

Lowering SCC Makes Cents For You

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PREMIUMS, PRODUCTION AND CLINICAL MASTITIS

Profit = (price x volume) – costs. It is worth noticing that two of the three contributors to profit (volume and cost) are things over which you have direct control. Reducing costs and increasing volume are profit winners for every dairy business. Disease costs are well-known profit robbers and mastitis is the most costly of all diseases on dairy farms. Estimated mastitis losses in the U.S. dairy industry are 1 billion dollars per year. Ninety percent of this loss is lost production. The association between herd bulk tank SCC (BTSCC) and production losses in U.S. dairy herds was evaluated. When medium and high SCC herds are compared to low SCC herds (<200,000), medium SCC (200,000 to 399,999) herds lost \$108 more per cow per year and high SCC (>400,000) herds lost \$295 more per cow per year. The overall production loss for the average U.S. dairy was \$110 per cow per year (6).

Reducing the level of mastitis will also indirectly increase price through quality premiums. In the Midwest, quality premiums can provide a significant boost to milk income. In addition, improved milk quality results in higher dairy product quality and yields at the processing plant. Pursuit of milk quality is a winner for everyone. The cow wins through better health. The dairy business wins by higher productivity and milk prices. The processor wins through increased yields and shelf life. And the consumer wins with high quality dairy products. Use the worksheet below to estimate your herd's mastitis loss (5).

<input type="checkbox"/> PRODUCTION LOSSES DUE TO SUBCLINICAL MASTITIS						
Lactation group	No. of cows		Avg LS	Goal	Production loss/unit LS	Lbs milk lost per group
1st Lactation:	_____	x	(_____ - 2.0)	x	220 lb	= _____
Other Cows:	_____	x	(_____ - 2.5)	x	440 lb	= _____
			_____	x	_____	=
			Total lbs lost		Milk price per lb	Annual production loss due to subclinical mastitis
<input type="checkbox"/> OPPORTUNITY FROM MILK QUALITY PREMIUMS						
Maximum SCC premium from your milk plant:		\$ 0. _____ per cwt (at 150,000 SCC)				
Average quality premium received last year:		\$ 0. _____ per cwt				
Potential premium difference:		\$ 0. _____ per cwt				
_____	x	_____	x	_____	/ 100 = 	
Rolling Herd Average		No. of cows		Prem. diff per cwt	Annual premium opportunity	
<input type="checkbox"/> LOSSES FROM CLINICAL MASTITIS:						
_____	-	_____	x	\$107	= 	
Estimated no. of cases (mastitis cases/yr)		Target no. of cases/yr (15% of no. of cows)			Annual loss to clinical cases	
<i>The average clinical mastitis will cost \$107, as a combination of \$12 in medication, \$90 in discarded and decreased milk, \$2 in veterinary cost, and \$3 in labor (Hoblet, NMC 1991).</i>						

GOT THE RIGHT ATTITUDE?

If the pursuit of high quality milk is such a winner, what is holding us back? There is sufficient knowledge available today for all dairy herds to maintain a herd SCC of less than 200,000. However, lowering herd SCC is not only a technical problem, it is an attitude challenge.

Management attitude and the application of quality management practices are not always easy to determine. Seabrook (9) found in comparing dairies with the exact same facilities, feed, genetic base and environmental circumstances that they often resulted in differing productivity. The only difference between these herds was the herd manager; thus, implicating management as the main cause of productivity difference. Although common sense tells us that those farms that visually appear to be neat and tidy are usually at a higher plane of sanitation, this is not entirely accurate. Tidiness does not always coincide with low BTSCC. There are some untidy farms that succeed in consistently producing high quality low BTSCC milk and vice versa. Bennett found, however, that BTSCC level is a dependable predictor not only of milk quality but also of the general quality of herd management (2).

The bottom line differences in management attitude are captured in the following questions: Are you just milking cows or are you producing quality milk? Are you just dipping teats or are you using a dip cup to completely immerse teats? There is an attitude difference and the resulting behavior is reflected in BTSCC. Whether or not high quality milk is produced depends on whether milk quality management practices are consistently and properly implemented. The idea that attitude is a determining factor in success is nothing new to any of us. There has been some indirect implication of an attitude effect on milk quality. However, there have been few studies that have attempted to directly correlate attitude and behavior with milk quality. Barkema et al. (1) may be one of the first studies where there has been demonstrated a direct and significant BTSCC difference between dairy farmers who were categorized by their management style as "clean and accurate" (BTSCC <150,000) and those categorized as "quick and dirty" (BTSCC 250,000 to 400,000). The association between management style and BTSCC was high ($P < 0.001$). The farmers categorized as "clean and accurate" were characterized as younger, more education minded, better record keepers and more hygienically meticulous. For example, "clean and accurate" farmers:

- were more likely to use records daily
- rarely forgot to take milk samples for culture on the clinical cases
- enjoyed milking more
- were more likely to believe it is important to work hygienically with clean hands, boots, etc.
- less likely to start milking later than planned
- kept farmyard, milking parlor and bulk tank room cleaner as determined by a standardized hygiene scoring system

The most striking difference between the "clean and accurate" farmers and the "quick and dirty" farmers was that the former preferred to work precisely while the latter preferred to work quickly. What is your attitude about producing high quality low SCC milk? Take the following SCC risk quiz to see how your milk quality attitude measures up.

SCC Risk Quiz	
Studies have shown the following are characteristics of low SCC herds (<150,000). Give your farm a score of 1 to 7 for each item, with 7 being the best and 1 the worst.	
	Cows have no visible manure or dirt on udder or lower rear legs and feet.
	Udder hair is removed every 3 months.
	Stalls are cleaned frequently. Soiled bedding is removed at each milking. Fresh organic (sawdust, straw, etc.) bedding is added daily or fresh sand bedding is added weekly.
	Generous amounts of bedding are used.
	Dry cows are checked daily for evidence of clinical mastitis.
	Calving pens are clean. Pens are completely cleaned and fresh bedding is added between calvings.
	Milking parlors are clean. There is no buildup of manure or dirt on the milking equipment.
	Milk is kept out of the bulk tank at least 48 to 72 hours after calving.
	Post-milking teat dip is used consistently.
	All quarters of all cows are dry-cow treated.
	Transition diets and nutrient supplementation are used for springing heifers, and dry and lactating cows.
	Herd owners and employees keep abreast of current practices to improve milk quality and udder health by reading and/or attending workshops.
	Detailed herd records, including clinical mastitis treatment records, are kept.
	Milkers enjoy milking cows.
	Emphasis is on getting the job done right rather than getting the job done quickly.
	YOUR SCORE
91-105:	Excellent. Keep up the good work!
76-90:	Good job. However, there is still room for improvement.
61-75:	Fair. Time to get serious about milk quality.
<60:	Get with it! Are you producing food or running a summer camp for bacteria?

MIRACLES, MAGIC OR A METHODOICAL APPROACH?

Effective problem solving is neither magical nor miraculous. It begins with a clear understanding of all the processes that affect mastitis and milk quality. Too often diagnostic tests are run and conclusions drawn with an insufficient understanding of all factors affecting milk quality or mastitis. As a result, unbalanced or erroneous diagnoses and ineffective recommendations may be given. What is needed is a systematic methodical approach. Below are the steps in solving a high SCC problem.

1. Define the problem.

Use DHIA and/or on-farm records, BTSCC records, bulk tank cultures, and individual cow cultures to understand which cows are infected and when they are getting infected.

2. Identify the troublemakers.

Use bulk tank and individual cow cultures to determine what are the main organisms causing elevated SCC or clinical cases. Different organisms will require different solutions (Figure 1).

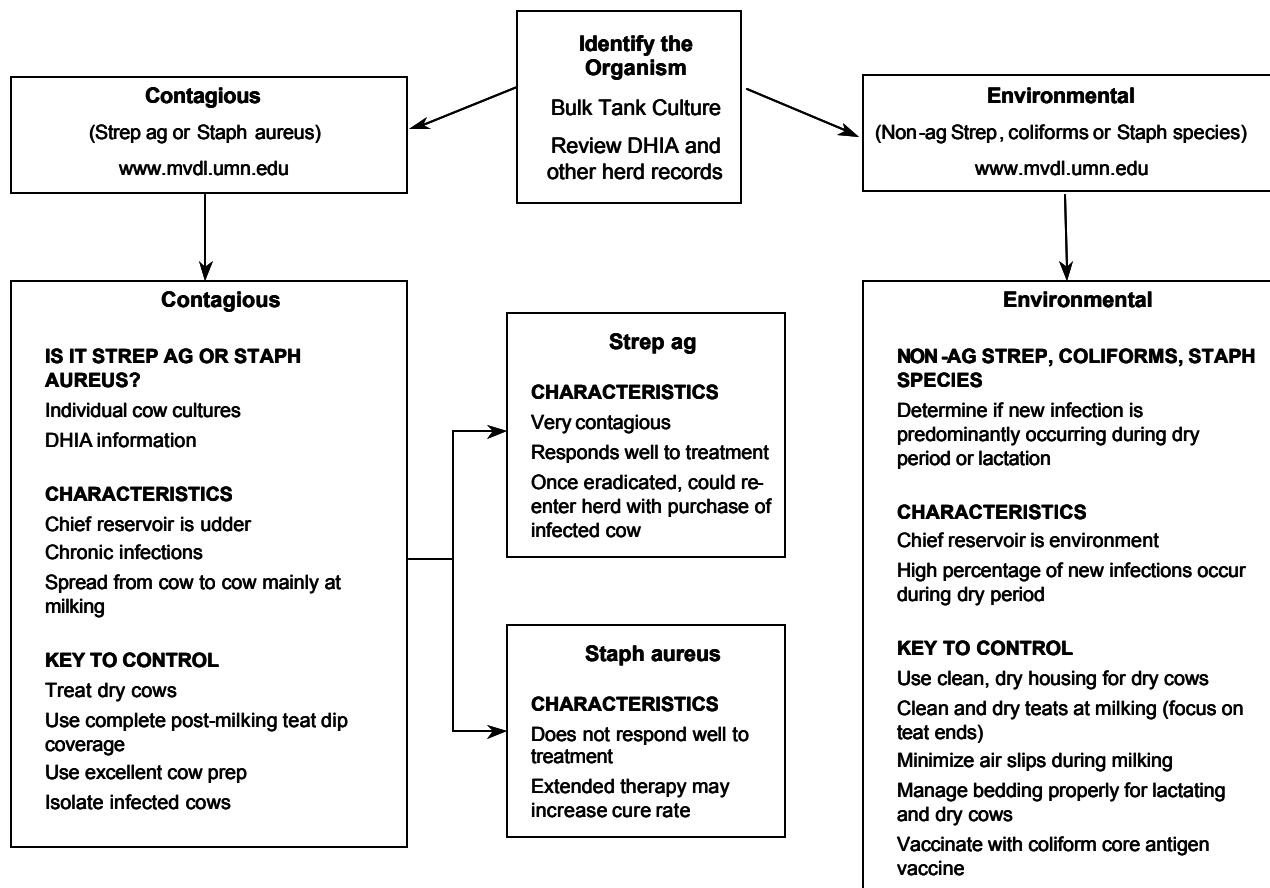


Figure 1. Mastitis microbiology flow chart.

3. Generate possible causes and solutions.

Based on the information you gathered in Steps 1 and 2, work with your diagnostics team to generate a list of possible causes and consider possible solutions. If there are multiple causes, you will need to use a multiple-pronged approach. The use of a cause and effect diagram may be helpful in this process. Decide on the most likely causes and what the best solutions may be.

Cause-and-effect diagramming (also called fishbone or Ishikawa diagrams) is helpful in identifying and systematically listing all the different potential causes that can be attributed to an “effect” or “problem” (3, 4). This approach helps all participants to understand and visualize the potential root causes of any problem being considered within the context of the whole system. It also can be used in process improvement by helping herd managers and consultants identify those factors that are most likely limiting performance. Development of a cause-and-effect diagram is relatively simple. Ideally it should be done as part of a brainstorming session where the herd consultant(s), herd manager, herds person and employees are working together to gain a clear understanding of the herd problem. A sample of a generic cause-and effect (fishbone) diagram is shown in Figure 2.

The diagram is begun by drawing a straight horizontal line (the backbone) with an arrow pointing to a brief statement of the “effect” or “problem”. Since every process has five standard inputs (people, material, methods, equipment, environment), all of which could be potential “causes”, the five large bones of the fishbone diagram can be drawn connecting to the “backbone” as show in Figure 2. Occasionally all five of the generic categories are not appropriate in which case those considered inappropriate may be discarded. With this accomplished, the next step is to brainstorm asking the question “why” for each of the “large bones” of the fishbone diagram. As responses are made, they are added to the diagram as contributing sub-cause “small” bones along each of the “large” bones (Figure 3).

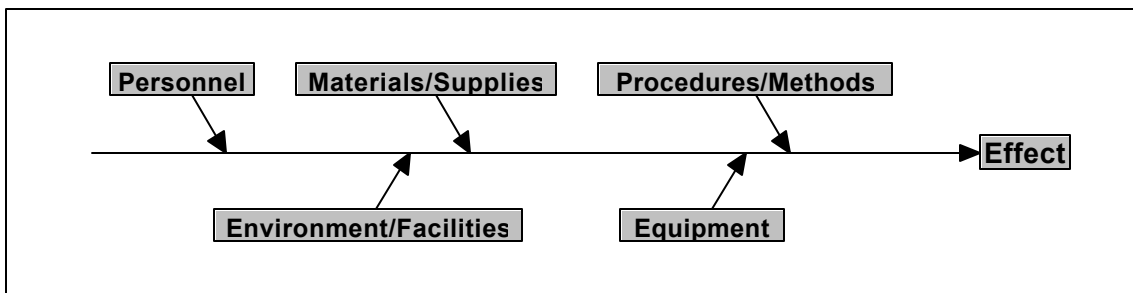


Figure 2. Generic fishbone diagram.

Each time a sub-cause is added, the why question is asked. This process is repeated and as each answer is given, it is added as an offshoot of the bone that spawned the question until no one can think of answers to the why questions. Using this procedure will lead you (in theory) to the potential root causes of the “problem” or “effect” of concern. Figure 3 is an example of a fishbone diagram for a dairy concerned about a high BTSCC. Every dairy’s high BTSCC fishbone diagram will have similarities but because of differences in process inputs (people, material, methods, equipment, and environment), every fishbone diagram may look very different. This is to be expected and is not important. What is important is that all interested parties have become involved in the systematic thought process. Because each has had input, they now are more likely to also feel ownership and as a team will now have a clearer understanding of what needs to be done.

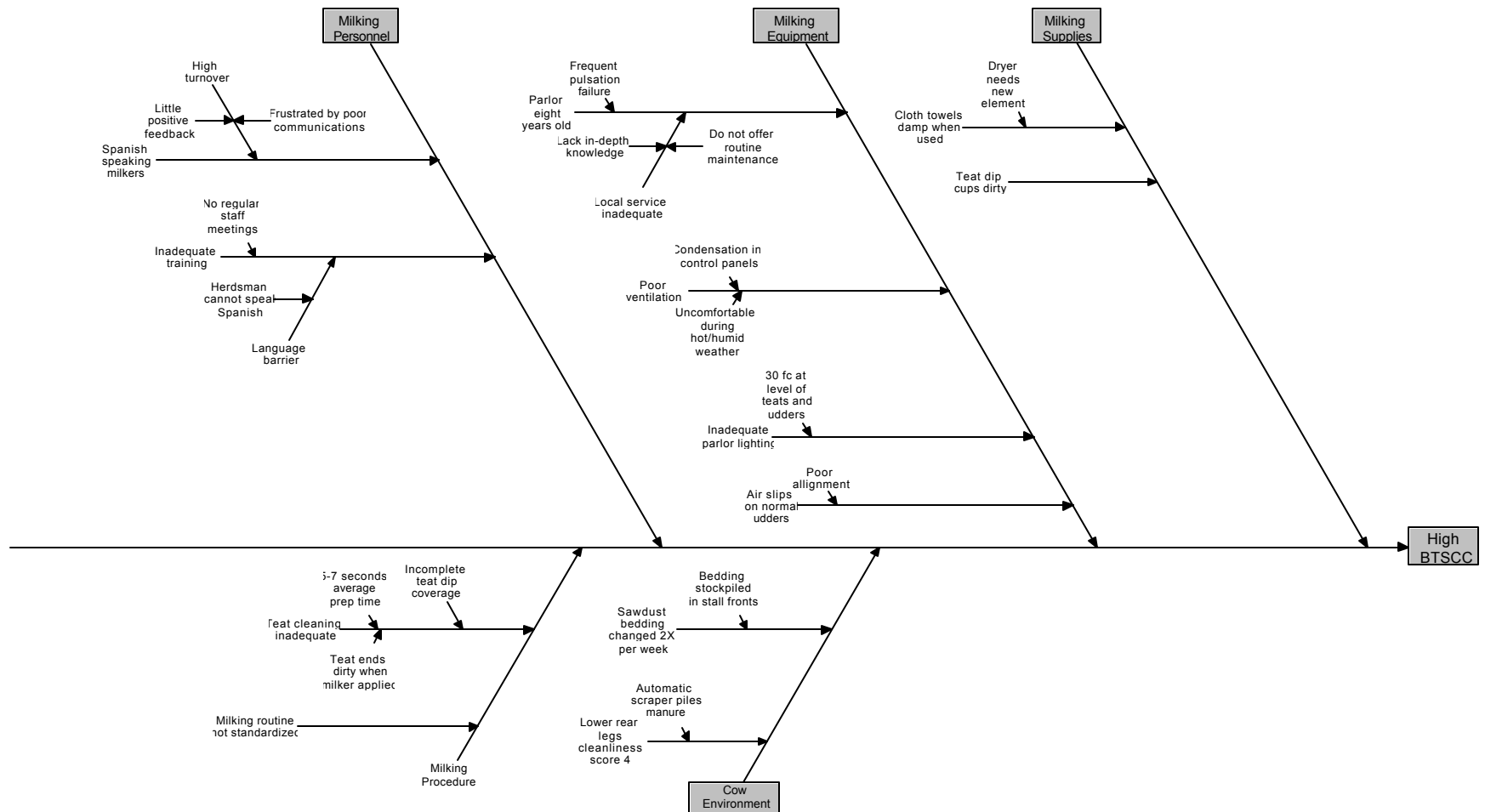


Figure 3. Fishbone diagram for an example herd with high BTSCC problem.

Once the cause-and-effect diagram is completed to everyone's satisfaction, the next step is to identify which of the potential contributing factors are most likely in need of improvement. A plan should then be devised and implemented with monitors identified to measure progress.

The use of cause-and-effect diagrams has the advantage of providing a better understanding of all the components of any process being considered and the relationship between each. As a result, they encourage systematic approach to problem solving or process improvement.

4. Develop an action plan.

Work with your team to develop an action plan based on Step 3. Determine how the preferred solutions will be implemented, who will be responsible for the implementation and who will need to be trained.

5. Set up plan to monitor progress.

One of the most important components of any plan is to set up monitors to show whether your plan is working. The use of multiple monitors (e.g., BTSCC and bulk tank culture) is often best since no monitor is perfect. Some possible mastitis and milk quality monitors are:

- BTSCC graph for each milk pickup.
- Monthly bulk tank culture for mastitis pathogens.
- Individual cow DHI SCC.
- CMT of all fresh cows. How many cows are calving infected? Which quarters are infected?
- Culture of all fresh cows with high CMTs. What organisms are causing infection?
- Culture of all new clinical cases and new sub-clinical infections (new cows over 200,000 SCC) each month. What organisms are causing infection?
- New infection rate on all cows (goal < 5%).
- New infection rate on fresh cows (goal <10%).
- Rate of clinical mastitis (goal < 2%/month).

6. Carry out the plan.

Make the changes you and your team decide are appropriate based on the facts you have gathered. Once implemented, be careful not to tinker with the plan unless there is strong evidence that the plan is not working.

7. Monitor progress and adjust plan as needed.

Review the monitors monthly (or more frequently) to determine if the desired progress is being made. If it is, continue on the same course. If not, find out why. Is the problem the plan of action itself or failure to successfully implement the plan? Reevaluate the action plan and/or retrain personnel. Continue to fine-tune your plan until you achieve your SCC goals. Progress can be slow depending on the causes of the high SCC or clinical mastitis problem or the plan being implemented. However, if you use a systematic approach, you will make consistent progress toward your goal. Once reached, a low SCC will reward your farm with increased profitability and personal satisfaction.

NEW TOOL FOR AN OLD PROBLEM

Statistical Process Control (SPC) is one of the most powerful tools for process improvement. However, unless SPC is used as a part of a production system where the idea of continuous improvement is embraced, it is just another way of representing data in a graph (7). It is important at the onset of this discussion to emphasize this point. Experience has shown that application of SPC without commitment to the continuous improvement concept will not be a

very productive or satisfying experience. Although SPC is new to agriculture, it is not really new. It has been successfully used in manufacturing businesses for over 60 years.

SPC is a set of several analytical tools of which the control chart is an important one. This discussion will focus only on control charts. Control charts are helpful in signaling that a real change has occurred. The fundamental concept of control charts is to distinguish between inherent random variation and real changes in output, quality or measured performance. SPC methods can be used to signal emerging problems, evaluate the positive or negative impact of a change in a management practice or the implementation of a new product.

The most common use of dairy herd management data is to compare this month's average with last month's average. Are we doing better or worse? The problem with such limited comparisons is that they are out of context. Context here means that the data should be interpreted in context of the time order in which they were generated. Context also means that the natural variation in the data and its relationship with similar data generated by the process needs to be taken into consideration. Data divorced from their context can be misleading.

Although several months of tabular data would provide ample context, most people find it difficult to assimilate and provide accurate interpretation. For example, consider the relatively simple table of daily BTSCC data for a Minnesota dairy (Table 1). Looking at the table, we might ask several questions to aid our interpretation:

- How were the data collected and calculated? By whom?
- What is the highest value? The lowest? The average? The median?
- What is the normal, day-to-day level of variation?
- What causes the normal variation?
- When is variation abnormal?
- When should we be worried?
- How does this herd compare to other herds?
- Is there potential for improvement? How much?
- Is intervention worth the cost?
- Does this herd currently have a problem as indicated by the BTSCCs?
- Have there been problems in the past?
- Is mastitis management “under control”? How can you tell?
- If mastitis was to go “out of control”:
 - ♦ How soon would these data tell you?
 - ♦ How quickly would you react?
 - ♦ What would you do?
 - ♦ How would you measure response?
 - ♦ Would you be confident that your intervention had made a difference?

Obviously, study of tabular data is overwhelming, time consuming and often unproductive.

Table 1. Bulk tank somatic cell count for a Minnesota dairy (BTSCC x 1000).

Date	BTSCC	Date	BTSCC	Date	BTSCC
10/1/98	236	11/14/98	235	12/27/98	312
10/2/98	303	11/15/98	265	12/28/98	294
10/3/98	236	11/16/98	238	12/29/98	242
10/4/98	219	11/17/98	212	12/30/98	248
10/5/98	224	11/18/98	239	12/31/98	215
10/6/98	246	11/19/98	267	1/1/99	212
10/7/98	292	11/21/98	229	1/2/99	292
10/8/98	270	11/22/98	272	1/3/99	300
10/9/98	225	11/23/98	219	1/5/99	327
10/10/98	238	11/24/98	257	1/6/99	229
10/11/98	228	11/25/98	279	1/7/99	244
10/13/98	243	11/26/98	205	1/8/99	274
10/15/98	226	11/27/98	218	1/9/99	295
10/16/98	225	11/28/98	235	1/10/99	306
10/17/98	227	11/29/98	281	1/11/99	314
10/18/98	275	11/30/98	272	1/12/99	242
10/19/98	248	12/1/98	256	1/13/99	266
10/20/98	244	12/2/98	269	1/14/99	243
10/21/98	231	12/3/98	227	1/15/99	262
10/22/98	250	12/4/98	258	1/16/99	293
10/23/98	239	12/5/98	261	1/17/99	281
10/24/98	267	12/6/98	250	1/18/99	278
10/25/98	271	12/7/98	230	1/19/99	238
10/26/98	226	12/8/98	266	1/20/99	233
10/27/98	244	12/9/98	262	1/21/99	257
10/28/98	189	12/10/98	219	1/22/99	271
10/29/98	303	12/11/98	271	1/23/99	232
10/30/98	229	12/12/98	266	1/24/99	244
10/31/98	242	12/13/98	220	1/25/99	275
11/1/98	255	12/14/98	243	1/26/99	213
11/2/98	217	12/15/98	180	1/27/99	254
11/3/98	205	12/16/98	213	1/28/99	312
11/4/98	238	12/17/98	221	1/30/99	352
11/5/98	214	12/18/98	276	1/31/99	303
11/6/98	250	12/19/98	268	2/1/99	284
11/7/98	220	12/20/98	334	2/2/99	227
11/8/98	212	12/21/98	303	2/3/99	298
11/9/98	241	12/22/98	323	2/4/99	347
11/10/98	265	12/23/98	329	2/5/99	325
11/11/98	261	12/24/98	285	2/6/99	281
11/12/98	242	12/25/98	241	2/7/99	336
11/13/98	255	12/26/98	275	2/8/99	349

Time Series Charts

Since we are visually oriented and tables of data are visually boring, graphs make data more accessible to the human mind. Graphs can remove extraneous detail while providing context for visual interpretation. Management data will usually have a time order. Therefore, a time series chart of data improves interpretation. Consider again the BTSCC data for a Minnesota dairy in a time series chart (Figure 4). Compared to the tabular format, the plotted data provide a much clearer idea of the BTSCC changes and trends over time. We can use our prior knowledge and experience of BTSCC data to form a general impression of udder health in this herd. We can see that this herd's BTSCC is generally too high with possibly a slightly upward shift. However, a simple time series chart doesn't have sufficient resolution for more meaningful interpretation. It is still difficult to identify subtle changes or to know if the BTSCC in this herd is "in control" or "out of control". This is because the inherent random variation (noise) masks real changes. Noise, like static on a car radio, makes listening annoying and difficult to understand. The Shewhart Control Chart is the simplest method to separate potential signals from probable noise.

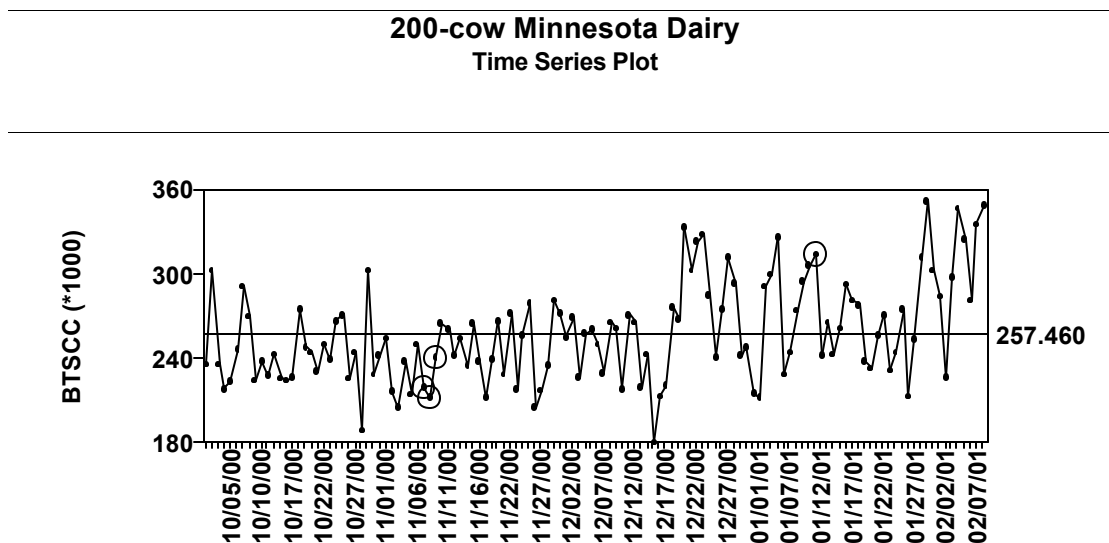


Figure 4. Time series plot of the daily BTSCC for a 200-cow Minnesota dairy.

Control Charts

In the 1920's, Dr. Walter Shewhart at Bell Laboratories invented control charts to help interpret data that is generated over time. Control charts provide further insight into data by displaying the level of normal, random variation in the data and by revealing the observations that indicate real change. This approach affords the practical application of statistical theory in a visual, easy to interpret context. The steps to develop a Shewhart Control Chart are as follows:

1. Start with a time series chart.
2. Add a centerline (mean) for central reference.

3. Add control limits equidistant on either side of the centerline that are computed from the data and based on the “normal” variation.
4. Apply “rules” to distinguish between data points due to “real” change (special cause variation) from data points due to “normal” variation (common cause variation) only.

Sigma (a measure of variation similar to standard deviation) is calculated for the data collected in a time frame called the “control period”. Control limits are set three sigma above and below the central line (mean). Experience has shown that a minimum of 20 data points are needed to calculate credible control limits (3, 4, 10). When initiating a control chart, it is appropriate to use the first 20 data points collected as the control period. Once control charting is established the control period can be set depending on the question being asked. If the intent is to monitor a process for the purpose of maintaining a stable process, then using data from an apparently stable period makes sense. If the intent is to use the control chart to evaluate the introduction of a new product or a change in process procedure, etc., then the control period should be calculated from data collected just prior to the introduction of the product or change in procedure. The control limits for our example using the BTSCCs were calculated using the October 1998 to December 1998 BTSCC data. Since there was no indication of special variation in that period, the process appeared to be “in control”. Note that the picture becomes more clear than a time series plot but it remains difficult to interpret the data without a formal and standardized approach to distinguish between “normal” variation and variation that deserves more attention.

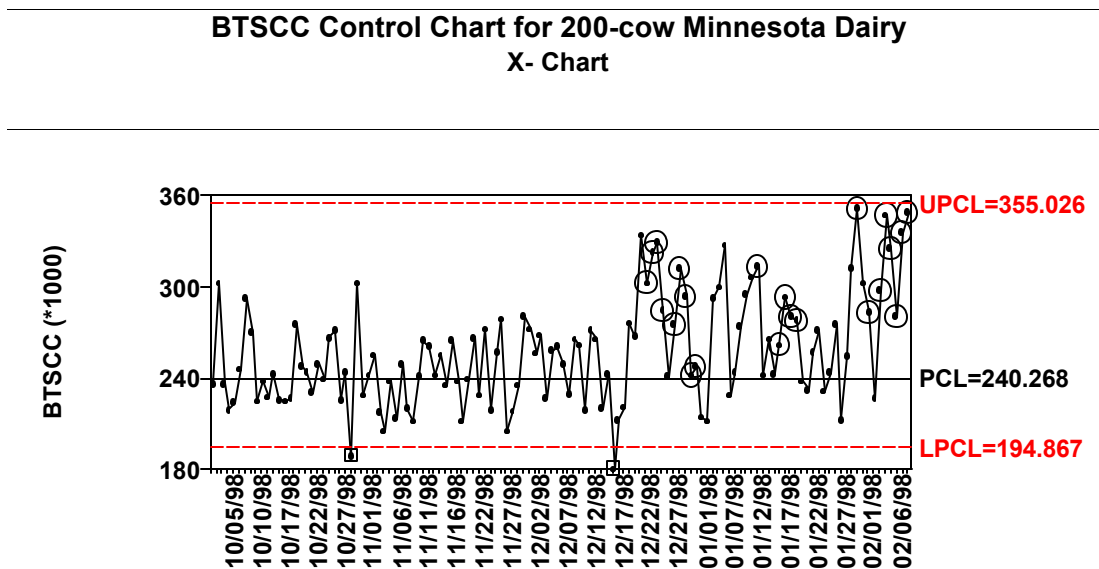


Figure 5. BTSCC for a Minnesota dairy plotted in a Shewhart Control Chart.

(The mean and control limits were calculated using the daily BTSCC data for the period from October 1, 1998 to December 1, 1998.)

Interpreting Control Charts Using Tests

Several rules exist that can help in the correct interpretation of control charts. When a single data point is observed outside one of the control limits, the probability that this point is not a real change (false positive) is only 3 out of 1000. Three other rules are used in the Western Electric Rules for control chart interpretation (4, 10). The combined probability that any of the four rules

indicate a “real change” when there is none, is about 20 out of 1000, or 2%. Thus, it is generally safe to assume that the process is “out of control” when any one of these rules indicates a change. The four rules are:

- **Rule 1** – A single point outside one of the control limits.
- **Rule 2** – Two of three successive points fall on the same side and more than two sigma away from the central line.
- **Rule 3** – Four out of five successive points are on the same side of the line and are more than one sigma away from the central line.
- **Rule 4** – Eight or more successive points on the same side of the central line.

Any time the conditions of any one of these four rules are met, you can be certain the process has changed and is by definition “out of control”. Considering these rules as new data becomes available ensures timely signaling of real changes. Using these four rules, let’s again consider the control chart of BTSCC data (Figure 5).

Rule 3 indicates that starting on December 18th, there it is clear and significant upward shift in the level of BTSCC. The process is “out of control”. There is no need to vacillate since you can be 98% certain that the shift is “real” and it is not just normal variation. Since data should be interpreted in their context, these observations may or may not be a surprise to the dairy manager. For example, in this case, the distractions of the Christmas holiday may have disrupted normal herd management. If this were the case, it may well explain the shift in BTSCC level. The control chart then confirms our expectation about the BTSCC level. However, if no explanation can be readily given, then investigating the probable causes of the shift in BTSCC is well worth the effort and cost. There are two basic questions regarding a breakdown in the process:

- Is this a personnel management issue? (i.e., protocols not being followed)
- Is there some flaw in the process itself? (i.e., breakdown in equipment or an inadequate protocol)

For example, maybe the new employee does not do a good job scraping the stalls or the replacement bedding material is contaminated. Control charts provide a means for early detection of “real” changes enabling the opportunity to nip the problem in the bud. In this particular case there was no action taken. As one can see, the consequences resulted in further process entropy and obvious deterioration of those processes contributing to BTSCC level.

Control charts also offer a means to evaluate efforts towards continuous process improvement. Figure 6 is a control chart of a large Wisconsin dairy that has kept their herd bulk tank count less than 200,000 for 20 years. During the period between January 1, 1999 through mid-February, the BTSCC was averaging 140,000 and was “in control”. However, the herd manager felt that the herd BTSCC should be 100,000 or less, as had been the case during previous years. During the March 21, 1999 meeting with the milking parlor staff, there was a consensus reached:

- that more attention be placed on pre-milking teat end sanitation, and
- that cows with extremely high SCC quarters would be identified with a leg band so that the high SCC quarters could be milked into a quarter bucket.

The plan was implemented immediately. Did the program work? Study of Figure 6 clearly indicates a dramatic and significant decline in herd BTSCC. Western Electric Rule #3 indicated that by March 27th the herd manager knew with 98% certainty that the plan was working and could use the chart as positive feedback to the parlor crew to reinforce their dedicated effort.

BTSCC of a Wisconsin Dairy X-Chart

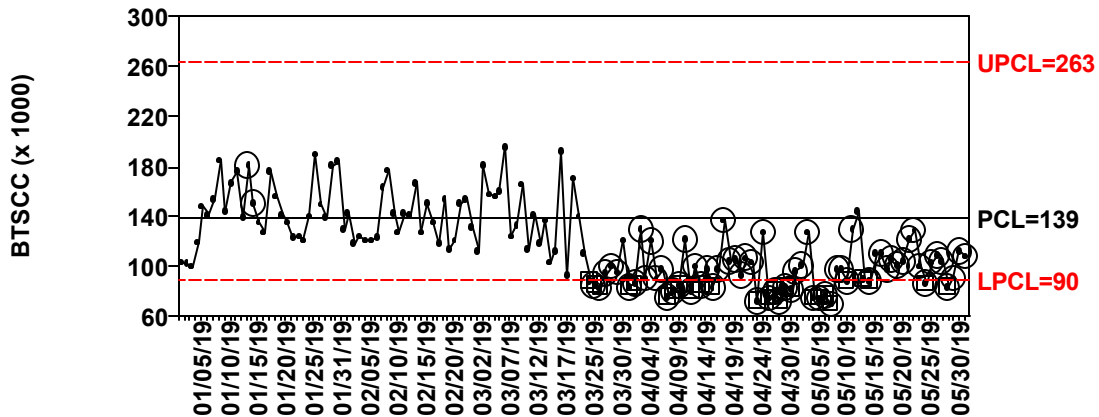


Figure 6. Shewhart Control Chart of daily BTSCC on a Wisconsin 700-cow dairy to determine the effectiveness of implementing changes in milking routine.

Control charts are commonplace in the manufacturing and service industries. They have great potential for improved decision-making in dairy management. Monitoring BTSCC with a Shewhart Control Chart is a good example of a valid application. Plotting of frequently collected individual data in a control chart (i.e., daily feed intakes, daily milk weights, milk components including MUN) is the simplest of SPC techniques. There is still much research work to be done in confirming which variables are appropriate for SPC applications. Generally data suitable for SPC application is:

- Data that is easy and practical to collect.
- Data that is collected on a frequent basis (daily, weekly) is preferable.
- Data of economic significance.
- Data that as directly as is possible reflects process behavior.

Although SPC and the use of control charts are useful monitoring tools, there are pitfalls. The greatest pitfall is initiating SPC techniques without the right mindset. If these techniques are attempted where management is not willing to embrace the philosophy of continuous improvement, they will inevitably fail to produce anticipated results. Another pitfall is improper calculations of control limits, as was previously mentioned, resulting in too many false signals. However, these techniques are robust and when used appropriately are very effective herd monitors. It is expected that SPC will play a major role in dairy monitoring in the future.

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