three days and was able to make additional contacts with individuals in the dairy industry.

On Sunday afternoon, Ramata met with Dr. Modi Toure, former Director of the Central Veterinary Laboratory. It appears that this facility has recently sold 14 of its 150 acres of land to public, which has not benefited progress in their research and development endeavors.

**Monday, December 22**

On Monday morning, Ramata visited Mali-Lait, the largest milk collection agency in Mali. Many farmers sell their milk to Mali-Lait because the company accepts milk from any farmer as long as the milk passes the two tests (alcohol and acidic tests). The company spokesman stated that they do a bacteriological count with the limit of 300 colonies (presumably equivalent to 300,000 bacteria/ml of milk. Ramata learned at Mali-Lait that there is private company (Firm Gakou) that tests milk for its quality, but her contact could not tell her what kind of test is done. Mali-Lait also uses imported powdered milk for processing.

On Monday afternoon, Ramata met with Mamadou Coulibaly and Ismaila Alhassane Maiga. She relayed that because our group noticed that a major problem in milk collection was related to premilking as well as milking time hygiene, we proposed the use of clean and sanitized milk buckets and sieves using soap and bleach, as well as designated shoes and blouses when milking cows, and perhaps these items could be provided to dairymen as a pilot study. In response, Mamadou Coulibaly provided her with 195.000 CFA francs (about $400.00 US) to purchase these materials. Ramata purchased fabrics to make 21 blouses in green, 34 different buckets to collect milk and to wash hands, 17 pairs of shoes, a box of soap, and a box of bleach.

**Tuesday, December 23**

Ramata and Bougader Diarra visited farms (from which the group had taken milk samples the previous week) to distribute and demonstrate the materials that would hopefully improve sanitation and eventually improve milk quality. These same materials were also delivered to the Kassela Milk Collection Center. The figure below shows team

members delivering green blouses, buckets, wash basin, kettle, shoes, and soap to a dairy farm that participated in the survey.

Farms where they distributed the materials included:

1. Bama Yara
2. Moussa (Ouzoubi) Sissoko
3. Bassidy Yatassay
4. Babourou Dicko
5. Mamadou Bathily
6. Ficou Koita: Samba Diallo, Boukary Diallo, Hambarky Diallo
7. Alou Gambi: Gouro Barry, Amadou Barry, Abourou Barry.
8. Kassela Milk Collection Center
9. Aguibou Sall
10. Souleymane Dembele

They could not get to all of the farmers previously visited, so Ramata left the remaining materials to Bougader Diarra who delivered them to the farmers after she departed.

Contact information of dairy farmers and other individuals visited:

1. Bama Yara: Tel. 011-223-76-30-92-26
2. Mamadou Gambi:  011-223-66-71-42-95
3. Aly Barry: 011-223-76-03-46-73
4. Mamadou tombo Bathily: 011-223-76-44-86-69
5. Siby Sissoko: 011-223-76-45-40-34
6. Mountagua Traore: 011-223-76-97-69-79
7. Seydou Toure: 011-223-76-16-36-87
8. Adama Amadou Boli. Tel: 221-27-24-88
9. Danna Niangadou: 011-223-66-67-83-36
10. Mme Diop Fatoumata Tiam: 11-223-76-43-68-23
11. Abou Niangadou. Tel. 011-223-76-04-91-17
12. Idrissa Sissoko: National Director of Veterinary Services
13. Kassoum Diakite: (Not available)

14. Boubacar Diallo: Vice Director of the Central Veterinary Laboratory
15. Issa Toure: Technical advisor of the veterinary services
16. Yaya Konate: Coordinator of development projects and processing of milk
17. Dr. Halimatou Traore: 011-223-76-28-69-72 halimatoutraore@yahoo.fr
18. Adama Fane: 011-223-76-48-45-35 afaneother@yahoo.fr
19. Mamadou Kane: (Microbiology) 011-223-76-28-69-72
20. Ibrahim Toure: (Pathology) 011-223-76-28-69-72
21. Kadiatou Sidibe: Mali-Lait 011-223-66-91-85-58
22. Khady Makalou: Mal-Lait 011-223-76-48-89-92
23. Bassidy Yatassay: 011-223-076-04-42-25
24. Ficou Koita: 011-223- 76-32-81-75
25. Amadou Koita (Baba) 12 years old: 011-223-66-71-67-23

## Results of CMT, microbiological analyses, and SCC testing:

Quarter and bulk tank milk samples from 53 cows from 14 herds visited were evaluated. Quarter milk samples were those collected from each of the four mammary glands of each cow's udder; whereas bulk milk samples represented that collected from the storage vessels that held all the milk from a particular milking of the cows in a herd.

Results of CMT testing demonstrated that of the 49 cows from which quarter milk samples could be obtained, 58% had at least one mammary quarter that reacted positively. Table 1 illustrates the percentages of cows having 0, 1, 2, 3, or all 4 quarters that were CMT positive.

Table 1. Percentages of cows having 0 to 4 mammary quarters testing CMT positive.

| 0 Quarters + | 1 Quarter + | 2 Quarters + | 3 Quarters + | 4 Quarters + |
|---|---|---|---|---|
| 42% | 20% | 22% | 4% | 12% |

Bacteriological results from the analysis of quarter milk samples is shown in Table 2. Among cows having samples (n = 47), the overall infection rate was 57%; 43% were infected with CNS, 21% were infected with *S. aureus*, 13% were infected with environmental streptococci, and 4% were infected with 'other' organisms. Among eligible mammary quarters (n = 188), the overall infection rate was 26%; 14% were infected with CNS, 7% were infected with *S. aureus*, 4% were infected with environmental streptococci, and 1% were infected with 'other' organisms. Among just the infected quarters (n = 51), 53% were infected with CNS, 27% were infected with *S. aureus*, 16% were infected with environmental streps, and 4% were infected with other microorganisms.

Table 2. Bacteriological results among cows and among quarters.

| | Coagulase-neg. Staphylococci | *Staphylococcus aureus* | Environmental streptococci | Other microorganisms |
|---|---|---|---|---|
| Among cows | 43% | 21% | 13% | 4% |
| Among quarters | 14% | 7% | 4% | 1% |
| Among infected quarters only | 53% | 27% | 16% | 4% |

Analysis of SCC demonstrated that in uninfected quarters, the average SCC was 322,000/ml, while in infected quarters, average SCC was 1,381,000/ml (Table 3). Quarters infected with *S. aureus* averaged 1,593,000/ml, those infected with CNS averaged 1,150,000/ml, and those infected with environmental streptococci averaged 1,949,000/ml. The mean SCC of all uninfected and infected quarters was 680,000/ml.

Table 3. Somatic cell counts among uninfected and infected quarters.

| All uninfected quarters | All infected quarters | Coagulase-neg. Staphylococci | *Staphylococcus aureus* | Environmental streptococci |
|---|---|---|---|---|
| 322,000/ml | 1,381,000/ml | 1,150,000/ml | 1,593,000/ml | 1,949,000/ml |

The level of mastitis found in the Malian herds sampled is higher than the level found in the US, but not alarmingly high. Somatic cell counts in uninfected and infected quarters are similar to those found in other countries; however, the mean SCC for quarters infected with CNS (1,150,000/ml) is much higher than commonly observed. With the adoption of routine mastitis control practices, the mastitis level in Malian herds can be reduced to acceptable levels. However, the greatest challenge is to improve milk quality while it is being harvested from the cow, while it is being stored on the dairy, and during transport to the milk collecting stations. This is discussed below. Routine sanitation and mastitis control practices to be recommended are:

1. Sanitization of hands prior to and during hand milking to reduce spread of mastitis-causing bacteria.
2. Sanitization of all materials used to collect, transfer, and transport milk including buckets, gourds, funnels, sieves, and collection tanks. Use of gourds should be eliminated as they cannot be properly sanitized.
3. Antibiotic treatment of clinical cases (Note: if calves are allowed to nurse post treatment, they will consume the antibiotic in the milk of the treated quarter. This treatment is best used in cows that have lost or weaned calves).
4. Nonlactating cow therapy: Infuse all quarters of all cows with an approved product at the end of lactation.

Milk quality:

Bulk milk samples to assess milk quality of the herds visited were collected from only three herds. The SCC ranged from 448,000 to 1,762,000/ml with an average of

826,000/ml. However, this was skewed upwards by one herd that averaged 1,632,000/ml; the other two herd SCC ranged from 448,000/ml to 575,000/ml.

Bacteria counts conducted on fresh bulk milk samples that had not set at ambient temperatures for more than 10 minutes averaged ~20,000/ml, excluding the count of one herd on which the colonies were too numerous to count. This herd was also the herd with the highest bulk milk SCC of 1,762,000/ml. This 20,000/ml bacteria count is far less than the legal limit set by the US of 100,000/ml, and thus is not excessive. However, bacteria counts that were conducted on samples of bulk milk from six dairy herds in the Kassela area that were allowed to set at ambient temperature for several hours were estimated to be far greater than 10,000,000/ml as colonies on culture plates were too numerous to count. See figure at bottom of page.

Bacterial cells divide every 20 min. Thus, although bacteria counts in fresh bulk milk samples averaged ~20,000/ml, the bacteria count would exceed 10,000,000/ml after 3 hours at ambient temperatures using the following example:

| | |
|---|---|
| Bacteria count at time 0 = | 20,000/ml |
| Bacteria count 20 minutes later = | 40,000/ml |
| Bacteria count 40 minutes later = | 80,000/ml |
| Bacteria count 60 minutes later = | 160,000/ml |
| Bacteria count 80 minutes later = | 320,000/ml |
| Bacteria count 100 minutes later = | 640,000/ml |
| Bacteria count 120 minutes later = | 1,280,000/ml |
| Bacteria count 140 minutes later = | 2,560,000/ml |
| Bacteria count 160 minutes later = | 5,120,000/ml |
| Bacteria count 180 minutes later = | 10,240,000/ml |

These bacteria produce enzymes such as proteases and lipases that breakdown milk protein and fat, respectively, leading to spoilage and off flavors. More importantly, pathogenic bacteria such as *Escherichia coli*, *Staphylococcus aureus*, *Salmonella*, *Listeria*, *Campylobacter*, and *Mycobacteria* may be present in large numbers, a condition which is a human health hazard. Even if milk is pasteurized, with extremely high bacterial numbers, the sterilization of milk is not guaranteed. In the present study, a sample of commercially bottled milk that was pasteurized was found to have a bacteria count of 10,000/ml. Also, if raw milk is consumed, exposure to these pathogens is very likely. The figure below illustrates four blood agar plates cultured for bacteria. The first three plates were conducted on samples of bulk milk from dairy herds that were allowed to set at ambient temperature for several hours, and the fourth is ‘pasteurized milk’ that was cultured.

The bacteria present in fresh bulk milk samples originates from six sources: 1) milk of mammary quarters infected with mastitis-causing bacteria; 2) surfaces of cows' teats (normal flora and from saliva of calves); 3) milkers' hands; 4) aerosols and dust from the environment; 5) flies; and 6) the surfaces of contaminated milk buckets/gourds, funnels, and sieves. The solutions to reducing the number of bacteria introduced to the harvested product include: 1) eliminating mastitis; 2) sanitizing cows teats; 3) sanitizing milkers' hands; 4) fly control; and 5) sanitizing milk buckets/gourds, funnels, and sieves. Flies are a major source of contaminating bacteria, and leave bacteria on the surfaces of any milk contact surface (see figure below); flies should be removed from bulk milk using sieves.

Several dairies did not use sieves. To illustrate the contribution of flies to the bacteria count, a fly was captured that was feeding from the inside surface of a milk bucket in the figure above. The live fly was trapped on a blood agar plate used to culture milk samples, and allowed to tread on the media overnight. The colony count revealed 500 colonies, each of which originated from one single bacterial cell (see figure below). One hundred flies, a number commonly observed in buckets and gourds, would therefore contribute at least 50,000 bacteria to milk.

## Suggestions for Follow-up and Future Collaboration

1. *General:* Training of veterinarians, extension workers, and milk collection personnel on how to best educate dairy farm owners and milkers on the sanitary collection, storage, and transport of milk.

2. *General:* Establish educational programs on mastitis: its cause, effect on milk quality and production, and practices used to control this disease.

3. *Specific:* Introducing a method to cool milk after collection for transport to the collection center. Dr. Kissilata of the Biological and Agricultural Engineering Dept. at UGA has developed a device for cooling milk that is chemically and vacuum driven and does not require electricity (via electrical lines or solar radiation). This device could be adapted for use in Mali where cooling of milk on the farm is nonexistent. Use of such a device will drastically reduce bacteria counts of raw milk and greatly improve milk quality and taste, improving consumer acceptance as well as human health and welfare.

4. *Specific:* Initiate a pilot study on a small group of 10 herds that are in close proximity to each other that use the same milk collecting center for efficient monitoring. The purpose of this study will be to determine if employing sanitization procedures, cooling of milk, and mastitis control will improve milk quality and milk production over a 6-month period of time. The goals for this 10-herd study will be four fold:

    a. To reduce the average bacteria count or raw milk in bulk milk cooling tanks to less than 10,000 colony-forming units per milliliter (cfu/ml).
    b. To reduce the average SCC to less than 500,000/ml.
    c. To increase milk production by an average of 10%.
    d. To measure zero antibiotic residues in milk.

    If successful, a larger scale trial will be conducted involving 200 herds as a means of introducing milk quality and mastitis control programs to a wide audience. The prerequisites and procedures listed below will be followed:

- Select a team of individuals to lead this effort, serving as advisors, associates, and a Trial Monitor. This may include individuals from the Ministry of Livestock and Fishery, such as Bougader Diarra; the Central Veterinary Laboratory; the milk collection center used by the 10 study herds; and Dr. Nickerson's Laboratory.

- Hire a motivated and dependable individual with an education in livestock agriculture to oversee the trial as the Trial Monitor, who will be a team member. This person will need to collaborate with microbiologists at the Central Veterinary Laboratory in the case that a referral is needed, as well as with operators of the local milk collecting center.

- Prior to the pilot study, send the Trial Monitor to Dr. S. C. Nickerson's Mastitis and Milk Quality Laboratory, Animal and Dairy Science Dept., UGA for 1-2 wk for training in microbiology, sanitation, somatic cell counting, antibiotic therapy, and trial monitoring.

- Upon his return to Mali, the Trial Monitor will visit 15-20 herds, discuss the owner and milker responsibilities in the study, and then select 10 herds whose owners as well as milkers can be depended upon to buy into the program and have a strong desire to improve their milk quality and milk production.

- The Trial Monitor along with other team members will visit with herd owners and milkers to educate them on the purpose of the trial, the significance of bacterial contamination, the necessity of using sanitary milking procedures, and the importance of mastitis control. Owners and milkers need to understand why they are utilizing new procedures to improve their milk quality and milk production.

- Purchase all standard materials needed for each farm, including all sanitizers and soaps, cleaning brushes, milk collection buckets, funnels, sieves, and bulk tanks.

- It is expected that the milk cooling devices mentioned above will be purchased through a grant for each farm or that one or two will be used for all 10 herds that are in close proximity to each other.

- Prior to initiating the pilot study, the Trial Monitor and other team members as necessary, will demonstrate proper sanitization to milkers at each farm as follows:

    a. All materials used for harvesting milk will be sanitized and dried prior to milking. Milkers' hands will be washed and dried, and proper attire will be worn.
    b. The bulk milk cooling tank will be activated prior to milking so that it is cool by the time the first milk is added.
    c. After the calf is secured to the dam's foreleg, the cow's teats will be sanitized by teat dipping in an iodine or chlorine solution, allowed to remain on teats for 30 seconds, and teats dried with paper towels or with newspaper.
    d. During milking, the milker should refrain from dipping his hands into the bucket milk as a lubricant, as this introduces bacteria to the milk.
    e. After each bucket becomes full, the milk should be poured into the bulk milk cooling tank by straining through a sieve to remove flies and other organic material.
    f. Before reusing a bucket to collect milk from additional cows, it must be sanitized and dried.
    g. Once all cows are milked and the bulk milk cooling tank is full, the lid is secured and transported to the milk collecting center, while all milking utensils are washed, sanitized, and dried.

h. At the center, the bulk milk cooling tank is rinsed out and returned to the farm where it is sanitized and allowed to dry.
i. After sanitization, the activator is reheated to restore it for the next milking.

- During milking, if any quarter of a cow exhibits signs of clinical mastitis, it will be milked out completely. Then, after the calf has nursed and is satiated, the affected quarter will be treated with a lactating cow antibiotic infusion product supplied to the study following label directions.

- At the end of lactation when calves are weaned, each cow will be dry cow treated with a nonlactating antibiotic infusion product supplied to the study following label directions. All four mammary quarters will be infused.

- The Trial Monitor will visit each farm at least once a week to monitor use of sanitary milking procedures and help solve any problems encountered by milkers. The Trial Monitor will also collect bulk milk samples from the bulk milk cooling tanks to perform the following tests and recordings:

  a. Standard plate count
  b. Differential bacteria count
  c. Somatic cell count
  d. Record milk temperature
  e. Antibiotic residue test
  f. Record milk volume

- Milk samples collected will be maintained on ice. The above tests will be carried out at the Central Veterinary Laboratory, the milk collection center, or a lab designated by the Ministry.

- The weekly data will be summarized and analyzed during the trial by the Trial Monitor to evaluate the progress toward the four goals identified above. This weekly monitoring will also be useful to identify and correct any problems encountered at each dairy. In addition, and problems with milk quality identified by the milk collection center can be addressed by the Trial Monitor.

- If successful, a larger scale trial will be conducted involving 200 herds as a means of further introducing milk quality and mastitis control programs.

- It is expected that the proposed studies will be supported by governmental, NGO, NASULGC, or USAID grants.

- As more dairy farms participate in such studies, and as dairy farmers and milkers become more educated on the merits of milk quality and mastitis control programs and apply this knowledge to their farms, the quality and quantity of milk produced in Mali will increase.

- It will be important for the government to create and enforce laws to demand that dairy farmers produce high quality milk for Malian consumers. This will require constant monitoring of bulk milk that is delivered to milk collection centers as well as to milk processing plants to ensure that only milk meeting lawful standards is accepted and processed for human consumption.

# APPENDIX

The Appendix, which contains the next 6 pages, presents three tables illustrating the raw data including CMT (Table 4), bacteriology (Table 5), and SCC (Table 6) for each herd studied. In some cases, there was either no sample taken, insufficient sample volume, or the sample was discarded, and such samples are record as dashed lines (---). In addition, quarters may have nonfunctional (blind) or the milk sample was contaminated (cont). Abbreviations: *S. aureus* = *Staphylococcus aureus*, E. strep = Environmental streptococci, CNS = Coagulase-negative staphylococci, and CNS/ES = a combination of coagulase-negative staphylococci and environmental streptococci. SCC are expressed the number of somatic cells present in one milliliter of sample x 1000. For example, a SCC of 500 is actually 500,000/ml.

Table 4. California Mastitis Test was recorded as Negative or Positive.

| Herd Name | Cow Name | RF | LF | LR | RR |
|---|---|---|---|---|---|
| Bama Yara | Sirgue | Positive | Negative | Negative | Positive |
| | Boddi | Negative | Negative | Negative | Positive |
| | Waggui | Positive | Negative | Negative | Positive |
| | Wounerou | Positive | Negative | Negative | Positive |
| | | | | | |
| Moussa Sissoko | Woule | Negative | Negative | Negative | Positive |
| | Gossi | Negative | Negative | Negative | Negative |
| | Saye | Negative | Negative | Negative | Negative |
| | | | | | |
| Mamadou Bathily | Relel | Negative | Negative | Negative | Negative |
| | Woulil-Boulel | Positive | Negative | Positive | Negative |
| | Boular-Tounguel | Negative | Negative | Negative | Negative |
| | Balel-Gualaguel | Negative | Negative | Negative | Negative |
| | Djamalel | Negative | Positive | Positive | Positive |
| | Woulebaba | Negative | Negative | Negative | Positive |
| | Woulesaye | Negative | Positive | Negative | Positive |
| | Bodrowe | Positive | Negative | Positive | Negative |
| | | | | | |
| Alou Gambi | Bodoro | Positive | Negative | Negative | Negative |
| | Woole | Negative | Negative | Negative | Negative |
| | Terkaya | Negative | Positive | Negative | Negative |
| | Sirguey | Positive | Positive | Positive | Positive |
| | Malley | Negative | Negative | Positive | Negative |
| | Yore | Negative | Negative | Negative | Negative |
| | Dague | Negative | Negative | Negative | Negative |
| | Beguel | Negative | Negative | Negative | Negative |
| | Gere | Negative | Negative | Negative | Negative |
| | | | | | |
| Mamadou Diallo | Woole | Positive | Positive | Positive | Positive |
| | Take | Positive | Negative | Positive | Negative |
| | | | | | |
| Sidiki Traore | Targuawe | Positive | Positive | Positive | Positive |
| (Livestock market) | Dake-Targuawe | Positive | Positive | Positive | Positive |
| | | | | | |
| Sidi Sissoko | No Name | Negative | Positive | Positive | Negative |
| | | | | | |
| Sidiki Traore | Amere | Negative | Positive | Negative | Positive |
| (Dairy farm) | Djamale | Negative | Positive | Negative | Negative |
| | Woole | Positive | Positive | Negative | Negative |
| | Woole Bale | Negative | Negative | Negative | Negative |
| | Onle | Positive | Positive | Positive | Positive |
| | Woole Bale 2 | Negative | Negative | Negative | Negative |

| Herd Name | Cow Name | RF | LF | LR | RR |
|---|---|---|---|---|---|
| Seydou Toure | Wode | Negative | Negative | Negative | Negative |
| | Nore | Negative | Negative | Negative | Negative |
| | Dague | Negative | Negative | Negative | Negative |
| | Nore Wune | Negative | Negative | Negative | Negative |
| | Saye | Negative | Negative | Negative | Negative |
| | Woole | Positive | Positive | Positive | Blind |
| | | | | | |
| Mamadou Djane | Onle | Negative | Negative | Negative | Negative |
| | | | | | |
| Adama Amadou Boli | Soume | --- | --- | --- | --- |
| | Dague Tarkeye | --- | --- | --- | --- |
| | | | | | |
| Souleyman Dembele | Dake | Positive | Positive | Positive | Positive |
| | Olea | Negative | Positive | Positive | Negative |
| | Nore | Positive | Positive | Negative | Negative |
| | Bodi | Negative | Negative | Negative | Positive |
| | Amare | Negative | Negative | Negative | Negative |
| | Dake 2 | Negative | Negative | Negative | Positive |
| | Hourowe | Positive | Positive | Negative | Negative |
| | Gossi | Negative | Negative | Negative | Negative |
| | | | | | |
| Aguibou Salle | Dry Cow | --- | --- | --- | --- |

Table 5. Bacteriological results of quarter milk samples.

| Herd Name | Cow Name | RF | LF | LR | RR |
|---|---|---|---|---|---|
| Bama Yara | Sirgue | CNS | CNS | E. strep | CNS |
| | Boddi | Negative | Negative | Negative | Negative |
| | Waggui | Negative | E. strep | CNS | E. strep |
| | Wounerou | Negative | Negative | Negative | Negative |
| | | | | | |
| Moussa Sissoko | Woule | Negative | Negative | Negative | Negative |
| | Gossi | Negative | Negative | Negative | Negative |
| | Saye | CNS | Negative | Negative | Negative |
| | | | | | |
| Mamadou Bathily | Relel | Negative | CNS | Negative | Negative |
| | Woulil-Boulel | Negative | CNS | Negative | Negative |
| | Boular-Tounguel | CNS | Negative | E. strep | Negative |
| | Balel-Gualaguel | Negative | CNS/ES | CNS | Negative |
| | Djamalel | Negative | Negative | Negative | Negative |
| | Woulebaba | Negative | Negative | Negative | CNS |
| | Woulesaye | Negative | *S.aureus* | *S.aureus* | *S.aureus* |
| | Bodrowe | --- | --- | --- | --- |
| | | | | | |
| Alou Gambi | Bodoro | CNS | Negative | Negative | Negative |
| | Woole | Negative | Negative | CNS/ES | Negative |
| | Terkaya | Negative | Negative | Negative | Negative |
| | Sirguey | Negative | Negative | Negative | Negative |
| | Malley | Negative | Negative | *S.aureus* | Negative |
| | Yore | CNS | CNS | Negative | CNS |
| | Dague | Negative | Negative | Negative | Negative |
| | Beguel | Negative | Negative | Negative | Negative |
| | Gere | Negative | Negative | Negative | Negative |
| | | | | | |
| Mamadou Diallo | Woole | *S.aureus* | *S.aureus* | CNS | *S.aureus* |
| | Take | Yeast | Yeast | CNS | CNS |
| | | | | | |
| Sidiki Traore | Targuawe | Negative | E. strep | CNS | *S.aureus* |
| (Livestock market) | Dake-Targuawe | Negative | Negative | *S.aureus* | Negative |
| | | | | | |
| Sidi Sissoko | No Name | Negative | Negative | *S.aureus* | Negative |
| | | | | | |
| Sidiki Traore | Amere | Negative | Negative | Negative | CNS |
| (Dairy farm) | Djamale | Negative | Negative | Negative | Negative |
| | Woole | CNS | *S.aureus* | Negative | Negative |
| | Woole Bale | Negative | Negative | Negative | Negative |
| | Onle | Negative | Negative | Negative | Negative |
| | Woole Bale 2 | Negative | Negative | Negative | Negative |

| **Herd Name** | **Cow Name** | **RF** | **LF** | **LR** | **RR** |
|---|---|---|---|---|---|
| Seydou Toure | Wode | --- | --- | --- | --- |
| | Nore | Negative | Negative | Negative | Negative |
| | Dague | CNS | Negative | Negative | Negative |
| | Nore Wune | Negative | Negative | Negative | Negative |
| | Saye | Negative | Negative | Negative | Negative |
| | Woole | *S.aureus* | Negative | Negative | Blind |
| | | | | | |
| Mamadou Djane | Onle | Negative | Negative | Negative | Negative |
| | | | | | |
| Adama Amadou Boli | Soume | --- | --- | --- | --- |
| | Dague Tarkeye | --- | --- | --- | --- |
| | | | | | |
| Souleyman Dembele | Dake | Negative | Negative | CNS | *S.aureus* |
| | Olea | Negative | E. strep | CNS | Negative |
| | Nore | Negative | Negative | Negative | Negative |
| | Bodi | Negative | Negative | Negative | Negative |
| | Amare | Negative | Negative | Cont. | *S.aureus* |
| | Dake 2 | --- | --- | --- | --- |
| | Hourowe | CNS | Negative | Negative | CNS |
| | Gossi | Negative | Negative | Negative | Negative |
| | | | | | |
| Aguibou Salle | Dry Cow | --- | --- | --- | --- |

Table 6. Somatic cell counts (x1000/ml) of quarter milk samples.

| **Herd Name** | **Cow Name** | **RF** | **LF** | **LR** | **RR** |
|---|---|---|---|---|---|
| Bama Yara | Sirgue | 503 | 167 | 3483 | 660 |
| | Boddi | 144 | 182 | 93 | 90 |
| | Waggui | 125 | 1689 | 91 | 1450 |
| | Wounerou | 40 | 71 | 75 | 94 |
| | | | | | |
| Moussa Sissoko | Woule | 282 | 30 | 22 | 171 |
| | Gossi | 165 | 241 | 45 | 53 |
| | Saye | --- | --- | --- | --- |
| | | | | | |
| Mamadou Bathily | Relel | 226 | 56 | 108 | 80 |
| | Woulil-Boulel | - | 42 | 49 | 79 |
| | Boular-Tounguel | 636 | 263 | 1689 | 216 |
| | Balel-Gualaguel | 65 | 39 | 61 | 59 |
| | Djamalel | 65 | 45 | 40 | --- |
| | Woulebaba | 2302 | 1760 | 1951 | 857 |
| | Woulesaye | 344 | 1182 | 1266 | 1538 |
| | Bodrowe | --- | --- | --- | --- |
| | | | | | |
| Alou Gambi | Bodoro | 456 | 98 | 108 | 131 |
| | Woole | 178 | 185 | --- | 111 |
| | Terkaya | 168 | 4659 | 266 | 178 |
| | Sirguey | 73 | 83 | 81 | 83 |
| | Malley | 80 | --- | 3214 | 77 |
| | Yore | 3980 | 2347 | 127 | 1005 |
| | Dague | 766 | 70 | 80 | 634 |
| | Beguel | 116 | 99 | --- | 152 |
| | Gere | 221 | 4595 | 352 | 296 |
| | | | | | |
| Mamadou Diallo | Woole | 723 | 3806 | 3603 | 2052 |
| | Take | 66 | 270 | 135 | 193 |
| | | | | | |
| Sidiki Traore | Targuawe | 2045 | 1436 | 1738 | 1481 |
| (Livestock market) | Dake-Targuawe | --- | --- | --- | --- |
| | | | | | |
| Sidi Sissoko | No Name | 433 | --- | 444 | --- |
| | | | | | |
| Sidiki Traore | Amere | | 142 | 524 | 509 |
| (Dairy farm) | Djamale | 3486 | 1697 | 2180 | 193 |
| | Woole | 962 | 1475 | - | 475 |
| | Woole Bale | 14 | 21 | 10 | 12 |
| | Onle | 119 | 60 | 658 | 96 |
| | Woole Bale 2 | 43 | 493 | 1554 | 21 |

| Herd Name | Cow Name | RF | LF | LR | RR |
|---|---|---|---|---|---|
| Seydou Toure | Wode | 72 | 52 | 55 | 1932 |
| | Nore | 31 | 93 | 28 | 29 |
| | Dague | 219 | 11 | 11 | 43 |
| | Nore Wune | --- | 61 | 71 | --- |
| | Saye | | | | |
| | Woole | 2246 | 37 | 5609 | --- |
| | | | | | |
| Mamadou Djane | Onle | --- | --- | --- | --- |
| | | | | | |
| Adama Amadou Boli | Soume | --- | --- | --- | --- |
| | Dague Tarkeye | --- | --- | --- | --- |
| | | | | | |
| Souleyman Dembele | Dake | --- | --- | --- | --- |
| | Olea | --- | --- | --- | --- |
| | Nore | --- | --- | --- | --- |
| | Bodi | --- | --- | --- | --- |
| | Amare | --- | --- | --- | --- |
| | Dake 2 | --- | --- | --- | --- |
| | Hourowe | --- | --- | --- | --- |
| | Gossi | --- | --- | --- | --- |
| | | | | | |
| Aguibou Salle | Dry Cow | --- | --- | --- | --- |