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ANIMAL HEALTH EFFECTS OF THE OCTOBER 2013 BLIZZARD: OBSERVATIONS

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Introduction

From Thursday, October 3, through Saturday, October 5, 2013, an unprecedented early season winter storm affected western South Dakota and portions of Wyoming, Montana, North Dakota, and Nebraska. This storm resulted in the deaths of an estimated 15,000 to 30,000 head of cattle, along with many sheep, horses, and other animals. The early occurrence of the storm as well as its severity contributed to direct losses of animals as well as subsequent health effects.

Conditions Leading up to the Storm

Pasture and range in western South Dakota were in relatively good condition during the late summer of 2013. Much of western South Dakota, and the majority of the areas hardest-hit by the blizzard, had experienced above-normal precipitation, with 5-10+ inches of precipitation falling during the months of July through September, 2013. As a result, grass was in relatively good supply at the time of the blizzard, and green-up of cool-season grasses had occurred. This forage was relatively high in moisture and protein, but not energy, compared to typical dormant fall forage. This meant that cattle ranchers in many cases had not needed to begin supplemental feed. Additionally, many cattle were still grazing summer pastures relatively far removed from ranch headquarters and the more protected areas they would inhabit during winter months.

Most producers in the area typically wean calves in mid- to late October. The abundant grass precluded any need for early weaning, therefore most calves were still on pasture nursing their mothers. This created two issues: first, the calves were exposed to the severe storm conditions, and second, it created a further strain on the dam nutritionally. This scenario presumably affected younger cows (first-, second-, and third-calf heifers) more profoundly than older cows, since the younger cows are still maturing themselves and some of the nutrients consumed are going into her own maturing body and frame. Cow body

condition was adversely affected by the fact that most cows were lactating at the time of the storm, relative to body condition post-weaning. This is a potential reason for heavier-milking, more productive cows within herds to be more severely affected due to increased energy demands.

During the Storm

The weather event began in western South Dakota with rain and wind on the night of Thursday, October 3. Rain continued until the late afternoon of Friday, October 4, at which time falling temperatures turned rain into snow. SDSU's Union Center and Cottonwood Automatic Weather Data Network (AWDS) stations indicated that at least 0.75 to 1.00 inches of rain fell in the area before the precipitation converted to snow. This precipitation meant that at the onset of the blizzard, cattle's haircoats were thoroughly saturated with moisture.

Wet haircoats have a profound effect on the animal's thermoregulatory ability, and affect the lower critical temperature at which animals begin to need to expend energy to maintain their core body temperature. A thick winter haircoat will trap an air layer next to the animal's skin, providing insulation and preventing the loss of body heat. In this case the protective air layer was eliminated due to saturation with rain. Exacerbating this situation somewhat was the fact that cattle had not yet developed a winter coat and were not acclimated to colder temperatures due to the mild temperatures prior to the storm (average temperatures during September ranged from the upper 60's F in northwest South Dakota to the lower 70's F in the southwest). Beef cattle with wet haircoats have a lower critical environmental temperature of 59 F. During the storm, wind chill at Union Center had dropped to 12 F. Because energy requirements for cattle increase by 1 percent for every degree below the lower critical temperature, and as much as 2 percent for cattle with wet haircoats, the energy requirements of these cattle increased by 47% to 94% over normal. It was impossible for cow to consume sufficient energy during and immediately after the blizzard. In normal years, even when cold weather ensues, cattle are able to meet this increased energy requirement because of their winter haircoat, through increased feed intake from either the base forage or supplemental feed.

Severe cases of cold exposure can result in hypothermia, even in adult cattle. Mild hypothermia can occur when body temperatures reach 86 F to 89 F, moderate hypothermia at 71 F to 85 F with severe cases occurring as body temperatures drop to 68 F or below. As rectal temperatures drop below 82 F, the cow cannot return to normal body temperature without some kind of assistance, either through warming or administration of warm fluids. It's not unreasonable to assume that under these conditions of colder than normal temperatures combined with precipitation and wind that many cows were suffering from at least mild to moderate hypothermia.

Winds during the blizzard were incredibly strong and sustained. Hourly sustained winds averaged 49 miles per hour two different times on Friday at the Union Center weather station. Peak wind gusts recorded were 62 mph at this station during the storm, occurring Friday afternoon and night (a gust of 71 mph was recorded at Ellsworth Air Force Base Friday evening). In the midst of these winds, 20 to 30 inches of snowfall occurred in many areas north and east of the Black Hills. This created 3 to 4 foot drifts in these areas, with

areas receiving more snow (58 inches in Lawrence County in the Black Hills) experiencing drifts 6 to 7 feet deep.

The heavy winds and driving snow pushed cattle to seek shelter if they had not already found it prior to the storm and, remarkably, for some animals to abandon it during the storm. Cattle congregated and drifted with the wind, which was north-northeast at the beginning of the storm and shifted to the northwest later. Heavy snowfall meant that fences were easily breached. Cattle wandered great distances -- miles in some cases -- away from their home pastures.

The final resting point of animals varied a great deal depending on the obstacles they encountered during their journey. In some cases, cattle stayed together and were able to weather the storm in their existing herd or with other groups of cattle that strayed from their home pastures as well. Cattle encountered many physical obstacles that they could not avoid in the blinding snow and wind. Many cattle were found in fencelines, especially in southeast and southwest corners of pastures, unable to cross them. Others were found to have sought shelter in creek beds or draws, only to be covered up by snowdrifts during the storm. In some instances, cattle followed railroad grades and fell into creek beds when they came upon bridges or trestles in the snowstorm.

Exhaustion was likely the cause of death of many of the cattle in the blizzard, either by struggling to free themselves from muddy creek bottoms (expanded in scope by the wet conditions prior to the blizzard) or snowdrifts, or simply by the exertion put forth due to the miles of walking in the wind and snow. Extreme physical exertion coupled with the previously mentioned increased energy demands placed upon them by the effect of wind chills on their wet bodies was enough to result in some animals becoming simply spent of energy and no longer able to walk. While many animals were found in fencelines or draws, others were found on the tops of ridges, collapsed in place after expending all the energy they could muster.

Pulmonary (lung) changes also likely played a role in the death of some of the cattle. Following the storm it was not uncommon for veterinarians and cattle producers to observe copious amounts of fluid running from the nose and mouth of dead animals when they were moved. While only a handful of animals were subjected to post-mortem evaluation following the blizzard, terminal pulmonary edema was very likely a contributor to death in some of the animals under extreme exhaustion and stress. In these cows, left sided heart failure was likely involved.

The pathogenesis of left-sided heart failure in these cattle would begin as the body's sympathetic nervous system responds to cold environmental temperatures. This response activates a specific hormonal pathway (the renin-angiotensin-aldosterone system) which serves to increase blood pressure throughout the body. Since the left ventricle of the heart is charged with pumping blood to the systemic circulation, under conditions of high blood pressure, the heart must work harder to pump against the higher pressure. When the left side of the heart can no longer effectively pump blood, the blood backs up into the lungs. The resulting hydrostatic pressure in the small blood vessels of the lungs means that fluid is forced out of the bloodstream into the lung tissue itself and eventually the alveolus, resulting in fluid entering the airways. This will be seen as fluid pouring out of the lungs at death. In

these animals the ultimate cause of death may have been the fluid buildup in the airways due to heart failure.

When this phenomenon was noted by producers and veterinarians, several wondered if enough water, through rain and snow, could have entered the lungs externally to have resulted in drowning of the animal. In cases such as this (freshwater), when water enters the alveoli, it actually passes into the blood vessels of the lungs due to osmotic pressure—the bloodstream has more solutes in it than the water entering the alveolus, so water passes into the bloodstream. (This would not be the case in saltwater drownings because then the water has more solutes in it than the blood, and water will flow the other direction, from the bloodstream to the airways). Therefore “drowning” as defined by fluid from an external source entering the airways was not possible in these cattle during the storm.

Immediately Following the Storm

Veterinarians reported several syndromes in cows and calves that survived the storm, including tetany, bloating, and behavioral changes in cows.

Several cases of a tetany-like condition, similar to grass tetany, were reported in animals immediately after the blizzard. Animals were found in a hyperexcitable phase, progressing to recumbency and muscle tremors. A couple of related syndromes could have been at play here, resulting in very similar clinical signs. Transport tetany has been reported mostly in cows and ewes in late pregnancy, but it has also been reported in lambs and fat cattle being transported to slaughter. Transport tetany is so named because of prolonged transportation, with the resulting long-term (> 24 hours) deprivation of feed and water being a major inciting factor, along with stress. Once at their destination, unrestricted access to feed and water precipitates the clinical signs. While cattle were not transported per se during the blizzard, stress and feed and water deprivation were certainly involved. Additionally, they had immediate access to reasonable quality forage as soon as the blizzard ended because large expanses of rangeland on ridges and hilltops had been blown clear of snow.

The other similar syndrome is grass tetany, which typically occurs on pasture when consumed forages are low in magnesium, and can also be exacerbated when weather conditions result in feeding disruptions. Rapid springtime pasture growth with relatively cold soils is usually associated with grass tetany, due to the lower magnesium content of forages in those conditions. However, cases of grass tetany have also been associated with rapid pasture growth in the fall when warm, moist conditions are present. While not documented in these areas prior to the storm, low forage magnesium levels are a potential contributory factor to these signs of tetany following the storm. Hypomagnesemia is also considered a precipitating factor in cattle with transport tetany. Treatment of these cases consists of calcium-magnesium-glucose infusions intravenously, and is not always rewarding. Prevention in spring and fall pasture situations involves use of high-magnesium mineral.

Cases of bloating in calves were not uncommon in the days immediately following the storm. The etiology of bloat in relation to the storm aftermath is a bit unclear, but likely resulted from disruptions in feeding patterns, or -- more likely -- rapid resumption of feeding and resulting milk overload or acidosis when the storm was over. Rumen acidosis and the

resulting paralysis of the rumen wall may have been a contributing factor. Most of these cases responded well to relief with a stomach tube and treatment with mineral oil, antacids, and similar medications.

With the distances traveled and animals being driven into fences, draws, and wooded areas, many reports of injuries to cattle, horses, and sheep were reported. These varied widely in their severity.

Of the few storm-related cases submitted to the SDSU Animal Disease Research and Diagnostic Laboratory, a case of exertional rhabdomyolysis was diagnosed in a horse that succumbed to the blizzard. Otherwise known as “tying up,” this syndrome results from prolonged muscular exertion in horses that are not previously conditioned to such activity. Damage to muscle cells from the exertion of walking through the blizzard resulted in the release of myoglobin into the bloodstream. This substance has a toxic effect on the kidneys, and in severe cases can lead to kidney failure. The SDSU diagnostic lab case exhibited relatively mild lesions. The horse in question likely died from hypothermia or other sequelae to exhaustion rather than the rhabdomyolysis, however it is possible that horses that traveled long distances in the blizzard may have shown the effects of this condition. Mildly affected horses will respond to stall rest and a hay diet.

Many producers relayed stories of behavioral changes in cattle, particularly older cows that showed signs of aggression when it had not been present in the past. There are two possible medical explanations for this observation, in context of the other conditions faced by some of the surviving animals. First, aggressive behavior has been noted in early cases of grass or transport tetany (see above). In addition, aggressive behavior, anecdotally at least, has been ascribed to several conditions that result in cerebral hypoxia (reduced oxygen to the brain), including nitrate poisoning and infections of the red blood cells as occurs with anaplasmosis or theileriosis. Cows that survived the blizzard but were affected by pulmonary edema or other circumstances in which blood oxygenation was impaired could be expected to show aggressive behavior as well, although this is not well-documented in the literature.

Cleanup and Recovery Efforts

Restoring power disrupted due to downed power lines and clearing roads of snow and debris were the first orders of business after the snow and wind subsided late Saturday afternoon. Once ranchers were able to leave their homes and check for their cattle, it quickly became evident that cattle losses were extraordinary.

The task of disposing of cattle carcasses entered the forefront of the minds of producers and governmental authorities. In South Dakota, legal methods of disposal of dead livestock include burning, burying, or rendering within 48 hours of death. In addition, producers may submit a plan for composting dead livestock to the state Animal Industry Board, although the numbers and sizes of the carcasses involved precluded this as a practical means of disposal. Rendering services do not serve this area of South Dakota. State and local officials assisted these disposal efforts through establishment of mass burial sites (by several counties), and contracting with rendering services from out of state to pick up carcasses in state and county highway right-of-ways.

Since many livestock were found dead in areas that were difficult at best to reach, including steep draws, creek beds, and stock dams, it became apparent quickly that it may be some time before all carcasses could be completely disposed of. The risks to public health of leaving carcasses in waterways were concerns among ranchers and officials, as well as the public.

When properly performed, the approved methods of livestock disposal mitigate any potential problems that may arise from dead carcasses. These methods eliminate the likelihood that carcasses can serve as an attractant for wildlife scavengers such as coyotes or skunks.

In the case of this storm, normal healthy cows and calves were affected – in contrast to death losses due to infectious disease. As such, these animals were not harboring infectious disease agents in sufficient quantities to pass to other animals, or in the case of zoonotic disease, to humans. While normal animals can occasionally harbor infectious agents that could potentially cause illness in people or animals, the expected concentration of these in normal range cattle is very low. Examples of these include:

- *Salmonella* bacteria, which can be quite hardy in local environments but would not be expected to be significantly present in normal cattle;
- *Campylobacter*, which is less likely to persist outside the animal, and would not be expected to be present in large numbers in normal cattle;
- *E. coli* O157:H7, which is typically not found in adult cows or nursing calves to a significant extent;
- The protozoa *Cryptosporidium*, which can be hardy in the environment but are not typically found in adult cows or calves older than one month of age; and
- Cattle viruses such as IBR, BRSV, and BVDV, that do not affect humans and have a very short survival time outside a living animal.

Even in the infrequent case in which animal carcasses harbor these agents, the action and flow of water through waterways will tremendously dilute these pathogens, making the risk to animals or people downstream negligible.

Animal carcasses can contribute to poor water quality through the products of their decomposition (increased dissolved solids, increased biological oxygen demand, etc.), so burial in close proximity to drinking water wells should be avoided. In the case of waterways, dilution through normal water flows typically means there is little to no effect on water quality downstream. The snow melt and subsequent additional rainfall increased streamflows to well-above average (including near-record flows for this time of year).

Weeks Following the Storm

The most significant lasting animal health effect of the storm centered on the increased incidence of Bovine Respiratory Disease Complex (BRDC) in calves that weathered the storm.

Prolonged stress placed on animals, especially younger animals, due to weather events results in increased cortisol levels in the animals' bloodstream, which can have profound effects on the immune system.

Long-term stress can have the effect of shifting the immune system towards production of antibodies and away from cell-mediated responses. In practical terms, this means that the body has less of an ability to respond to diseases caused by viruses. In growing cattle, the inciting causes of BRDC are typically Infectious Bovine Rhinotracheitis (IBR, or "red-nose"), Bovine Respiratory Syncytial Virus (BRSV), and Bovine Viral Diarrhea Virus (BVDV).

These viruses were not likely to be present at a higher rate in cattle that weathered the blizzard; rather the animals' immune response to the usual levels of virus present in herds was diminished. Ranchers and veterinarians noticed an increase in clinical signs due to respiratory agents roughly two weeks post-storm, which is consistent with the incubation period of these germs of 7-14 days. Prompt identification of affected calves and individual treatment was important, and reports were that most calves responded to individual injections of appropriate antibiotics. In many cases, group treatments with feed- or water-based medications were not possible when calves or replacement heifers were still out on rangeland.

Calves that were exposed to the blizzard were in various stages of preparation for fall, with very few that had been weaned already. Others were in various stages of the process, anywhere from calves having their first pre-weaning vaccination for respiratory disease, to calves that had not had pre-weaning vaccinations at all. Ranchers were advised to delay any planned vaccination for at least 7-14 days following the storm, to ensure that cortisol levels had waned to the point at which they would not inhibit the calf's immune system from responding to the vaccine.

Another health issue that arose in the weeks following the blizzard was pinkeye in calves. Pinkeye is associated with bacteria such as *Moraxella bovis* and *Moraxella bovoculi*, but exposure to these agents by themselves is not sufficient to cause clinical signs of pinkeye. Some type of irritation such as dust or face flies is necessary for the bacteria to establish themselves. In these cases, presumably it was driven snow that served as the irritant. From most reports, these pinkeye cases were not especially resistant to the usual treatments.

Recovery and healing

For the weeks and months to come, ranchers will still be dealing with unique issues concerning animal health. Some producers chose to wean, keep, and feed calves rather than selling them soon after the blizzard, and are reacquainting themselves with the practice of starting calves on feed and monitoring calves during backgrounding.

Whether surviving cattle will face impaired reproductive performance as a result of the stress of enduring the blizzard is yet to be determined. It is largely believed that cows that were pregnant for longer than a couple months should not experience significant fetal loss due to this event. Anecdotal reports from individual ranchers exist that indicate less than optimal pregnancy rates when cows were preg-checked after the blizzard. Sublethal effects

of prolonged stress as that that occurred during the storm on developing fetuses are largely unknown.

Conclusion

The October 2013 blizzard was an unprecedented event for western South Dakota cattle producers and those who serve them. The extraordinary conditions affected cattle in a wide variety of ways, both short-term and long-term. Particularly disheartening for cattle producers was the fact that the storm affected cattle that were on open range as well as those in sheltered areas. Any cattle losses and subsequent health effects that were experienced happened through no fault of the cattle producers, because cattle were predominantly in good health and condition prior to the storm. A significant unknown is how severe the rest of the 2013-14 winter will be and what further effects this will have on animals and the people who take care of them. On the positive side, surface water was recharged, and adequate moisture for grass next spring should be present in the areas affected.

Typically, following a natural disaster, there are many lessons to be gleaned from the lack of, or inadequate, preparations. Those lessons are not apparent in the wake of this event. If there is any lesson to learn from the October 2013 blizzard, it may be that good management and proper animal care may not be enough to avert losses or adverse health effects. However, if cattle producers are armed with the knowledge of the sequelae that occur following these events (e.g. respiratory disease, bloating, tetany, etc.), they will be in a position to much more rapidly and appropriately respond to the survivors of the event and minimize further losses.

One can only hope that the extraordinary conditions of this storm will never be repeated. But cattle producers can almost guarantee that they will encounter some type of natural catastrophe, similar to flooding in Colorado, drought in Texas, or a blizzard in South Dakota. While these examples are widely different in their effects, they all present major disruptions to the normal feeding and management of cow-calf herds. Learning from the experiences of cattle producers who have endured such disasters can be informative as other producers face the uncertain future of what lies ahead for their own herd.

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