Beef and dairy cattle are responsible for producing nearly 50% of annual ammonia emissions in the United States. Ammonia is a major contributor to PM$_{2.5}$ formation. Beef and dairy cattle are responsible for producing nearly 50% of annual ammonia emissions in the United States. Ammonia is a major contributor to PM$_{2.5}$ formation.

Role of Protein

High protein feeds contain excess nitrogen, which is excreted as ammonia and urea, an ammonia precursor.

Improving Air Quality through Dietary Protein Management in Cattle

Feeding Strategies

<table>
<thead>
<tr>
<th>Forage</th>
<th>Maturity</th>
<th>Crude Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>Beef</td>
<td>22 – 26</td>
</tr>
<tr>
<td>Early Flower</td>
<td>Mid Bloom</td>
<td>14 – 18</td>
</tr>
<tr>
<td>Mid Bloom</td>
<td>Early Bloom</td>
<td>09 – 13</td>
</tr>
<tr>
<td>Corn Silage</td>
<td>Well Eared</td>
<td>07 – 09</td>
</tr>
<tr>
<td>Poorly Eared</td>
<td>Tall Forage, Orchardgrass</td>
<td>07 – 09</td>
</tr>
<tr>
<td>Vegetative – Boot</td>
<td>Boot – Heat</td>
<td>12 – 16</td>
</tr>
<tr>
<td>Boot – Heat</td>
<td>Annual Ryegrass</td>
<td>08 – 12</td>
</tr>
<tr>
<td>4 weeks old</td>
<td>Bermedagrass</td>
<td>10 – 12</td>
</tr>
<tr>
<td>8 weeks old</td>
<td>Red Clover</td>
<td>06 – 08</td>
</tr>
<tr>
<td>14 – 16</td>
<td>Tall Fescue</td>
<td>14 – 16</td>
</tr>
</tbody>
</table>

Growth

- Reducing dietary protein (while still meeting minimum requirements for the stage of production) has no effect on growth rates.

Effects on Reproduction

- Conception Rates
  - Increased protein reduces conception rates in dairy cattle due to high urea levels.
  - Excess protein is less detrimental in beef.

- Uterine Environment
  - Uterine pH is inversely related to plasma urea.
  - Uterine pH affects sperm capacitation and uterine secretions that aid maternal recognition.

- Hormones
  - Urea may interrupt signaling by decreasing GnRH.
  - Effects are dependent on reproductive state.
  - High protein can reduce progesterone.

- Due to the higher level of lactational stress, protein imbalances have a more significant effect on dairy cattle.

- Higher crude protein content correlates to higher milk production, but only when balanced with metabolic energy cost of nitrogen excretion.

- Raising crude protein concentrations from 14.4 to 19.8% in lactating dairy cows resulted in a 42% increase in urinary urea concentration (Cole, 2005).

- Raising crude protein concentrations from 15 to 19% in lactating Holstein cows resulted in no noteworthy increase in milk yield (Olmos et al., 2003).

Conclusion

Through management of dietary protein, it is possible to reduce the levels of urea excreted by cattle and thus limit ammonia production among livestock, reducing its availability for PM$_{2.5}$ formation. Reducing dietary protein can improve reproduction in cattle, and has had no ill effects on production traits. This goal should be desirable to most livestock producers, and can be achieved in many ways, though it is highly recommended to consult with a nutritionist before making significant dietary changes.

Sources