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Invited presentation at the 2018 Southern Agricultural Economics Association Annual Meeting, February 2-6, 2018, Jacksonville, Florida

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Cropping Matrix as a Constraint to Land Application of Feedyard Manure in the Texas Panhandle

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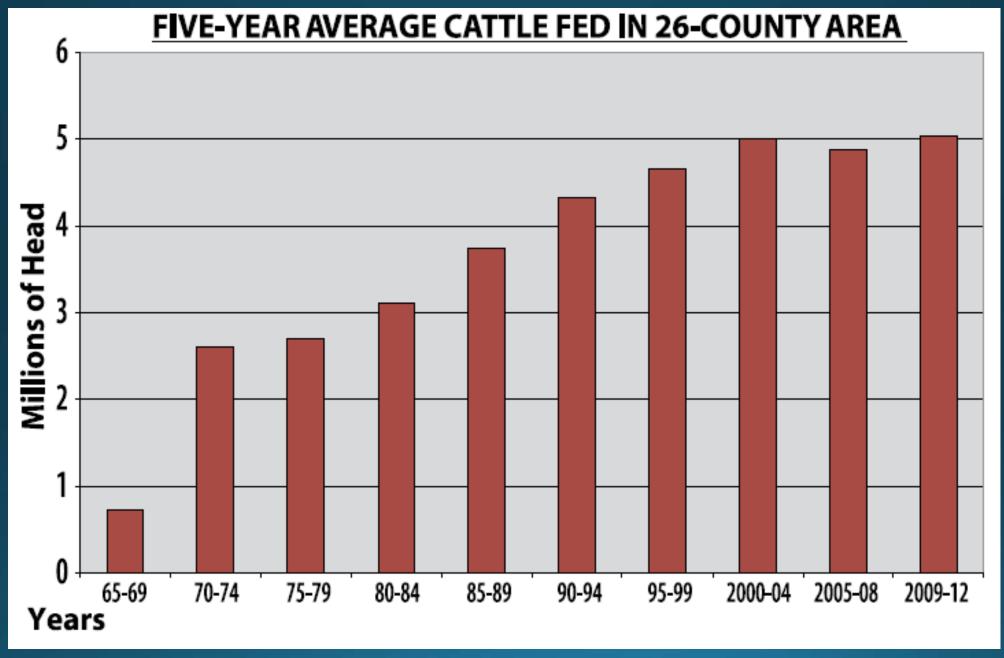


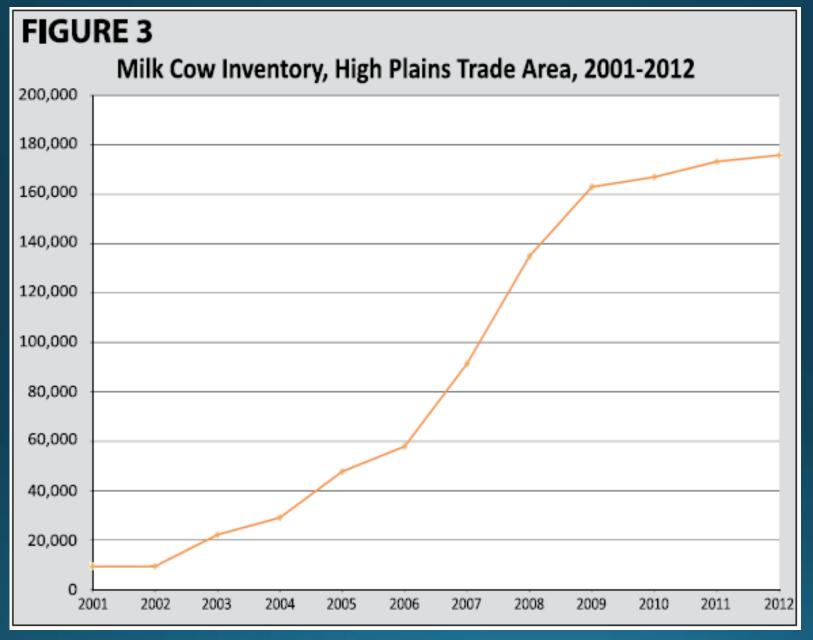


| Table 2. Average Annual Agricultural Cash Receipts, High Plains Trade Area, 2009-2012. | | | | | | | | | | | | | |
|--|------------------------|---------------------------|---|--|--|--|--|--|--|--|--|--|--|
| | Value (\$1,000,000) | Percent of State Total | Regional Economic Impact* (\$1,000,000) | State Economic Impact* (\$1,000,000) | | | | | | | | | |
| Crops: | | | | | | | | | | | | | |
| Corn | \$688.1 | 58.0 | \$1,043.8 | \$1,383.9 | | | | | | | | | |
| Wheat | \$218.4 | 40.8 | \$331.3 | \$439.2 | | | | | | | | | |
| Cotton | \$320.9 | 13.2 | \$536.7 | \$721.9 | | | | | | | | | |
| Sorghum | \$133.6 | 20.3 | \$202.6 | \$268.6 | | | | | | | | | |
| Ensilage | \$138.3 | 63.3 | \$219.8 | \$285.4 | | | | | | | | | |
| Hay | \$126.2 | 9.9 | \$200.5 | \$260.3 | | | | | | | | | |
| Other Crops | \$73.1 | | \$116.2 | \$150.9 | | | | | | | | | |
| Total Crop Receipts | \$1,698.6 | | \$2,650.9 | \$3,510.2 | | | | | | | | | |
| Livestock and Livestock P | Products: | | | | | | | | | | | | |
| Fed Beef - Value Added | \$1,865.8 | 78.5 | \$3,555.6 | \$4,367.5 | | | | | | | | | |
| Cow-calf and Stockers | \$357.4 | 8.5 | \$681.1 | \$836.6 | | | | | | | | | |
| Hogs | \$204.9 | 94.2 | \$277.3 | \$322.5 | | | | | | | | | |
| Dairy | \$595.3 | 36.9 | \$866.6 | \$1,043.1 | | | | | | | | | |
| Other | \$27.0 | | \$36.6 | \$42.6 | | | | | | | | | |
| Total L & LP | \$3,050.4 | | \$5,417.2 | \$6,612.3 | | | | | | | | | |
| Other Ag-Related | \$14.5 | | \$21.8 | \$25.5 | | | | | | | | | |
| Total Agricultural Receipts* | \$4,763.5 | | \$8,089.9 | \$10,148.0 | | | | | | | | | |
| *Does not include impacts o | . , | through the processing se | | | | | | | | | | | |

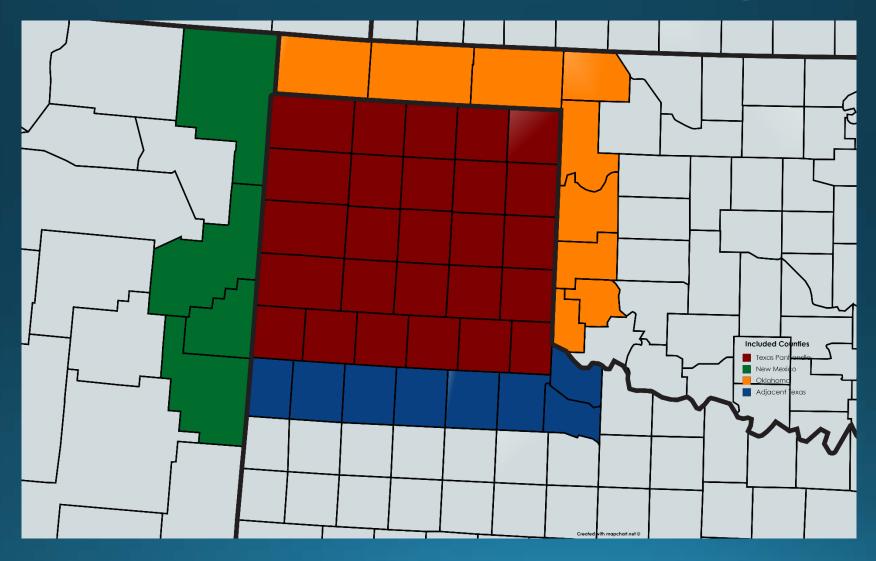
Crop Nutrient Needs

| | | Irriga | ated | | Non-Irrigated | | | | | |
|-------------------------------|------------|----------------|-------------|----------|---------------|---------|-------------|----------|--|--|
| | Wheat | Corn | Cotton | Sorghum | Wheat | Corn | Cotton | Sorghum | | |
| Quantity Produced/Acre | 30 | 180 | 900 | 3800 | 20 | | 400 | 2500 | | |
| Production Units | bu/acre | bu/acre | lint lbs/ac | lbs/acre | bu/acre | bu/acre | lint lbs/ac | lbs/acre | | |
| | | | | | | | | | | |
| Nutrient Requirements (lbs): | | | | | | | | | | |
| Nitrogen (N) | 53 | 240 | 121 | 94 | 35 | | 54 | 62 | | |
| P ₂ O ₅ | 23 | 100 | 55 | 41 | 15 | | 24 | 27 | | |
| K₂O | 38 | 240 | 108 | 144 | 25 | | 48 | 95 | | |
| Source: | McFarland, | M. and Stichle | er, C. | | | | | | | |





Counties Included in the Analysis



Manure Production

| Feedyard Manure (lbs)/Ton: | Production: | 8 pounds pe | r head per o | lay | | | | | | | | |
|----------------------------------|-------------|-------------|--|------------|------------|-----------|--|--|--|--|--|--|
| Nitrogen (N) | 18.8 | | | | | | | | | | | |
| P ₂ O ₅ | 17.1 | | | | | | | | | | | |
| K ₂ O | 25.2 | Source: | Texas Catt | le Feeders | Associatio | n Service | | | | | | |
| | | | | | | | | | | | | |
| Dairy Manure Ibs/hd/yr/available | | | | | | | | | | | | |
| Nitrogen (N) | 73.5 | | | | | | | | | | | |
| P ₂ O ₅ | 29.4 | | | | | | | | | | | |
| K ₂ O | 58.1 | Source: | : http://livestocktrail.illinois.edu/dairynet/paperDisplay.cfm?ContentID=274 | | | | | | | | | |

Methods

- 2012 Census of Agriculture county cropping data
- Calculate crop fertilizer demand
- Census dairy cattle by county
- NASS fed cattle by county
- Calculate manure output and nutrient content
- Establish balance using Phosphorus as the constraint
- Transportation from "producing" counties to adjacent counties

A Transportation LP Problem

| 4 | Α | В | С | | D | Е | | F | | G | Н | 1 | J | | K | L | M | |
|----|---|---------------|-----------------------------|------|--------|-------|---------------|--|-------------------------|--------|------------|----------------|---------|--------|--------|---------|-----------|--------|
| 1 | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | Shippii | Shipping Cost Per Ton Between Counties | | | | | | | | | | |
| 4 | | County | Quay, | MM | Old | ham | Potter | Ca | rson | Arn | nstrong | Briscoe | Swisher | Casti | 0 | Parmer | | |
| 5 | | Randall | \$ 19 | 9.60 | \$ | 8.34 | \$ 4.10 | \$ | 8.58 | \$ | 8.01 | \$ 9.61 | \$ 6.65 | \$ 8 | 8.71 | \$12.63 | | |
| 6 | | Deaf Smith | \$ 17 | 7.15 | \$ | 6.11 | \$ 8.68 | \$ | 12.35 | \$ | 11.85 | \$12.73 | \$ 8.46 | \$ 4 | 4.55 | \$ 8.70 | | |
| 7 | | Curry, NM | \$ 13 | 3.30 | \$ | 13.96 | \$16.93 | \$ | 21.57 | \$ | 21.07 | \$18.30 | \$14.01 | \$ 8 | 8.88 | \$ 2.60 | | |
| 8 | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | Tons | Tons | | |
| 11 | | County | Quay, | NM | Old | ham | Potter Carson | | Armstrong Briscoe | | Briscoe | Swisher Castro | | О | Parmer | Shipped | Available | |
| 12 | | Randall | | 0 | | 0 | 0 0 | | | 0 | 0 | 0 |) 0 | | 0 | 0 | 85,055 | |
| 13 | | Deaf Smith | | 0 | | 0 | 0 | | 0 | | 0 | 0 | 0 | | 0 | 0 | 0 | 50,846 |
| 14 | | Curry, NM | | 0 | | 0 | 0 | | 0 | | 0 | 0 | 0 | | 0 | 0 | 0 | 29,808 |
| 15 | | Received | 0 0 | | 0 | | 0 | | 0 | 0 | 0 | | 0 | 0 | | | | |
| 16 | | Capacity | 17,031 23,702 | | 11,859 | 24 | 16,849 | | 81,992 | 61,360 | 4,140 | 181, | 535 | 69,630 | | | | |
| 17 | | | | | | | | | | | | | | | | | | |
| 18 | | Total Cost (i | otal Cost (in dollars) \$ - | | - | | Average C | | ost per ton (in dollars | | s) #DIV/0! | | V/0! | | | | | |
| 19 | | | | | | | | | | | | | | | | | | |

| Se <u>t</u> Objective: | | | \$D\$18 | | <u>**</u> |
|--|--------------|----------------|---|---|-------------------|
| To: <u>N</u> | <u>/l</u> ax | ● Min | O <u>V</u> alue Of: | 0 | |
| By Changing \ | /ariable C | ells: | | | |
| \$C\$12:\$K\$14 | | | | | |
| S <u>u</u> bject to the | Constrair | nts: | | | |
| \$C\$12:\$K\$14 > \$C\$15:\$K\$15 < | | \$K\$16 | | ^ | <u>A</u> dd |
| \$L\$12:\$L\$14 = | \$M\$12:\$I | M\$14 | | | <u>C</u> hange |
| | | | | | <u>D</u> elete |
| | | | | | <u> </u> |
| | | | | | <u>R</u> eset All |
| | | | | v | <u>L</u> oad/Save |
| Ma <u>k</u> e Unco | onstraine | d Variables N | on-Negative | | |
| S <u>e</u> lect a Solvin Method: | g Sin | nplex LP | | ~ | O <u>p</u> tions |
| Solving Meth | od | | | | |
| Select the GR | G Nonlin | ear Solver Pro | or Solver Problems th blems, and select th | | |

Solver Solution

| A | Α | В | С | D | E | F | G | Н | 1 | J | K | L | M |
|----------|---|---------------|-------------|--|---------------|-----------|-------------|--------------|---------|---------|--------------|-------|-----------|
| 1 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | Shipping Cost Per Ton Between Counties | | | | | | | | | |
| 4 | | County | Quay, NM | Oldham | Potter | Carson | Armstrong | Briscoe | Swisher | Castro | Parmer | | |
| 5 | | Randall | \$ 19.60 | \$ 8.34 | \$ 4.10 | \$ 8.58 | \$ 8.01 | \$ 9.61 | \$ 6.65 | \$ 8.71 | \$12.63 | | |
| 6 | | Deaf Smith | \$ 17.15 | \$ 6.11 | \$ 8.68 | \$ 12.35 | \$ 11.85 | \$12.73 | \$ 8.46 | \$ 4.55 | \$ 8.70 | | |
| 7 | | Curry, NM | \$ 13.30 | \$ 13.96 | \$16.93 | \$ 21.57 | \$ 21.07 | \$18.30 | \$14.01 | \$ 8.88 | \$ 2.60 | | |
| 8 | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | Tons | Tons |
| 11 | | County | Quay, NM | Oldham | Potter | Carson | Armstrong | Briscoe | Swisher | Castro | astro Parmer | | Available |
| 12 | | Randall | 0 | 0 | 11859 0 | | 69056 | 0 | 4140 | 0 | 0 | 85055 | 85,055 |
| 13 | | Deaf Smith | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50846 | 0 | 50846 | 50,846 |
| 14 | | Curry, NM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29808 | 29808 | 29,808 |
| 15 | | Received | 0 0 | | 11859 | 0 | 69056 | 0 | 4140 | 50846 | 29808 | | |
| 16 | | Capacity | 17,031 | 23,702 | ,702 11,859 2 | | 81,992 | 61,360 | 4,140 | 181,535 | 69,630 | | |
| 17 | | | | | | | | | | | | | |
| 18 | | Total Cost (i | in dollars) | \$938,009 | | Average C | ost per ton | (in dollars) | | \$ 5.66 | | | |
| 19 | | | | | | | | | | | | | |

Apply Water Limitations 40% cut in irrigated acres 50% increase in dryland acres

| 4 | Α | В | С | D | Е | F | G | Н | 1 | J | K | L | M | N | 0 | Р | Q | R | S |
|----------|---|-------------------|----------|-------------|----------|----------|----------|----------|-------------|-------------|-------------|--------------|----------|----------|----------|----------|----------|---------|-----------|
| 1 | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | Shipp | ing Cost Pe | er Ton Betw | een Counti | es | | | | | | | |
| 4 | | County | Quay, NM | Union, NM | Dallam | Sherman | Moore | Oldham | Potter | Carson | Armstrong | Briscoe | Floyd | Hale | Castro | Lamb | Bailey | | |
| 5 | | Hartley | \$ 15.66 | \$ 12.11 | \$ 5.78 | \$ 9.47 | \$ 6.11 | \$ 6.40 | \$ 8.93 | \$ 12.58 | \$ 13.11 | \$ 19.97 | \$ 23.91 | \$ 19.52 | \$ 13.73 | \$ 20.81 | \$ 18.68 | | |
| 6 | | Randall | \$ 19.60 | \$ 22.38 | \$ 14.87 | \$ 15.84 | \$ 10.47 | \$ 8.34 | \$ 4.10 | \$ 8.58 | \$ 8.01 | \$ 9.61 | \$ 13.56 | \$ 9.18 | \$ 8.71 | \$ 14.88 | \$ 13.20 | | |
| 7 | | Deaf Smith | \$ 17.15 | \$ 22.67 | \$ 15.12 | \$ 20.04 | \$ 15.23 | \$ 6.11 | \$ 8.68 | \$ 12.35 | \$ 11.85 | \$ 12.73 | \$ 14.74 | \$ 10.36 | \$ 4.55 | \$ 10.39 | \$ 8.26 | | |
| 8 | | Parmer | \$ 15.09 | \$ 28.47 | \$ 22.77 | \$ 27.63 | \$ 22.93 | \$ 12.47 | \$ 15.46 | \$ 20.09 | \$ 19.59 | \$ 16.82 | \$ 17.40 | \$ 13.03 | \$ 8.32 | \$ 8.55 | \$ 4.81 | | |
| 9 | | Curry, NM | \$ 13.30 | \$ 26.89 | \$ 24.26 | \$ 29.31 | \$ 24.42 | \$ 13.96 | \$ 16.93 | \$ 21.57 | \$ 21.07 | \$ 18.30 | \$ 18.95 | \$ 15.46 | \$ 8.88 | \$ 10.09 | \$ 6.30 | | |
| 10 | | Roosevelt, NM | \$ 14.70 | \$ 29.82 | \$ 26.96 | \$ 32.00 | \$ 27.12 | \$ 16.66 | \$ 19.63 | \$ 24.27 | \$ 23.77 | \$ 21.00 | \$ 19.83 | \$ 14.57 | \$ 11.58 | \$ 10.98 | \$ 6.67 | | |
| 11 | | Swisher | \$ 26.65 | \$ 27.78 | \$ 20.28 | \$ 21.23 | \$ 15.88 | \$ 12.43 | \$ 8.39 | \$ 12.30 | \$ 9.54 | \$ 5.36 | \$ 8.86 | \$ 5.22 | \$ 6.44 | \$ 12.09 | \$ 12.33 | | |
| 12 | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | Tons | Tons |
| 15 | | County | Quay, NM | Union, NM | Dallam | Sherman | Moore | Oldham | Potter | Carson | Armstrong | Briscoe | Floyd | Hale | Castro | Lamb | Bailey | Shipped | Available |
| 16 | | Hartley | 0 | (| 19714 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19714 | 19,714 |
| 17 | | Randall | 0 | (|) 0 | 0 | 0 | 0 | 11595 | 0 | 78614 | 0 | 0 | 0 | 0 | 0 | 0 | 90209 | 90,209 |
| 18 | | Deaf Smith | 0 | (|) 0 | 0 | 0 | 23288 | 0 | 0 | 0 | 0 | 0 | 106336 | 11480 | 0 | 0 | 141105 | 141,105 |
| 19 | | Parmer | 0 | (|) 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 63416 | 0 | 63416 | 63,416 |
| 20 | | Curry, NM | 0 | (|) 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 168 | 56573 | 56741 | 56,741 |
| 21 | | Roosevelt, NM | 0 | (|) 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24057 | 24057 | 24,057 |
| 22 23 | | Swisher | 0 | (| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 56741 | | 0 | 0 | 56741 | 56,741 |
| 23 | | Received | 0 | (| 19714 | 0 | 0 | 23288 | | | 78614 | 0 | 0 | 163077 | 11480 | 63584 | 80630 | | |
| 24 | | Capacity | 16,696 | 31,846 | 258,744 | 189,454 | 142,943 | 23,288 | 11,595 | 211,957 | 79,951 | 55,081 | 250,564 | 334,916 | 11,480 | 288,981 | 80,630 | | |
| 25 | | | | | | | | | | | | | | | | | | | |
| 26 | | Total Cost (in de | ollars) | \$3,443,854 | | | | | | Average C | ost per ton | (in dollars) | \$ 7.97 | | | | | | |
| 27 | | | | | | | | | | | | | | | | | | | |

Conclusions

- Crops can utilize all the manure generated
- No problem getting rid of future manure

Further Research

- Quantify value of manure as crop input
- Look at profit maximization for crop producers
- Examine alternatives; raw, compost, energy generation
- Develop the economics

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