The Veterinarian Position
Wisconsin's Stray Voltage Program

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Introduction

The Public Service Commission (PSC) and Department of Agriculture, Trade and Consumer Protection (DATCP) have jointly administered Wisconsin's stray voltage[a] program since 1987. The history and outcomes of this program have been well documented in PSC publications and dockets.[1] Based on the sheer volume of material, a reviewer of this documentation would conclude that the defining, testing, and mitigation of negative interactions between electricity and dairy cows has been the entire focus of the program. Veterinarians have been an integral part of this unique program since its beginning, but relatively little has been published about the history and outcomes of veterinary involvement. This paper will document 20-plus years of veterinary experience in Wisconsin's stray voltage program.

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[a] Stray voltage is defined by the Public Service Commission of Wisconsin (PSCW) as a natural phenomenon that can be found at low levels between two contact points in any animal confinement area where electricity is grounded. Electrical systems - including farm systems and utility distribution systems- must be grounded to the earth by code to ensure continuous safety and reliability. Inevitably, some current flows through the earth at each point where the electrical system is grounded and a small voltage develops. This voltage is called neutral-to-earth voltage (NEV). When a portion of this NEV is measured between two objects that may be simultaneously contacted by an animal, it is frequently called stray voltage. It is the "level of concern" defined as follows that dictates the significance of the voltage at cow contact. In Wisconsin, the "level of concern" is derived from the 1996 PSCW docket 05-EI-115. In that docket, the "level of concern" is defined as 2 milliamps, AC, rms (root mean square), steady-state or 1 volt, AC, rms, steady-state across a 500-ohm resistor in the cow contact area. The Institute of Electrical and Electronics Engineers (IEEE) defines "steady-state" as "the value of a current or voltage after all transients have decayed to a negligible value." The State of Wisconsin deems that this level of voltage/current is an amount of electricity where some form of mitigative action is taken on the farmer's behalf, although only some small percentage of cows may actually perceive its presence. The "level of concern" is not a damage level. Instead, it is a very conservative, pre-injury level, below the point where moderate avoidance behavior is likely to occur and well below where a cow's behavior or milk production would be harmed. The "level of concern" is further broken down into two parts. The first part is a 1-milliamp contribution from the utility, at which level mitigative action must be taken by that utility to reduce its contribution to below the 1-milliamp level. The second part is a 1-milliamp contribution from the farm system, at which level mitigative action should be taken by the farmer.

History of the Veterinary Position

Veterinary involvement with the program began in 1987 as a voluntary position on the Stray Voltage Analysis Team (SVAT). The veterinary position was filled by a UW-Extension veterinarian. The focus of the first year of SVAT was to characterize the on-farm electrical environment with survey-type measurements and data collection from nine chosen farms. The veterinarian's role was to contribute background material to what was primarily an electrical characterization of stray voltage on dairy farms in Wisconsin. Resolution of the farmer's herd health or production concerns was not a veterinary goal. Not all farms were visited by the veterinarian. *SVAT Nine Farm Study* [2] summarizes the findings. The veterinarian's minor role is evident in that report.

In 1990, the first paid veterinary position with SVAT was as a ¾-time position. SVAT began responding to farmers who submitted an application to the PSC. The three-page application included a few veterinary-related questions about symptoms in the herd.

The *SVAT Nine Farm Study* Report recommended the "complete farm analysis" approach to assisting farmers with stray voltage concerns. This recommendation established the veterinarian's initial role. In practical terms it became two days of electrical testing, during which the veterinarian reviewed farm records, collected samples, and performed tests. The SVAT veterinarian became more responsive to farmer concerns by providing a report with general recommendations, based on abnormalities identified in the complete farm analysis.

In 1994, along with a personnel change in the position, the SVAT veterinary position was increased to full-time. Sample reports from farm visits were sent to 10 well-respected Wisconsin veterinarians for their evaluation and recommendations. As a result, testing became more comprehensive and several state-of-the-art upgrades were added to the SVAT veterinary investigative format, including rumenocentesis for the evaluation of subacute rumen acidosis. Milk system testing was upgraded to match National Mastitis Council guidelines[3] and bulk tank culturing was added. Analysis of the farm's nutritional program were brought in line with procedures taught at American Association of Bovine Practitioner seminars[4]. Comprehensive water quality testing[5] was added (see Appendix 1 for list of tests). Actual water intake was measured and compared against the farm-specific water needs (calculated from established formula).[6] Barn lighting was measured. Dew points were measured to evaluate ventilation. Eating, drinking, milking, and entrance/exit behavior were videotaped and analyzed (see Appendix 2 for summary of tests performed and data collected in the complete farm analysis).

In 1995, the program's *Report to the Wisconsin Legislature*[7] resulted in a name change from the Stray Voltage Analysis Team to the Rural Electric Power Services (REPS) and a change in status from project (temporary) to program (permanent). The report stated the program's goal "is to reduce the problems associated with stray voltage, not merely to reduce stray voltage itself. The purpose of the on-site [farm] visits is to address the farmers' questions and concerns about why their herds are not performing as expected, and to determine through objective testing if these concerns are related to stray voltage."[7] This goal statement proactively redefined and expanded the veterinarian's role.

At that time, stray voltage was being found on 42% of farm investigations.[7] This left 58% of farms where the program's goal to address "the farmers' questions and concerns…" would not be accomplished through electrical mitigation. On other farms, stray voltage was reduced, yet herd performance did not improve. On most farms (72%), the farmer was primarily interested in the bottom-line issue of improving herd performance, regardless of who provided the answer.[7] In many cases, by the time a farmer reached the point of requesting state assistance, the farmer had grown dissatisfied with the ability of local professionals to resolve herd performance concerns. The program's 1994 *Report to the*

Wisconsin Legislature describes this well: "Often they have exhausted their financial and psychological resources."[7] The program's veterinary position would no longer play a minor role.

The report to the legislature described a farmer preference for having the electrical and veterinary visits scheduled at different times.[7] Thus, by the end of 1996 , the whole team was no longer on the farm at the same time. This enhanced the veterinary-farmer working relationship and eliminated farmer speculation as to why a veterinarian was present during electrical testing. Now, when the veterinarian was on the farm, it was clear to the farmer that he was there to look at veterinary issues.

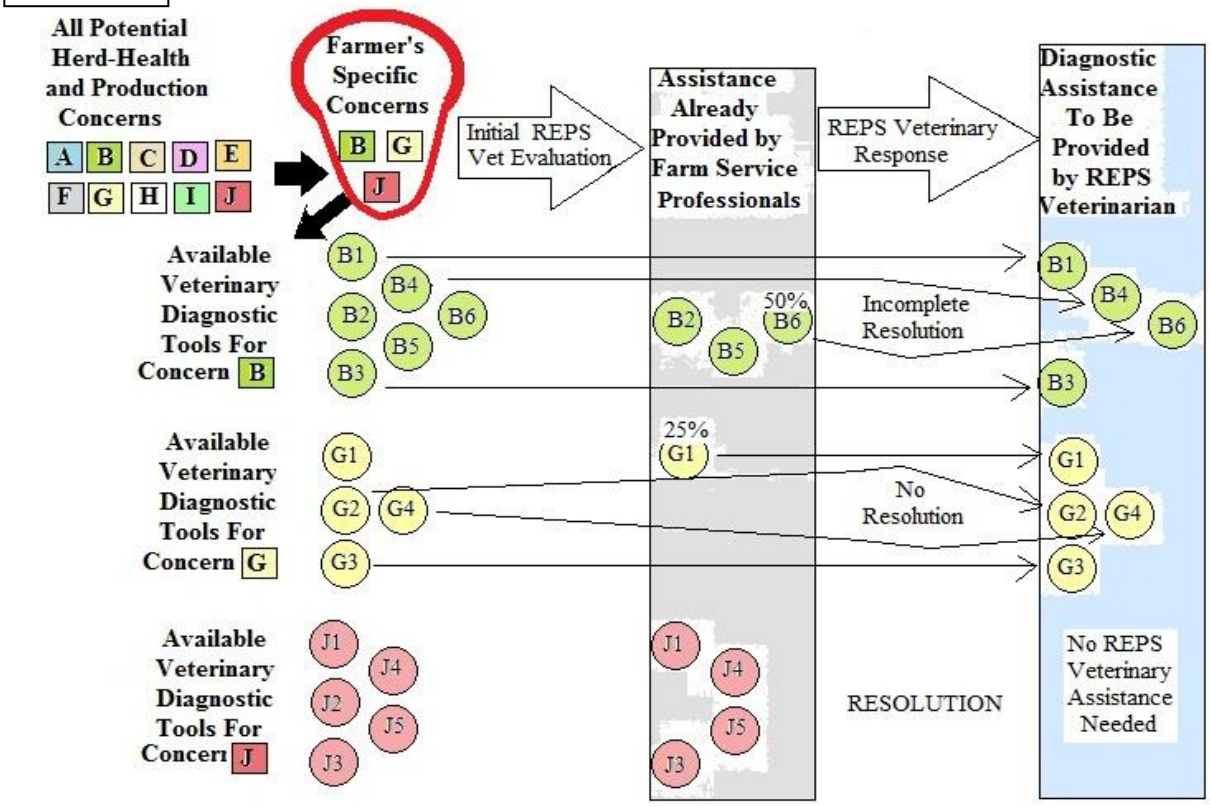
By 1998 the PSC had transitioned away from requiring farmers to submit applications for assistance. This meant that farmers interested in REPS veterinary assistance would need to call the veterinarian directly. This step improved farmer-veterinary dialogue and further clarified the purpose of veterinary farm visits. The veterinarian's focus was now entirely on resolution of the farmer's specific herd health or production concerns. The broad survey methodology of the complete farm analysis was replaced by a problem-solving strategy.

During a farmer's initial phone call to request assistance, three questions were routinely asked:

1) What are this farmer's concerns?
2) Who has been involved in the effort to resolve those concerns?
3) What testing has been done by those who have been involved?

The answers formulated the type of assistance to be provided to the farmer. The new goal became to identify what standard, problem-specific, veterinary diagnostic testing had not been done and then fill in the diagnostic blanks. This approach has proven effective and remains in place today (see Appendix 3 for handout describing REPS-veterinary service). Figure 1 diagrams how a unique, farm-specific, REPS veterinary diagnostic approach is assembled for each new request for assistance.

Figure 1

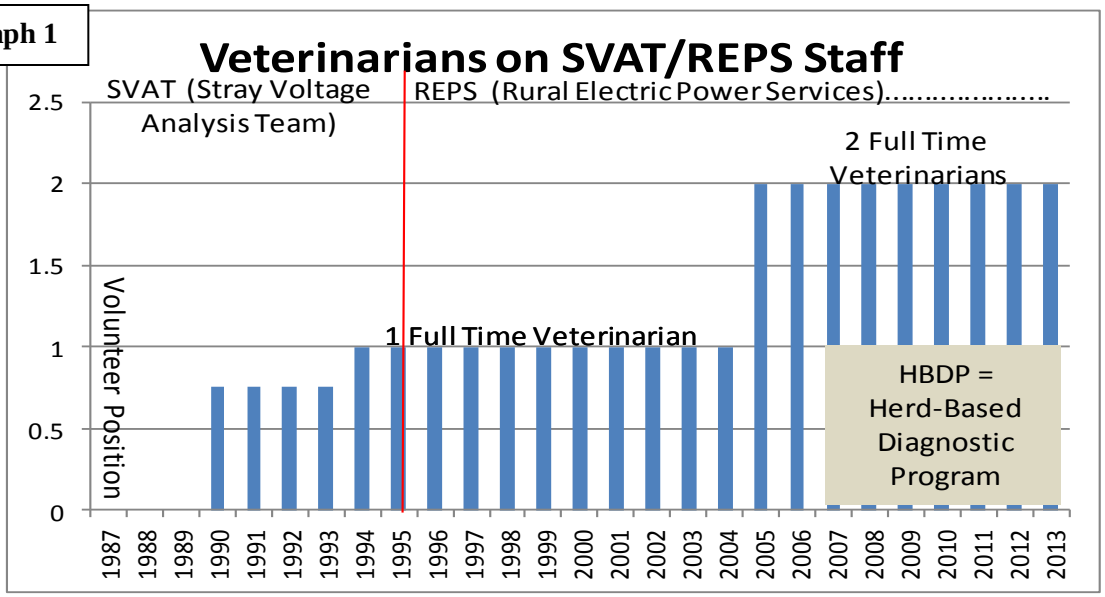


Beginning in the mid-90s, the REPS veterinarian position was strengthened by two very beneficial developments. The first was Dr. Doug Reinemann's research on animal response to stray voltage.[8] With no formal training and little practical experience on the subject, REPS veterinarians would have struggled to determine which animal behaviors and clinical signs could be attributed to stray voltage. Dr. Reinemann's research and publications allowed REPS veterinarians to know which of the perceived signs of stray voltage in a farmer's herd needed more veterinary attention and better veterinary advice.

REPS-DATCP staff responded to this need with an exhaustive literature search for what was known of the actual significance of behaviors, such as whole-herd tail-switching, nose-pressing, lapping at water, and flinch-step-kick behavior during milking. Time-lapsed videotaping of behavior was initiated on farm visits in order to further improve understanding. REPS veterinarians were on the forefront of efforts to use time-lapsed video study to reveal causes of previously misunderstood behaviors in dairy cattle.

The second development was the appearance of a new suite of next-generation veterinary diagnostic tools. Herd-based diagnostic testing was developed by Wisconsin's School of Veterinary Medicine - Food Animal Production Medicine Program.[9] Unlike traditional veterinary diagnostic skills, which focused on the individual sick cow, these tools evaluated the health and performance of a herd. The net effect of the change in the REPS veterinary investigative process, the research on animal response to stray voltage, and the development of potent herd-based veterinary diagnostic tools was a dramatic increase in effectiveness in REPS veterinarian diagnostic assistance. In 2005 a second full-time veterinarian position was added to the REPS program (Graph 1).

Graph 1



By 2007, the use of herd-based veterinary diagnostic tools had become such an integral part of the REPS veterinary service that the name Herd-based Diagnostic Program (HBDP) became the common name for DATCP's part of the REPS program. It was used as the title of two presentations to DATCP's Ag Board in 2008 and 2010.[10]

Upgrades to the state's veterinary diagnostic lab also improved effectiveness of REPS veterinarians. In 1998 the lab was characterized as being "under-budgeted, under-staffed and lacking in effective leadership to the point that its national accreditation status was in jeopardy."[11] In 2000 the ailing Wisconsin Animal Health Laboratory was replaced by the new Wisconsin Veterinary Diagnostic

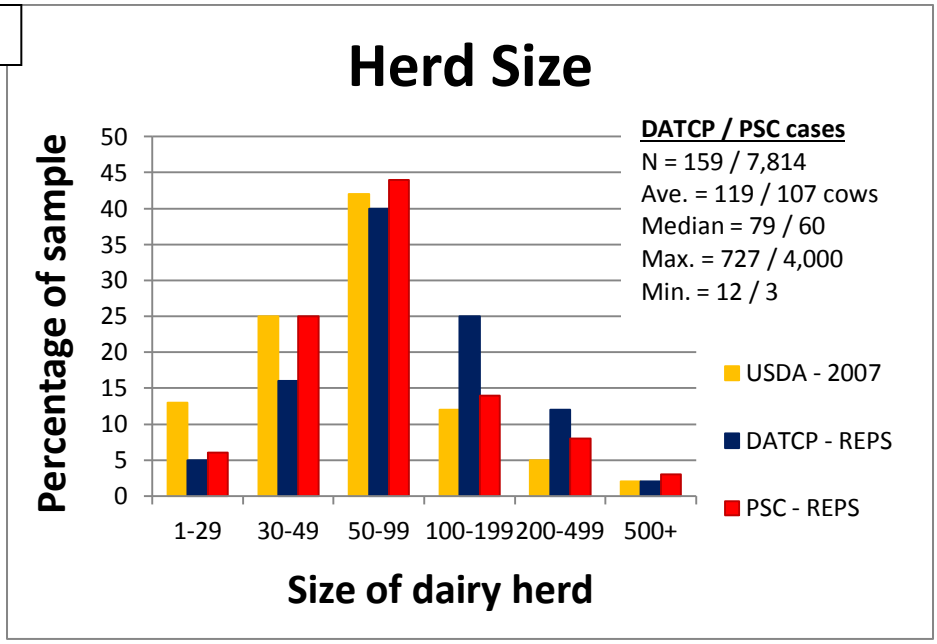
Laboratory, became part of the School of Veterinary Medicine, and added both staff and technical capacity. The culmination of this effort was the 2007 completion of a state-of-the-art diagnostic facility in Madison.

In 2009, the initiation of veterinary assistance changed from a direct phone call from the farmer to a written application. The application provided a large blank space for farmers to respond to the following statement: "What are the primary herd health and/or production issues you are seeking REPS veterinary diagnostic assistance with? Briefly describe these concerns, and any specific goals or expectations you have of REPS assistance with these concerns." It also included questions to determine if the farmer was concerned about stray voltage and whether stray voltage testing had been done. The application more accurately communicated a farmer's herd health and production concerns, allowed for better pre-visit understanding of the farm layout and work schedules, and streamlined the effort to contact the farmer's local support professionals. It continues to be used today.

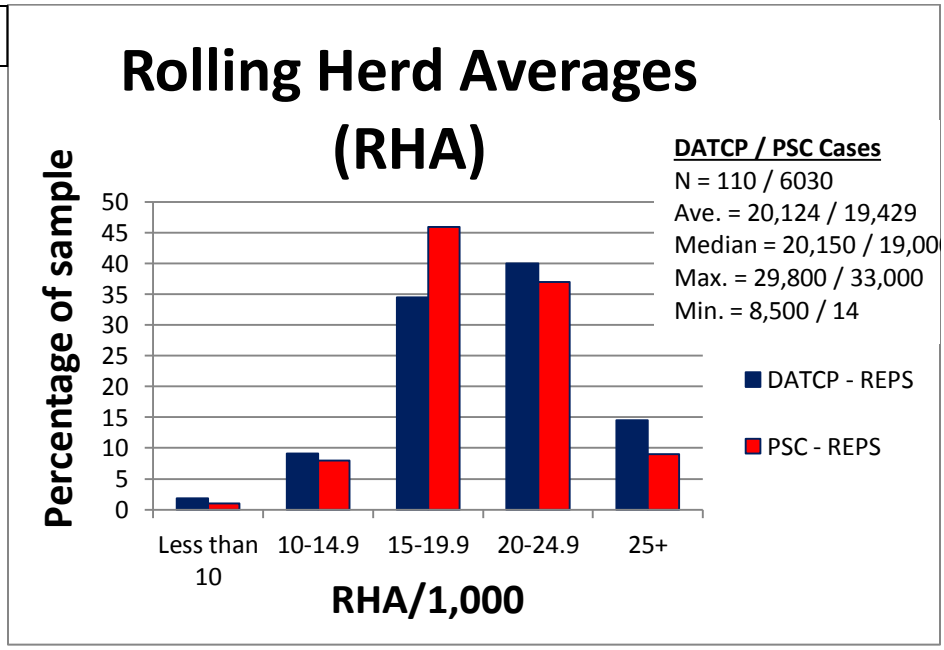
REPS Veterinary Farm Visits

Herd size, production, and somatic cell count data show that REPS veterinary diagnostic assistance is provided to a representative cross-section of Wisconsin dairy herds and to dairy farms that are similar to herds in the PSC database[b] (Graphs 2-4)[10]

Graph 2

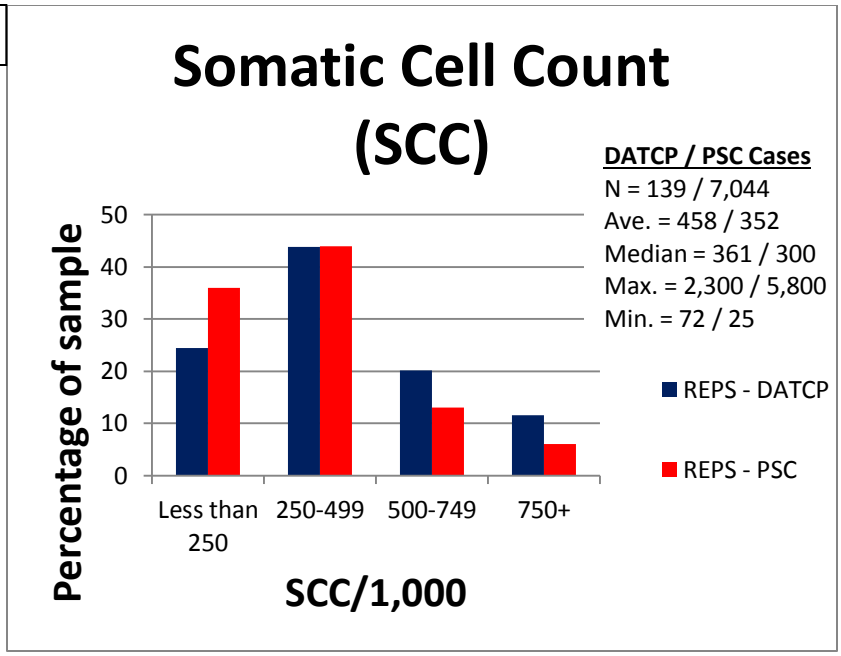


Graph 3



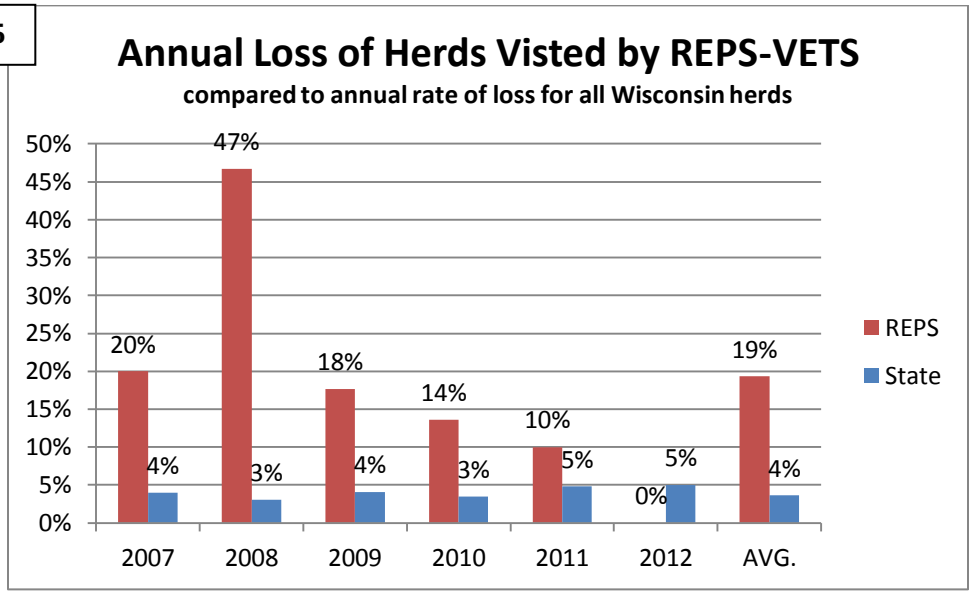
[b] **Explanation of Data Sets:** Early in the program the PSC began keeping a database on herd size, rolling herd average, and somatic cell count from herds where local utilities conducted stray voltage investigations. DATCP did not track this data on herds receiving program assistance until 2007. Furthermore, there is no veterinary equivalent to data from stray voltage investigations done by local utilities. Consequently, the DATCP-REPS dataset is much smaller and more recent.

Graph 4

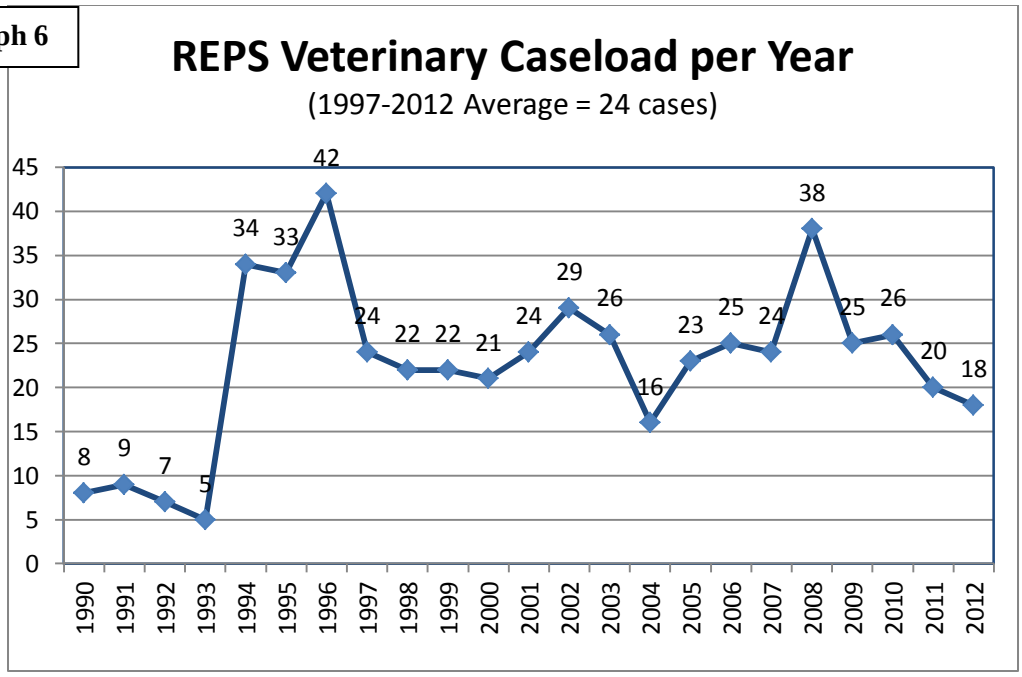


For herds that requested REPS veterinary assistance between 2007 and 2012, 19% were no longer in business by the end of 2013(Graph 5).[10] Over the same time period, the average annual attrition rate for dairy herds across Wisconsin was 4%, suggesting that 15% of herds that seek REPS veterinary assistance were out of business earlier than predicted. While comparison of herd size, production, and cell count suggests that assistance is being provided to a cross-section of Wisconsin's dairy farmers, this data suggests an increased degree of financial distress amongst farmers requesting REPS veterinary assistance. Not all requests are from financially-distressed farms, but there is a commonality. Regardless of financial status, the inability to resolve persistent herd health or production concerns through their local farm service professionals is what motivates a farmer to take that extra step of seeking assistance from a state program. In 15% of these herds, unresolved herd problems have critically impaired farm finances.

Graph 5



Graph 6

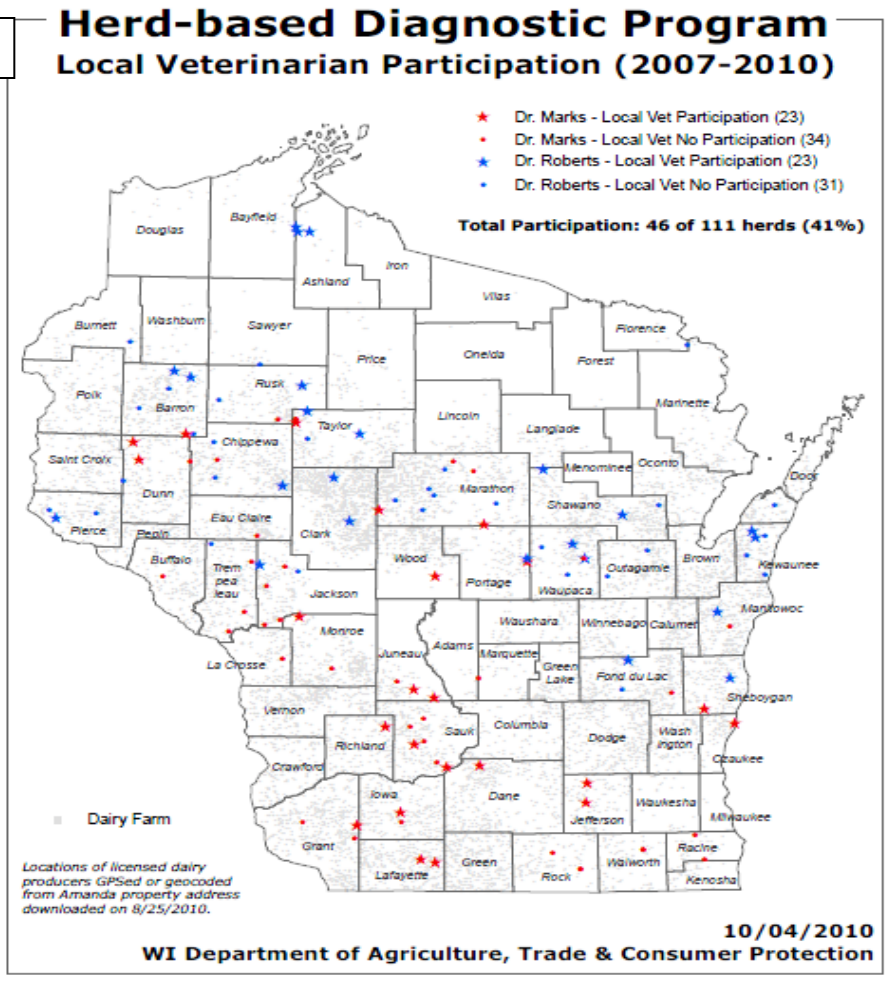


Graph 6 summarizes the history of REPS veterinary caseload. The number of visits a farm receives from the REPS veterinarian varies. Follow-up visits are done on 43 % of the farms visited.[10] Some farms will receive as many as six follow-up visits. The need for follow-up visits increases when two, somewhat opposite, situations occur. First, when local professionals interact with the farmer as a team, it is beneficial to that farm and its wider farm community. REPS veterinarians are highly supportive of this team-meeting concept and choose to participate in them while engaged with the farm.

Second, when local farm service professional support is under-engaged or not involved in the effort to resolve a farmer's concerns, REPS veterinarians often conduct follow-up visits. Occasionally a local professional will actually be contributing to the farmers problems. In such cases REPS veterinarians will use follow-up visits to be more fully supportive.

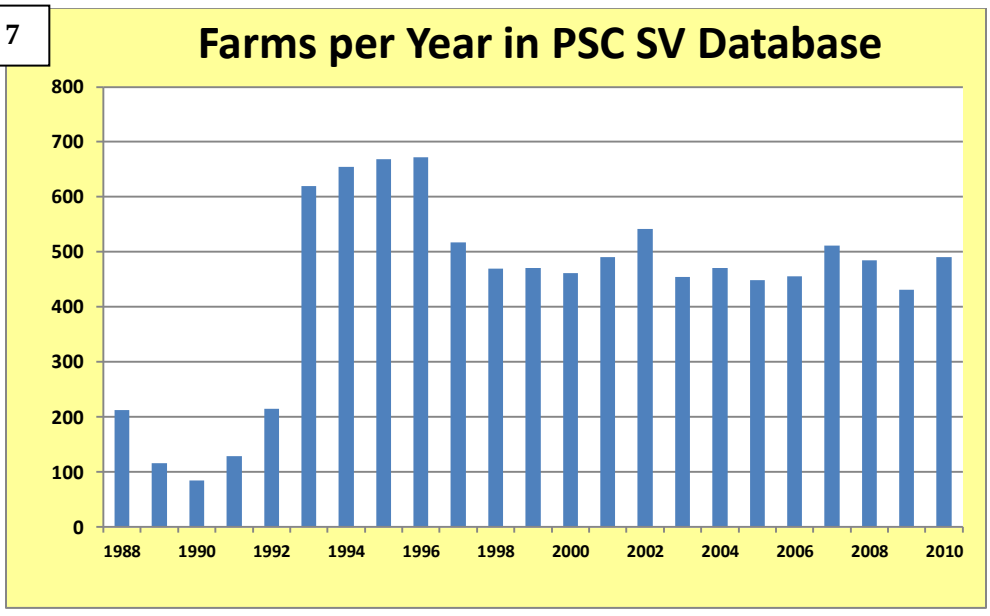
In some cases REPS veterinarians may not visit a farm at all when assistance is requested. For over a decade, it has been a REPS veterinary priority to facilitate local professional efforts to resolve the farmer concerns. Most commonly, local professionals are permitted to use REPS accounts when submitting concern-relevant samples to diagnostic labs. Also, when a local veterinarian is interested in doing the necessary Herd-Based Diagnostic tests, REPS will pay that veterinarian's service fees rather travel to the farm. Underlying both situations is the goal to improve the diagnostic capacity of local professionals and thus provide a farther-reaching and longer-lasting benefit to that farm community. Local veterinary involvement has occurred on 41% of farms visited (Figure 2).[10]

Figure 2



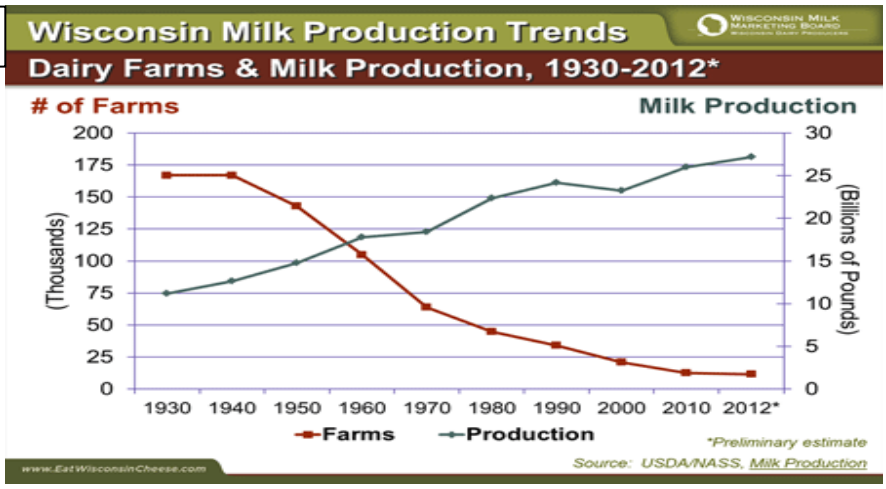
While farmer demand for stray voltage testing has remained steady (Graph 7),[10] two major changes have occurred.

Graph 7



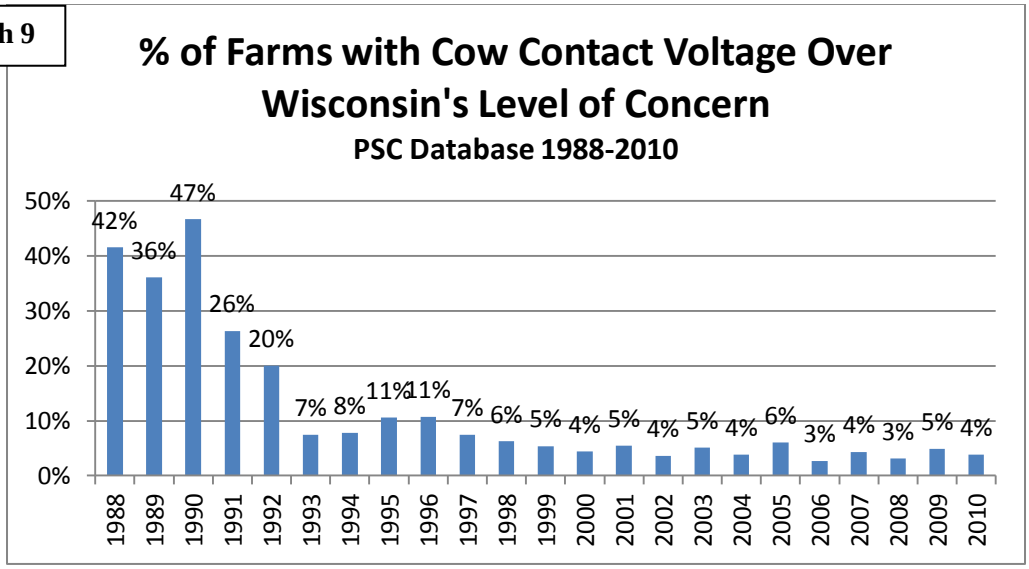
First, the number of dairy farms in Wisconsin has decreased (Graph 8).[12]

Graph 8



Second, the number of dairy farms where electrical testing identifies stray voltage has dramatically decreased (Graph 9).[10]

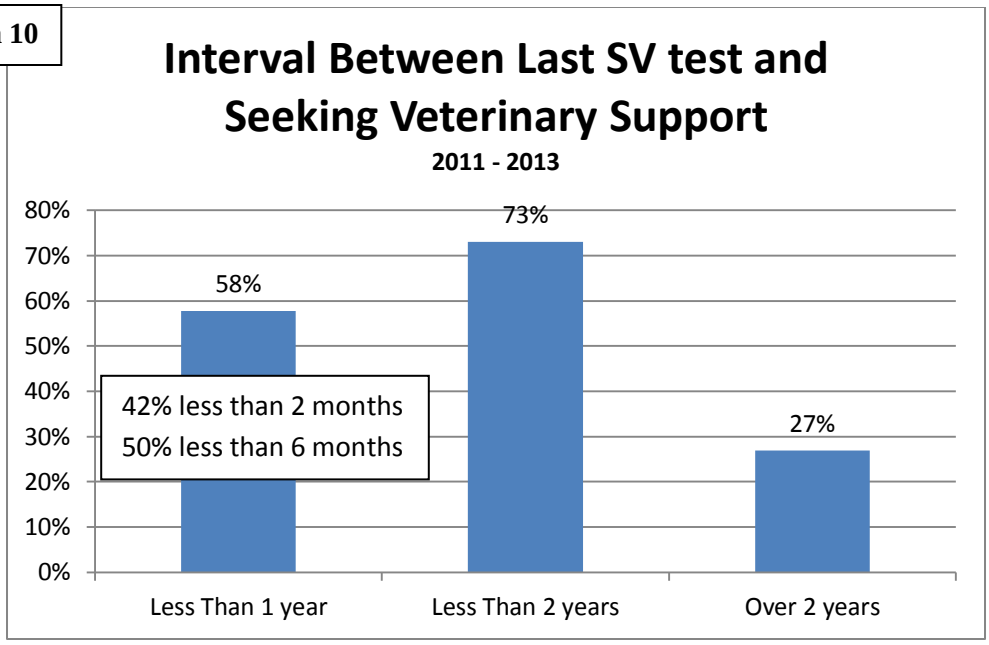
Graph 9



Because the demand for stray voltage investigations is steady but stray voltage is found on fewer farms, a higher percentage of farms tested for stray voltage need to look beyond stray voltage, towards veterinary diagnostic assistance, for the resolution of their herd health or production concerns.

Data from REPS veterinary farm visits between 2001 and 2013 indicate that there remains a strong connection between farmer concern about stray voltage and requests for REPS veterinary assistance. Though the two arms of the REPS program have functioned independently since 1995, 87% of the farms visited by REPS veterinarians indicated that their utility had done stray voltage testing on their farm[10] and most of those were within one year of their request for veterinary assistance (Graph 10).[10]

Graph 10



Veterinary diagnostic assistance to dairy farmers has always been operating in the background of successful PSC efforts to resolve farmer concerns. The difference now is that a) the percentage of tested farms where stray voltage is **not** found to be a problem has greatly increased, and b) with many fewer dairy farms in Wisconsin, the ramifications of each farm "not performing as expected" has also increased. The net result of these trends is that the importance of the veterinary position within REPS has increased substantially.

Herd Health and Production Concerns

Diagnostic assistance provided by REPS veterinarians has afforded a unique perspective from which to understand how unresolved herd health and production concerns motivate a farmer to consider stay voltage.

In the program's first attempt to identify which animal symptoms farmers attributed to stray voltage, the PSC included a highly suggestive list of possible stray voltage symptoms in their application. A ranking based on the percentage of boxes checked on the applications is seen in Table 1.[10]

Table 1

Concern	Responses	%Yes
Increased SCC	284	87
Reduced Milk Production	279	78
Foot/Leg Problems	284	77
Uneven Milkout	285	76
Nervous Cows	284	75
Increased Mastitis	284	72
Poor Milk Let Down	285	70
Small/Weak Calves	284	52
Water Intake	285	50
Feed Intake	285	46
Other	283	26

Many of the applications had all of the boxes checked, and nearly all of the boxes were checked on 75% of the applications. Somatic cell count was the most checked box, but this format resulted in no real difference in frequency among most of the listed concerns.

In 1996 the Minnesota Public Utilities Commission developed a comprehensive survey[13] that was sent to Minnesota and Wisconsin dairy farmers (752, or 30%, responded). REPS staff served as advisors to the effort. With REPS veterinary advice, the survey took a complex, professionally-constructed look at what leads a farmer to be concerned about stray voltage. A unifying characteristic of herds receiving REPS program assistance is farmer frustration with resolving an economically significant herd problem. REPS veterinary staff led the survey developers to explore the differences between herds having persistent herd health or production problems and the general population of dairy herds.

The survey's summary, "Dairy Herd Health and Production Survey Findings" states:[13]

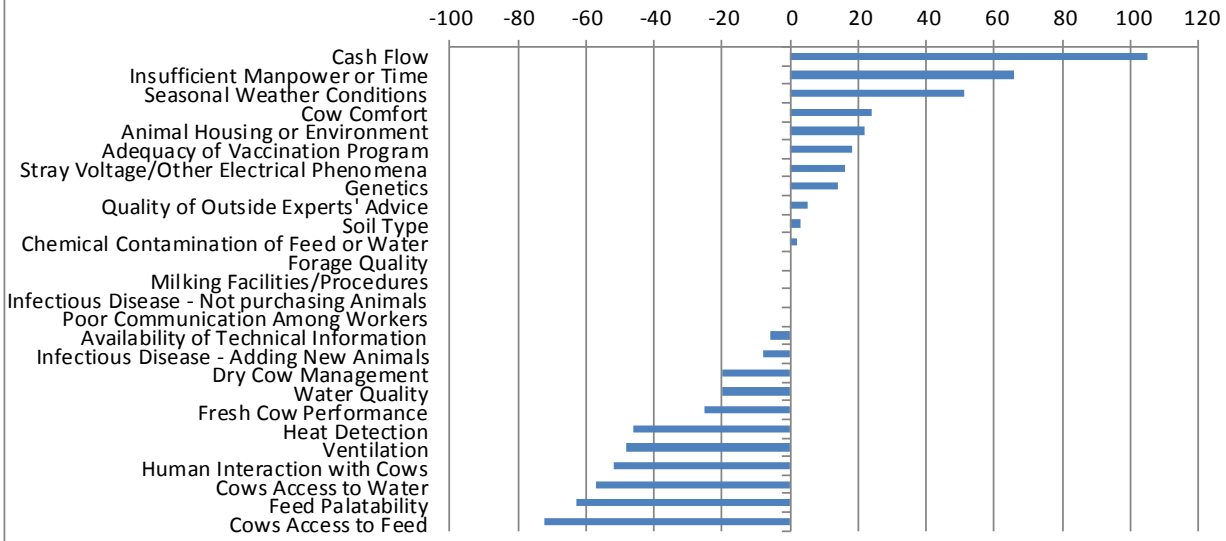
> Ten percent of all herd owners, or 3,600 of the approximately 36,000 in Minnesota and Wisconsin, think that cows in their herd now have persistent health and/or milk production problems. These dairy herds tend to have lower rolling herd average milk production, higher somatic cell counts, and more frequently display certain clinical signs than herds for which no such problems were reported.

It was no surprise that low production and high somatic cell count were common in herds with persistent problems compared to herds in general, but the rest of the statement, "more frequently display certain clinical signs," needed greater scrutiny. A REPS veterinary analysis of the survey[13] results (initial ranking of all herds times degree of ranking change in problem herds) is shown in Graphs 11 and 12.

Graph 11

Perceived Causes of Herd Health and Production Problems:

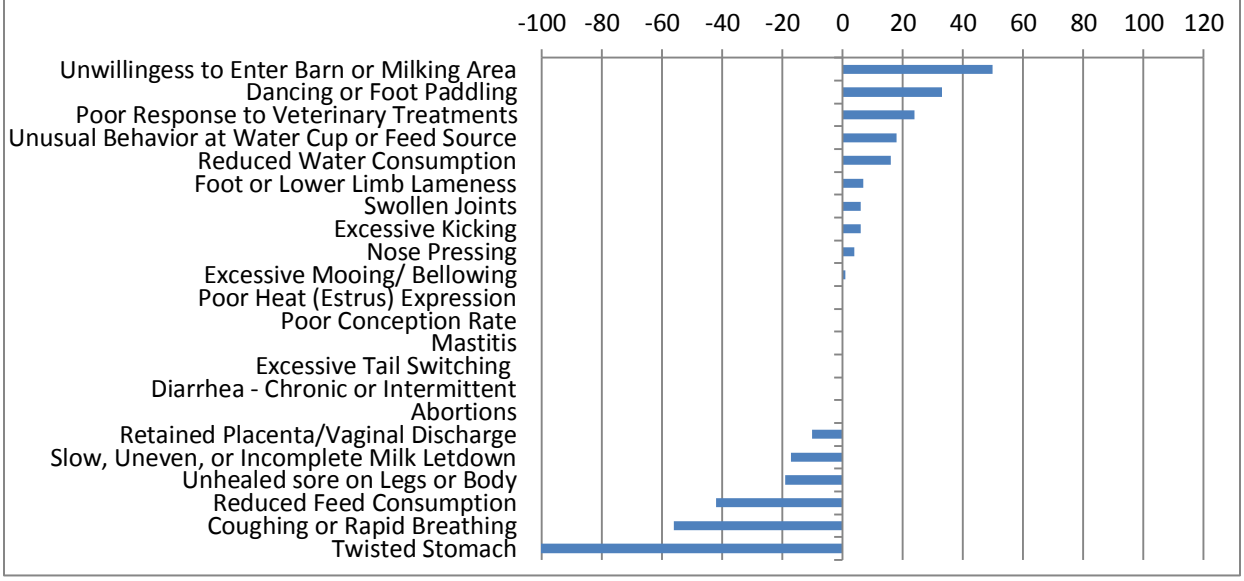
The Degree of Change in Herds with Persistent Problems Compared to All Herds



Graph 12

Clinical Signs in Herds with Health and Production Problems:

The Degree of Change in Herds with Persistent Problems Compared to All Herds



The survey confirmed a tendency for farmers with persistent herd problems to consider stray voltage as a cause (Graph 11). It also confirmed that "certain clinical signs" occur more frequently in herds with unresolved health or production concerns (Graph 12). Therefore, low production, high cell count, and certain clinical signs may lead a farmer to be concerned about stray voltage.

Tables 2a and 2b compare potential farmer perceptions about the effects of stray voltage against what research indicates is the effect of stray voltage on animals. The comparison confirms that between perception and reality there may be very little common ground.

Table 2a

What Farmers May Perceive as Evidence of Stray Voltage*

Performance Issues:
- Unresolved Low Milk Production
- Unresolved High Somatic Cell Count

Behavioral Issues:
- Reluctance to Enter,
- Dancing or Foot Paddling,
- Unusual Behavior at Water Cup or Feed Source,
- Reduced Water Consumption,
- Excessive Kicking,
- Nose Pressing,
- Excessive Mooing/Bellowing,

Symptoms:
- Foot or Lower Limb Lameness,
- Swollen Joints,
- Poor Response to Veterinary Treatment

*From MN Survey Results[13] and Graph 12

Table 2b

How Stray Voltage Actually Effects Animals*

Performance Issues:
- Low production is either an unlikely or transient effect, but possible in extreme cases.

Behavioral Issues:
- Flinch, Twitch, or Eye blink at contact with voltage above that animal's annoyance threshold
- Avoidance of contact with voltage. Altering time of use, frequency of use, duration of use, or alternative choice is more likely with exposure at water than with exposure during eating. Reluctance to enter is another form of avoidance.

*From Dr. Reinemann's article, "*What do we know about Stray Voltage*," [8]

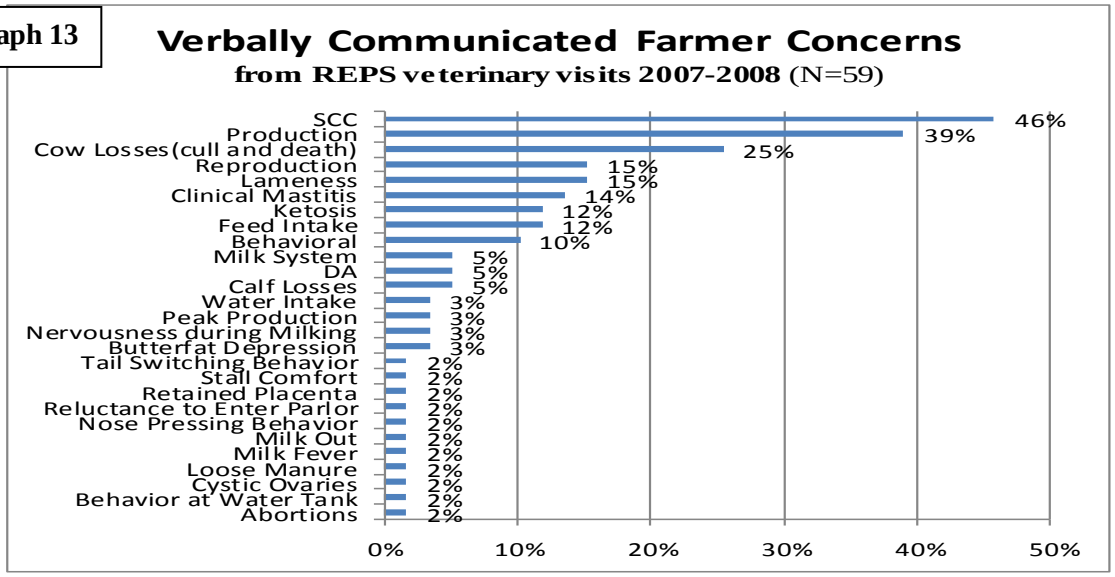
Consequently, when a farmer interprets resolution of stray voltage on the basis of behaviors and symptoms that are not caused by stray voltage, the farmer is likely to remain dissatisfied with what might otherwise be considered a successful electrical investigation. The clinical signs and performance issues that are not caused by stray voltage cannot be resolved by electrical mitigation.

The survey documented the reality of REPS veterinary on-farm experience and perhaps the most critical reason why veterinarians have become an essential part of the program. Theoretically, local service professionals should help the farmer to interpret animal behaviors and symptoms (Graph 12) but REPS experience is that, for the most part, they do not. Lack of professional training in the areas of ethology, calculating water intake needs, and stray voltage is one major reason for this deficit.

REPS veterinary staff have worked to improve competence by providing classes for undergraduate and graduate veterinary students, producing and distributing an educational video, presenting at veterinary post-grad conferences, state and local veterinary association meetings, and UW extension seminars, training individual veterinarians and farmers during farm visits, and publishing articles. Publications include; *Rumen Acidosis and Cow Comfort*,[10] *Understanding Stray Voltage - a Veterinarian's Perspective*,[14] *Understanding Cow Behavior*,[15] *Stray Voltage and Water for Dairy Cattle*,[16] and *Stray Voltage Education - A Veterinarian's Perspective*[17]. The most recent article, *Water Intakes: A Meta-Analysis of Prediction Equations*, should be published later in 2014.[18]

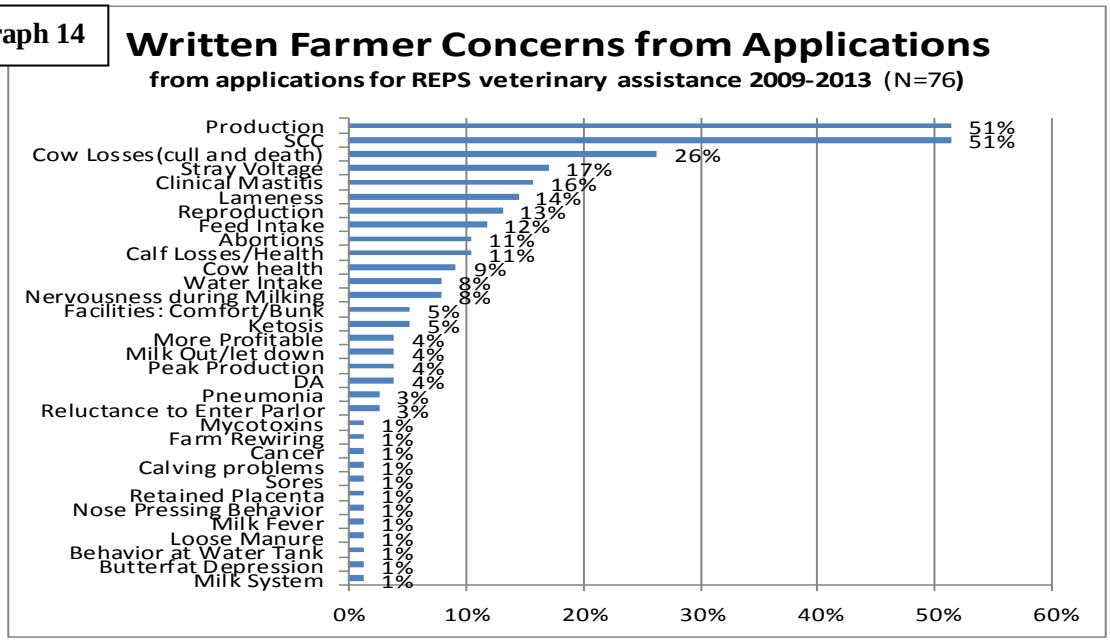
In 1998, when the program began requiring farmers to contact REPS veterinarians directly, the data on actual farmer concerns became more accurate. Somatic cell count and production remained the number one concerns. However, cow losses (from both culls and deaths) properly entered the field as a strong, third-ranked concern (Graph 13). Stray voltage did not appear in this list. REPS veterinarians have never tested for stray voltage, so a stray voltage concern was referred to the PSC and not listed as an issue requiring veterinary assistance.

Graph 13



In 2009, REPS veterinarians began using an application for requests for diagnostic assistance. When farmers were required to write out their list of concerns, low production, high somatic cell count, and high rate of cow losses remained as the top concerns. Because farmers included it as a concern, stray voltage was added to the list (Graph 14).

Graph 14



Over the past 5 years, 17% of farmers requesting REPS veterinary assistance have also had a concern about stray voltage.[10] This percentage is over 4 times higher than the percent of farms where stray voltage investigations identify cow contact voltages above the state level of concern.[10]

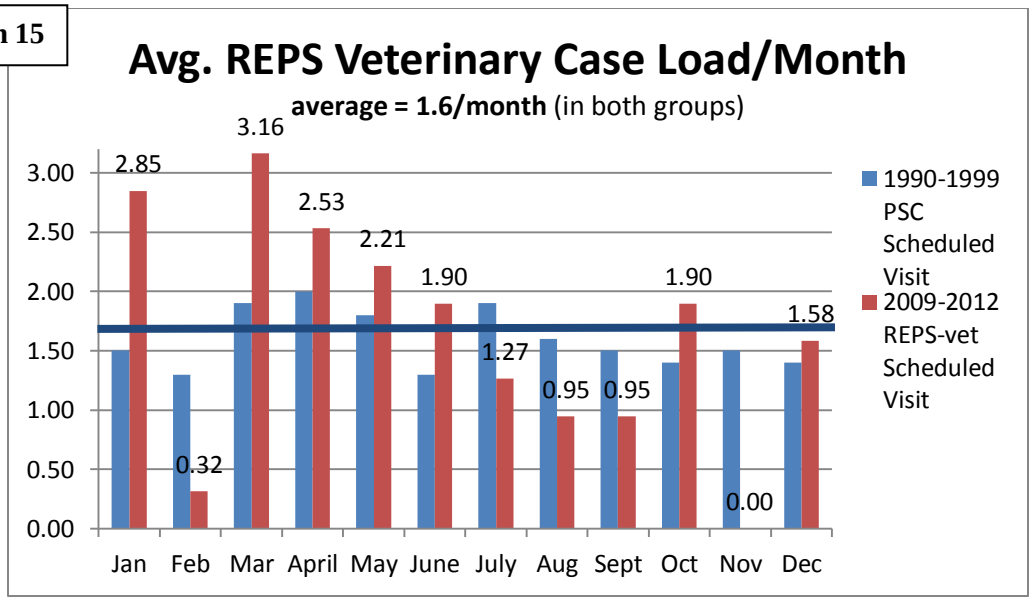
Minnesota Public Utilities Commission's survey was the last large-scale attempt to characterize which herd health or production concerns lead a farmer to suspect stray voltage as an underlying cause of persistent herd problems. The farmer-concern data accumulated though REPS veterinary efforts is different because the information just happens to have become available while REPS veterinarians were focused on their primary goal – to resolve a farmer's persistent animal health and production concerns. It is this focus that places REPS veterinary efforts in the best position to have a beneficial impact in herds concerned about stray voltage.

Veterinary Diagnostic Capacity

The structure of the REPS program enables veterinary diagnostic capacity in a number of ways:

1) In contrast to the more individual-cow, task-oriented work patterns of private practice, REPS veterinary work focuses entirely on herd-based problem resolution and thus brings a significantly different perspective into the local effort.
2) REPS veterinarians can dedicate uninterrupted time to resolution of a problem. Unlike private practice, REPS veterinarians are not called away by other scheduled farm visits or emergencies.
3) When farm cash flow problems limit the availability of local diagnostics, obtaining REPS veterinary diagnostic support on a no-fee basis can improve outcomes. It is not uncommon that a relatively small amount of no-fee support from REPS is highly effective in restoring the local diagnostic capacity. In such cases, support is often greatly appreciated by both the farmer and the local farm service professionals.
4) When dairy farmers operate with a bare minimum of local professional support, REPS veterinarians provide diagnostic assistance that is locally unavailable.
5) When the basis of scheduling a veterinary farm visit changed to direct farmer requests, the caseload per month began to reflected seasonal and biologically-based variations in herd health and production concerns on Wisconsin dairy farms (Graph 15). Timely response to farmer requests for assistance improved the diagnostic effectiveness of REPS veterinary assistance.

Graph 15



Unique to the program's SVAT years was that veterinary tests were done at the same time as PSC stray voltage testing. It was known which veterinary test results came from herds that had stray voltage and which did not. Test results in herds with and without stray voltage were not significantly different (see Appendix 4 for summary of SVAT-veterinary test results and comparisons). The conclusion was that no veterinary diagnostic test can be used to identify stray voltage on a farm. Stray voltage is an electrical

issue and it appears that identifying whether it is or is not a problem on a farm can only be done through the proper electrical diagnostic testing.

By far, the most powerful asset that REPS veterinarians can insert into a local effort at problem solving is the actual diagnostic testing. This has not always been the case. Looking back at the veterinary diagnostic capacity during the SVAT years leads one to consider if the state-of-the-art in veterinary diagnostics may have been more a part of the problem rather than the solution. When REPS veterinary efforts were directed at the complete farm analysis, farmer-perceived connections between persistent herd problems and stray voltage remained relatively unaddressed. Even if the veterinary focus could have been directed towards resolution of herd health and production concerns, it is doubtful that the available diagnostic tools would have been adequate. Until the early 90s, veterinary diagnostic tools were focused on individual sick cows, which could not effectively evaluate what is now recognized as a farmer's herd-based concerns.

The arrival of new veterinary diagnostic resources increased the profession's ability to resolve previously unresolvable, herd-based problems. While an early forerunner of herd-based evaluation tools, Body Condition Scoring, was widely in use prior to the formation of SVAT, the full volume of herd-based diagnostic tools only became available 10-15 years after the start of the program. These included hygiene scoring, lameness scoring, stall comfort scoring and others.[9] Unlike Body Condition Scoring, which was interpreted as a change over the days of a lactation, these new tests were compared to a statistical distribution (Figure 3).[19] Interpretation of test results moved from the somewhat arbitrary "good" or "bad" to a significance based on a distribution of occurrence in Wisconsin dairy herds. The difference may seem subtle but its importance to REPS veterinary diagnostic effectiveness cannot be overstated.

Figure 3 [19]

Table 1—Distribution of locomotion scores during summer and winter for dairy cows in 30 herds in Wisconsin

	Locomotion score							
	Summer				Winter			
Variable	1	2	3	4	1	2	3	4
Minimum	18.5	6.7	7.3	0.0	27.2	8.8	9.6	0.0
25th percentile	46.0	19.4	11.2	0.2	46.8	16.9	14.0	0.0
Mean	54.9	23.3	18.0	3.0	55.9	19.0	20.7	3.2
75th percentile	66.6	27.8	24.7	4.7	63.9	21.9	28.0	5.0
Maximum	80.0	31.9	35.2	16.7	79.3	29.4	35.1	12.3

Values represent percentages of cows in the herds that were assigned each locomotion score.

Traditionally, farmers expect their veterinarian to offer professional opinions. Opinion-based advice is common and useful where there is an established trust relationship. For a consulting government employee, attempting to provide veterinary assistance to a farmer with concerns about stray voltage, there is no established trust relationship. To the extent that dialogue remained opinion-based, effectiveness was marginal. When veterinary diagnostics moved toward quantification and results that were presented against a statistical representation of Wisconsin dairy herds, it allowed REPS veterinarians

to have a more productive dialogue. For example, consider a farmer's reaction to the following two statements:

1) Your cows are dirty.
2) For Wisconsin dairy herds in freestall barns, bedded with sand, in the winter, your herd's hygiene score is worse than 75% of similar dairy farms.

Both deliver the same message, but when reading statement 2 in a report, the farmer is less likely to take offense and more likely to consider both the message and how recommendations may help to resolve a persistent concern about high cell counts.

Another new array of herd-based diagnostic tools looked more potently at nutritional and metabolic conditions. Rumenocentesis, as a herd-based method to evaluate subacute rumen acidosis, became available in the mid-1990s,[20] after the formation of SVAT and the original Nine Farm Study. By 2000 there were a number of additional herd-based blood tests that evaluated different types of subacute ketosis, failure of immunological passive transfer in calves, and protein-energy metabolism in the milking herd.[9] These diagnostic tests afforded a powerful means to evaluate what previously went undetected or misinterpreted. The diagnostic tests came with statistically driven guidelines for interpretation (Figure 4).[21]

Figure 4

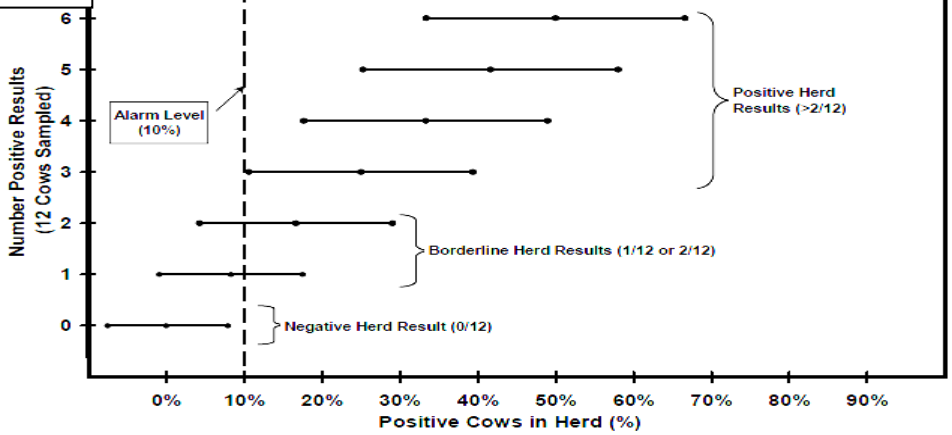
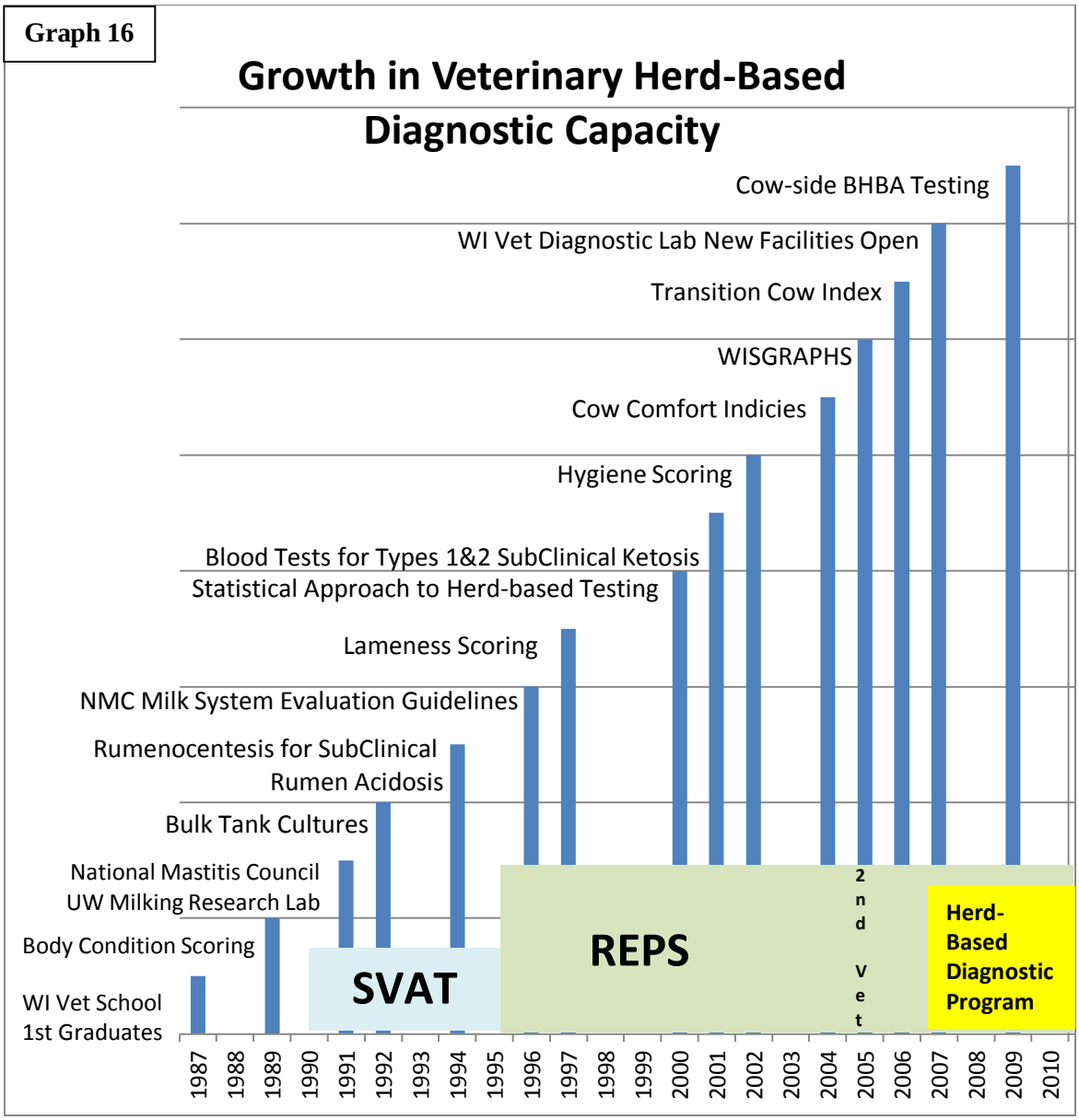


Figure 1. Interpretation of blood BHBA test results using 75% confidence intervals and an alarm level of 10% for test results from 12 cows sampled from within a group 50 cows. Adapted from Oetzel, GR: Monitoring and testing dairy herds for metabolic disease. Vet. Clin. Food Anim. 20:651-674, 2004.

The relationship between the growth of the REPS veterinary position and the arrival of new diagnostic resources is approximated in Graph 16. The graph is not totally inclusive nor meant to be exact. New techniques are adopted by a profession over time. The indicated dates are good estimates and are intended to convey the big-picture reality that many diagnostic advances became available around the same time that REPS veterinarians needed to contribute more to the overall effectiveness of the program.

Graph 16



Perhaps the three most influential drivers to improved REPS veterinary diagnostic capacity were:

1) The UW School of Veterinary Medicine – Food Animal Production Medicine Program for development of herd-based diagnostic testing and tools for interpretation
2) National Mastitis Council, including the UW Milking Research and Instruction Lab for its revolutionary work on milk system testing and milking procedure evaluation.
3) Wisconsin Veterinary Diagnostic Lab (new facilities, improved capacity, accreditation)

When the SVAT program was making its first farm visits, practically speaking, none of the currently available, powerfully beneficial diagnostic resources were in place. It is likely that REPS veterinary diagnostic capacity would still be constrained by the limitations of individual, sick-cow diagnostics and a dialogue based solely on professional opinion if not for the advances in diagnostics made available by the UW Vet School, the National Mastitis Council, the UW Milking Research Lab, and WI Veterinary Diagnostic Lab.

Benefit of REPS Veterinary Diagnostic Assistance

Early attempts to evaluate the effectiveness of REPS veterinary diagnostic assistance were in the form of post-visit surveys. In 1994 post-visit surveys were sent to 18 farms, eight were returned. All eight indicated that the veterinarian was beneficial or very beneficial. Through 2005 and 2007, follow-up surveys were sent to farmers six months after the each herd visit. Approximately 64 surveys were sent out and 16 (25%) of the surveys were returned. The returns were strongly positive, but their interpretive value was suspect. An example of this can be seen in the return from a farmer whose only concern was clinical mastitis (Figure 5). Even the issues receiving no REPS-veterinary attention, like culling and death rate, were marked as improved.

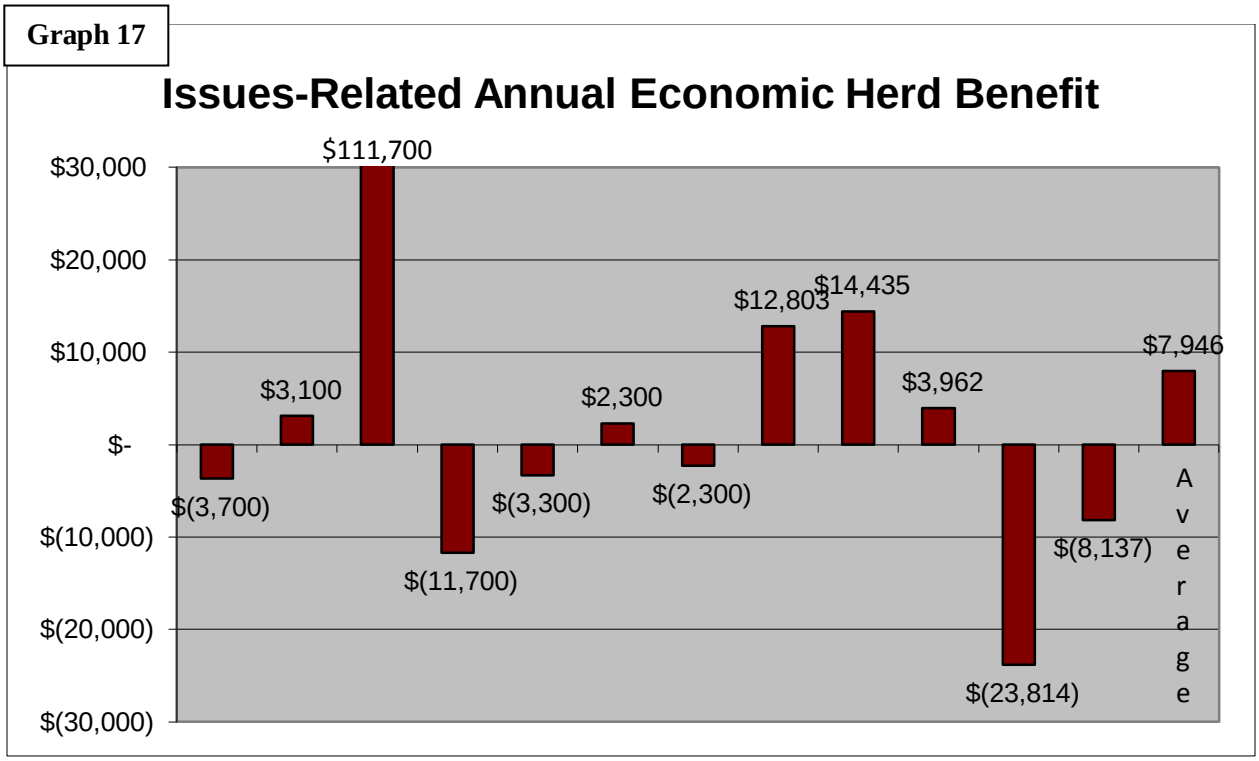
Figure 5

3. As a result of the visit, how has your business been affected?

	Better	Worse	No Effect
A. Profitability	✓		
B. Milk Production			
C. Milk Quality			
D. Herd Health			
E. Culling Rate			
F. Cow Behavior			
G. Death Rate			
H. Other:			

In 2009, dairy farmers with DHIA service through AgSource were offered a new option called the Profit Opportunity Analyzer (POA).[22] This tool provided REPS an opportunity to obtain third party data-based snapshots of the profitability of a dairy farm. With farmer permission, REPS obtained POA results prior to a farm visit and then again six months after the visit. A comparison between the two snapshots has been used, in a limited way, to evaluate REPS program effectiveness on a dollar basis (Graph 17).

Graph 17



On this basis, 50% (6 of 12) of the herds showed a positive dollar benefit from REPS veterinary services. The average annual dollar benefit per REPS veterinary herd visit is $7,946. This number is inflated by one herd with a very large positive response ($111,700). Of herds that have a positive

economic benefit, the median annual dollar benefit from REPS veterinary assistance is $8,383. POA analysis is only available for herds using AgSource DHIA testing, but at present this is the best available, objective method of evaluating whether REPS veterinary diagnostic assistance is economically beneficial to farmers.

Three Case Histories:

Another, more subjective, way to convey the benefits of REPS veterinary diagnostic assistance is through case histories. Among the following cases, there is one where pre/post-visit POA data indicate that REPS veterinary assistance had a negative dollar impact. POA data was not available on the others. These example cases represent 1) subjectively determined positive outcomes, 2) how the REPS veterinary approach becomes uniquely matched to the particular needs of each herd, and 3) how different follow-up strategies are selected to enhance outcomes. In all cases, stray voltage was tested and not found to be a significant issue.

CASE 1

Issue of Concern: High Somatic Cell Count

Diagnostics Provided by Local Professionals:

1) Local vet not involved
2) Milk system service provider:
   a. System check done well and two significant faults were corrected
   b. Vacuum performance at claw during milking was not done.
   c. Slope not checked
   d. Milking procedures not evaluated
3) Milk Plant Field Support:
   a. Monthly bulk tank culture done through plant lab, did not include Mycoplasma
   b. Individual cow cultures done through plant lab found 44% of herd infected with Staph aureus

Action taken based on local diagnostics:

1) 26% of herd were culled as Staph aureus positive cows.
2) Remaining 18% of herd that was Staph aureus positive were milked last.

Result: SCC dropping but still high. Economic hardship from aggressive culling.

(Case 1 continued)

REPS Veterinary Diagnostic Assistance:

1) Pipeline Slope Checked
2) Milking Procedures Evaluated.
3) Vacuum performance at claw during milking evaluated
4) Bulk Tank recultured at WI vet diagnostic lab which includes screening for Mycoplasma
5) Individual cows recultured.

Results:

1) Slope and procedures were good.
2) Vacuum performance at claw was acceptable.
3) Mycoplasma negative
4) Bulk tank and all cows were Staph aureus negative resulting in a concern that original lab results were erroneous (and financial losses from aggressive culling were perhaps unnecessary)

Outcome: Without reliable local support, follow-up visits by REPS vet to reculture herd and bulk tank confirmed herd as Staph aureus negative. Cell Count continued to drop. Farmer was extremely pleased with how REPS veterinary diagnostic assistance helped to sort out a very confused situation.

CASE 2

Issue of Concern: High Somatic Cell Count

Diagnostics Provided by Local Professionals:

1) Local vet, very engaged but frustrated with lack of progress. Focus on hygiene problems in certain pens. Hygiene scoring and bedding cultures not performed.
2) Milk system Service Provider excellent. Milk system and procedure evaluation and service was done well Vacuum performance at claw during milking was not done
3) Milk Plant Field Support: Monthly bulk tank culture done through dairy plant lab, did not include Mycoplasma.

Action taken based on local diagnostics: Concern about pen hygiene was addressed when ample bedding became available

Result: No improvement in Cell Count

(Case 2 continued)

REPS Veterinary Diagnostic Assistance:

1) Vacuum performance at claw during milking evaluated.
2) Bulk Tank recultured at WI state vet diagnostic lab which includes screening for Mycoplasma
3) Each pen was hygiene scored.
4) Bedding was cultured

Results:

1) Vacuum at claw acceptable.
2) Mycoplasma was positive
3) Hygiene scoring and bedding cultures confirmed certain pens to still be a problem.

Outcome: Local veterinarian took REPS offer to pay for lab costs of Mycoplasma eradication effort. In consult with REPS veterinarian, a strategy of targeted pen and cow cultures was designed. Implementation was by local veterinarian. Positive cows were identified, segregated and culled. No REPS follow-up visit was needed. Confidence that the dominant underlying cause was found inspired additional improvement in pen bedding. Cell Count dropped in half. The farmer was very pleased with REPS support.

CASE 3

Farmer's concern was an insidiously debilitating condition in lactating cows. This resulted in a decreasing herd size and frustrating farm finances. A variety of suspicions and accusations, including stray voltage, had developed.

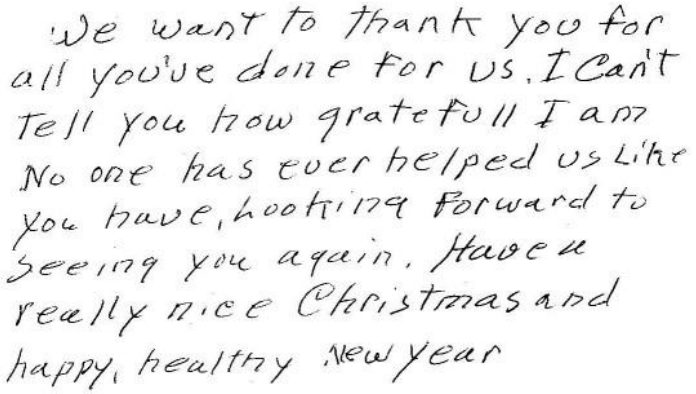
DHIA downloads done by the REPS veterinarian clearly suggested a chronic subacute rumen acidosis problem. Testing for acidosis had not been done. The acidosis appeared to start after a TMR mixer was installed. The ration mix had not been professionally adjusted for a very long time.

When the REPS veterinarian tested for subacute rumen acidosis on the farm, it confirmed that the ration was the source. The farmer called the nutritionist immediately. The nutritionist came out to the farm but would not get out of his truck, believing that the farmer was antagonistic towards him and had plans to sue the company he worked for. The farmer thought that the nutritionist was refusing to service him. REPS veterinary intervention allowed the misconceptions to be discussed and clarified. The outcome was an improved service relationship and better (farmer) realization of the importance of regular

nutritional service to the TMR ration. The farmer was pleased with the resulting increase in production and decrease in cow losses.

Like case histories, the notes and gestures of appreciation that REPS veterinarians receive confirm a perceived value (Figure 6). Most farmers express appreciation for REPS veterinary assistance, but every year some make an extra effort to do so.

Figure 6



On a personal level, REPS veterinary staff gain satisfaction from an awareness of the importance of what they do and the benefits they provide to the farmers that request their assistance. The intimacy of experiencing animals in serious peril, of death and suffering, of farmers with relentless, perhaps ever-deepening frustration over unresolvable problems, of farms in jeopardy, which are families and all of the interconnections of community, income, jobs, the past, and the future, knowing this personally, one-to-one, face-to-face, in the countless dark and cold and hot and far-from-home moments of actually being there, one learns that the dispensing of hope is a powerfully satisfying outcome to witness. Serving as a REPS veterinary provides a unique and powerful opportunity to help farmers and farm businesses. It has been and continues to be a privilege to do so.

Summary

The veterinary position in Wisconsin's Rural Electric Power Services Program is a unique experience. Worldwide, there is no other veterinary position like it. It started as a minor, almost insignificant, part of a program focused on electrical testing and mitigation of electrical factors associated with stray voltage. Over the past 20 years, the position has evolved into a major contributor to the program's success. The primary factors that influenced this have been:

1) PSC's early and sustained success in reducing the potential risk of stray voltage on Wisconsin dairy farms. The percent of tested dairy farms where cow contact voltage was found to be over the state's level of concern has dropped from 42% to 4%.

2) Dr. Doug Reinemann's research and publications on animal response to stray voltage allowed REPS veterinarians to know, amongst the farmer-perceived signs of stray voltage in herds, which signs needed more veterinary attention and better veterinary advice.

3) Program realization that the primary underlying issue on farms with concern about stray voltage is the persistence of unresolved herd health or production problems. Whether resolution occurred through stray voltage mitigation or veterinary resolution was of little concern to the farmer. REPS has been successful by addressing both.

4) The change from a "complete farm analysis" format to an approach directed toward resolution of a farmer's specific unresolved herd health or production concerns improved the effectiveness of REPS veterinary assistance.

5) Separating REPS veterinary service from REPS electrical testing for stray voltage and requiring farmers to directly request veterinary assistance greatly enhanced the veterinary-farmer working relationship

6) Growth in veterinary diagnostic capacity, especially the arrival of herd-based diagnostic approaches developed by the UW School of Veterinary Medicine - Production Medicine Program, the National Mastitis Council, the UW Milking Research and Instruction Lab, and upgrades to Wisconsin's Veterinary Diagnostic Lab, were all instrumental in improving REPS veterinary diagnostic effectiveness.

Appendices

Appendix 1: List of Tests in Comprehensive Water Quality Analysis (used from 1994 to present)

TOTAL COLIFORM COUNT

PHYSICAL PROPERTIES

AKALINITY	TOTAL SOLIDS	PH	TURBIDITY
HARDNESS			

INORGANIC ELEMENTS

ALUMINUM	ARSENIC	BARIUM	CADMIUM
CHROMIUM	COPPER	IRON	LEAD
MANGANESE	MERCURY	NICKEL	SELENIUM
SILVER	SODIUM	ZINC	CHLORIDE
FLORIDE	NITRATE	NITRITE	

ORGANIC ELEMENTS

BROMOFORM	2,2-DICHLOROPROPANE	SILVEX 2,4,5-TP
BROMODICHLOROMETHANE	1,1-DICHLOROPROPENE	SIMAZINE
CHLOROFORM	ETHYLBENZENE	TOXAPHENE
DIBROMOCHLOROMETHANE	ETHYLENEDIBROMIDE	TRIFLURALIN
BENZENE	STYRENE	2,4-D
VINYL CHLORIDE	1,1,1,2-TETRACHLOROETHANE	
CARBON TETRACHLORIDE	1,1,2,2-TETRACHLOROETHANE	
TRICHLOROETHYLENE	TETRACHLOROETHYLENE	
1,4-DICHLOROBENZENE	1,2,4-TRICHLOROBENZENE	
1,1-DICHLOROETHYLENE	1,2,3-TRICHLOROBENZENE	
1,1,1-TRICHLOROETHANE	1,1,1-TRICHLOROETHANE	
BROMOBENZENE	TRICHLOROFLOUROMETHANE	
BROMOMETHANE	1,2,3-TRICHLOROPROPANE	
CHLOROBENZENE	TOLUENE	
CHLOROETHANE	XYLENE	
CHLOROMETHANE	ALALHLORE	
2-CHLOROTOLUENE	ATRAZINE	
4-CHLOROTOLUENE	CHLORDANE	
DIBROMOCHLOROPROPANE	ALDRIN	
DIBROMOMETHANE	DICHLORAN	
1,2-DICHLOROBENZENE	DEILDREN	
1,3-DICHLOROBENZENE	ENDRIN	
DICHLORODIFLUOROMETHANE	HEPTACHLOR	
1,1-DICHLOROETHANE	HEPTACHLOR EPOXIDE	
TRANS-1,2-DICHLOROETHYLENE	HEXACHOLOBENZENE	
CIS-1,2-DICHLOROETHYLENE	HEXACHLOROCYCLOPENTADIENE	
DICHLOROMETHANE	LINDANE	
1,2-DICHLOROPROPANE	METHOXYCHLOR	
TRANS-1,3-DICHLOROPROPENE	PCBs	
1,3-DICHLOROPROPENE	PENTACHLORONITROBENZENE	

Appendix 2

Complete Herd Analysis: Summary of Tests and Data Collected (used 1994 to +/-1997)

HISTORY

FACILITY, MILK, AND LIVESTOCK PROFILE

- DHIA records
- Disease and Health Problem Inventory
- Management Procedure Inventory
- Body Condition Scoring evaluated across herd
- Cow Comfort evaluation:
  - Stall Size, construction, bedding usage, sanitation
  - Population density, Animal handling skills, Auditory environment

- Relative humidity (ventilation evaluation
- Light level evaluation

VIDEO TAPE RECORD

- Eating and Drinking Behavior, including cud chewing activity
- Milking Time, Techniques, and Behavior
- Percent Standing or Laying (comfort)
- Entering and Leaving Behavior
- Feed Bunk and Water Trough Use and Behavior
- Specific Concerns (lameness, teat health, swollen hocks, etc.)

WATER

- 24-hour Water Intake Metering
- 94-element Water Quality Laboratory Analysis

NUTRITION

- Daily feeding schedule and Feed Bunk Management evaluation
- Evaluate Feed Scoops and determine actual amounts fed
- Laboratory analysis of rations and all ration ingredients
- On-site feed quality evaluation
- Measurement of ration dry matter content and percentage of fiber over 1.5" long
- Measurement of acidity of feed, manure and aspirated rumen fluid
- Manure screened for particle size
- Computer reconstruction of representative ration for ration performance analysis
- Laboratory blood testing of blood cells, serum profile, vitamins and minerals
- Laboratory evaluations of Mycotoxin levels in feeds

MILK MANAGEMENT

- Milking time and technique analysis
- Complete milk system analysis
  - Milking Vacuum and vacuum drop at various locations
  - Effective and Manual Reserve
  - Air Usage by components
  - Pump Capacity
  - Regulator performance
  - Pulsator performance
  - Dynamic testing of vacuum level and stability at claw and locations
  - Inflations and teat end evaluation
  - Evaluation of claw weight, distribution, and positioning.
  - Evaluation of system condition (rubber parts, air vents, liner twisting, and leaks)
  - Pipeline slope, Inlet size and location (or angle), maximum lift
  - Washing performance
- CMT testing of entire herd
- Laboratory bacterial culturing of all high CMT quarters
- Bulk Milk Tank Culture (including Mycoplasma)
- Teat-end Scoring immediately after milking machine is removed
- Evaluation of unit squawks and slippage

DISEASE PROFILE

- Laboratory screening for parasites in composite manure sample
- Blood tests for Johnes, BLV, and BVD
- Abortion work-up as needed
- Calf loss testing as needed

Appendix 3: DATCP handout for REPS Herd-Based Diagnostic Program (used 2013 to present)

Herd-Based Diagnostic Program

Veterinary diagnostic support is available to assist farmers (and their local farm-service professionals) to resolve complex herd-health and production concerns.

About the Herd-Based Diagnostic Program

The Herd-Based Diagnostic Program serves Wisconsin dairy herds of all sizes and management types. It addresses production, cell count, cow loss, and other concerns. There is no charge for the assistance provided by the Herd-based Diagnostic Program.

To utilize the program, farmers must complete an application that provides a description of the concerns to be addressed, contact information for local farm-service professionals, and a basic orientation to the farm.

Upon receipt of the application, the Wisconsin Farm Center veterinarian will respond. Each response is careful , comprehensive, and tailored to the specifics of the farmer's concerns. Farm data is reviewed. Phone or e-mail pre-visit conversations are held with the farmer and all significantly-involved local farm-service professionals. A farm visit is made as soon as possible. When all lab test results become available, a detailed report is written and sent to the farm and (with permission) to any of the farmer's local professional support. Where follow-up testing is helpful, the program may pay local professionals to collect and submit the test samples.

The basic process can be summarized as this:

1) What are the farmer's specific concerns?
2) Who has already been significantly involved in attempting to resolve this concern?
3) What concern-focused, standard diagnostic testing has already been done?
4) The Herd-based Diagnostic Program will then , most commonly, "fill in the gaps" by providing whatever concern-specific, standard veterinary diagnostic information that has not been provided by the local efforts.
5) The answers often surface when we fill in those diagnostic blanks that were missing.

Nearly 20 years of experience has taught those of us involved in the Herd-based Diagnostic Program that resolution to complex herd health and production concerns comes when farmers have the information they need to make informed business decisions.

Contact us

Requests for veterinary assistance from the Herd-Based Diagnostic Program can be initiated by contacting the Wisconsin Farm Center at 1-800-942-2474 or farmcenter@wisconsin.gov.

Appendix 4: Test results showing average in herds with and without stray voltage (from 1994 thru 1996)

Data from Complete Blood Counts				
138 Cows Tested 32 From Herds	WBC	RBC	HG	PCV
NORMALS	5-10	5-12	9-14	22-44
Median	7.35	6.06	11.15	26.35
Average	7.62	6.05	11.11	26.53
% Low	9%	7%	3%	4%
% High	10%	0%	0%	0%
Lowest	4.00	4.30	5.90	16.10
Highest	25.30	8.80	14.00	37.20
Avg. in Herds with Stray Voltage	7.70	5.95	11.08	26.40
Avg. in Herds without Stray Voltage	7.57	6.11	11.12	26.61
DIFFERENCE	0.13	-0.16	-0.05	-0.21

BLOOD SERUM CHEMISTRY AND ELECTROLYTES (160 Cows Tested from 35 Herds)												
SERUM CHEMISTRY	TP	ALB	CHL	GLU	BUN	CREAT	T BILI	GGT	ALK PH	CPK	SGOT	GLOB
NORMALS	6-9.4	3-5	50-240	45-90	2-20	.7-1.5	.13-.38	9-40	15-95	15-160	60-150	2.6-5.4
Average	7.82	3.11	150.18	49.29	12.34	0.95	0.17	32.29	57.13	142.88	94.71	4.69
Median	7.80	3.10	134.50	52.27	12.00	0.90	0.14	31.00	51.00	106.00	90.00	4.60
% Low	1%	33%	0%	34%	1%	3%	34%	0%	0%	0%	1%	1%
% High	3%	0%	8%	0%	8%	0%	4%	15%	7%	22%	4%	13%
Lowest	5.30	0.70	62.00	12.00	1.00	0.40	0.00	11.00	24.00	35.00	10.00	2.30
Highest	10.20	4.10	342.00	90.00	26.00	1.40	0.94	79.00	395.00	955.00	268.00	7.90
Avg. in Herds with Stray Voltage	7.81	3.10	147.57	42.73	12.37	0.92	0.17	30.94	58.85	131.25	92.84	4.70
Avg. in Herds without Stray Voltage	7.82	3.11	152.14	54.43	12.31	0.97	0.17	33.31	55.83	151.67	96.12	4.68
DIFFERENCE	-0.02	0.00	-4.57	-11.69	0.06	-0.04	0.01	-2.37	3.02	-20.42	-3.28	0.01
ELECTROLYTES	NA	K	CL	CA	MG	PH						
NORMALS	141-150	4.3-6.2	97-118	8.6-11.1	1.9-2.9	4-9						
Average	140.06	4.95	100.68	9.34	2.22	5.75						
Median	140.00	4.80	100.00	9.35	2.20	5.70						
% Low	59%	9%	9%	6%	15%	4%						
% High	0%	7%	1%	0%	2%	1%						
Lowest	134.00	2.60	89.00	7.00	1.40	0.70						
Highest	147.00	7.60	124.00	10.60	5.60	9.40						
Avg. in Herds with Stray Voltage	139.81	5.02	100.21	9.34	2.26	5.53						
Avg. in Herds without Stray Voltage	140.24	4.89	101.04	9.34	2.20	5.91						
DIFFERENCE	-0.44	0.13	-0.84	0.00	0.06	-0.37						

TRACE MINERALS AND VITAMINS (153 Cows Tested from 34 Herds)					
	COPPER	SELENIUM	ZINC	VITAMIN A	VITAMIN E
NORMALS	0.8-1.5 ug/ml	0.2-1.2 ug/ml	0.8-1.4 ug/ml	0.2-0.4 ug/ml	2.0-4.0 UG/ML
Average	0.75	0.21	0.87	0.29	2.16
Median	0.75	0.20	0.84	0.27	1.80
% Low	56%	50%	42%	21%	57%
% High	0%	0%	1%	17%	9%
Lowest	0.37	0.00	0.40	0.07	0.10
Highest	1.43	2.20	2.06	0.65	10.20
Avg. in Herds with Stray Voltage	0.76	0.20	0.83	0.34	2.45
Avg. in Herds without Stray Voltage	0.74	0.20	0.88	0.27	1.95
DIFFERENCE	0.02	-0.01	-0.04	0.07	0.51

HERD COUNT		**WATER INTAKE**		
31		MEASURED INTAKE	CALCULATED NEED	DIFFERENCE
SV AVERAGE		19.4	20.1	-0.7
NON SV AVERAGE		20.6	20.6	0
	DIFFERENCE	1.2	0.5	
	MINIMUM	8.7	11.7	-3
	MAXIMUM	31.5	31.4	0.1
	AVERAGE	20.1	20.4	-0.3
	MEDIAN	20.4	21.0	-0.6

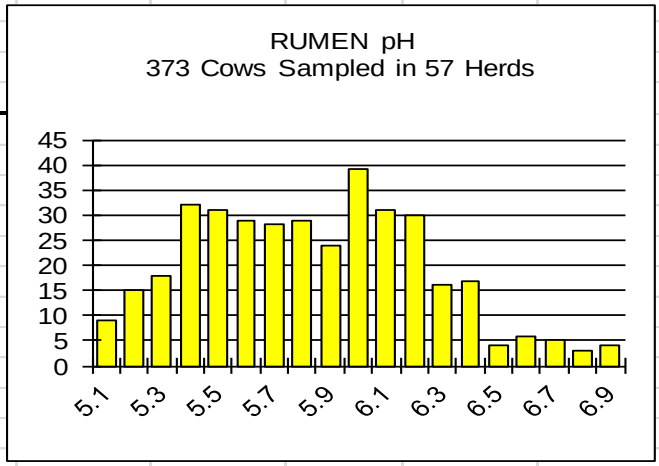
Water Quality Test Results

	NORMALS	UNITS	Average	Median	% High	Highest	Average in Herds with Stray Voltage	Average in Herds without Stray Voltage	Difference
PHOSPHORUS	<0.03	PPM	0.14	0	25%	0.70	0.15	0.15	0.01
POTASIUM	<5.0	PPM	2.02	0.9155	4%	22.32	0.65	3.04	-2.38
CALCIUM	<200	PPM	52.00	50.87	0%	117.70	38.70	50.40	-11.69
MAGNESIUM	<100	PPM	28.26	26.745	0%	55.00	21.86	30.15	-8.30
SULFUR	<25	PPM	8.81	5.705	0%	21.32	6.52	9.05	-2.53
ZINC	<1.3	PPM	0.01	0	0%	0.09	0.01	0.02	-0.01
BORON	<1	PPM	0.01	0	0%	0.12	0.01	0.02	-0.02
MANGANESE	<0.05	PPM	0.03	0.0015	4%	0.20	0.05	0.02	0.02
IRON	<0.3	PPM	0.04	0	0%	0.19	0.05	0.03	0.02
COPPER	<1	PPM	0.01	0	0%	0.17	0.02	0.00	0.02
ALUMINUM	<0.2	PPM	0.07	0	13%	0.61	0.00	0.10	-0.10
SODIUM	<175	PPM	15.99	6.44	0%	110.20	7.48	14.35	-6.87
CHLORIDE	<250	PPM	13.88	2.5	0%	58.50	14.13	16.63	-2.50
CADMIUM	<.01	PPM	0.00	0	0%	0.01	0.00	0.00	0.00
CHROMIUM	<.05	PPM	0.00	0	0%	0.03	0.00	0.00	0.00
COBALT	<1	PPM	0.00	0	0%	0.02	0.00	0.00	0.00
NICKEL	<1	PPM	0.02	0	0%	0.15	0.00	0.02	-0.02
ARSENIC	<0.2	PPM	0.00	0	0%	0.00	0.00	0.00	0.00
LEAD	<0.1	PPM	0.00	0	0%	0.00	0.00	0.00	0.00
SELENIUM	<0.01	PPM	0.00	0	0%	0.00	0.00	0.00	0.00
AMMONIUM	<0.5	PPM	0.22	0	13%	2.00	0.36	0.08	0.27
NITRATES	<10	PPM	5.98	2	29%	26.00	4.57	5.25	-0.68

	UDDER CULTURE RESULTS				MILKING SYSTEM PERFORMANCE				MILKING	
35 Herds	% of Herd Cultured	% Staph aureus	% Strep ag	% Environ-mentals	Number of Units	Vacuum at Claw During Peak Flow	Maximum Vacuum Fluctuation at Claw	Pump Capacity (CFM)	PREP TIME (minutes)	UNIT-ON TIME (minutes)
Average	44%	10%	6%	17%	5	11.1	3.0	58	2.3	6.8
Median	37%	8%	0%	16%	4	11.2	2.8	55	2.0	6.8
Lowest	16%	33%	44%	52%	16	12.7	7.0	104	5.6	12.3
Highest	100%	0%	0%	3%	3	9.2	1.0	30	0.6	2.7
Avg. in Herds with Stray Voltage	45.4%	10%	10%	20%	5	11.0	3.2	53	2.1	7.0
Avg. in Herds without Stray Voltage	39.6%	10%	3%	15%	5	11.2	2.9	63	2.5	6.7
UNITS OF DIFFERENCE	6%	0%	7%	5%	0	-0.2	0.3	-10.0	-0.4	0.3

RATION ANALYSIS										
34 Herds	Crude Protein (%DM)	Energy (NEL)	Fiber (ADF)	Fiber (NDF)	Calcium (%DM)	Sodium (%DM)	Zinc	Selenium	Vitamin A	Vitamin E
Average	15.28	0.74	21.97	34.95	0.85	0.52	73.08	0.41	3.37	7.51
Median	15.50	0.76	20.84	34.25	0.84	0.23	65.14	0.31	3.72	6.99
Lowest	19.70	0.82	30.91	49.36	1.73	3.68	365.83	2.65	13.70	23.35
Highest	10.33	0.64	15.42	24.60	0.30	0.06	0.24	0.00	0.20	0.00
Avg. in Herds with Stray Voltage	15.16	0.75	21.97	35.75	0.15	0.66	72.91	0.35	3.44	8.19
Avg. in Herds without Stray Voltage	15.38	0.73	21.96	34.31	0.92	0.40	73.22	0.45	3.32	7.02
UNITS OF DIFFERENCE	-0.21	0.02	0.01	1.45	-0.77	0.26	-0.31	-0.10	0.12	1.17

SUB CLNICAL RUMEN ACIDOSIS (pH)	
373 Cows Tested from 57 Herds	
Average	5.84
Median	5.82
Lowest	4.92
Highest	7.10
% with Healthy pH >5.8)	49%
% Suspect (pH= 5.8-5.6)	23%
% with Hazardous pH<5.6	28%
Avg. in Herds with Stray Voltage	5.82
Avg. in Herds without Stray Voltage	5.80
UNITS OF DIFFERENCE	0.02



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