Crop Alternatives for Declining Water Resources

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Outline

- Introduction
- Current & Future Challenges
- Why Alternative Crops?
- What Crops?
- Lessons Learned
  - Canola Research
  - Safflower Research
- Summary
Current and Future Challenges

- Ogallala Aquifer/Irrigation Situation
- Uncertain Rainfall
- Wind
- Temperature
- Future Climate
Ogallala Water Situation

- WY
- SD
- NB
- KS
- OK
- TX
- NM
- CO

Map showing the Ogallala Aquifer and Clovis location.
Ogallala Water Situation
Hectares Irrigated by Method - USA

USDA, National Agricultural Statistics Service (2012 estimates by Valmont Irrig.)
Texas Ground Water Districts limiting pumping to 15 to 20 inches
Low and Uncertain Rainfall

Legend (inches)
- Less than 5
- 5 to 10
- 10 to 15
- 15 to 20
- 20 to 25
- 25 to 30
- 30 to 35
- 35 to 40
- More than 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 100
- 100 to 140
- 140 to 180
- More than 180

Clovis

Modeling performed by Christopher Daly using the PRISM model, based on 1961-1990 normals from NOAA Cooperative stations and NRCS SNOTEL sites. Sponsored by USDA-NRCS Water and Climate Center, Portland, Oregon.

Oregon Climate Service
George Taylor, State Climatologist
(541) 737-5705
Seasonal Wind Patterns
Daily Wind Velocity

Winter Wheat is the only annual crop at this time.
Abiotic Stresses – Wind
Sand Blasting

Reseeding
Or
>50% evaporation
Wind and Water Erosion on Cropland, 2007

Ogallala Aquifer

Focus Area

Clovis, NM

Each red dot (wind) or blue dot (water) represent 100,000 tons soil loss by erosion per year

NRCS, 2009
Exposed Clovis to National Media

(CNJ, Clovis, Jan 28, 2014)
Temperature Extremes
Temperature Extremes: Cold!!!
Multiple Abiotic Stresses (Clovis, 2013)

Heat Stress

Killing Frost

April 8, 2013

May 7, 2013

Field day
Rain Storms

Future Climate

(Clovis 7th June 2014)

Runoff
Why Alternative Crops?

- Improve Crop Diversity
- Rotational Benefits
- Buffer Seasonal Extremes
- Natural Resources Conservation
- Sustainable Use of Limited Resources
Why Alternative Crops? (contd)

- Improve Resource Use Efficiency
- Value Addition & Virtual Water
- Changing Consumer Demand
- Opportunistic or Alternative Uses
- Market Fluctuation
Improve Crop Diversity

- Stress Tolerant Cereals
- Deep rooted Oil seeds
- N Fixing & P solubilizing Legumes
Rotational Benefits: Wheat Yields

W-W 10bu/ac  C-W 25bu/ac

Same Planting Date, Variety, and Fertility in the middle of the drought

“Canola production makes wheat farmer a better wheat farmer”....
Rotational Benefits: Weed Control

Roundup  Osprey  No herbicide

(WSU, FS068E)
Buffer Seasonal Extremes:
‘Low and high rainfall’, ‘hail storm’, ‘wind storm’, ‘heat and freeze temperatures’
Canola and Wheat at Harvest

≈ 50% canola yield (combined)

Not harvested
Safflower Hail Damage and Regrowth

Alternative Crops: Hail Damage

- **Corn:** Hail damaged
- **Safflower:** Zero Hail damage
- **Canola:** Hail damaged

(Clovis, 8/8/2012)
Canola Freeze Injury & Recovery

Late Spring Frost
(Mar 28, 09)

Freeze Injury
(Apr 17, 09)

Recovery
(Apr 30, 09)

(Clovis, NM)
Multiple Abiotic Stresses (Clovis, 2013)

W. wheat: failed completely...

W. Canola:
Avg. of 50 cvs 2707 lbs
Range 3494 to 1680 lbs

April 8, 2013

May 7, 2013

Field day
Herbicide Drift Injury and Recovery

Guar (Drift from neighbor, unknown herbicide, July 10, 2014)

Guar (Recovered, Aug 15, 2014)

Safflower is fairly tolerant to herbicide drift and recovers very well.

We have not seen herbicide drift issues with Winter Canola.
Multispecies cover cropping uses similar principle.
Changing Consumer Demand:
‘healthy food’, ‘more fiber’, ‘nutrient profile’, ‘disease prevention’
Changing Consumer Demand:
Food for ‘Energy, etc’ vs. ‘Nutrition, healthy living’
Healthy Chips Isle:
Market Place, Lubbock

Oat Products:
Sams, Lubbock

Breakfast I am
tired of

Flax Spread:
Laxmi Delights
Even in Walmart
Opportunistic or Alternative Uses:
‘guar for fracking’, ‘canola meal for cattle’
What Crops??

- What is my ideal crop??
- Spring vs. Winter Crops
- Dual Purpose Crops
- Low Input Requirement and Stress Tolerant Crop
Ideal Crop for the Region

- Current crops
- Ideal crop ???
Biomass Crops Water Use

Water Use

Months

Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Conventional Crop

Dream Crop
Chia
Sesame
Lessons Learned

- Winter Crops Irrigation Trial
- Dual Purpose Canola Production
- Safflower Water Management
Winter Canola: Deficit Irrigation Management

- Develop water use and yield relationships for oilseed crops
- Compare water productivity with winter wheat
Canola Seeding Date (Our Experience)

- Sept 1
- Sept 15
- Oct 1
Winter Canola Root System and Water Needs

(Clovis, 2014)
Water Extraction

(Winter Canola & Wheat)

Soil Moisture Content (m$^3$ m$^{-3}$)

Soil depth (cm)

16 19 22 25 28

16 19 22 25 28

16 19 22 25 28

12 in

Begining

End of season

6 in

0 in

1.86 in

2.33 in

1.55 in

2.22 in

0.56 in

2.02 in

(Clovis, 2009)
Water Use and Forage Production

By Winter Canola & Wheat

Seed Yield (Mg ha\(^{-1}\))

Biomass Yield (Mg ha\(^{-1}\))

Total Water Use (mm)

2009

2010

2011

Canola (DKW41-10)

Canola (Rally)

Wheat (TAM 111)

(Clovis, 2009-11)
Dual Purpose Crops

What’s for me!!!
Why Canola!!!
Winter Survival Canola vs. Wheat

(Clovis, 2013)
Forage Productivity

Forage Biomass (t ac⁻¹)

- Griffin
- DKW 44-10
- Saffron
- Wheat

Forage Harvest:
- 1st: (Nov 29, 12)
- 2nd: (Feb 13, 13)
- 3rd: (Mar 13, 13)
- 4th: (Apr 17, 14)

Regrowth Harvest: (Apr 17, 14)

(Clovis, 2012-13)
Forage Quality

Forage Harvest

1st (Nov 29, 12)
2nd (Feb 13, 13)
3rd (Mar 13, 13)
4th (Apr 17, 13)

Griffin
DKW 44-10
Safran
Wheat (Tam 111)

Relative Feed Quality (RFQ)
150.0
200.0
250.0
300.0
350.0

(Clovis, 2012-13)
Forage Nitrate Content

<table>
<thead>
<tr>
<th>Forage Harvest</th>
<th>Griffin</th>
<th>DKW 44-10</th>
<th>Safran</th>
<th>Wheat (TAM 111)</th>
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<td>1st (Nov 29, 12)</td>
<td>2500.0</td>
<td>2200.0</td>
<td>2000.0</td>
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<td>2nd (Feb 13, 13)</td>
<td>1800.0</td>
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<td>1200.0</td>
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<td>3rd (Mar 13, 13)</td>
<td>1300.0</td>
<td>1200.0</td>
<td>1000.0</td>
<td>300.0</td>
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<tr>
<td>4th (Apr 17, 13)</td>
<td>900.0</td>
<td>800.0</td>
<td>800.0</td>
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</table>

(Clovis, 2012-13)
Winter Canola: Farmer Experience

Minimally Irrigated

Rainfed Pivot Corner
Tips for grazing

• Use untreated canola seed.
• Adjust rate so new growth is consumed, and remove cattle when 50% of original growth remains.
• Have a minimum of 25% high-fiber hay.
• Treat as a concentrate – use a bloat preventer.
• Closely monitor livestock.
• Test forage for nitrate.
• Graze after a hard freeze.
A New Generation of Desert Crops

Safflower
Pre-season and in-season irrigation management in safflower

• Experimental Design: Split Plot
  – Main plot: Soil Profile
    1. Pre-irrigation (PI) (160 mm)
    2. No-pre-irrigation (NPI) (depleted soil profile)
  – Sub plot: cultivars and irrigation levels
    ▪ Cultivars: 2 (S333 & PI8311)
    ▪ Irrigation levels: 5
      ▪ I₁, I₂, I₃, I₄ and I₅
      ▪ (75, 150, 225, 300 and 375 mm)
Safflower response to pre- and in-season irrigation

No Pre-irrigation | Pre-irrigation

**cv. S333**

**cv. PI8311**

Irrigation Levels: $I_5$, $I_4$, $I_3$, $I_2$, $I_1$
Water Use Efficiency

![Graph showing Water Use Efficiency for 2012 and 2013, with data for Soil Profile, Cultivars, and Irrigation levels.](image-url)
## Yield and Yield Attributes

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Heads plant (^{-1})</th>
<th>Seeds head(^{-1})</th>
<th>Seed yield (kg ha(^{-1}))</th>
<th>Oil yield (kg ha(^{-1}))</th>
<th>Heads plant (^{-1})</th>
<th>Seeds head(^{-1})</th>
<th>Seed yield (kg ha(^{-1}))</th>
<th>Oil yield (kg ha(^{-1}))</th>
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<td>NPI</td>
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<td>1047 b</td>
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<td>18.3 b</td>
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<td>Irrigation levels</td>
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<td>I(_1)</td>
<td>4.9 d</td>
<td>21.2 c</td>
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<td>995 a</td>
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<tr>
<td>S333</td>
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<td>438.5 a</td>
<td>4.6 a</td>
<td>20.0 b</td>
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</table>
Conclusions

- Pre-irrigation was beneficial to improve WUE and HI, however increase in irrigation level does not always aid to WUE and HI.

- Safflower yield responded positively to pre-irrigation and increased irrigation levels in both the years.

- Increase in yield was due to increase in head numbers, seeds per head and photosynthesis.
Thank You