Project Summary

Prevalence of *E. coli* O157:H7 on Hides and in Feces of Feedlot Cattle over Time

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**Background**
Hides have been shown to be the primary source of *E. coli* O157:H7 contamination on beef carcasses. As a result, the beef industry has begun focusing on reducing the prevalence of fecal and *E. coli* O157:H7 contamination on hides prior to cattle being harvested. Pre-harvest interventions such as probiotics (dietary administration of lactic acid bacteria to compete with *E. coli* O157:H7), vaccination, and dietary administration of antibiotics, have been investigated as possible means of reducing *E. coli* O157:H7 prevalence rates in feces and on the hides of cattle. While these interventions are showing promise, none of them are one hundred percent effective. To help establish more information on how to effectively apply pre-harvest interventions, researchers sought to determine what the “threshold” level or number of cattle shedding *E. coli* O157:H7 in their feces is required to contaminate the hides of most of the cattle in the same pen.

As part of this project, researchers also sought to examine the changes in the prevalence of *E. coli* O157:H7 in feces and on the hides of animals in adjacent feedlot pens over several months.

**Methodology**
Prior to the arrival of test animals, feedlot pens and water troughs were screened for *E. coli* O157:H7. The pens were vacant for approximately 30 days before arrival of calves. In the week before the calves arrived, soil samples were also collected.

At weaning, hide and fecal samples from 319 calves were sampled for *E. coli* O157:H7 and then the calves were randomly assigned to feedlot pens. Cattle were held in 10 adjacent pens with 30 to 35 head per pen. Four of the pens contained heifers and six pens housed steers. The cattle were allowed to acclimate to their pens for six weeks before the second sampling period. From that point on, cattle were sampled with hide sponges approximately every 28 days.

Hide, feces and water trough samples were collected and analyzed for *E. coli* O157:H7 using U.S. Meat Animal Research Center Meats Research Unit (USMARC-MRU) laboratory protocols. Up to three isolates for each feces and hide sample positive for *E. coli* O157:H7 were collected for pulsed-field gel electrophoresis (PFGE) analysis to determine the source of *E. coli* O157:H7.

**Findings**
Seven of the 10 regular pens, as well as two of the short-term holding pens had at least one soil sample that was positive for *E. coli* O157:H7 prior to animals entering the facility. One of the pens had an *E. coli* O157:H7 concentration of 200 colony forming units (CFU) per gram (g) of soil. No water troughs were positive for *E. coli* O157:H7 at the initial sampling.

In September of 2004, feeder calves were sampled as they entered the feedlot facility. Fecal samples from 16 (5 percent) of the 321 animals coming from a pasture were positive for *E. coli* O157:H7. Two of the animals were shedding O157:H7 at high levels with concentrations of 1,400 and 9,000 CFU/g of feces. Over one-half (54 percent) of the individuals were positive for *E. coli* O157:H7 on their hides. The genotypes, as determined by pulsed-field gel electrophoresis
(PFGE), of the pen soil isolates were identical to those from the incoming cattle indicating a limited diversity of *E. coli* O157:H7 strains in this feedlot.

After the six-week acclimation period, *E. coli* O157:H7 prevalence had risen sharply. The overall fecal prevalence had gone up to 40 percent by the October sampling period with one pen as high as 83 percent. The hide prevalence had also risen to an overall level of 98 percent with cattle from eight of the 10 pens being 100 percent positive for *E. coli* O157:H7. The prevalence rates remained high during the November sampling period with fecal and hide prevalence rates of 49 and 98 percent, respectively. With such high prevalence rates, the researchers found it impossible to identify the effects of individual cattle shedding *E. coli* O157:H7.

During the winter months, *E. coli* O157:H7 prevalence on hide and fecal samples declined, as was expected. As the overall prevalence dropped, fluctuations in pen prevalence could be observed. At the February sampling period, two of the pens had hide prevalence rates of 97 percent (Pen 5) and 84 percent (Pen 8). Pens that shared water troughs with Pen 5 and Pen 8 (Pen 6 and Pen 7) had hide prevalence rates of 16 percent and 3 percent, respectively. The remaining pens did not exceed 16 percent prevalence rates. One factor common to both Pen 5 and Pen 8 was the presence of an animal shedding *E. coli* O157:H7 at a high level (defined as ≥ 200 *E. coli* O157:H7 CFU/g of feces). The researchers determined that the presence of animals shedding *E. coli* O157:H7 at high levels in their feces also had the highest hide prevalence rates. The situation was repeated during the March sampling period, when it was again observed that those pens with one or more animals shedding *E. coli* O157:H7 at high levels in their feces also had the highest hide prevalence rates. The prevalence rates in adjacent pens remained low and *E. coli* O157:H7 was not detected in the water troughs in the pens with the animals with high shedding rates.

The April sampling period further demonstrated the effect of animals with high shedding rates. Pens 5 and 8 no longer had any animals shedding at high levels and their respective hide prevalence rates dropped to 7 and 3 percent, respectively. During the same period, an animal in Pen 10 was identified as shedding *E. coli* O157:H7 at high levels. The hide prevalence in this pen rose from zero to 97 percent in April.

A second sampling period was added in April, 14 days after the initial collection. During this sampling period, the number of high shedders in Pen 10 had increased to 15 and hide prevalence was at 100 percent. An animal in Pen 9 was identified as being a high shedder and the hide prevalence in this pen had risen from 3 percent, 14 days earlier, to 94 percent. The water trough common to Pens 9 and 10 was found to harbor *E. coli* O157:H7 in both April sampling periods and the researchers hypothesized that it could have served as a mechanism for the increased prevalence in Pen 9.

In the final sampling period, it was seen again that the pens containing animals shedding *E. coli* O157:H7 at high levels (Pens 9 and 10) also had the highest hide prevalence rates. At the completion of the study, cattle were assigned to three groups for slaughter. At the time of this writing, one of the three groups had been transported to the processing facility. Hide and fecal samples were collected from these animals just prior to their being loaded onto the transport trucks. The results from this sampling indicated that 28 percent of the animals harbored
E. coli O157:H7 on their hides and 9 percent had E. coli O157:H7 present in their feces, including four animals that were shedding at a high level. Hide samples were also collected after the animals had been stunned. At that sampling point, E. coli O157:H7 was detected on 89 percent of the hides.

Table 1. E. coli O157:H7 hide prevalence during 10 sampling periods on 319 head of feedlot cattle held in 10 adjoining pens.

<table>
<thead>
<tr>
<th>Month</th>
<th>Pen 1</th>
<th>Pen 2</th>
<th>Pen 3</th>
<th>Pen 4</th>
<th>Pen 5</th>
<th>Pen 6</th>
<th>Pen 7</th>
<th>Pen 8</th>
<th>Pen 9</th>
<th>Pen 10</th>
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<td>42</td>
<td>60</td>
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<td>73</td>
<td>71</td>
<td>79</td>
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<td>100</td>
<td>94</td>
<td>100</td>
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<td>100</td>
<td>100</td>
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<td>100</td>
<td>100</td>
<td>97</td>
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<td>97</td>
<td>97</td>
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<td>100</td>
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<tr>
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<td>100</td>
<td>100</td>
<td>100</td>
<td>86</td>
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<td>9</td>
<td>97</td>
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<td>3</td>
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<td>3</td>
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<td>97</td>
<td>14</td>
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<td>56</td>
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</table>

Implications
This study demonstrated that large variations in prevalence rates of E. coli O157:H7 may exist between neighboring feedlot pens. Additionally, large fluctuations in hide and fecal prevalence rates can occur within a pen in a short span of time, as exemplified by the increase in hide prevalence from 3 percent to 94 percent in only a two-week period. Animals shedding E. coli O157:H7 at high levels in their feces greatly affects the hide prevalence within a pen. It was observed that one pen containing only two fecal-positive animals—one shedding at a high level—had a hide prevalence rate of 84 percent. Transport and lairage at the processing plant also led to large increases in hide prevalence of E. coli O157:H7.

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