Evaluation of Grazing Systems in the southern Great Plains of USA

Twain Butler, Noble Research Institute
Background:
B.S. Texas Tech, M.S. OSU, PhD Texas A&M, Professor Forage Agronomy; Noble since 2004
Research Emphasis: Grazing systems, Agronomy, Sensor evaluation, and Cover Crops
Outline

• Introduction (year-round grazing)
• Establishment
• Grazing Systems Research
  – Cool-season (small grains, tall fescue, alfalfa)
  – Warm-season (Bermudagrass/Alfalfa)
  – Monoculture alfalfa
• New technology
• Summary and Conclusions
Tall Fescue Utilization in the USA
SDTF Establishment - Monoculture

Herbicide Screening
- PRE, early-POE
- 20 herbicides

No herbicide would selectively control annual ryegrass without killing SDTF

Agronomic Method
Planting date (Sept – Oct) x glyphosate timing (spring – autumn)
Cool-season perennial grass establishment

- No glyphosate, Sept planting
- May glyphosate, Sept planting
- Oct glyphosate, Oct planting
- May + Oct glyphosate, Oct planting
Alfalfa-Tall Fescue Establishment - M&M

Clean-tilled seedbed
  – Roller-packed (firm)

Planted in Sept each year
  – 2008 and 2009
  – 25, 30, 35 inch rainfall zones

No-till drill with 2 seedboxes
  – TF in grain box
    • 15 PLS
  – Alfalfa in legume box
    • 12 PLS
Tall Fescue-Alfalfa Establishment
Alfalfa-TF alternating rows – 2 YAP
Establishment Summary

Checkerboard orientation

24 MAP

12 MAP

6 MAP
Alfalfa-Bermudagrass Establishment – M&M

- RCBD with 4 reps each in 2012-13 and 2013-14
  - Main plot: Planting date (**Sept 15, Oct 15, Feb 15**)
    - 12 lb PLS/A
  - Sub-plot: Seedbed preparation
    - Hay (H), Hay-Glyphosate (HG), Tillage (CT)
  - Sub-sub-plot: Seed treatment
    - Fungicide, **Insecticide**, Combination seed treatment
  - Sub-sub-sub-plot: Post-emergent insecticide (no effect)
Planting Date: Sept vs Feb vs Oct
Sept Planting Date:
Hay/Glyphosate vs Hay vs Tillage
Establishment Summary

C3PG: spring/fall glyphosate to control grassy weeds

Alfalfa-TF: “checkerboard” orientation

Alf-BG: Sept Glyphosate / No-till drill is Easiest and Cheapest

• Early Frost negated Oct Glyphosate (1 yr)
  – Optimal Seed treatment – any with Cruiser insecticide
  – No benefit to post-emergent application of insecticide
Grazing Systems Research

- Forage mass
- Nutritive value
- Forage allowance
- Average daily gain
- Total gain
- Total grazing days

- Economics: Net Returns
Economics

Expected Net return = (gross revenue – input costs)

Expected Revenue = total gain (TG) x value of gain (VOG)

TG = total no. grazing days/unit area x ADG
VOG=(Wt₂ * price₂ – Wt₁*price₁)/Wt₂– Wt₁

Input cost = establishment cost (amortized) plus maintenance cost (fertilizer, chemical, mowing, interest, etc.)
## Results: Cool-season Systems

<table>
<thead>
<tr>
<th></th>
<th>Stocking rate</th>
<th>Actual days</th>
<th>Average daily gain</th>
<th>Grazing days acre⁻¹</th>
<th>Gain acre⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5-yr avg.</strong></td>
<td>AU acre⁻¹</td>
<td># days</td>
<td>lb day⁻¹</td>
<td>days acre⁻¹</td>
<td>lb acre⁻¹</td>
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<tr>
<td>Wheat-100 N</td>
<td>1.0</td>
<td>118</td>
<td>2.16</td>
<td>165</td>
<td>356</td>
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<tr>
<td>Crabgrass</td>
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<td>46</td>
<td>1.68</td>
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<td>226</td>
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<tr>
<td>Alfalfa (only)*</td>
<td>1.1</td>
<td>90</td>
<td>2.04</td>
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<tr>
<td><strong>W-A-C 2 paddock system</strong></td>
<td><strong>254</strong></td>
<td><strong>2.02</strong></td>
<td><strong>210</strong></td>
<td><strong>424</strong></td>
<td></td>
</tr>
<tr>
<td>Tall fescue-N fertilizer</td>
<td>1.0</td>
<td>144</td>
<td>1.81</td>
<td>188</td>
<td>340</td>
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<tr>
<td>Tall fescue-Alfalfa*</td>
<td>1.7</td>
<td>103</td>
<td>2.23</td>
<td>154</td>
<td>343</td>
</tr>
<tr>
<td>TF-wheat-TF system (20 bu wheat)</td>
<td>187</td>
<td>1.98</td>
<td>157</td>
<td>311</td>
<td></td>
</tr>
</tbody>
</table>

Alfalfa was replanted due to stand loss (2015 tropical storm Bill – 12 inches rain in 12 hours)
2015 Historic Flood:
- 12 in (305 mm) 12 hours (Tropical Storm Bill - June)
- 35 in (889 mm) in 35 days (May-June)
Autumn 2015
Alfalfa
Summer-Dormant
Tall Fescue
## Results: Cool-season Systems

<table>
<thead>
<tr>
<th>2013-17</th>
<th>Value of gain</th>
<th>Total Gain</th>
<th>Revenue</th>
<th>Production Cost</th>
<th>Net Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-yr avg.</td>
<td>$</td>
<td>lb acre(^{-1})</td>
<td>$ acre(^{-1})</td>
<td>$ acre(^{-1})</td>
<td>$ acre(^{-1})</td>
</tr>
<tr>
<td>Tall fescue-N fertilizer</td>
<td>0.8</td>
<td>340</td>
<td>272</td>
<td>133</td>
<td>139</td>
</tr>
<tr>
<td><strong>W-A-C 2 paddock system</strong></td>
<td>0.8</td>
<td>424</td>
<td>339</td>
<td>222</td>
<td>117</td>
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<td>TF-wheat-TF system (20 bu wheat)</td>
<td>0.8</td>
<td>311</td>
<td>299</td>
<td>182</td>
<td>117</td>
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<tr>
<td>Tall fescue-Alfalfa*</td>
<td>0.8</td>
<td>343</td>
<td>275</td>
<td>162</td>
<td>113</td>
</tr>
</tbody>
</table>

Alfalfa was replanted due to stand loss (2015 tropical storm Bill – 12 inches rain in 12 hours)
We used amortized stand life of 3.5 years
Alfalfa-BG vs BG +/-N, +/- Supplements

Rotationally vs Continuously Stocked Systems
### 3 YR Avg (2016-18): Grazing days, SR, ADG, and TG:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stocking</th>
<th>Grazing days</th>
<th>Stocking rate</th>
<th>ADG</th>
<th>Grazing days/acre</th>
<th>Total gain</th>
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<tbody>
<tr>
<td>Bermudagrass:</td>
<td></td>
<td></td>
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<tr>
<td>800RR alfalfa</td>
<td>Continuous</td>
<td>168</td>
<td>1.4</td>
<td>0.99</td>
<td>231</td>
<td>228</td>
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<td>800 RR alfalfa</td>
<td>Rotational</td>
<td>177</td>
<td>1.5</td>
<td>1.02</td>
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<td>275</td>
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<tr>
<td>100 N</td>
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<td>0.45</td>
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<td>127</td>
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<td>100 N</td>
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<td>0.46</td>
<td>305</td>
<td>140</td>
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<tr>
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<td>138</td>
<td>2.0</td>
<td>1.10</td>
<td>280</td>
<td>309</td>
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<tr>
<td>100 N + 0.5% suppl</td>
<td>Rotational</td>
<td>140</td>
<td>1.9</td>
<td>1.10</td>
<td>276</td>
<td>303</td>
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<td>0 N</td>
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<td>131</td>
<td>1.6</td>
<td>0.41</td>
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<td>89</td>
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<tr>
<td>0 N</td>
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<td>180</td>
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<tr>
<td>0 N + 0.5% suppl</td>
<td>Rotational</td>
<td>131</td>
<td>1.8</td>
<td>0.90</td>
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<td>210</td>
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<td>Monoculture:</td>
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<tr>
<td>800RR alfalfa</td>
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<td>148</td>
<td>1.6</td>
<td>2.19</td>
<td>236</td>
<td>516</td>
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</tbody>
</table>
Alfalfa rotationally vs continuously stocked – July, (second season)

3 yr old alfalfa stands:
60% rotation vs 15% continuously stocked
### Grazing days, ADG, and TG: Avg 2016-18

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rel Cost/yr</th>
<th>Grazing days</th>
<th>ADG lb/day</th>
<th>Grazing days /acre</th>
<th>Total Gain lb/acre</th>
<th>Break-even COG</th>
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<tbody>
<tr>
<td>Bermudagrass:</td>
<td></td>
<td>AU/acre</td>
<td></td>
<td></td>
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<tr>
<td>800 RR alfalfa</td>
<td>~75</td>
<td>186</td>
<td>1.01</td>
<td>250</td>
<td>251</td>
<td>0.49</td>
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<tr>
<td>100 N/A</td>
<td>~60</td>
<td>153</td>
<td>0.46</td>
<td>294</td>
<td>134</td>
<td>1.71</td>
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<tr>
<td>100 N/A + 0.5% BW supplement</td>
<td>~113</td>
<td>153</td>
<td>1.10</td>
<td>278</td>
<td>306</td>
<td>0.55</td>
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<tr>
<td>0 N/A</td>
<td>-</td>
<td>137</td>
<td>0.49</td>
<td>201</td>
<td>99</td>
<td>-</td>
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<tr>
<td>0 N/A + 0.5% BW supplement</td>
<td>~49</td>
<td>141</td>
<td>0.84</td>
<td>231</td>
<td>195</td>
<td>0.51</td>
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Averaged across 2016, 2017, 2018 and (continuously and rotationally stocked)
<table>
<thead>
<tr>
<th>Production System</th>
<th>Study</th>
<th>Years (%)</th>
<th>Date</th>
<th>Date</th>
<th>Duration (days)</th>
<th>ADG (lbs/hd/day)</th>
<th>Gain (lbs/acre)</th>
<th>VOG ($/lb)</th>
<th>Revenue ($/acre)</th>
<th>Cost ($/acre)</th>
<th>Net Return ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF101 wheat/Impact Crabgrass</td>
<td>5 yr avg (2013-18)</td>
<td>114</td>
<td>12/16</td>
<td>8/19</td>
<td>164</td>
<td>1.9</td>
<td>549</td>
<td>0.80/0.6</td>
<td>400</td>
<td>213</td>
<td>187</td>
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<tr>
<td>800RR experimental alfalfa</td>
<td>3 yr avg 2015-18</td>
<td>110</td>
<td>3/13</td>
<td>11/25</td>
<td>148</td>
<td>2.2</td>
<td>517</td>
<td>0.80</td>
<td>413</td>
<td>241</td>
<td>172</td>
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<tr>
<td>Maton II rye/ Marshall ryegrass</td>
<td>7 yr avg (2005-12)</td>
<td>82</td>
<td>11/18</td>
<td>4/28</td>
<td>130</td>
<td>2.3</td>
<td>421</td>
<td>0.80</td>
<td>337</td>
<td>183</td>
<td>154</td>
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<tr>
<td>Flecha summer dormant</td>
<td>5 yr avg (2013-18)</td>
<td>114</td>
<td>12/28</td>
<td>5/22</td>
<td>144</td>
<td>1.81</td>
<td>340</td>
<td>0.80</td>
<td>272</td>
<td>133</td>
<td>139</td>
</tr>
<tr>
<td>Chisholm summer-dormant</td>
<td>5 yr avg (2013-18)</td>
<td>114</td>
<td>12/28</td>
<td>5/22</td>
<td>145</td>
<td>1.77</td>
<td>327</td>
<td>0.80</td>
<td>262</td>
<td>127</td>
<td>135</td>
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<tr>
<td>TF-wheat-TF system (20 bu wheat)</td>
<td>5 yr avg (2013-18)</td>
<td>114</td>
<td>12/16</td>
<td>5/22</td>
<td>187</td>
<td>1.98</td>
<td>311</td>
<td>0.80</td>
<td>299</td>
<td>182</td>
<td>117</td>
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<tr>
<td>Wheat-Alf-CG (2 paddock) system</td>
<td>5 yr avg (2013-18)</td>
<td>114</td>
<td>9/18</td>
<td>8/19</td>
<td>127</td>
<td>2.02</td>
<td>424</td>
<td>0.80</td>
<td>339</td>
<td>222</td>
<td>117</td>
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<tr>
<td>Flecha-Alfalfa checkerboard mix</td>
<td>5 yr avg (2013-18)</td>
<td>114</td>
<td>11/19</td>
<td>5/20</td>
<td>103</td>
<td>2.23</td>
<td>343</td>
<td>0.80</td>
<td>275</td>
<td>162</td>
<td>113</td>
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<td>Texoma MaxQII SATF</td>
<td>6 yr avg (2005-11)</td>
<td>78</td>
<td>1/24</td>
<td>6/9</td>
<td>116</td>
<td>1.9</td>
<td>298</td>
<td>0.80</td>
<td>238</td>
<td>133</td>
<td>105</td>
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<tr>
<td>NF101 wheat</td>
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<td>114</td>
<td>12/16</td>
<td>4/20</td>
<td>118</td>
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<td>356</td>
<td>0.80</td>
<td>285</td>
<td>183</td>
<td>102</td>
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<td>Alfagraze alfalfa</td>
<td>3 yr avg (2002-04)</td>
<td>89</td>
<td>4/29</td>
<td>9/16</td>
<td>140</td>
<td>2.1</td>
<td>420</td>
<td>0.80</td>
<td>336</td>
<td>237</td>
<td>99</td>
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<td>Bermudagrass</td>
<td>3 yr avg (2008-10)</td>
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<td>5/23</td>
<td>8/29</td>
<td>98</td>
<td>0.35</td>
<td>167</td>
<td>0.80</td>
<td>134</td>
<td>87</td>
<td>47</td>
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</tbody>
</table>
Factors affecting production and economics

Revenue
- VOG
- TG
  • Grazing Days, ADG

Production Costs
- Lime, P, K, B
- Seed cost (RR vs Conv)
- Pesticides (Insecticides)

✓ Stand life (Persistence)
  - Percent Stand
Summary and Conclusion: Grazing Research

• Alfalfa/TF ($113) not as profitable as N fertilizer in Summer-dormant Tall Fescue ($139)
• Profitability (grazing alfalfa) is HIGHLY dependent on stand life (amortized over 3.5 yr stand life)
  • Rotationally stocked, summer deferment, and improved genetics (800RR) improved persistence
• Preliminary results suggest alfalfa MAY have potential in a Wheat/Alfalfa/ Crabgrass year-round grazing system
• Preliminary results suggest alfalfa MAY have potential in Bermudagrass grazing systems (rotationally stocked)
• Current studies are on-going (6th year; 4th year of alfalfa)
Current Research - Technology

Develop high throughput phenotyping “Spider” system (biomass and CP) to assist plant breeders be more efficient.

Develop automated walk-over-weighing system to collect daily animal weights

Develop automated forage tower system to collect daily biomass estimation – still in development
Spider Platform Specifications

- Trimble/OmniStar GNSS-enabled GPS System
- Holland Scientific Multi-Parameter Sensors
  - Crop Circle Model ACS-430
  - Crop Circle Model DAS43X
  - Crop Circle Model ACS-470
- 120 Mhz Ultrasonic Distance Sensor
- Trimble Greenseeker
- (2) Time-Of-Flight Lasers

Driver Seat View
Walk-Over-Weigh Livestock Systems
1. Weight Data Controller
2. Radio Transmitter
3. EID Data Controller
4. Dual EID Antenna Adapter
5. Power Inverter
6. Solar Charger Controller

Wireless Connectivity

Xetawave Xeta9 Series dual-band 902-960 Mhz software-defined radio

Wireless Connectivity

Electronics & Power System

Water Source

Scale Load Bars

Walk-Over-Weigh Platform

EID Reader Panels

<table>
<thead>
<tr>
<th>DATE_TIME_STAMP</th>
<th>LOCATION</th>
<th>WEIGHT</th>
<th>RFID</th>
</tr>
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<tbody>
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<td>10/1/2018 17:54</td>
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<td>982 000421539332</td>
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<tr>
<td>10/1/2018 18:28</td>
<td>Paddock#5</td>
<td>306</td>
<td>982 000421539260</td>
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<tr>
<td>10/1/2018 19:32</td>
<td>Paddock#18</td>
<td>652</td>
<td>982 000421539391</td>
</tr>
</tbody>
</table>

WOW Data Output Example
Forage Tower Systems
Forage Tower System

System Components:
- Hokuyo URG-04LX Scanning Laser Rangefinder
  - Distance Data Output
  - Programmable Data Retrieval Angles
    - Example: 45° x 45° angle = 256 height measurements per second (mm)
- Xetawave Xeta9 Series Dual-Band 902-960 MHz Software-Defined Radio
- Solar Power System
- Metal-Fabricated Mobile/Flexible Design

Advanced TCP/IP Software
- Data Retrieval Angle
- ON/OFF Retrieval Times
- Retrieval Duration Time
- Data Storage (.csv)

Diagram:
- Master Radio + Computer
- AGGSOFT Advanced TCP/IP Software
  - Custom Plug-In
  - Programmable Features
  - Direct Data Storage
- Towers
  - Data Retrieval Angle
  - ON/OFF Retrieval Times
  - Retrieval Duration Time
  - Data Storage (.csv)
Summary and Conclusion: Technology

• High throughput phenotyping system tremendous tool for plant breeding

• Walk-Over-Weighing (in pasture) effective tool to replace traditional static scales
  • Daily weight will allow for greater management decision tools

• Forage Towers are still under development
  • Daily forage biomass will allow for modeling and contribute to decision support tools

• Technology development is continually under development and is constantly changing
Future Research

Russian wheatgrass
Hybrid tall fescue
Cover crops
Questions?