Gaining value from beef feedlot manure

Russ Euken
Iowa State University
Manure from beef feedlots

• What is manure worth to your operation?
  – $10/head
  – $20/head
  – $30/head
  – Less
  – More

• Can you make money spreading manure?
Manure from beef feedlots

Nutrients in feed
- Nutrients retained by animal
  = Nutrients excreted
- Nutrients lost – facility, weather, etc etc
  = Nutrients captured in manure
- Nutrients lost or unavailable after application
  = Nutrients available to crops
Manure from beef feedlots

• About 10 -20 % of N and P fed in diet is retained in beef feedlot animal
  – Varies with diet and animal
  – The rest is excreted
Manure from beef feedlots

% P in diets | .29% P | .41% P | .53% P
---|---|---|---
DGS, % DM | 0 | 20 | 40
Phosphorus, lbs/steer | | | |
Manure from beef feedlots

Raw manure varies with diet and cattle size but on average per day:

- 64 lbs / 1000 lb animal @ 92% moisture
  - .38 lbs N
  - .15 lbs P2O5
  - .30 lbs K2O per lb.

» ASAE D384.2
Manure from beef feedlots

Finishing beef (153 days) as excreted (92% moisture)

9800 pounds manure

12.6 % CP .35% P  16 % CP .5% P

Lbs N    60   79
Lbs P$_2$O$_5$ 23   34
Lbs K2O   46   46 ??
Manure from beef feedlots

Raw manure varies with diet and cattle size but on average per day

- 64 lbs / 1000 lb animal @ 92 % moisture
  - .38 lbs N - 137 lbs/ year /space
  - .15 lbs P2O5- 54 lbs /year/space
  - .30 lbs K2O - 108 lbs/ year/space

» ASAE D384.2
Manure from beef feedlots comparing facilities

- Open lot
  - Earth lot
  - Concrete lot
    - Runoff controls
- Deep pit confinement barns
- Bedded confinement facilities
Manure nitrogen
Nitrogen losses

• To the air
  • N (Urea) conversion to Ammonia
    • Happens fastest under warm, moist, aerated conditions
  • Control with frequent scraping, stockpiling, and incorporation
Manure nitrogen

What does not volatilize stays in manure
Nutrient losses

• To runoff water
  • N, P and K
  • Control with clean water diversion, frequent scraping, stockpiling, settling basins, and runoff control basins
Open lot management

- Variability

Biggest Variable???

- Moisture!
- Bedding
- Added soil
N loss in open lot

Average diet N, 13.5% CP
Summer-Yearlings

46.0 lb (71%) volatilized

65.0 lb excreted

2.2 lb (3%) runoff

7.9 lb animal

16.7 lb (26%) manure

72.9 lb Intake

Feedlot pen
### Decreasing surface area
### Cleaning frequency

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<td>1464</td>
<td>803</td>
<td>1529</td>
<td>1103</td>
</tr>
<tr>
<td>OM</td>
<td>440</td>
<td>230</td>
<td>449</td>
<td>269</td>
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<tr>
<td>N manure</td>
<td>21.3</td>
<td>12.6</td>
<td>21.3</td>
<td>15.8</td>
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<tr>
<td>N loss</td>
<td>36.9</td>
<td>45.6</td>
<td>26.6</td>
<td>33.6</td>
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<tr>
<td>N loss, %</td>
<td>63.6</td>
<td>78.4</td>
<td>55.5</td>
<td>68.0</td>
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</table>

2001 54 pens, 1.45 – 1.57% N  
2002 48 pens, 1.39 – 1.43% N
Manure from beef feedlots

• Open lot management
  • Up to 70% of N volatilized in summer and 40% in winter
  • More frequent cleaning
    – Earth lots - 13 % less loss of N with monthly versus end of feeding period cleaning – More manure also- U of Neb 2004 beef research report
  • Divert water
Lorimor Data on open beef feedlots  5 feedlots

21 lbs of manure/head/day at 68 % moisture – 43 % CV
3.75 tons per space per year

<table>
<thead>
<tr>
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<th>lbs/ton</th>
<th>lbs/year calc</th>
<th>CV</th>
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<tr>
<td>N</td>
<td>10.2</td>
<td>38.25</td>
<td>63%</td>
</tr>
<tr>
<td>P2O5</td>
<td>6.8</td>
<td>25.5</td>
<td>71%</td>
</tr>
<tr>
<td>K2O</td>
<td>34</td>
<td>127.5</td>
<td>161%</td>
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## 2006 Nebraska Beef Cattle Report Summary of Manure Amounts, Characteristics, and Nitrogen Mass Balance for Open Feedlot Pens in Summer Compared to Winter

118 research trials on earth lots

<table>
<thead>
<tr>
<th></th>
<th>Summer</th>
<th>Winter</th>
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<tbody>
<tr>
<td><strong>Avg manure lbs/hd/day</strong></td>
<td>Avg 15 lbs at 69.6% DM 3.5-35.7 range</td>
<td>Avg 31.9 lbs at 61.4% DM 31.5-76.9 range</td>
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<tr>
<td><strong>Yearly manure</strong></td>
<td>1.36 ton/space/year</td>
<td>2.91 ton/space/year</td>
</tr>
<tr>
<td><strong>N lbs/hd/day</strong></td>
<td>.13 avg Range .03-.27</td>
<td>.22 avg Range .04-.36</td>
</tr>
<tr>
<td><strong>N pounds per 6 months avg.</strong></td>
<td>23.7</td>
<td>40</td>
</tr>
<tr>
<td><strong>N pounds per ton</strong></td>
<td>17.4</td>
<td>13.75</td>
</tr>
<tr>
<td><strong>% N volatilized</strong></td>
<td>69% avg 38-98 range</td>
<td>47 % avg 10-89 range</td>
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Open Lot Beef $P_{205}$ Samples

- **Bedded Pack**
- **Manure off Dirt**
- **Manure off Concrete**
- **Scraped**
- **Land Applied**

**Book Value for P205**

**P205 by Lot Location**

**Average**

Lbs P205/ton
Manure from beef feedlots

- Deep pit beef facilities
  - 6.5 gallon per head per day - 60 lbs
    - 2340 gallons per space per year

<table>
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<tr>
<th></th>
<th>Lbs/ 1000 gal</th>
<th>Lbs/space/year</th>
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<tbody>
<tr>
<td>N</td>
<td>40</td>
<td>94</td>
</tr>
<tr>
<td>P2O5</td>
<td>25</td>
<td>59</td>
</tr>
<tr>
<td>K2O</td>
<td>35</td>
<td>82</td>
</tr>
</tbody>
</table>
Manure from bedded confinement

- Sampled hoops and monoslopes
  - Varied management
- 11 different operations- Approx 60 samples
- Jan- July 08
- Apron, Pack, Stockpile locations sampled separately

Analyzed for moisture, N, P, K, S some for ammonia
Manure from bedded confinement nutrient analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Avg.</th>
<th>CV</th>
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</thead>
<tbody>
<tr>
<td>% DM</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>Total N</td>
<td>18.5</td>
<td>21</td>
</tr>
<tr>
<td>Ammonia</td>
<td>4.6</td>
<td>65</td>
</tr>
<tr>
<td>P2O5</td>
<td>9.9</td>
<td>29</td>
</tr>
<tr>
<td>K2O</td>
<td>11.8</td>
<td>26</td>
</tr>
<tr>
<td>S</td>
<td>2.4</td>
<td>21</td>
</tr>
</tbody>
</table>
Amount of manure from bedded confinement - calculated

One head for one year

21000 lbs manure at 92 % moisture
2190 lbs bedding at 20 % moisture 6 lbs/day
23000 lbs at 85 % moisture

Adjusted to 70 % moisture
11328 lbs – 6 ton of manure at 30 % DM
Manure from bedded confinement

• Raw manure- as excreted per day
  – Total lbs. per year per space  20880
    N       P2O5       K2O       S
    122.4   75.6       93.6     16.2
  – Cornstalks – 6 lbs/hd/day added-
    • 2160 lbs per year per space
      N       P2O5       K2O       S
      13.8    6.5        29       2.4
    Total  136.2      82.1      112.6     18.6
Manure from bedded confinement nutrient analysis

By location of sample
- Pack, apron and stockpile were all similar- Stockpiles and aprons were a little wetter

By operation
- Not as much variation between samples from one operation
- With the exception of one - operation averages were all similar to overall avg.
### Manure from bedded confinement nutrient analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Avg. lbs/ton</th>
<th>Lbs per year @ 6 ton</th>
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<tbody>
<tr>
<td>Total N</td>
<td>18.5</td>
<td>111</td>
</tr>
<tr>
<td>P2O5</td>
<td>9.9</td>
<td>60</td>
</tr>
<tr>
<td>K2O</td>
<td>11.8</td>
<td>71</td>
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</table>
## Manure from beef feedlots

### Summary Nutrients per space per year

<table>
<thead>
<tr>
<th>Facility</th>
<th>Total N lbs/space/year</th>
<th>P2O5 lbs/space/year</th>
<th>K2O lbs/space/year</th>
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</thead>
<tbody>
<tr>
<td>Open lot- ASABE and ISU Runoff not included</td>
<td>66</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>Bedded confinement- w/o nutrient additions from bedding</td>
<td>98</td>
<td>57</td>
<td>58</td>
</tr>
<tr>
<td>Deep pit</td>
<td>94</td>
<td>59</td>
<td>82</td>
</tr>
<tr>
<td>Excreted</td>
<td>122</td>
<td>68</td>
<td>93</td>
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</table>
Sampling and analysis of beef feedlot manure

Test your manure!

• Moisture, total N, P, K (around $30 test)
• Take good representative samples
• Make note of variability by source & season

Ammonia analysis??
Ash analysis??
Manure nutrients from feedlots - Land application

Stored manure – stockpiled or compost

Nutrient availability – mainly nitrogen

Application - Timing, method, Rate, Match crop needs, calibration, and uniformity
Solid Manure Storage

- Fresh

- Stockpile

- Compost

  - Nitrogen
    - Fresh → Stockpiled → Composted
    - Larney et al., 2006
  - Nutrient recoveries in finished compost is greater when OM is increased
    - Adams et al., 2004; Ferran et al., 2014
Manure nutrients from feedlots - Storage?

Stored solid manure – stockpiled or compost allow for more timely application??

Stockpiled manure – more volume more N regulations??

Compost less volume and less N
## Manure storage

<table>
<thead>
<tr>
<th></th>
<th>Compost</th>
<th>Stockpile</th>
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<tr>
<td>% N retained</td>
<td>56%</td>
<td>86%</td>
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<tr>
<td>After 104 days</td>
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Increase in organic N in compost relative to stockpile and increase in ammonium N in stockpile

U of Neb Beef Research report  2009
Manure nutrients from feedlots - Land application
Application - Calibration and Consistency
Manure application rates
Application rates
Application rates

10 ton

5 ton
Manure nutrients from feedlots- Land application

Figure 2. Typical single-swath pattern for a rear-beater spreader.
Uniformity of spread

Rear delivery - 6

Application rate, lb/ac

Horizontal distance, ft
Rate and uniformity

Figure 5. Side-delivery spreader.

![Side-delivery spreader image]

<table>
<thead>
<tr>
<th>Horizontal distance, ft.</th>
<th>lbs/acre</th>
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<tr>
<td>7.5</td>
<td>500</td>
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<tr>
<td>15</td>
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<td>22.5</td>
<td>3,500</td>
</tr>
<tr>
<td>30</td>
<td>4,000</td>
</tr>
<tr>
<td>37.5</td>
<td>3,500</td>
</tr>
<tr>
<td>45</td>
<td>2,000</td>
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<td>52.5</td>
<td>1,500</td>
</tr>
<tr>
<td>60</td>
<td>1,000</td>
</tr>
<tr>
<td>67.5</td>
<td>500</td>
</tr>
<tr>
<td>75</td>
<td>2,000</td>
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Manure nutrients from feedlots- Land application

Figure 6. Typical single-swath pattern for side-delivery spreader.
Manure nutrients from feedlots- Land application

Nutrient availability – PMR 1003 Using manure nutrients for crop production

Nitrogen – Inorganic and Organic form
Inorganic is ammonium available to crop
Organic needs to be mineralized to be available
Manure nutrients from feedlots- Land application

Availability – Pm 1003

Feedlot solid manure –

30-40 % 1\textsuperscript{st} year availability of N
10 % 2\textsuperscript{nd} year
5 % 3\textsuperscript{rd} year

Some of the N doesn’t break down and becomes part of organic matter
Manure nutrients from feedlots- Land application

Availability Pm 1003

Feedlot solid manure – nutrient availability
60-100 % P2O5 and 90-100 % of K2O

Lower soil tests = less available
High soil tests and history of manure use 100%
Manure nutrients from feedlots- Land application

Application rate- Timing, method

Spring or fall?
Incorporated or not incorporated
95-100% of N if incorporated in 1 day
70-85% of N without incorporation
Manure nutrients from feedlots- Land application

180 bu. continuous corn –
   190 lbs N, 67 lbs P2O5, 54 lbs K2O
w/stalk removal 80 lbs P2O5, 126 lbs K2O

Feedlot manure nutrients /ton
21 lbs N- 8 lbs available, 12 lbs P2O5 and 14 lbs K2O

What rate?
Manure nutrients from feedlots- Land application

180 bu. continuous corn –
  190 lbs N, 67lbs P2O5, 54 lbs K2O
with stalk removal 80 lbs P2O5, 126 lbs K2O

25 ton = 200 lbs N, 300 lbs P2O5, 350 lbs K2O
15 ton = 120 lbs N, 180 lbs P2O5, 210 lbs K2O
5 ton =   40 lbs N,   48 lbs P2O5,   56 lbs K2O
Manure nutrients from feedlots - Land application

21 lbs N, 12 lbs P2O5 and 14 lbs K2O per ton

500 head capacity @ 6 ton = 3000 ton
200 head capacity @ 3 ton = 600 ton

25 ton = 200 lbs N 1st yr, 300 lbs P2O5, 350 lbs K2O

3600 ton/25 ton = 144 acres
Manure from feedlots land application

Assume $.28 lb N, $.55 P2O5 and $.65 K2O

– Potential value
  • $18.78 per ton or @ 25 ton per acre $465.50/acre
Manure from feedlots land application

4 years of corn

<table>
<thead>
<tr>
<th></th>
<th>N lbs</th>
<th>P2O5 lbs</th>
<th>K2O lbs</th>
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</thead>
<tbody>
<tr>
<td>Manure nutrients available</td>
<td>190</td>
<td>300</td>
<td>350</td>
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<tr>
<td>Commercial fertilizer applied</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Crop use</td>
<td>190</td>
<td>80</td>
<td>126</td>
</tr>
<tr>
<td>Excess or deficient</td>
<td>0</td>
<td>220</td>
<td>224</td>
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<tr>
<td>Manure nutrients value</td>
<td>$53.20</td>
<td>$44.00</td>
<td>$81.90</td>
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<table>
<thead>
<tr>
<th></th>
<th>N lbs</th>
<th>P2O5 lbs</th>
<th>K2O lbs</th>
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<tr>
<td>Manure nutrients available</td>
<td>47.5</td>
<td>220</td>
<td>224</td>
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<tr>
<td>Commercial fertilizer applied</td>
<td>142.5</td>
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<td>0</td>
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<td>Crop use</td>
<td>190</td>
<td>67</td>
<td>54</td>
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<tr>
<td>Excess or deficient</td>
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<td>170</td>
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<td>Manure nutrients value</td>
<td>$13.30</td>
<td>$36.85</td>
<td>$35.10</td>
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Manure from feedlots land application

4 years of corn

<table>
<thead>
<tr>
<th></th>
<th>N lbs</th>
<th>P2O5 lbs</th>
<th>K2O lbs</th>
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<tbody>
<tr>
<td>Manure nutrients available</td>
<td>24</td>
<td>153</td>
<td>170</td>
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<tr>
<td>Commercial fertilizer applied</td>
<td>166</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Crop use</td>
<td>190</td>
<td>67</td>
<td>54</td>
</tr>
<tr>
<td>Excess or deficient</td>
<td>0</td>
<td>86</td>
<td>116</td>
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<td>Manure nutrients value</td>
<td>$6.72</td>
<td>$36.85</td>
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<td>86</td>
<td>116</td>
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<td></td>
<td>190</td>
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<tr>
<td></td>
<td>$0.00</td>
<td>$36.85</td>
<td>$35.10</td>
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</table>

Value/yr

|                      | $78.67 | $71.95  |

(IBC - Iowa Beef Center)
Manure rate

• Apply rate that uses some commercial N and some manure N?

• Take credit for P and K

• Costs of application
Other considerations

Not all land owners may be willing to pay for excess nutrients beyond next year’s need

Also consider other impacts and application cost

• Organic matter value
• Compaction
• Timeliness
• Application cost (distance hauled- rate applied)
Plot data

• Manure plot – applied this spring
  – 5, 10 and 20 ton of bedded manure and 200 lbs commercial N side dressed.
  – Each treatment replicated 2x
### Plot data with bedded manure

<table>
<thead>
<tr>
<th>Manure tons</th>
<th>Total N applied</th>
<th>Calculated N lbs available</th>
<th>Spring ntirate test ppm</th>
<th>Stalk test ppm</th>
<th>Yield bu. per acre</th>
<th>before manure app</th>
<th>Avg.</th>
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</thead>
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<td></td>
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<tr>
<td>0</td>
<td>200 lbs</td>
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<td>1220</td>
<td>226</td>
<td>40</td>
<td>234</td>
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<tr>
<td>0</td>
<td>200 lbs</td>
<td>200</td>
<td>6</td>
<td>559</td>
<td>209</td>
<td>70</td>
<td>268</td>
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<tr>
<td><strong>Avg.</strong></td>
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<td></td>
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<td>5 ton</td>
<td>130</td>
<td>49.4</td>
<td>7</td>
<td>&lt;20</td>
<td>138</td>
<td>31</td>
<td>205</td>
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<tr>
<td>5 ton</td>
<td>130</td>
<td>49.4</td>
<td>10</td>
<td>55</td>
<td>136</td>
<td>55</td>
<td>236</td>
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<td><strong>Avg.</strong></td>
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<td>137</td>
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<tr>
<td>10 ton</td>
<td>260</td>
<td>98.8</td>
<td>6</td>
<td>&lt;20</td>
<td>164</td>
<td>60</td>
<td>267</td>
</tr>
<tr>
<td>10 ton</td>
<td>260</td>
<td>98.8</td>
<td>8</td>
<td>&lt;20</td>
<td>172</td>
<td>51</td>
<td>248</td>
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<td>168</td>
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<td>20 ton</td>
<td>520</td>
<td>197.6</td>
<td>10</td>
<td>&lt;20</td>
<td>212</td>
<td>45</td>
<td>222</td>
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<tr>
<td>20 ton</td>
<td>520</td>
<td>197.6</td>
<td>8</td>
<td>&lt;20</td>
<td>228</td>
<td>56</td>
<td>219</td>
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<td><strong>Avg.</strong></td>
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<td></td>
<td></td>
<td>220</td>
<td></td>
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</tbody>
</table>
Manure rules

All manure application must follow 200 foot separation distance from water sources (wells, lakes, streams) unless incorporated same date.

Confinement beef operations over 500 head and total beef capacity over 1000 head are subject to other rules and regulations (Iowa Manure Management Plans, Iowa Manure Applicator Certification, Construction permits, NPDES permits, etc.) Consult Iowa DNR or other consultants for advice.

SF 432 – bedded confinement manure stockpiling and liquid manure application on frozen or snow covered ground.