Feeding Value of Corn DDGS for Poultry

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University of Minnesota
Presentation Outline

- DDGS nutrient contributions to poultry diets
- Review Research re. DDGs Inclusion in Poultry Diets
What does corn-derived DDGS contribute to poultry diets?

- Protein (corn)
  - Amino acid content
  - Amino acid digestibility
- Energy (metabolizable energy)
  - Proximate Composition
- Phosphorus
  - Availability
- Xanthophylls (yolk and carcass pigmentation)
- Fiber – reduction of ammonia emissions
What does DDGS contribute to poultry diets

- Protein (corn)
  - Amino acid content/balance
  - Influence of dietary protein level
    - Lowered protein diets

- Research by Parsons ('83)
  - Lysine – 1st limiting
    - Supplementation with lysine
  - Tryptophan and arginine almost equally limiting
Limiting nature of tryptophan and arginine in DDGs for turkey toms

- University of Minnesota Trial (2003)
- No performance difference – control diet & 10% DDGS diet
- Lowered protein diet (LP) with 10% DDGs resulted in poorer F/G
- F/G restored with try & arg supplementation

Noll et al, 2003
What does DDGS contribute to poultry diets

- Protein (corn)
  - Amino acid content/balance
    - Corn protein in DDGS limiting in lysine, arginine and tryptophan (Parsons et al 1983; Noll, 2003)
    - Source of threonine and sulfur amino acids (Noll, 2003)
    - Important to formulate with minimums for:
      - Lys
      - Arg
      - Try
What does DDGS contribute to poultry diets

- Protein (corn)
  - Amino acid digestibility
    - Ingredient processing in particular that of heating decreases digestibility of amino acids
      - Oil seed meals
      - Meat and bone meal
    - Associated with color change – darkening
    - Amino acids most affected – lys, thr, cys
  - In DDGs, digestibility of amino acids is variable among sources, in particular that of lysine (Ergul et al, 2003)
# Lysine Content and Digestibility

<table>
<thead>
<tr>
<th>Source</th>
<th>No. of Samples</th>
<th>Lysine Content (%)</th>
<th>Lysine Digestibility Coefficient (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ave.</td>
<td>Range</td>
</tr>
<tr>
<td>Ergul et al. 2003(^1)</td>
<td>20</td>
<td>.73</td>
<td>.59-.89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>72</td>
<td>59-84</td>
</tr>
<tr>
<td>Batal and Dale 2006(^2)</td>
<td>8</td>
<td>.71</td>
<td>.39-.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70</td>
<td>46-76</td>
</tr>
<tr>
<td>Fastinger et al. 2006(^1)</td>
<td>5</td>
<td>.64</td>
<td>.48-.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>76</td>
<td>65-82</td>
</tr>
</tbody>
</table>
Lysine Digestibility for Poultry as Affected by Production Source

Ergul et al., 2003
Economics and DDGs
Quality-Lysine Digestibility

DDGS Opportunity Cost in
Commercial Poultry Grower Diet
Comparison of DDGS Quality Total Amino Acids (Digestible)

<table>
<thead>
<tr>
<th>%</th>
<th>Hi Dig Lys</th>
<th>Lo Dig Lys</th>
</tr>
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<tbody>
<tr>
<td>CP</td>
<td>26.4</td>
<td>27.8</td>
</tr>
<tr>
<td>Met</td>
<td>.49(.43)</td>
<td>.51(.44)</td>
</tr>
<tr>
<td>Cys</td>
<td>.53(.42)</td>
<td>.49(.32)</td>
</tr>
<tr>
<td>Lys</td>
<td><strong>.81(.64)</strong></td>
<td><strong>.72(.46)</strong></td>
</tr>
<tr>
<td>Thr</td>
<td>1(.82)</td>
<td>1.03(.75)</td>
</tr>
<tr>
<td>Tryp</td>
<td>.24(.19)</td>
<td>.2(.16)</td>
</tr>
</tbody>
</table>
## Influence of digestible lysine on value of DDGs (US $/cwt)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Cost</th>
<th>High Dig Lys</th>
<th>Low Dig Lys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn, 3.10</td>
<td>4.78</td>
<td>4.28</td>
<td></td>
</tr>
<tr>
<td>Corn, 3.50</td>
<td>5.00</td>
<td>4.54</td>
<td></td>
</tr>
<tr>
<td>Corn, 5.30</td>
<td>6.02</td>
<td>5.70</td>
<td></td>
</tr>
<tr>
<td>SBM, 8.25</td>
<td>5.00</td>
<td>4.54</td>
<td></td>
</tr>
<tr>
<td>SBM, 8.70</td>
<td>5.21</td>
<td>4.72</td>
<td></td>
</tr>
</tbody>
</table>
What does DDGS contribute to poultry diets – Re. Protein/amino acids

- Recommendations re. amino acids
  - Formulate with minimums for arg, & try in addition to lys, TSAA, and thr
  - Formulate on a digestible amino acid basis
What does DDGS contribute to poultry diets

- Protein (corn)
- Energy (metabolizable energy)
- Phosphorus
  - Availability
- Xanthophylls (yolk and carcass pigmentation)
- Fiber
Metabolizable Energy for DDGS

- Importance of energy level
  - Feed conversion
  - Least cost formulation for high energy diets
- More recent determinations much higher than NRC (1994) reported value of AMEn 2480 kcal/kg (9% fat vs 10-11% in current DDGS)

<table>
<thead>
<tr>
<th>Source</th>
<th>AMEn (kcal/kg)</th>
<th>TMEn</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRC, 1994</td>
<td>2480</td>
<td></td>
</tr>
<tr>
<td>Potter, 1966</td>
<td>2880</td>
<td></td>
</tr>
<tr>
<td>Noll, 2004</td>
<td>2810-2850</td>
<td>2833</td>
</tr>
<tr>
<td>Roberson 2004</td>
<td>2760</td>
<td></td>
</tr>
<tr>
<td>Batal &amp; Dale, 2006</td>
<td></td>
<td>2820</td>
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</tbody>
</table>
# DDGs Economics and AME Energy Level

<table>
<thead>
<tr>
<th>DDGs ME Kcal/kg</th>
<th>Fat Cost $/100 lbs</th>
<th>% DDGs Inclusion $4/100 lbs</th>
<th>DDGs Opportunity Cost, US $/100 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2810</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2810</td>
<td>15</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2480</td>
<td>11</td>
<td>0</td>
<td>3.82</td>
</tr>
<tr>
<td>2480</td>
<td>15</td>
<td>0</td>
<td>3.34</td>
</tr>
</tbody>
</table>
What does DDGS contribute to poultry diets

- Protein
- Energy (metabolizable energy)
- Phosphorus
  - Availability
- Xanthophylls (yolk and carcass pigmentation)
- Fiber
# Availability of Phosphorus

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>P, %</th>
<th>P, avail. %</th>
<th>% P Avail.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn*</td>
<td>.28</td>
<td>.08</td>
<td>28</td>
</tr>
<tr>
<td>SBM*</td>
<td>.62</td>
<td>.22</td>
<td>35</td>
</tr>
<tr>
<td>DDGs*</td>
<td>.72</td>
<td>.39</td>
<td>54</td>
</tr>
<tr>
<td>DDGs (UGA)</td>
<td>.74</td>
<td>~.47</td>
<td>61-68 (64)</td>
</tr>
<tr>
<td>DDGs (UI)</td>
<td>.73</td>
<td>~.6</td>
<td>69-102 (82)</td>
</tr>
<tr>
<td>DDGs (MSU)</td>
<td></td>
<td></td>
<td>76-85 (80)</td>
</tr>
</tbody>
</table>

*NRC, 1994*
What does DDGS contribute to poultry diets

- Protein
- Energy (metabolizable energy)
- Phosphorus
- Xanthophylls
  - yolk and carcass pigmentation
- Fiber
DDGs and Xanthophylls – Book Values

- Corn 15-25 mg/kg
- Corn Gluten Meal 130-170 mg/kg
- DDGs 15-20 mg/kg
  - Limited analytical results
  - May have value in diets low in corn grain
DDGS and Egg Yolk Pigmentation

- Roberson (2004) –
  - 10% 2 wks fed (Exp 1)
  - 5% at 3 wks (Exp 2)
- Lumpkins (2005) – no change
- Sanfandila field trial (Shurson, 2003)
  - Slight change in yolk color (10.6 vs 10.8)
## Roberson Experiment 2 – Yolk Color (9 wks)

<table>
<thead>
<tr>
<th>DDGS</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>Roche</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 %</td>
<td>77.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.70&lt;sup&gt;d&lt;/sup&gt;</td>
<td>88.1</td>
<td>8.63&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>5 %</td>
<td>75.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.19&lt;sup&gt;c&lt;/sup&gt;</td>
<td>86.7</td>
<td>8.98&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>10 %</td>
<td>76.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.74&lt;sup&gt;b&lt;/sup&gt;</td>
<td>87.5</td>
<td>9.02&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>15 %</td>
<td>75.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>87.7</td>
<td>9.22&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>SE</td>
<td>0.4</td>
<td>0.19</td>
<td>0.6</td>
<td>0.08</td>
</tr>
<tr>
<td>Trt, p&lt;</td>
<td>0.004</td>
<td>&lt;0.001</td>
<td>0.352</td>
<td>0.001</td>
</tr>
<tr>
<td>Linear, p&lt;</td>
<td>0.007</td>
<td>&lt;0.001</td>
<td>0.846</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
DDGS and Carcass Fat Pad Pigmentation

- Lu and Chen, 2004
- Domestic dark color chicken
- Control and pigments (AP)
- 10 or 20% DDGS
- 20% DDGS plus AP
- Xanthophyll content of
  - DDGS 20 mg/kg
  - Corn 6-7 mg/lg
- Diets fed to 16 wks of age
- DDGS provided some pigmentation to abdominal fat pad and cooked carcass skin
- Concluded AP use could be decreased by 50% with DDGs use
What does corn-derived DDGS contribute to poultry diets?

- Protein (corn)
  - Amino acid content
  - Amino acid digestibility
- Energy (metabolizable energy)
  - Proximate Composition
- Phosphorus
  - Availability
- Xanthophylls (yolk and carcass pigmentation)
- Fiber – reduction of ammonia emissions
DDGS Fiber and Reduction in Ammonia Emissions

- Addition of fiber to laying hen diets (K. Bregendahl http://www.ddgs.umn.edu/info-poultry.htm)
- Diet treatments
  - Corn soy control
  - CS + 10% corn DDGS
  - CS + 7.3% wheat midds
  - CS + 4.8% soy hulls
- Reduction in ammonia emissions by 50%

**NH₃ emission from manure over 7 days**

![NH₃ emission chart]

**Diet Trt**

- Control
- DDGS
- Midds
- Hulls

**NH₃, g/kg manure**

0 0.5 1 1.5 2 2.5 3 3.5 4

Control DDGS Midds Hulls
Inclusion levels for poultry

Broilers

- Waldroup (1981) up to 25% (adjusted for lys and ME)
- Lumpkins et al (2004) up to 15%
Performance Response of Broiler Chickens (0-42 days) to DDGS in Diets Adjusted and Not Adjusted for Energy

*Different from control

Waldroup et al, 1981
DDGs – Broiler Diets 
(Lumpkins et al., 2004)

- Experiment 1 - 0 and 15% DDGs at two dietary energy levels (3200 and 3000 kcal/kg)
- Experiment 2 – 0, 6, 12, & 18%
### DDGs and Broiler Performance

<table>
<thead>
<tr>
<th>Diet Density &amp; DDGs Level</th>
<th>Gain 18d G</th>
<th>G:F 18d</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, 0%</td>
<td>556a</td>
<td>782a</td>
</tr>
<tr>
<td>High, 15%</td>
<td>555a</td>
<td>772a</td>
</tr>
<tr>
<td>Low, 0%</td>
<td>523b</td>
<td>712b</td>
</tr>
<tr>
<td>Low, 15%</td>
<td>518b</td>
<td>705b</td>
</tr>
</tbody>
</table>

Lumpkins et al., 2004
## DDGs and Broilers

<table>
<thead>
<tr>
<th>Level of DDGs</th>
<th>Gain 42d (kg)</th>
<th>G:F 0-42 d</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.31a</td>
<td>566</td>
</tr>
<tr>
<td>6</td>
<td>2.29a</td>
<td>554</td>
</tr>
<tr>
<td>12</td>
<td>2.29a</td>
<td>565</td>
</tr>
<tr>
<td>18</td>
<td>2.24b</td>
<td>554</td>
</tr>
</tbody>
</table>

Lumpkins et al., 2004
DDGs – Broiler Diets (Lumpkins et al., 2004)

- Experiment 1 - 0 and 15% DDGs at two dietary energy levels (3200 and 3000 kcal/kg – no difference in performance to 18 d re. DDGs

- Experiment 2 – 0, 6, 12, & 18%
  - BW to 42 days similar to 12%
  - Slight depression in BW at 18%
    - Lowered wts through 16 da
DDGs in Chicken Broiler Diets

- Adjustment for lysine and energy level
  - Lowered level of use without adjustment
- Inclusion level of 15% possible
  - Starter diets 6%
  - Grower/Finisher 15%
Inclusion levels for poultry

- Chicken Layers
  - Roberson 2004 up to 15%
  - Lumpkins 2005 up to 15% in diets of commercial energy density
DDGs and Chicken Layers

- Roberson, 2004
- Hy-line W36
- 48 wk old hens
- Two 9/10 wk trial
- Level
  - 0, 5, 10, 15% DDG

![Graph showing %EP over weeks of study with different levels of DDGs and experimental conditions.](image-url)
Laying Hen Study
(Roberson, 2004)

- Inconsistent level effects on:
  - Weekly egg production (1 wk of 9 wks)
  - Specific gravity
    - Exp 1 (1 wk of 4)
    - Exp 2 – no effect
  - No effect on egg weight
DDGS and Layer Performance
(Lumpkins, et al. 2005)

- Treatments
  - 0 or 15% DDGs
  - Energy density
    - Commercial (2870 kcal/kg; 18.5% CP)
    - Low energy density (2800 kcal/kg; 17% CP)
- Hy-line W36 White Leghorns
- Summer trial (20 wk trial, June-October)
DDGS and Layer Performance (Lumpkins, et al. 2005)

- No effect of DDGs on:
  - Hen feed intake
  - Egg weight
  - Yolk color
  - Egg quality
- Interaction of DDGs level & diet energy
Egg production of hens fed diets with and without DDGs (0, 15%) at commercial or low energy density

From: Lumpkins et al., 2005
DDGS and Layer Performance (Lumpkins, et al. 2005)

- Low energy & 15% DDGs slight depression in egg production
  - Insufficient caloric intake
  - Amino acid digestibility
    - Diets formulated on total amino acid basis
Field trial – Sanfandila (Shurson, 2003)
- Babcock 300
- 12 wk trial (Post-molt, 68 wks to 80 wks of age)
- 0 or 10% Norgold DDGS
- Four buildings (2 each diet)
- Study terminated early
  - Short on DDGs
  - Health problems – Influenza and Newcastle disease
## Sanfandila Layer Diets

<table>
<thead>
<tr>
<th>Ingredient, %</th>
<th>Phase 2 Control</th>
<th>Phase 2 +DDGS</th>
<th>Phase 3 Control</th>
<th>Phase 3 +DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>65</td>
<td>59.5</td>
<td>68.5</td>
<td>62.9</td>
</tr>
<tr>
<td>SBM</td>
<td>21.3</td>
<td>16.3</td>
<td>19.1</td>
<td>14.3</td>
</tr>
<tr>
<td>Acidified Oil</td>
<td>1.3</td>
<td>1.80</td>
<td>.3</td>
<td>.7</td>
</tr>
<tr>
<td>DDGS</td>
<td></td>
<td>10</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Dical P</td>
<td>1.3</td>
<td>1.0</td>
<td>1.0</td>
<td>.8</td>
</tr>
<tr>
<td>DL Met</td>
<td>.085</td>
<td>.084</td>
<td>.074</td>
<td>.07</td>
</tr>
<tr>
<td>Phytase</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</tbody>
</table>
# Sanfandila Layer Diets - Nutrients

<table>
<thead>
<tr>
<th>Nutrient, %</th>
<th>Phase 2 Control</th>
<th>Phase 2 +DDGS</th>
<th>Phase 3 Control</th>
<th>Phase 3 +DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME kcal/kg</td>
<td>2797</td>
<td>2800</td>
<td>2781</td>
<td>2774</td>
</tr>
<tr>
<td>Protein</td>
<td>16.2</td>
<td>16.2</td>
<td>15.4</td>
<td>15.5</td>
</tr>
<tr>
<td>Lysine</td>
<td>.82</td>
<td>.82</td>
<td>.76</td>
<td>.75</td>
</tr>
<tr>
<td>M+C</td>
<td>.63</td>
<td>.63</td>
<td>.59</td>
<td>.6</td>
</tr>
<tr>
<td>Thr</td>
<td>.6</td>
<td>.59</td>
<td>.57</td>
<td>.56</td>
</tr>
<tr>
<td>Tryp</td>
<td>.19</td>
<td>.18</td>
<td>.18</td>
<td>.17</td>
</tr>
<tr>
<td>Xanthophyll, mg/kg</td>
<td>8.75</td>
<td>8.75</td>
<td>8.75</td>
<td>8.75</td>
</tr>
</tbody>
</table>
Measurements

- Hen-days
- Feed
- Egg production & egg weight
- Mortality
- Egg condition
  - First quality, broken, DY, shell-less
- Egg quality
  - Albumen height, SPG, yolk pigmentation
Egg Production (Weekly, %)
## Sanfandila Field Trial

<table>
<thead>
<tr>
<th>Performance</th>
<th>Control</th>
<th>Norgold DDGS</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP, %</td>
<td>68.7</td>
<td>72.4</td>
<td>.02</td>
</tr>
<tr>
<td>First class EP, %</td>
<td>66.2</td>
<td>68.9</td>
<td>.10</td>
</tr>
<tr>
<td>EW/hen/wk, kg</td>
<td>.31</td>
<td>.32</td>
<td>.11</td>
</tr>
<tr>
<td>Cull eggs, % of total</td>
<td>2.2</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Dirty Eggs</td>
<td>1.4</td>
<td>2.2</td>
<td>.002</td>
</tr>
<tr>
<td>Egg Quality</td>
<td></td>
<td></td>
<td>NS</td>
</tr>
</tbody>
</table>
Diet Xanthophyll Content

Egg Yolk Color (Roche Units)
Sanfandila Field Trial - Summary

- Equivalent performance
  - Feed intake, egg wt, egg quality
- Feeding of DDGS
  - Increased number & % of eggs
  - Increased proportion of broken & dirty eggs
    - Combination of phytase supplementation and high P av. in DDGS perhaps led to excess P resulting in poorer shell quality
    - Effect of AI and NC disease
  - Increased production of first quality eggs
  - Darker egg yolks
Summary: DDGs and Recent Chicken Layer Studies – Inclusion Levels

- Roberson, 2004
  - 0, 5, 10, 15%
- Lumpkins, et al. (2005)
  - 0, 15%
- Field trial – Sanfandila (Shurson, 2003)
  - 10% inclusion
DDGs in Chicken Layer Diets

- Possible source of xanthophyll
- Inclusion level of 15 %
  - acceptable performance
  - Less than 15% for low density diets
Current Market Turkey Research

- Roberson, 2003
  - Hen turkeys – grow/finish diets
  - Isocaloric; digestible amino acids
- Noll ongoing – several experiments
  - Tom turkeys – grow/finish diets (5-19 wks)
  - Formulation - isocaloric; digestible amino acids
### DDGs and Turkey Hen Diets

From: Roberson, 2003

<table>
<thead>
<tr>
<th>DDGs %</th>
<th>BW 105 da, kg</th>
<th>F/G 75-105 da</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exp. 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>8.53*</td>
<td>2.99</td>
</tr>
<tr>
<td>9</td>
<td>8.41</td>
<td>3.07</td>
</tr>
<tr>
<td>18</td>
<td>8.23</td>
<td>3.21</td>
</tr>
<tr>
<td>27</td>
<td>8.16</td>
<td>3.21</td>
</tr>
<tr>
<td><strong>Exp. 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>8.51</td>
<td>3.44</td>
</tr>
<tr>
<td>7</td>
<td>8.46</td>
<td>3.54</td>
</tr>
<tr>
<td>10</td>
<td>8.50</td>
<td>3.46</td>
</tr>
</tbody>
</table>

* Significant Linear Component
Market Tom Trials-Grow/Finish Diets
(University of Minnesota)

<table>
<thead>
<tr>
<th>Trial*</th>
<th>Trt</th>
<th>DDGs, %</th>
<th>BW, kg</th>
<th>F/G</th>
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<td>DDGS</td>
<td>10</td>
<td>18.3</td>
<td>2.63</td>
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*Trial weeks of age; 1=5-19 wks; 2=8-19 wks; 3=11-19 wks
Inclusion levels for turkeys

- Market Turkeys
  - Hens
    - Up to 10% (Roberson et al 2003)
  - Toms (Noll, 2006)
    - Up to 10% in summer season or lowered protein diets
    - Up to 20% in winter season or normal protein diets; or diets without animal protein
Recommendations for Use of DDGs

- Corn DDGs (to 15%) can be fed to chicken layers and broilers; Turkeys - to 10% for hens; 20% of diet for toms
  - Lower levels in diets for young poultry
- Formulate with minimums for tryptophan and arginine in addition to those for lys, TSAA, and thr
- Formulate on basis of digestible amino acid content
- Lower maximum level of use in low density or low protein diets
- Consider AMEn value of 2750 to 2850 kcal/kg
- Increase available phosphorus (higher than NRC '94) – 65%
University of Minnesota
DDGS Webpage

www.ddgs.umn.edu
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