Crop Alternatives for Declining Water Resources

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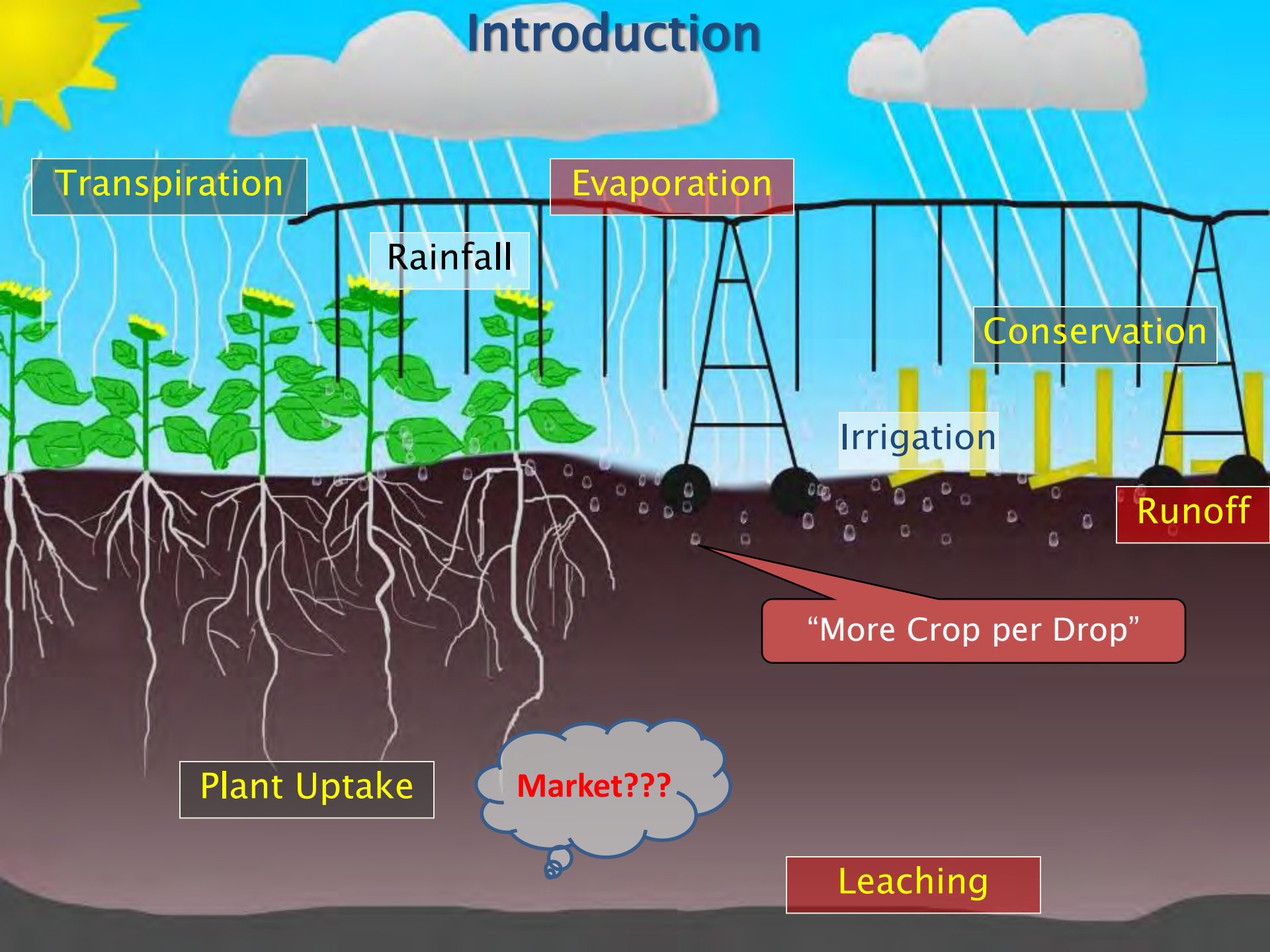
Outline

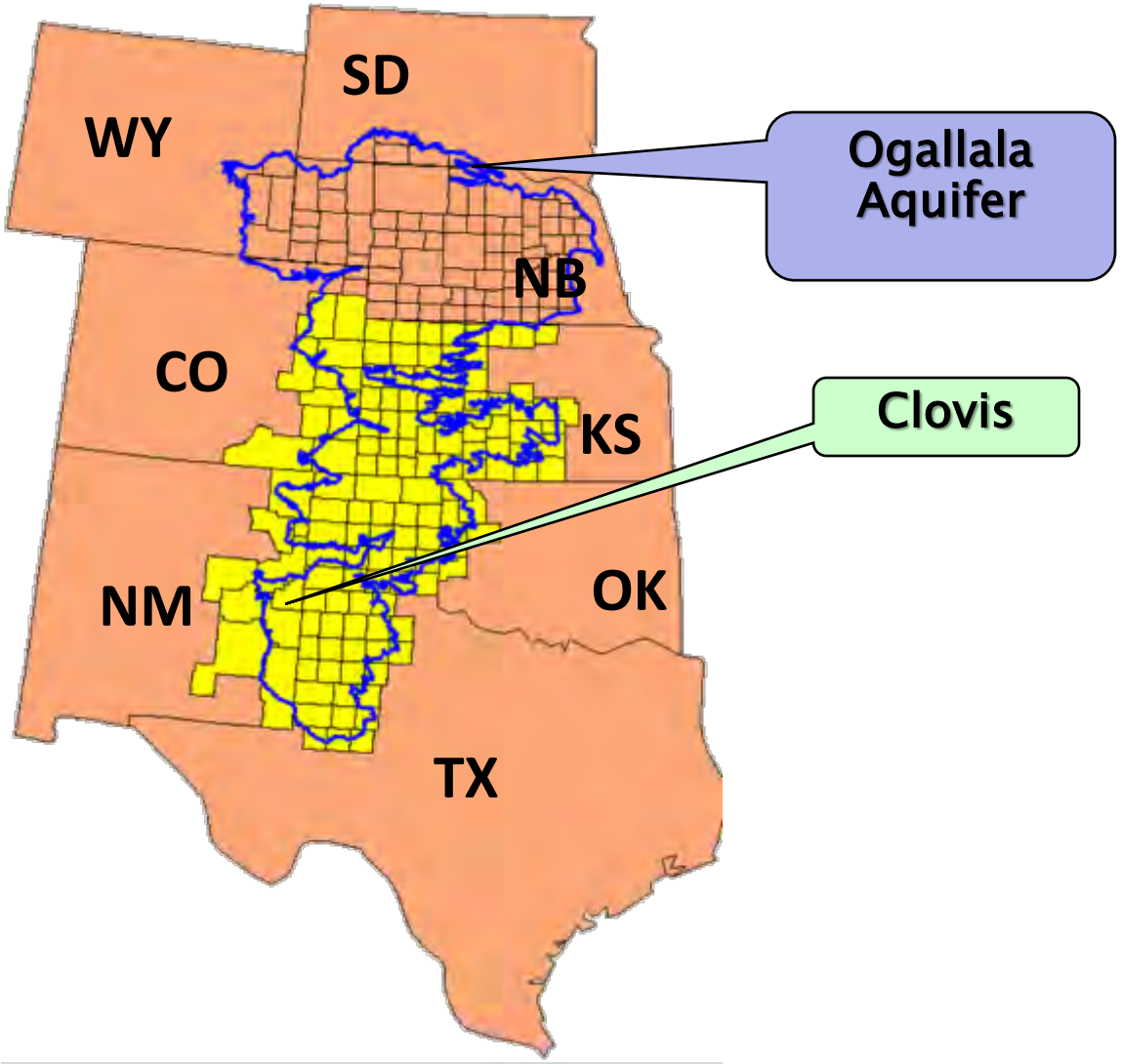
- Introduction
- Current & Future Challenges
- Why Alternative Crops?
- What Crops?
- Lessons Learned
  - Canola Research
  - Safflower Research
- Summary

Introduction

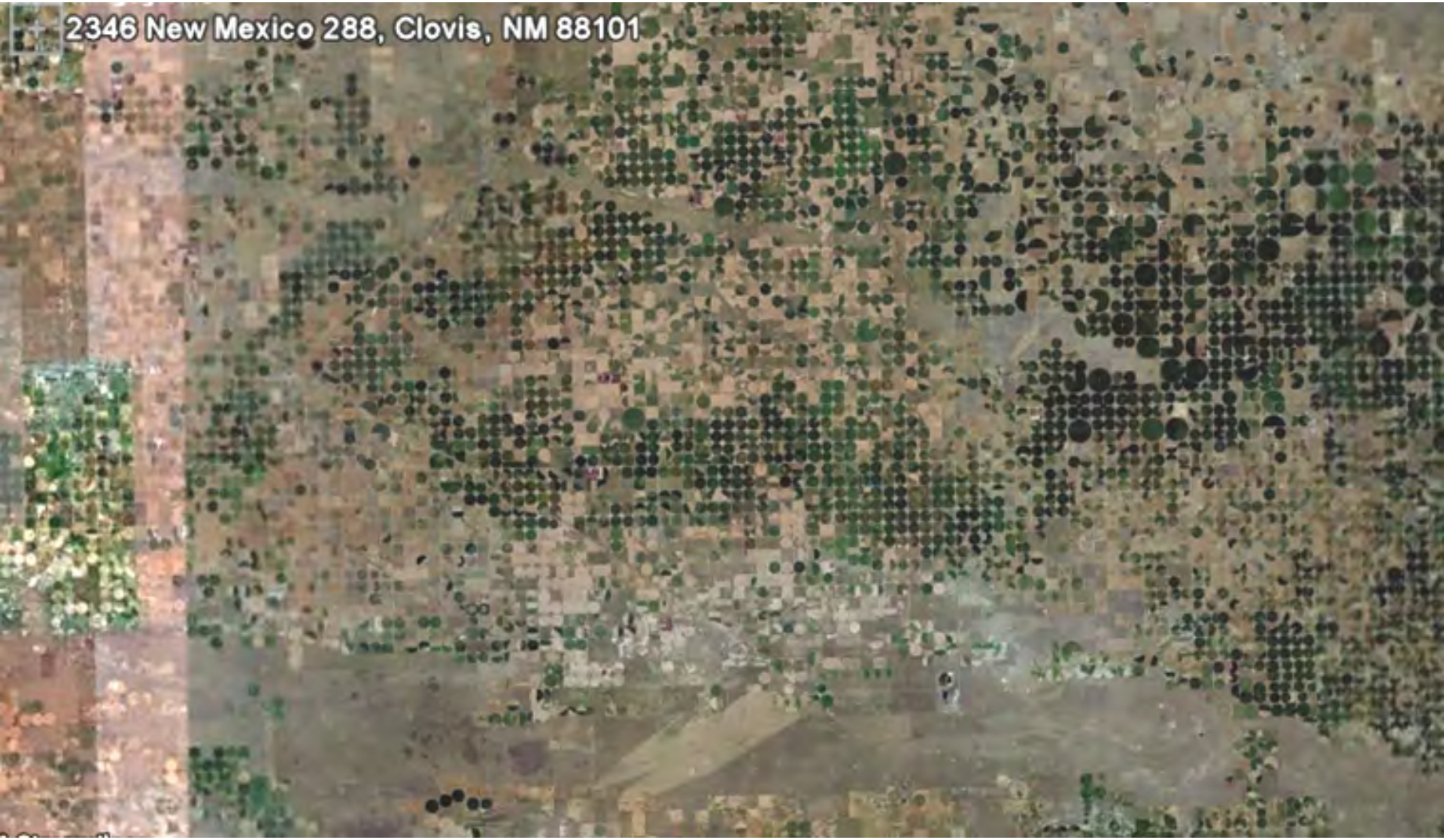


- **Current and Future Challenges**
  - **Ogallala Aquifer/Irrigation Situation**
  - **Uncertain Rainfall**
  - **Wind**
  - **Temperature**
  - **Future Climate**

Ogallala Water Situation



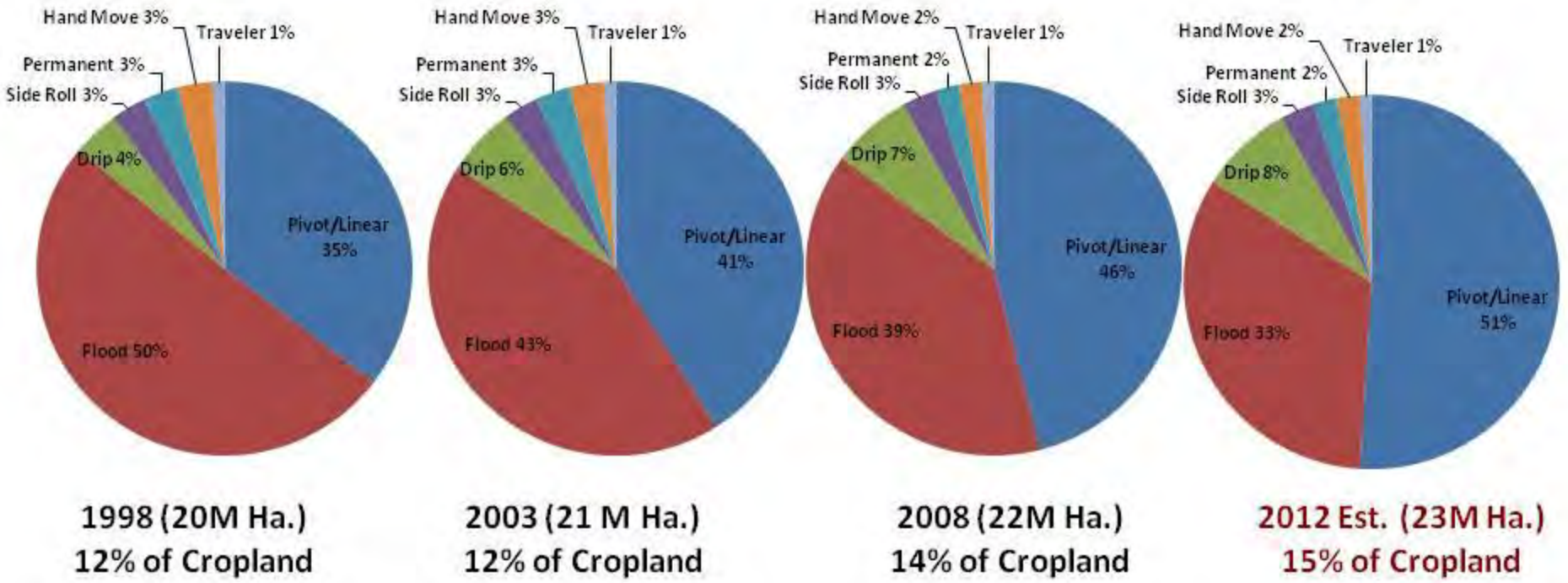
Ogallala Water Situation



(From Google Earth)

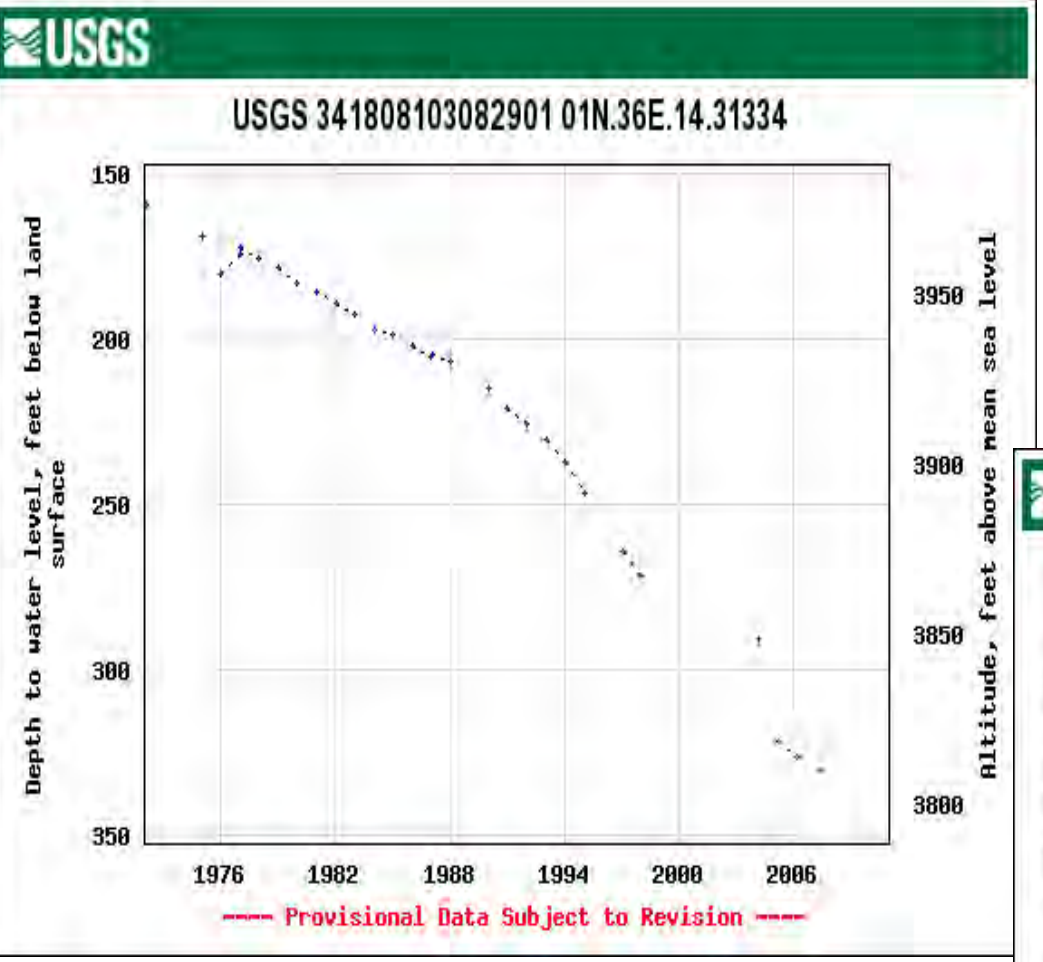
Ogallala Water Situation

Hectares Irrigated by Method - USA

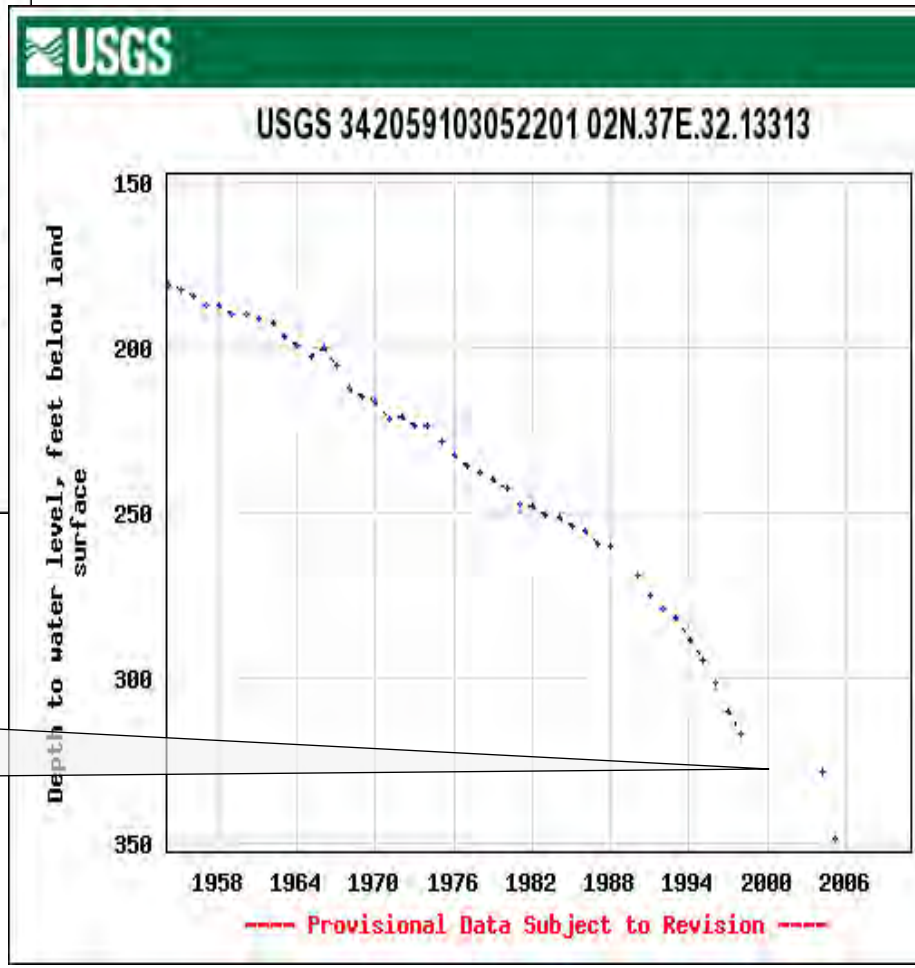


Source: 1998, 2003, 2008 Farm and Ranch Irrigation Surveys
USDA, National Agricultural Statistics Service (2012 estimates by Valmont Irrig.)

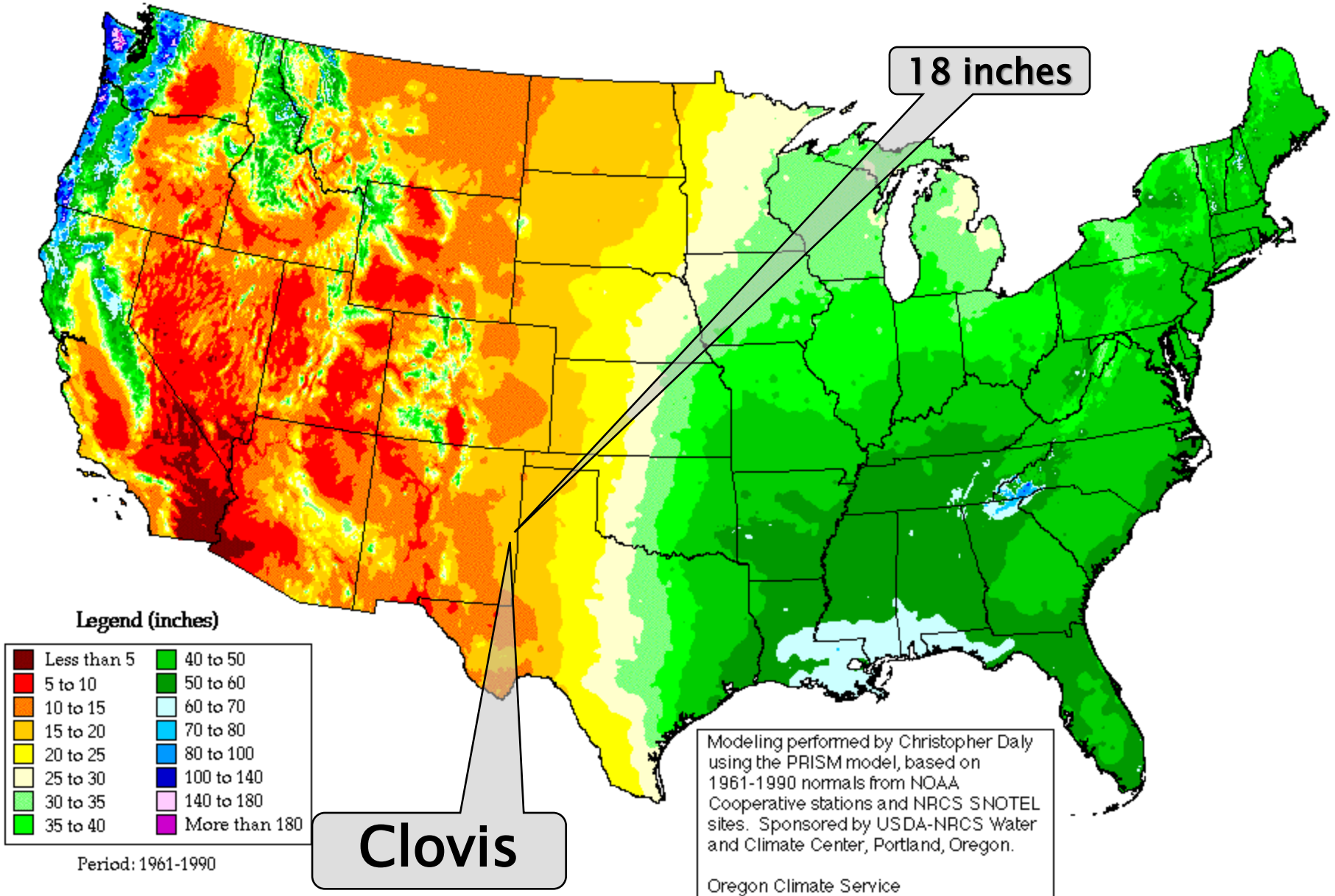
Well Depth

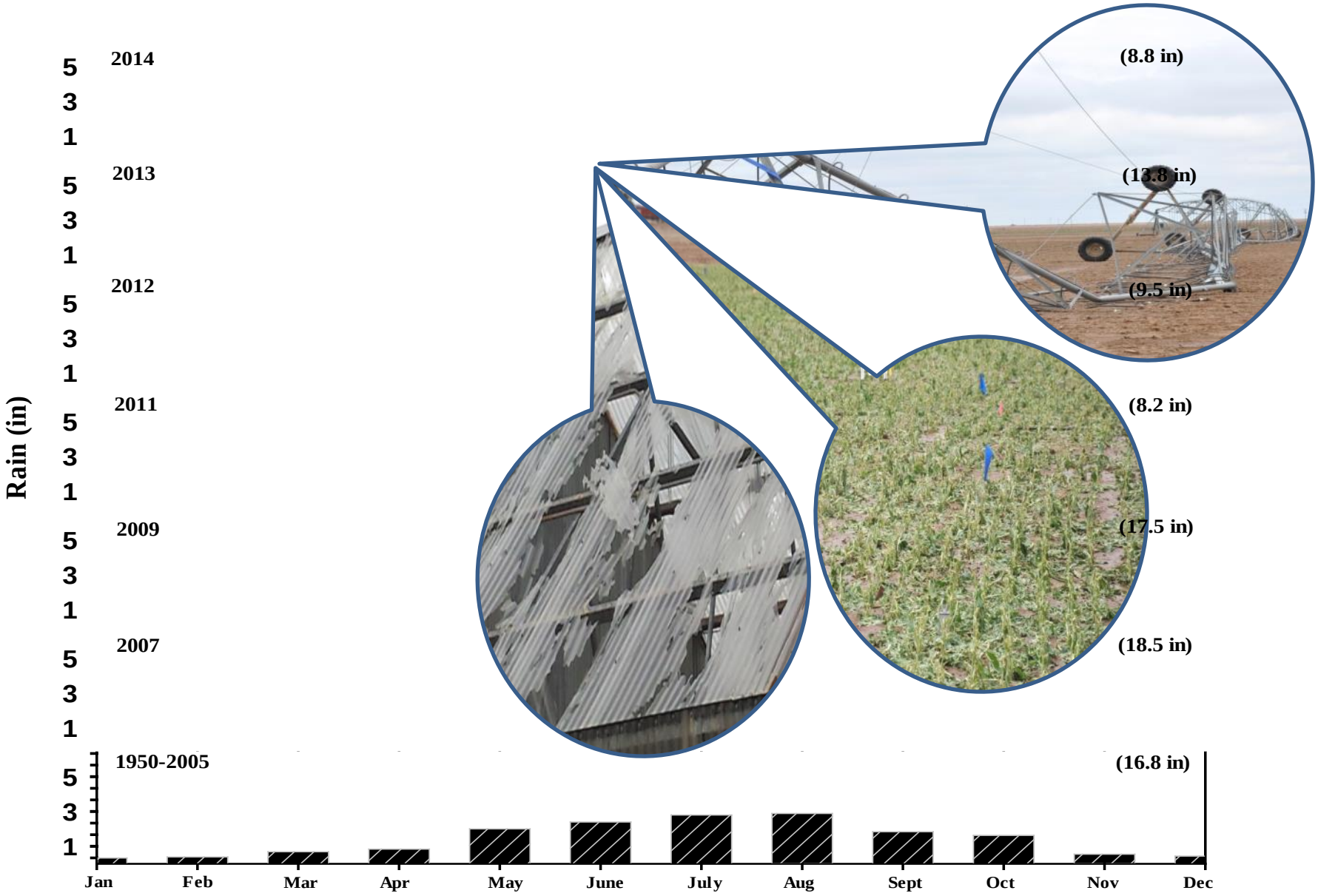


Texas Ground Water Districts limiting pumping to 15 to 20 inches



Low and Uncertain Rainfall

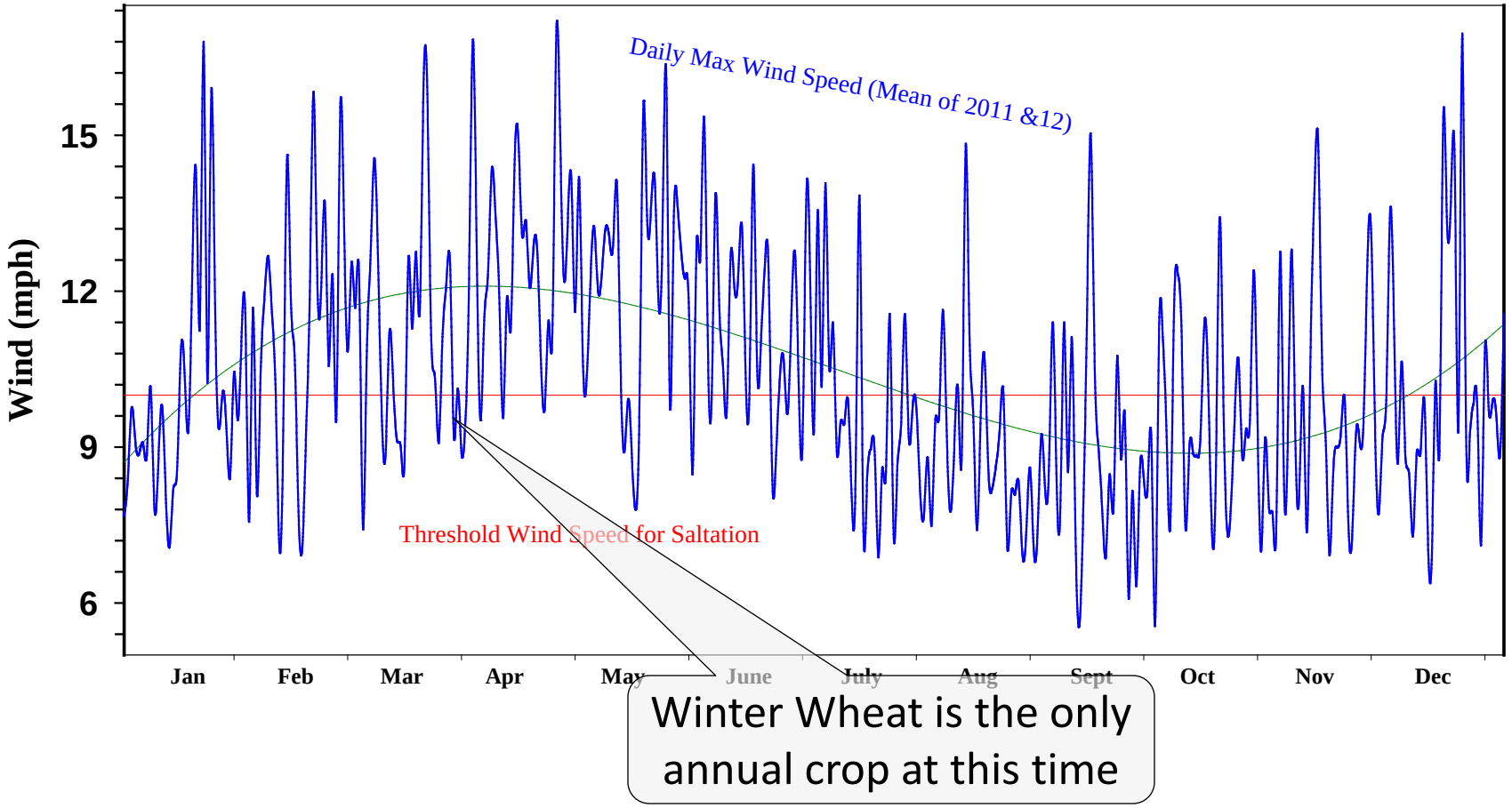



Rain (in)
5
3
1
2014
(8.8 in)
2013
(13.8 in)
(9.5 in)
2012
(8.2 in)
2011
(17.5 in)
2009
(18.5 in)
2007
1950-2005
(16.8 in)
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec

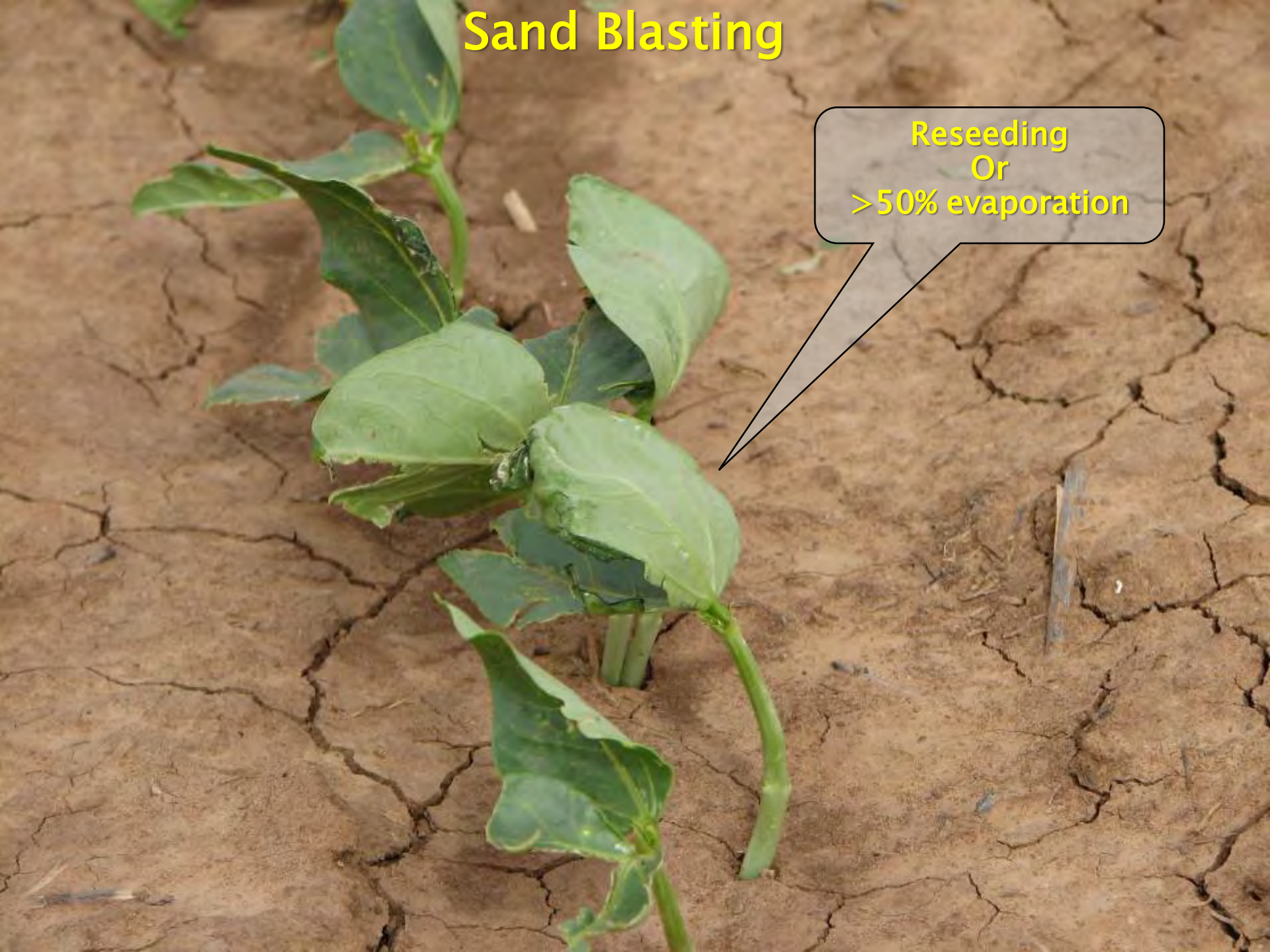
Seasonal Wind Patterns

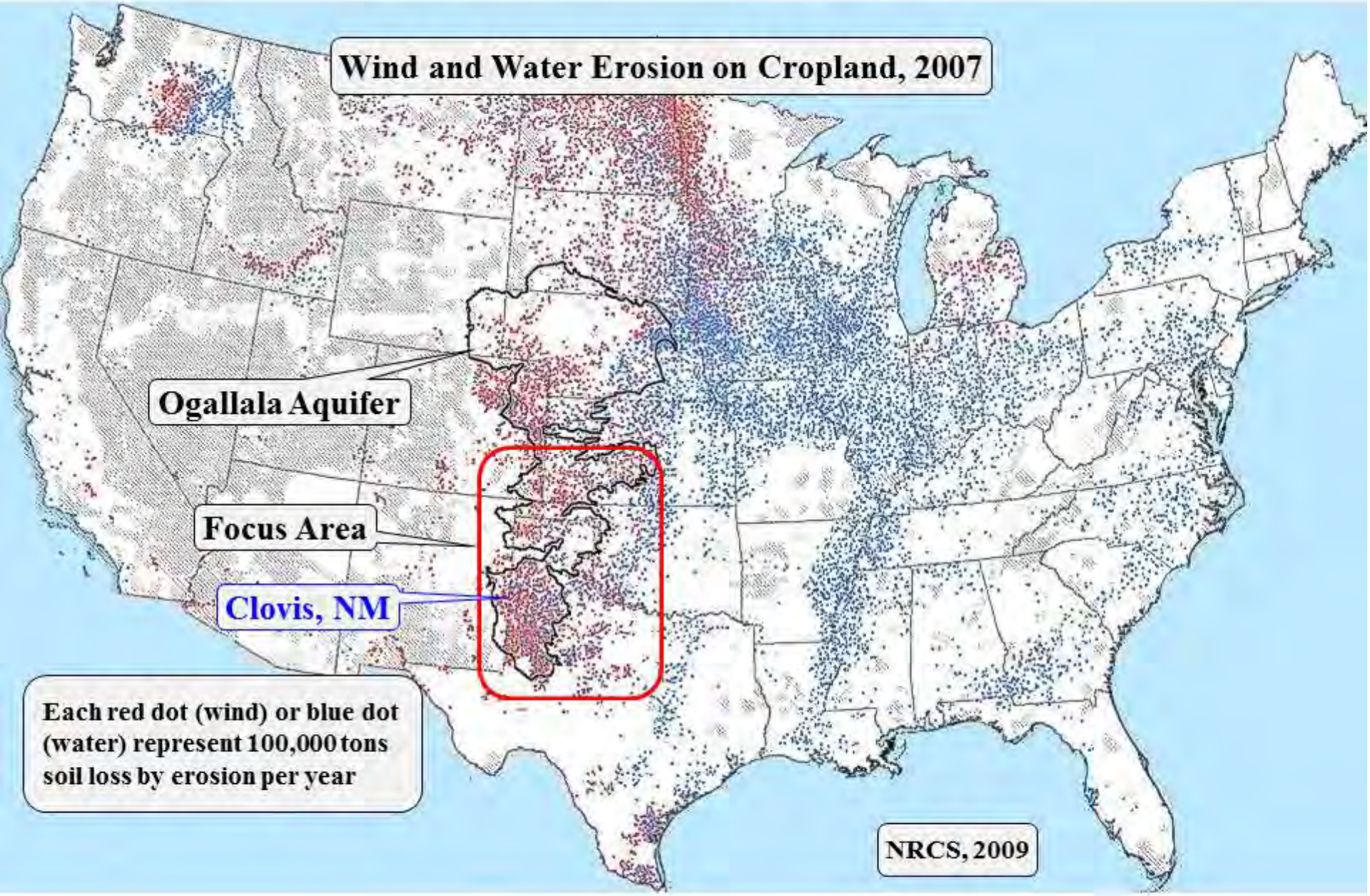
Abiotic Stresses –Wind

Daily Wind Velocity

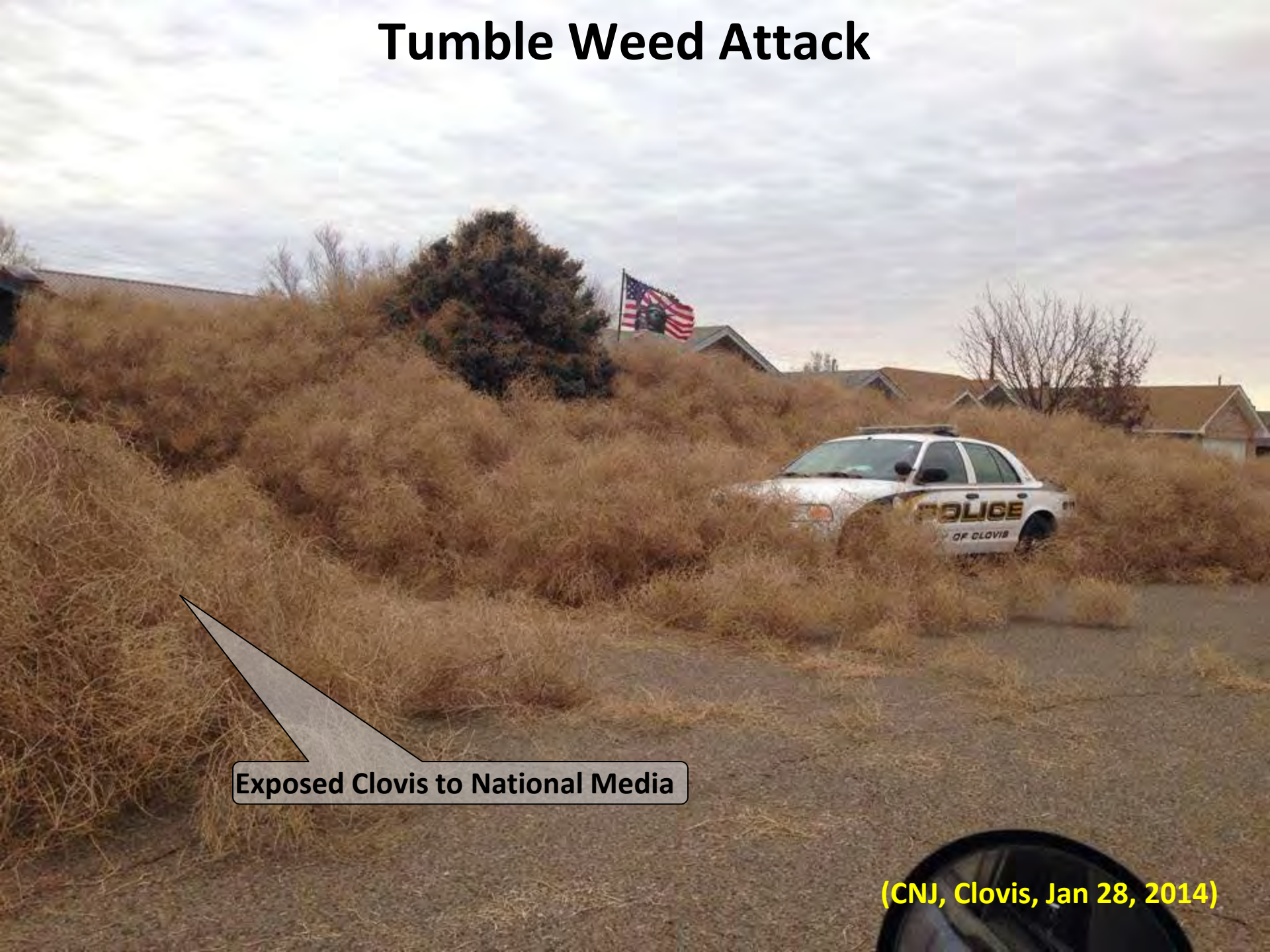



Abiotic Stresses –Wind


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

Tumble Weed Attack



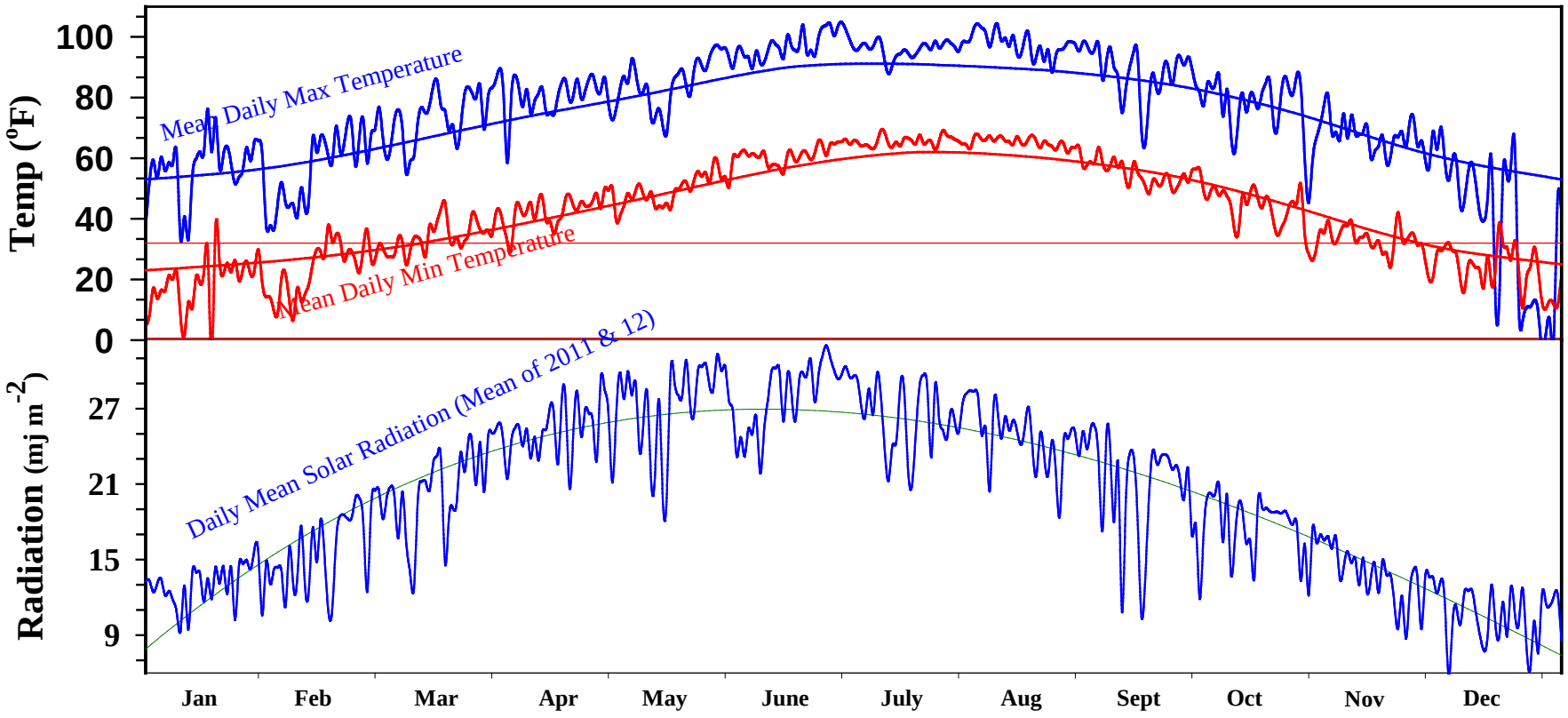
(CNJ, Clovis, Jan 28, 2014)

Temperature Extremes

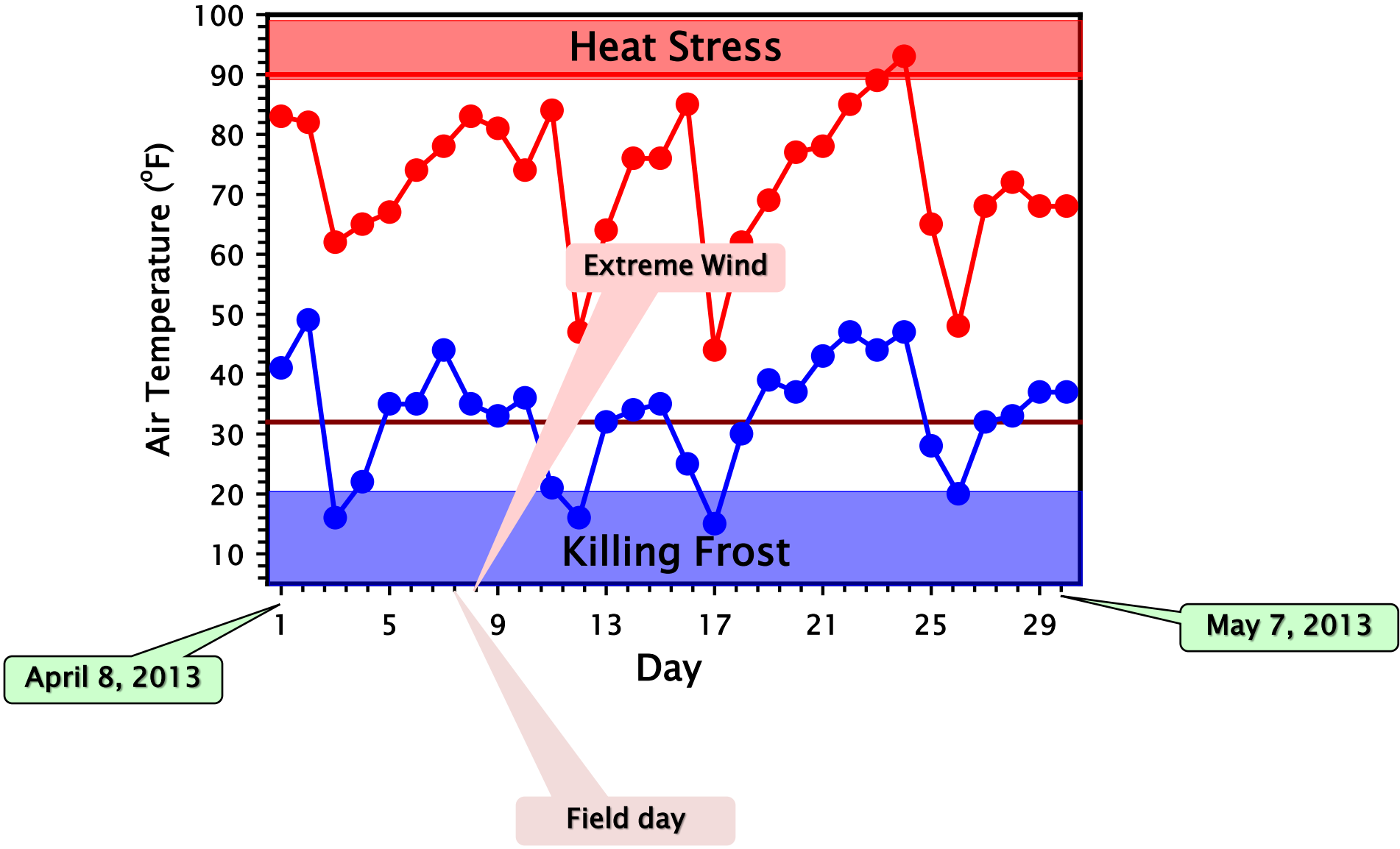
Temperature Extremes: Cold!!!

(Clovis, 2013)

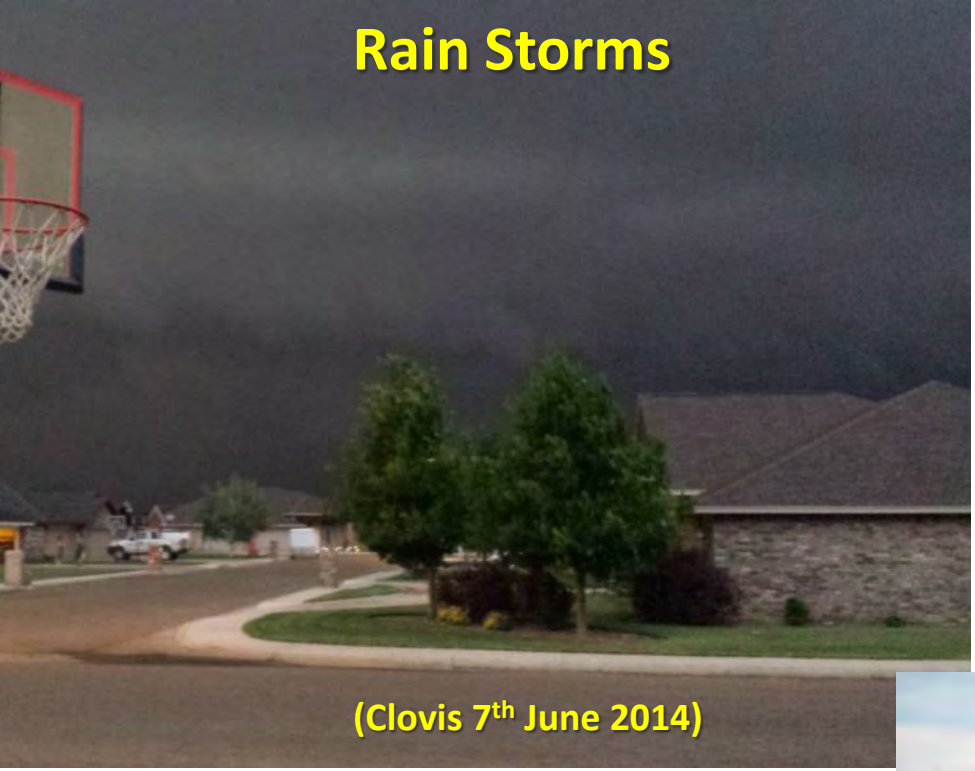
Temperature Extremes



Multiple Abiotic Stresses (Clovis, 2013)



Future Climate



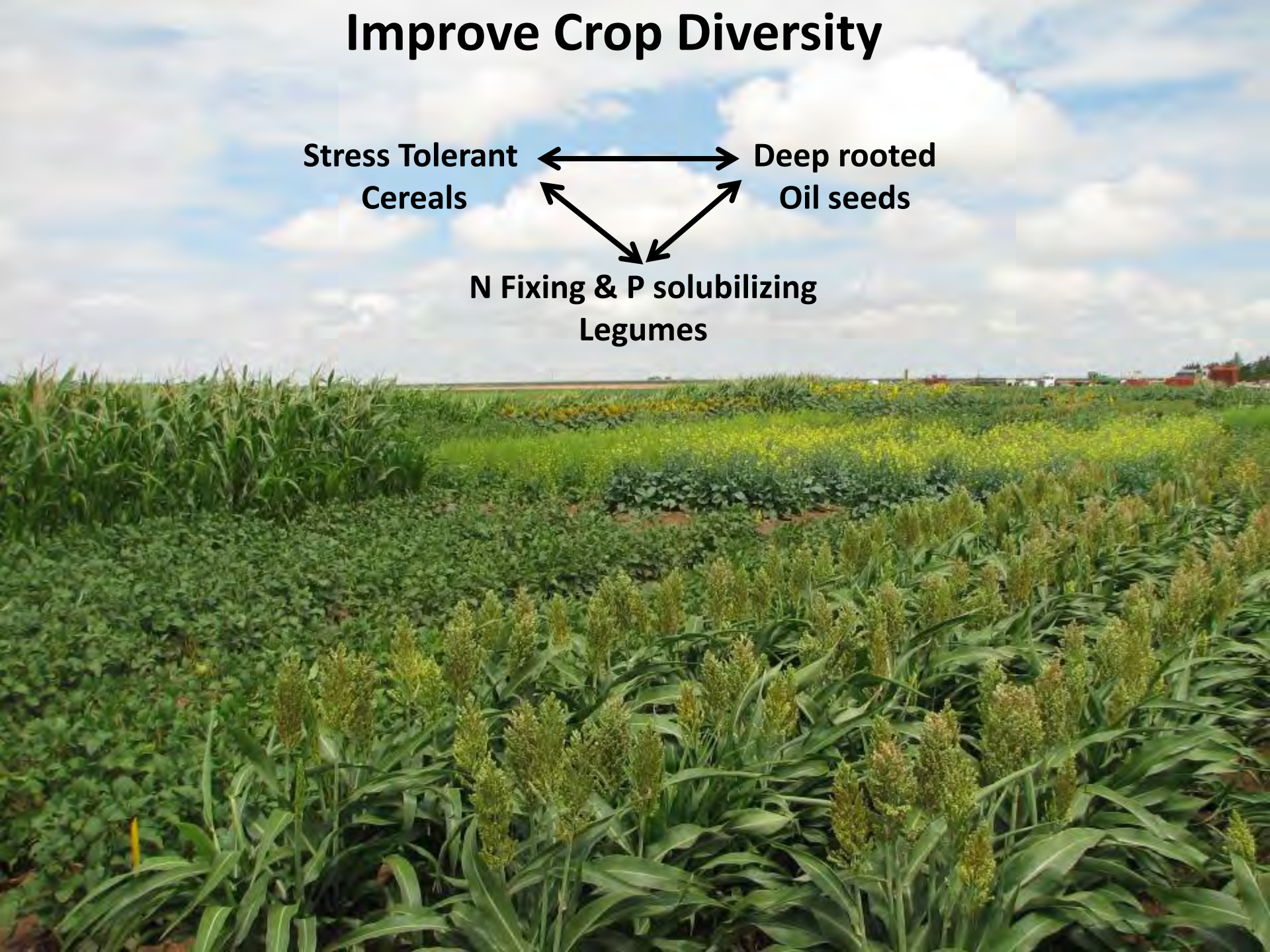
Why Alternative Crops?

- Improve Crop Diversity
- Rotational Benefits
- Buffer Seasonal Extremes
- Natural Resources Conservation
- Sustainable Use of Limited Resources

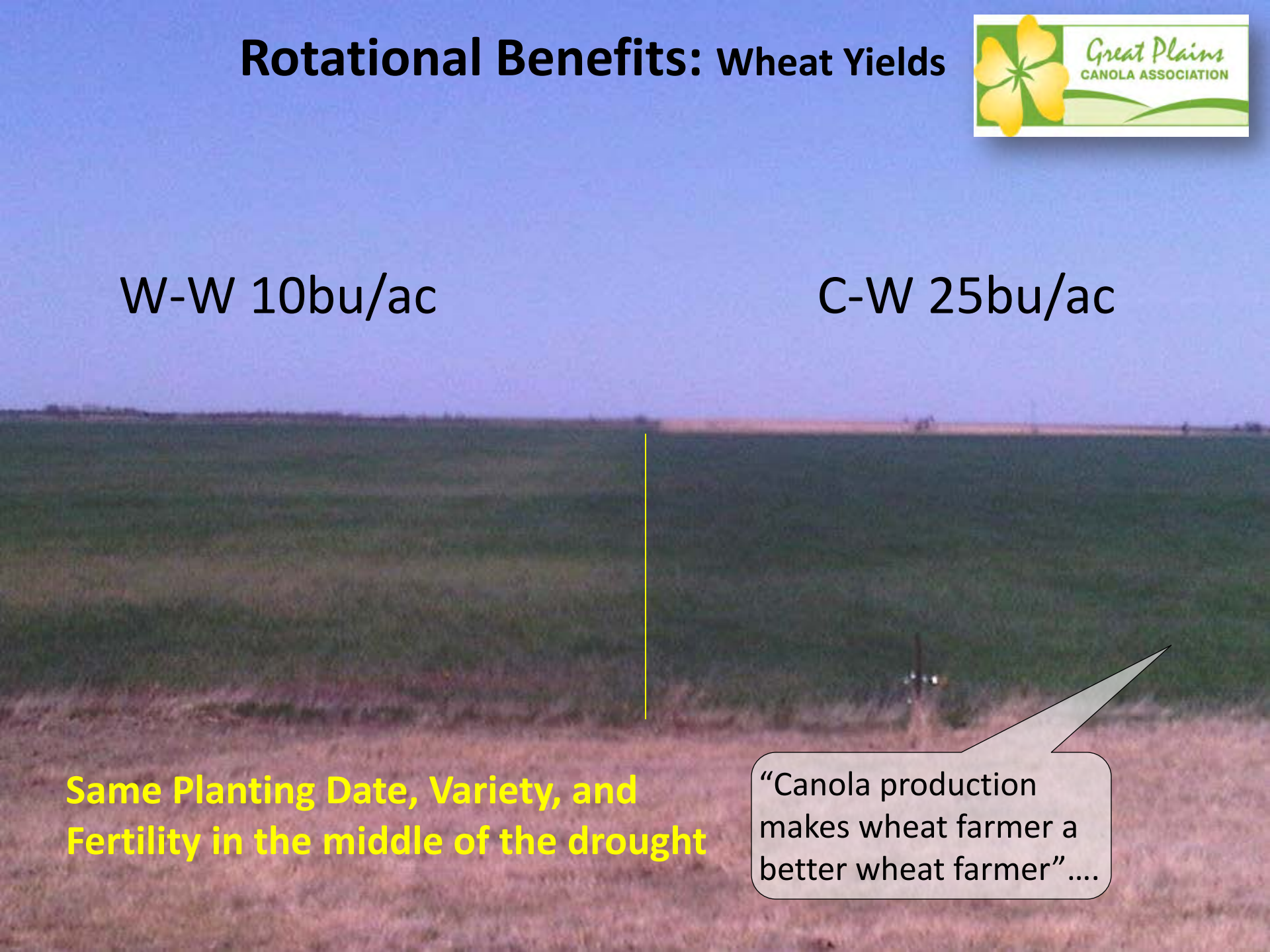
Why Alternative Crops? (contd)

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

Improve Crop Diversity



Rotational Benefits: Wheat Yields



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’

Hail Storm, Clovis (June 8, 2014)

Canola and Wheat at Harvest

≈ 50% canola yield (combined)

Not harvested

Safflower Hail Damage and Regrowth

Hail Damaged (June 9, 2014)

Regrowth vs. Replanted (Aug 17, 2014)

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

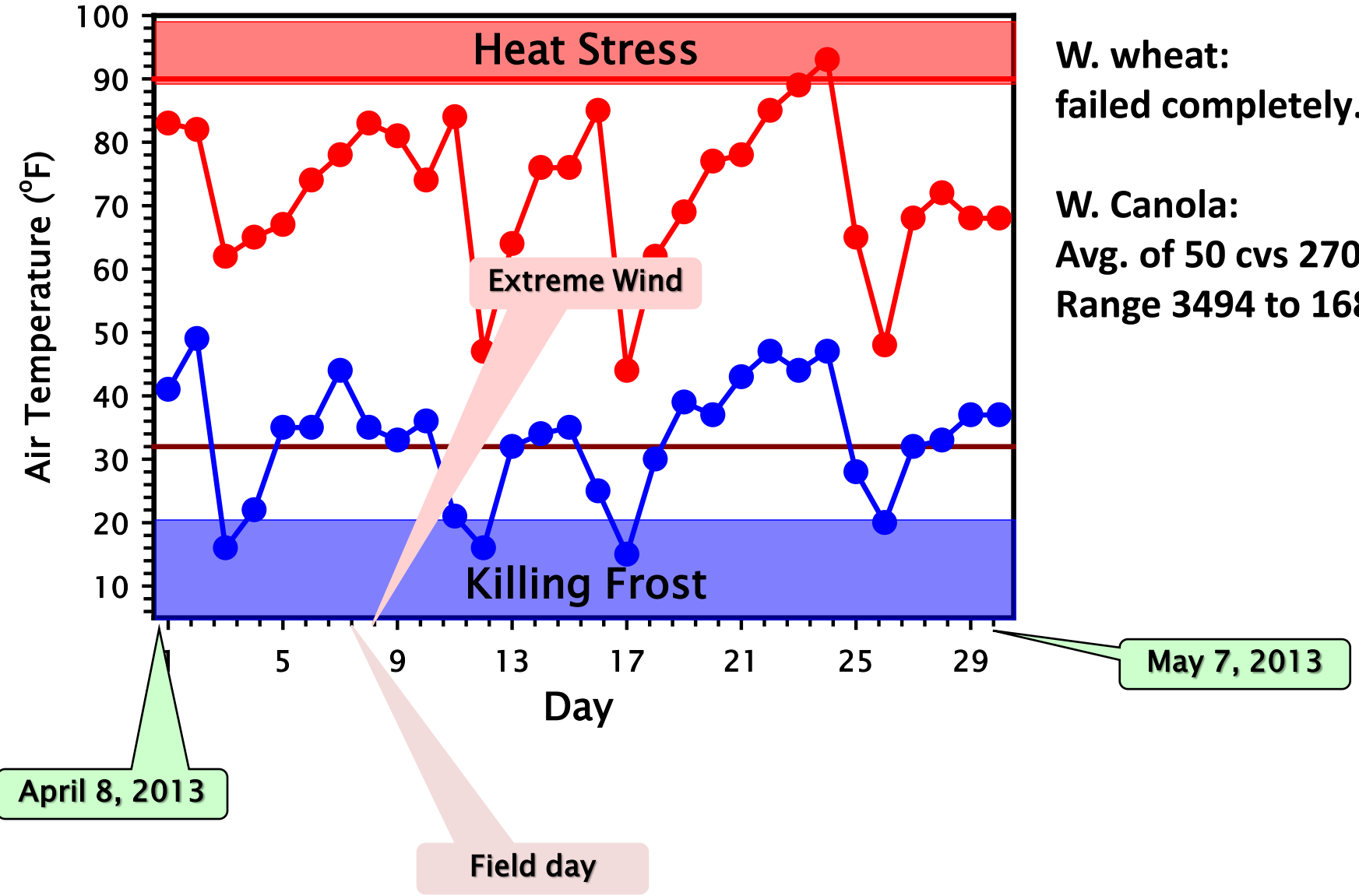
(Apr 17, 09)

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

Herbicide Drift Injury and Recovery

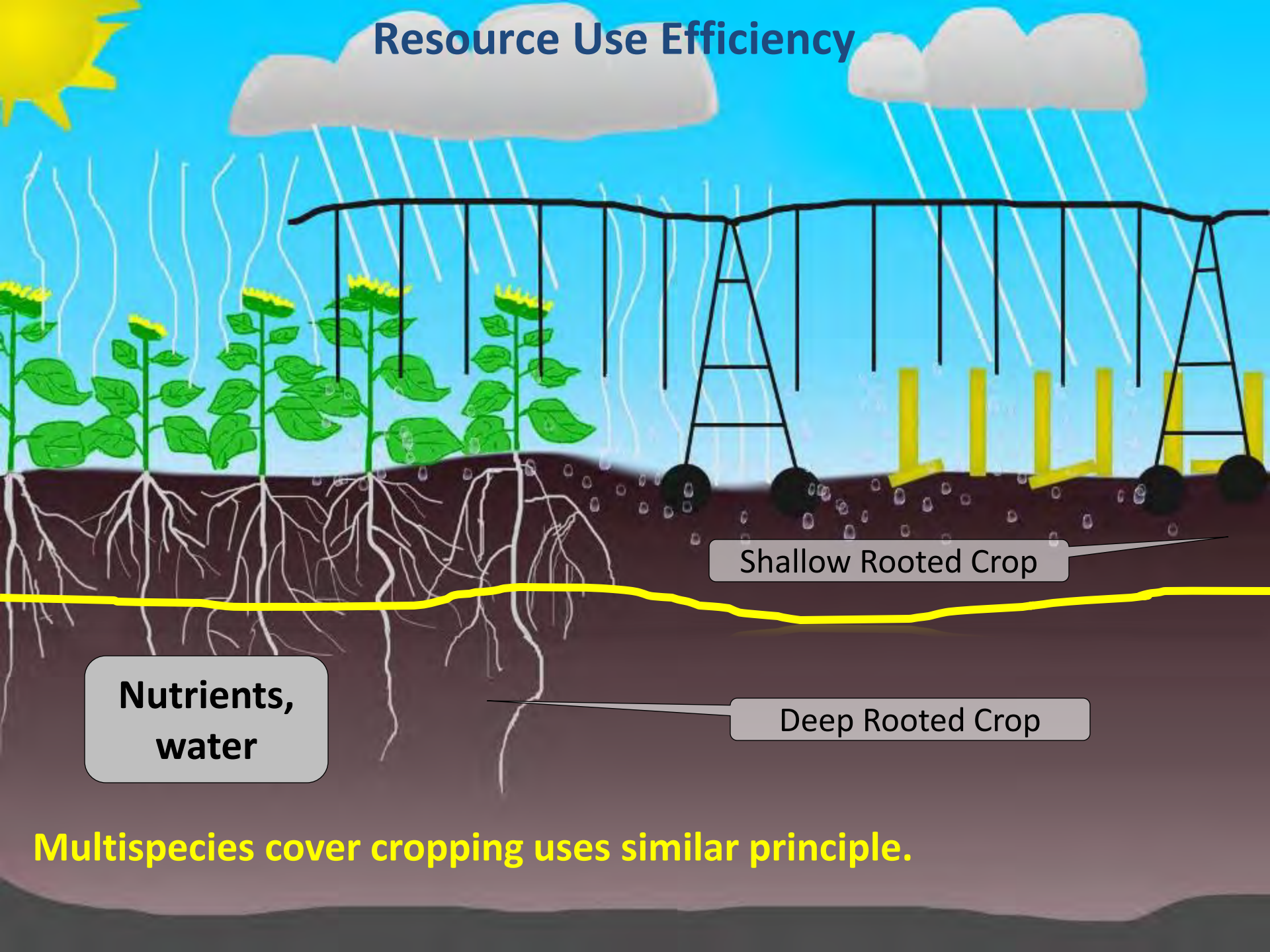
Guar (Drift from neighbor, unknown herbicide, July 10, 2014)

Guar (Recovered, Aug 15, 2014)

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

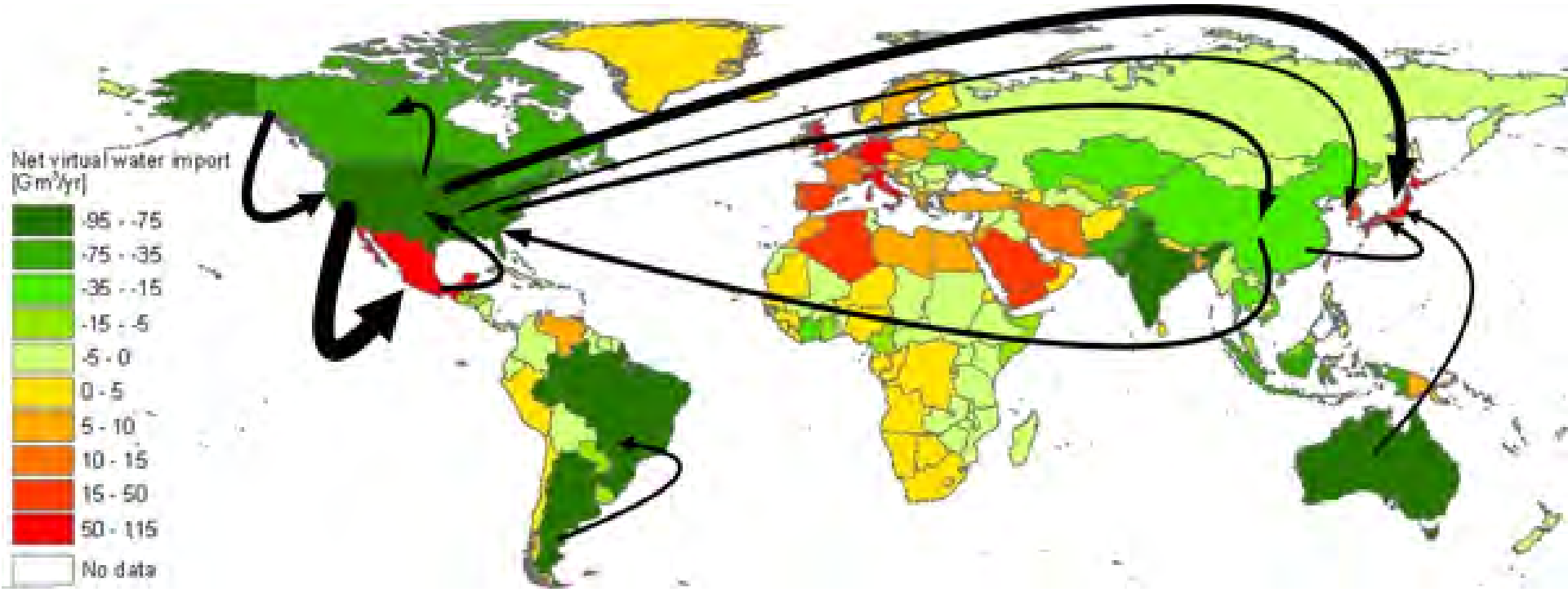
We have not seen herbicide drift issues with Winter Canola.

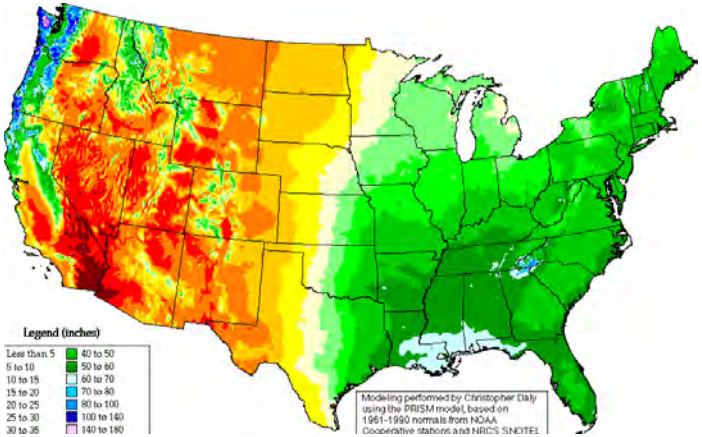
Resource Use Efficiency



Multispecies cover cropping uses similar principle.

Value Addition and Virtual Water Movement



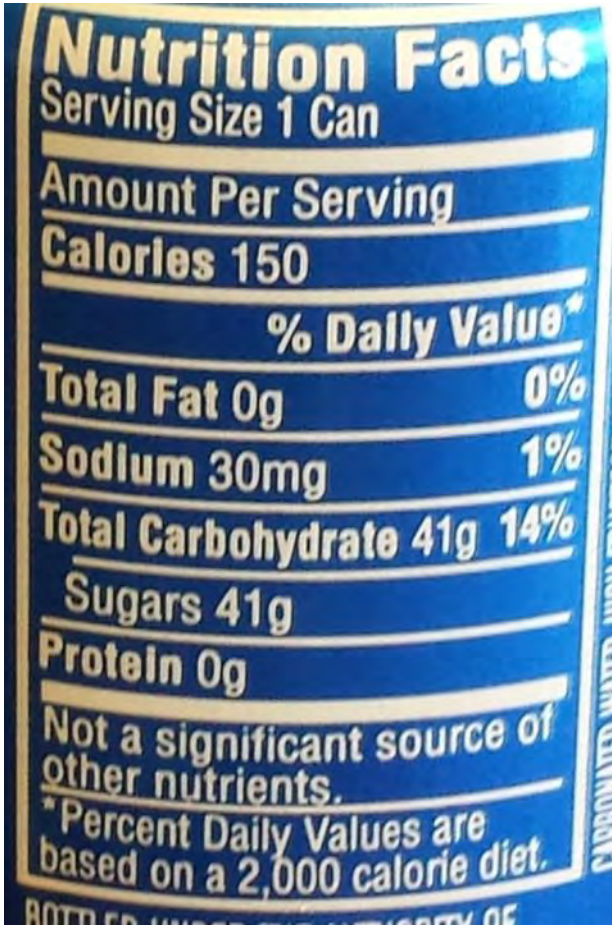


Changing Consumer Demand:

‘healthy food’, ‘more fiber’, ‘nutrient profile’, ‘disease prevention’

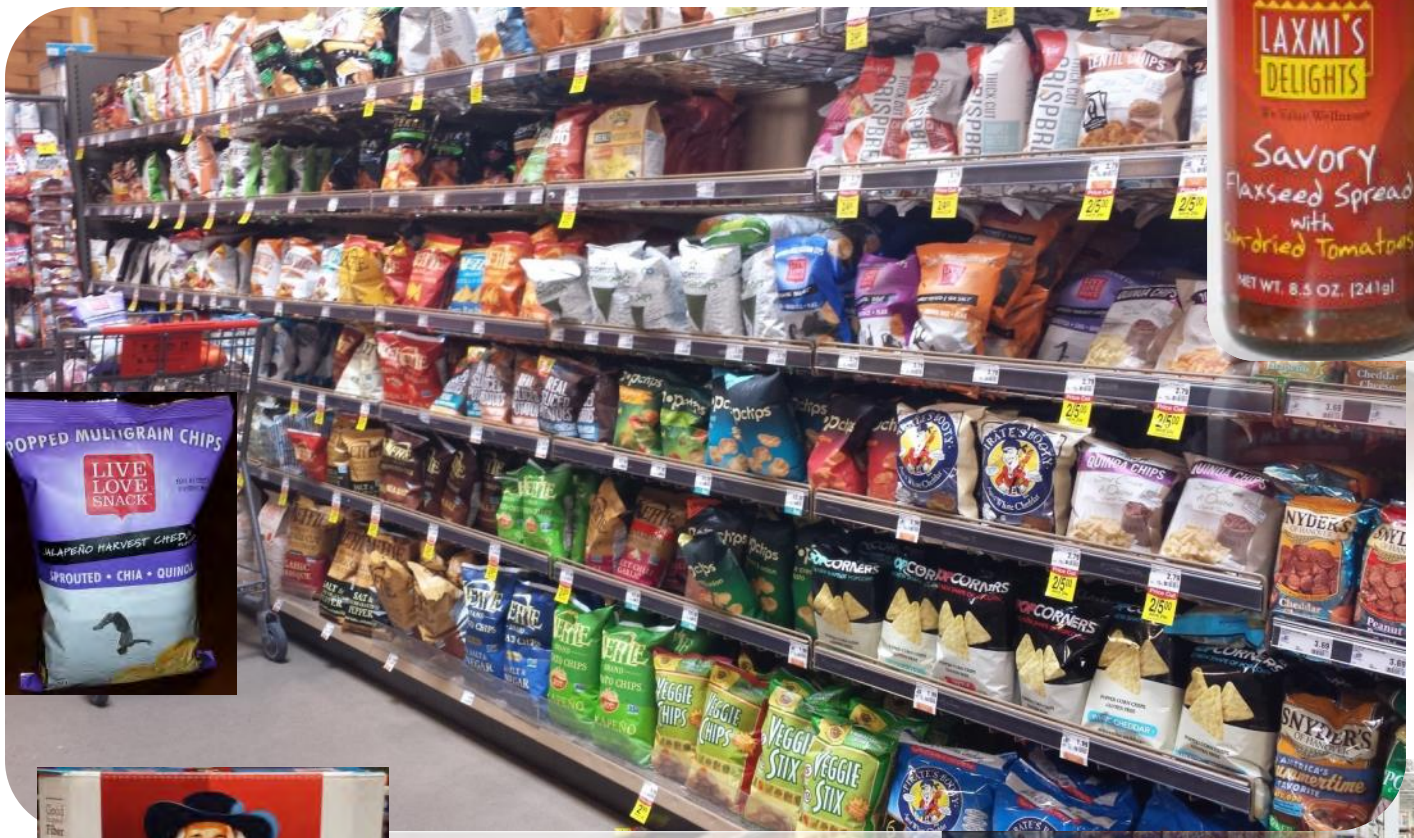
Changing Consumer Demand:

Food for ‘Energy, etc’ vs. ‘Nutrition, healthy living’



Healthy Chips Isle:

Market Place, Lubbock



Flax Spread:

Laxmi Delights

Oat Products:

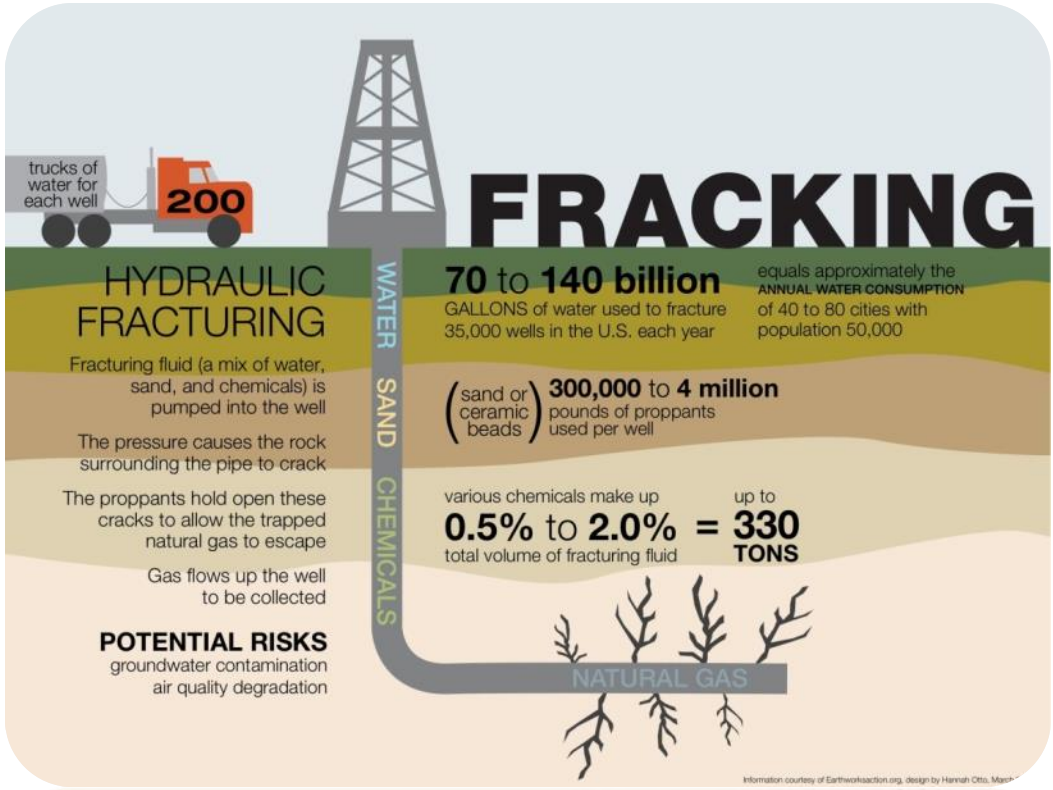
Sams, Lubbock

Breakfast I am tired of

Even in Walmart

Opportunistic or Alternative Uses:

‘guar for fracking’, ‘canola meal for cattle’

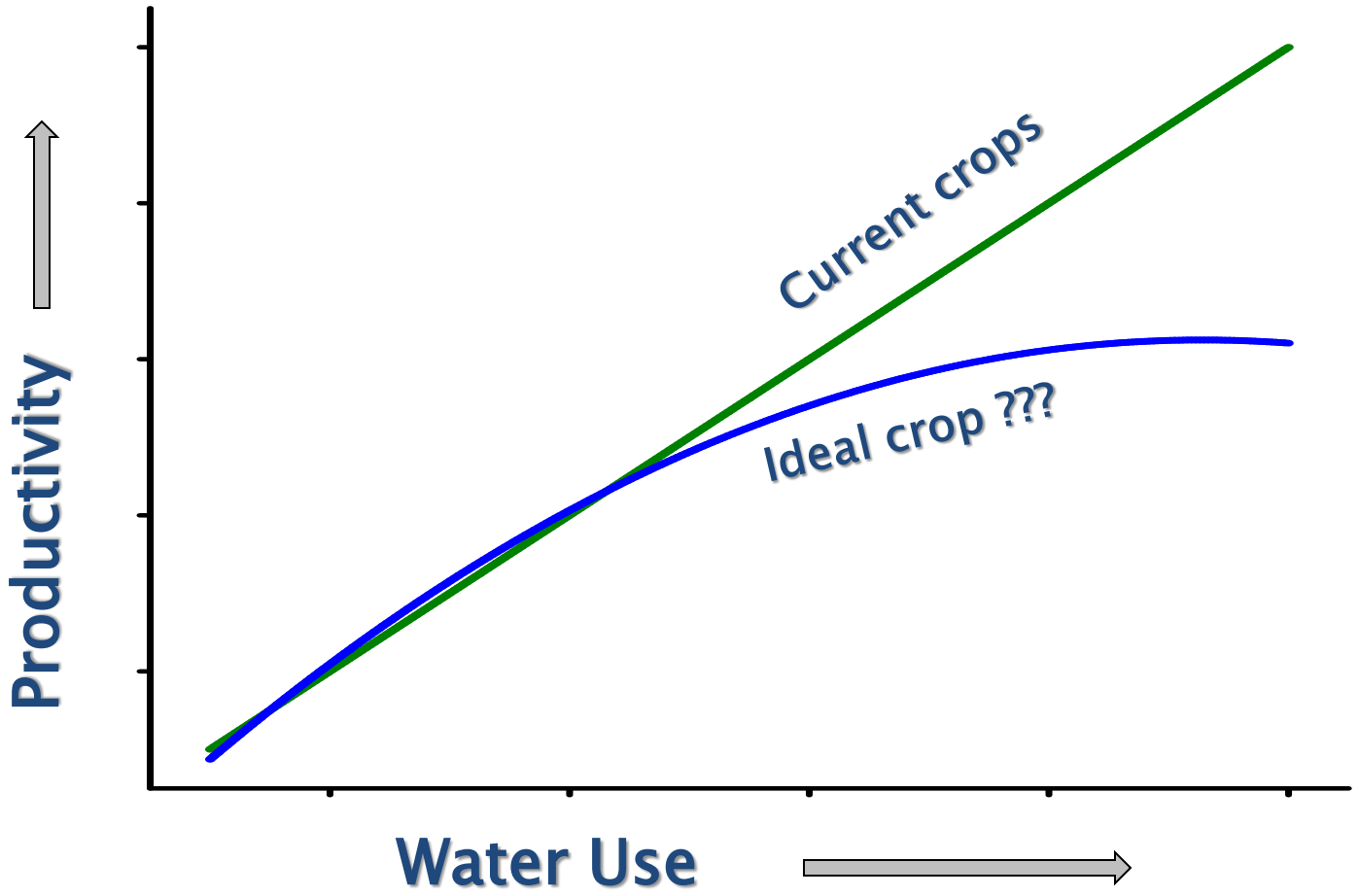



UNITED STATES
Canola Production
Canola Production
Processing
Processing
Canola Production
Meal distribution to local dairies
New Processing
Oil Export
Biodiesel Export
1. MAINE
2. NEW HAMPSHIRE
3. VERMONT
4. MASSACHUSETTS
5. RHODE ISLAND
6. CONNECTICUT
7. NEW JERSEY
8. DELAWARE
9. MARYLAND
CANADA
MEXICO
CUBA
PACIFIC OCEAN
Gulf of Mexico
Gulf of Alaska
Bering Sea
ROCKY MOUNTAINS
GREAT PLAINS
APPALACHIAN MOUNTAINS
CASCADE RANGE
SIERRA NEVADA
Coast Ranges
Blue Mountains
Olympic National Park
Mt. Rainier 4394 m
Redwood National Forest
Yellow Stone National Park
Dinosaur National Monument
Yosemite National Park
Golden Gate Bridge
Mt. Whitney 4421 m
Death Valley National Park
Zion N.P.
The Hoover Dam
Copper Canyon
Mt. Elbert 4401 m
Mt. Mckinley 6194 m
Niagara Falls
Disney World
Everglades National Park
Olympia
Salem
Boise
Helena
Pierre
Lincoln
Cheyenne
Salt Lake City
Carson City
Sacramento
San Francisco
Las Vegas
Los Angeles
San Diego
Phoenix
Tucson
Santa Fe
Oklahoma City
Topeka
Jefferson City
Springfield
Des Moines
Madison
Chicago
Detroit
Lansing
Columbus
Indianapolis
Harrisburg
Albany
Nashville
Little Rock
Jackson
Montgomery
Atlanta
Tallahassee
Jacksonville
Tampa
Orlando
Baton Rouge
Houston
Dallas
San Antonio
Austin
Charleston
Frankfort
Raleigh
Columbia
Anchorage
Honolulu
Hilo
Yukon
Lake Superior
Lake Michigan
Lake Huron
Missouri
Mississippi
Ohio
Snake
Colorado
Gila
Rio Grande
Tennessee
Arkansas
Red
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
WASHINGTON DC
RUSSIA
ALASKA
HAWAII
LEGEND
Country Boundary
State Boundary
Major Road
River
Major City
Sea Port
Country Capital
Airport
Point of Interest
120°W
110°W
100°W
90°W
80°W
50°N
40°N
30°N
(Updated on 21st January, 2013)

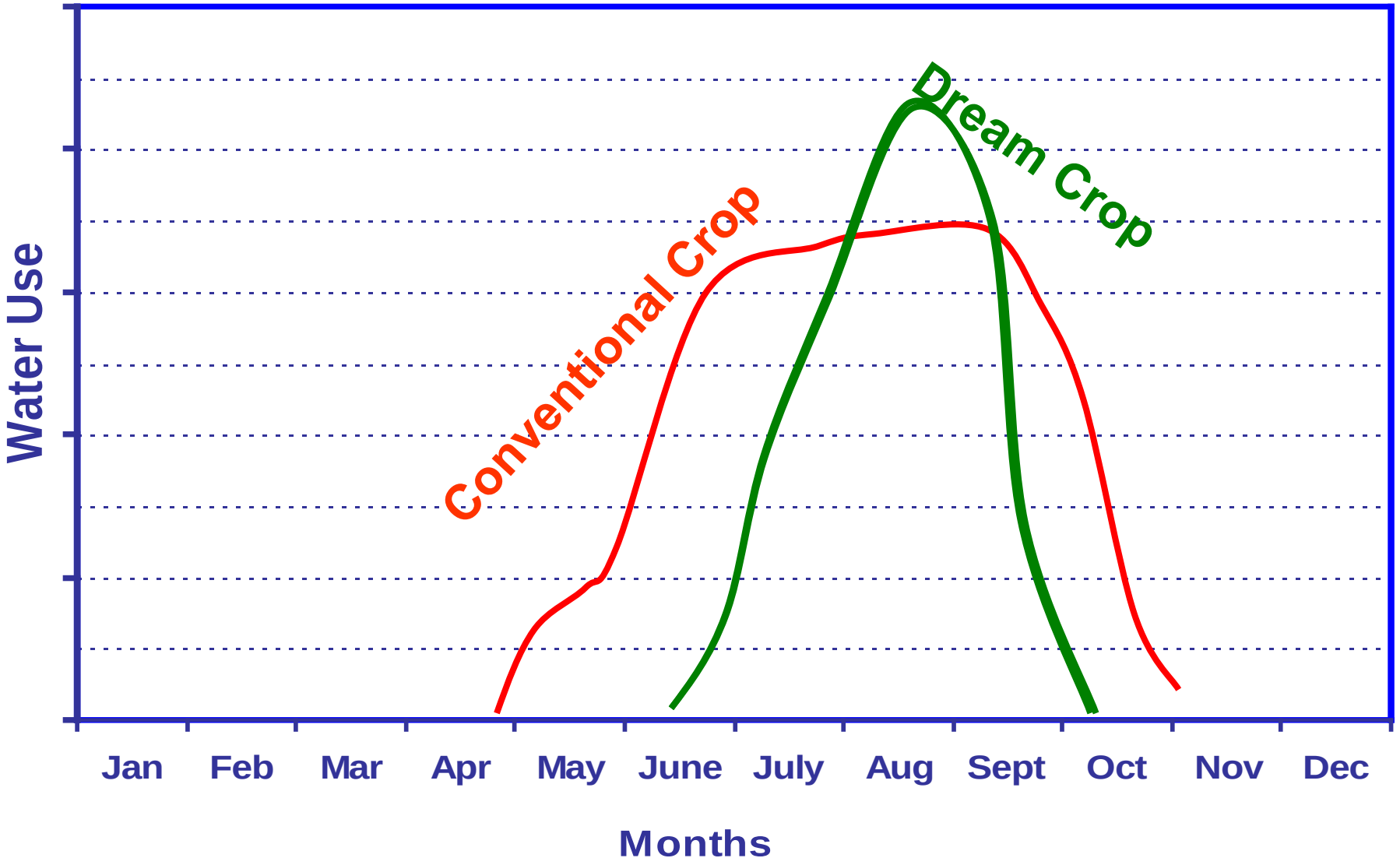
What Crops??

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

Ideal Crop for the Region



Biomass Crops Water Use



Alternate Biodiesel Crops

Canola

Sunflower

Glycerin

Seeds

Protein supplement

Mustard

Camelina

Safflower

Quinoa

Chia

Sesame

Amaranth

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

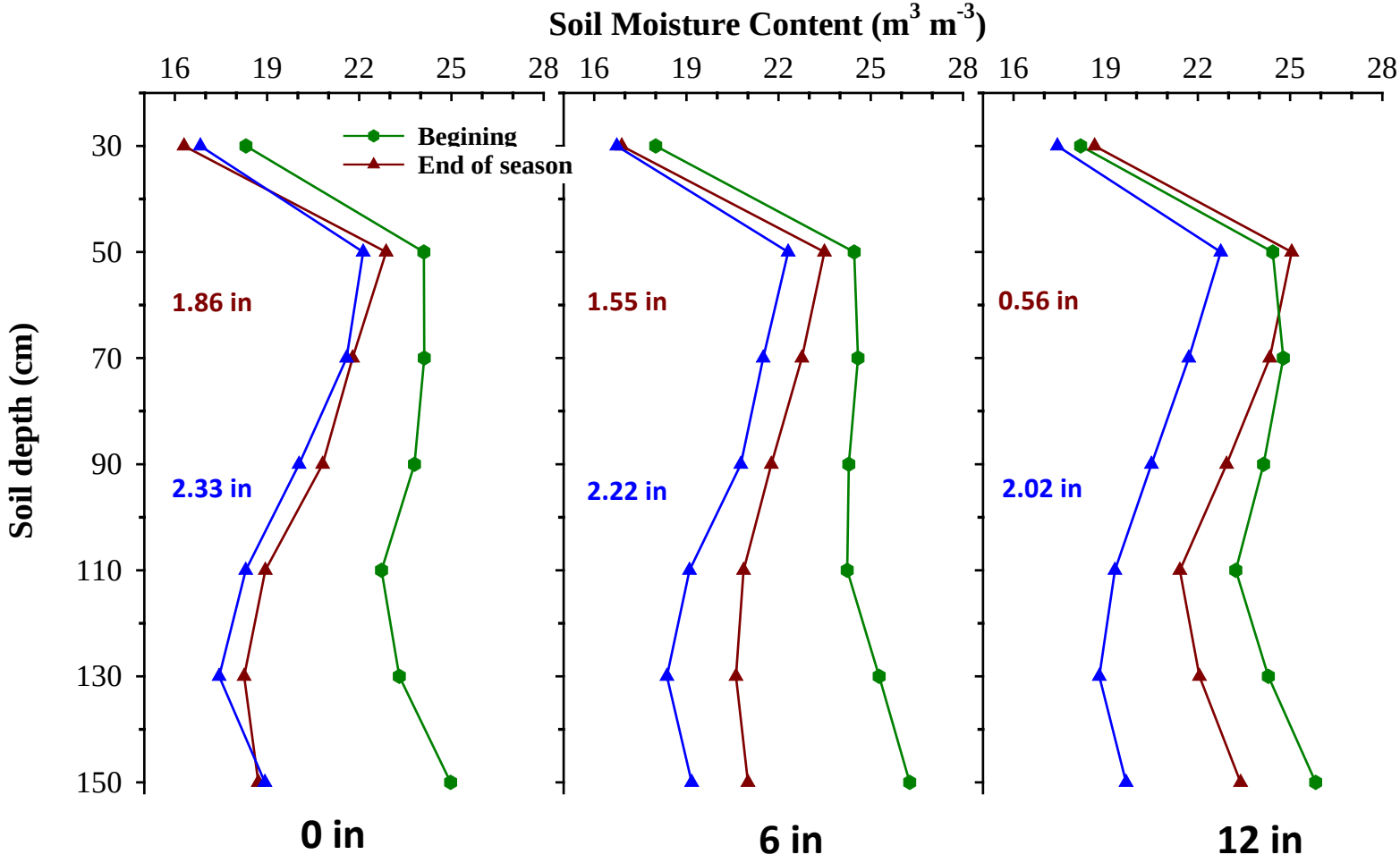
Canola Seeding Date (Our Experience)

Winter Canola Root System and Water Needs

(Clovis, 2014)

Water Extraction

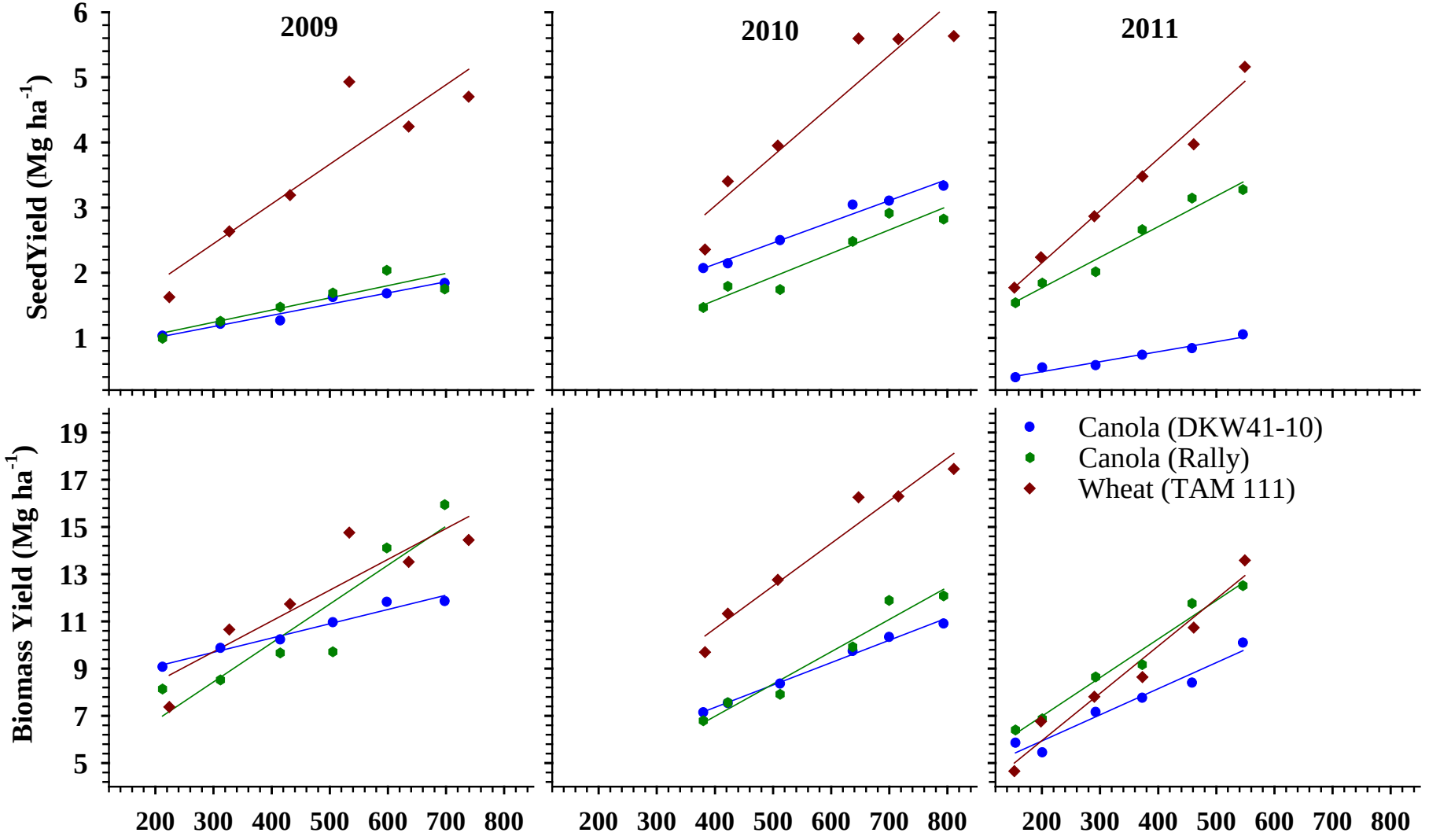
(Winter Canola & Wheat)



(Clovis, 2009)

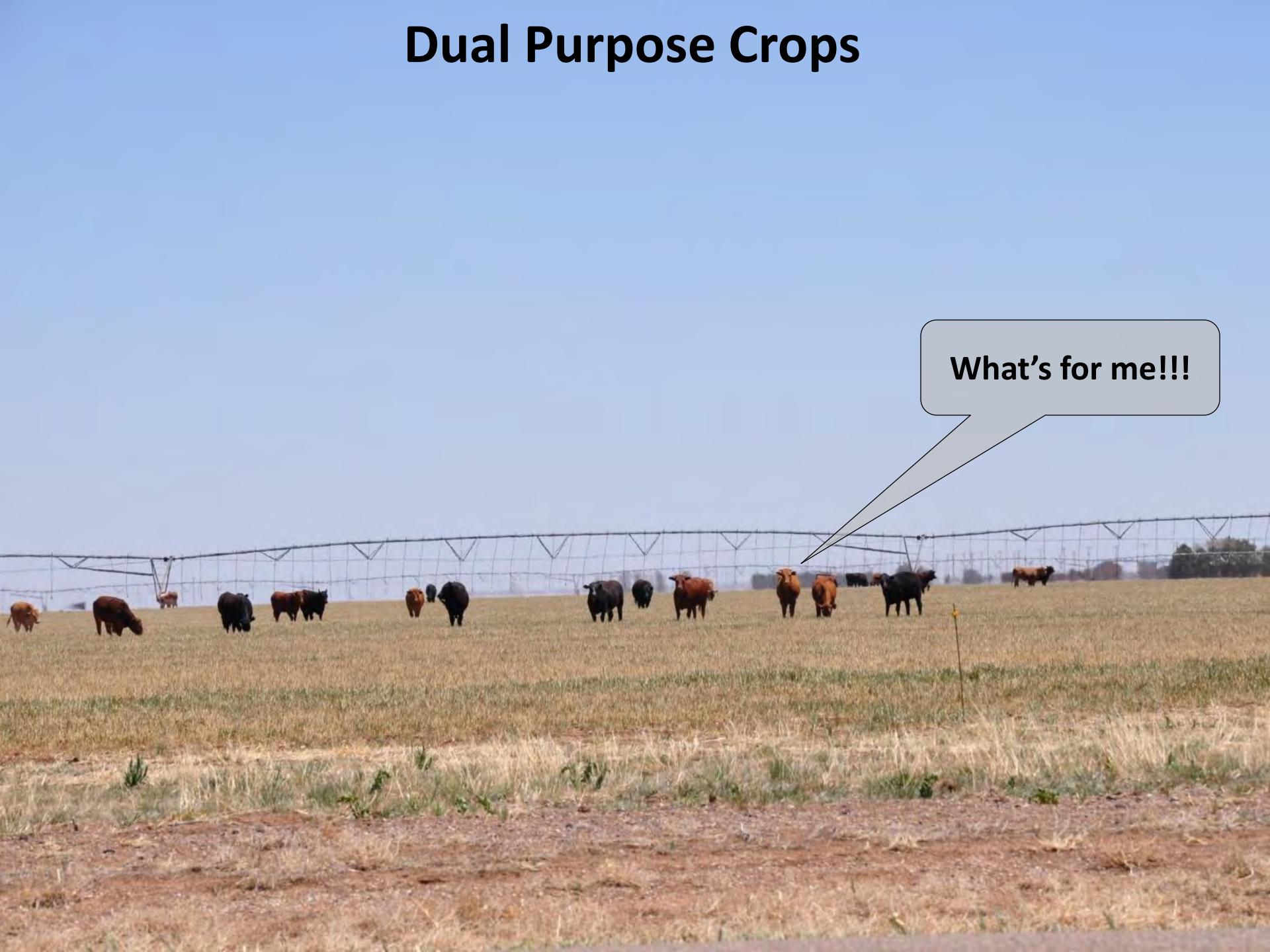
Water Use and Forage Production

By Winter Canola & Wheat



(Clovis, 2009-11)

Dual Purpose Crops

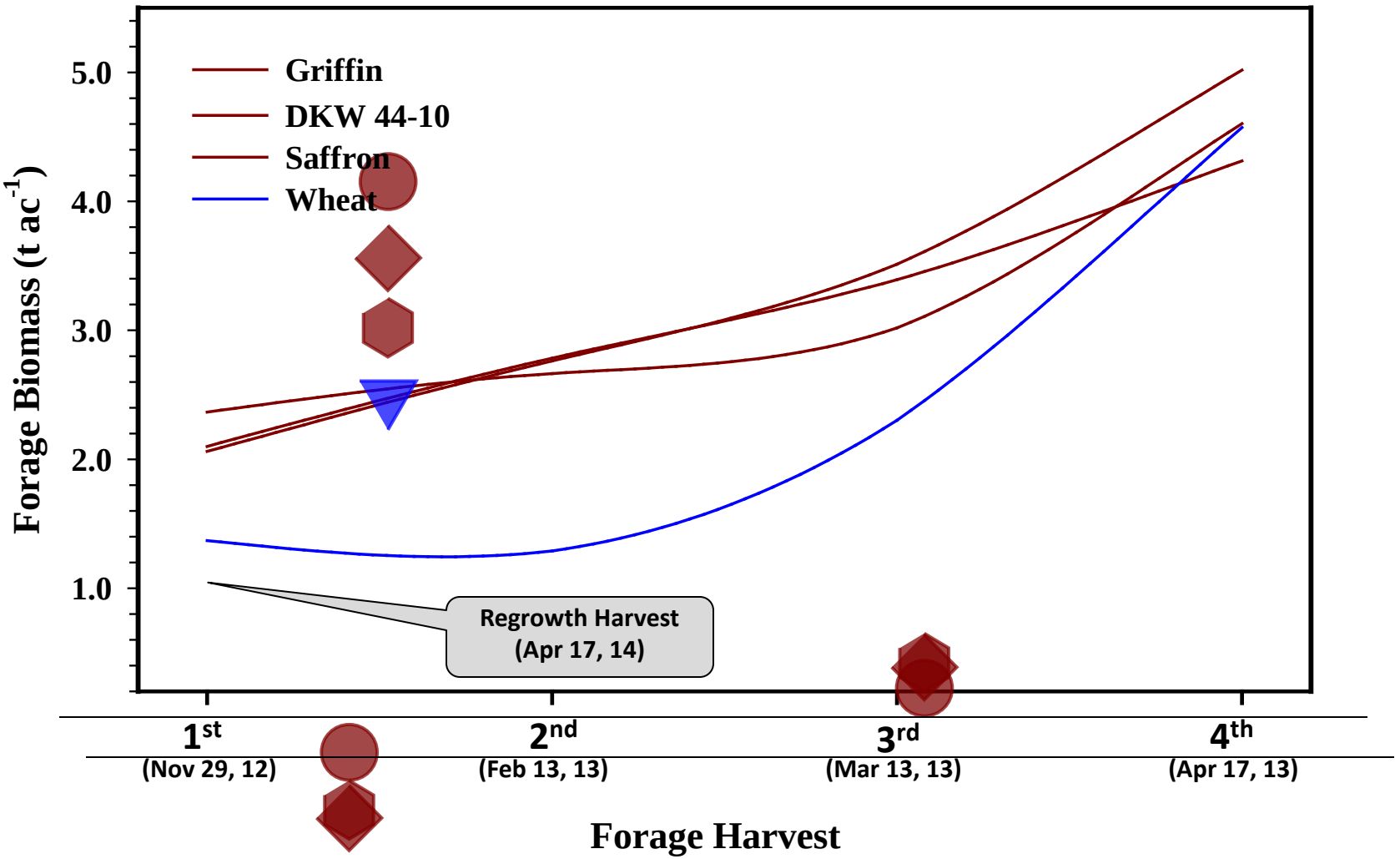


Why Canola!!!

Winter Survival Canola vs. Wheat

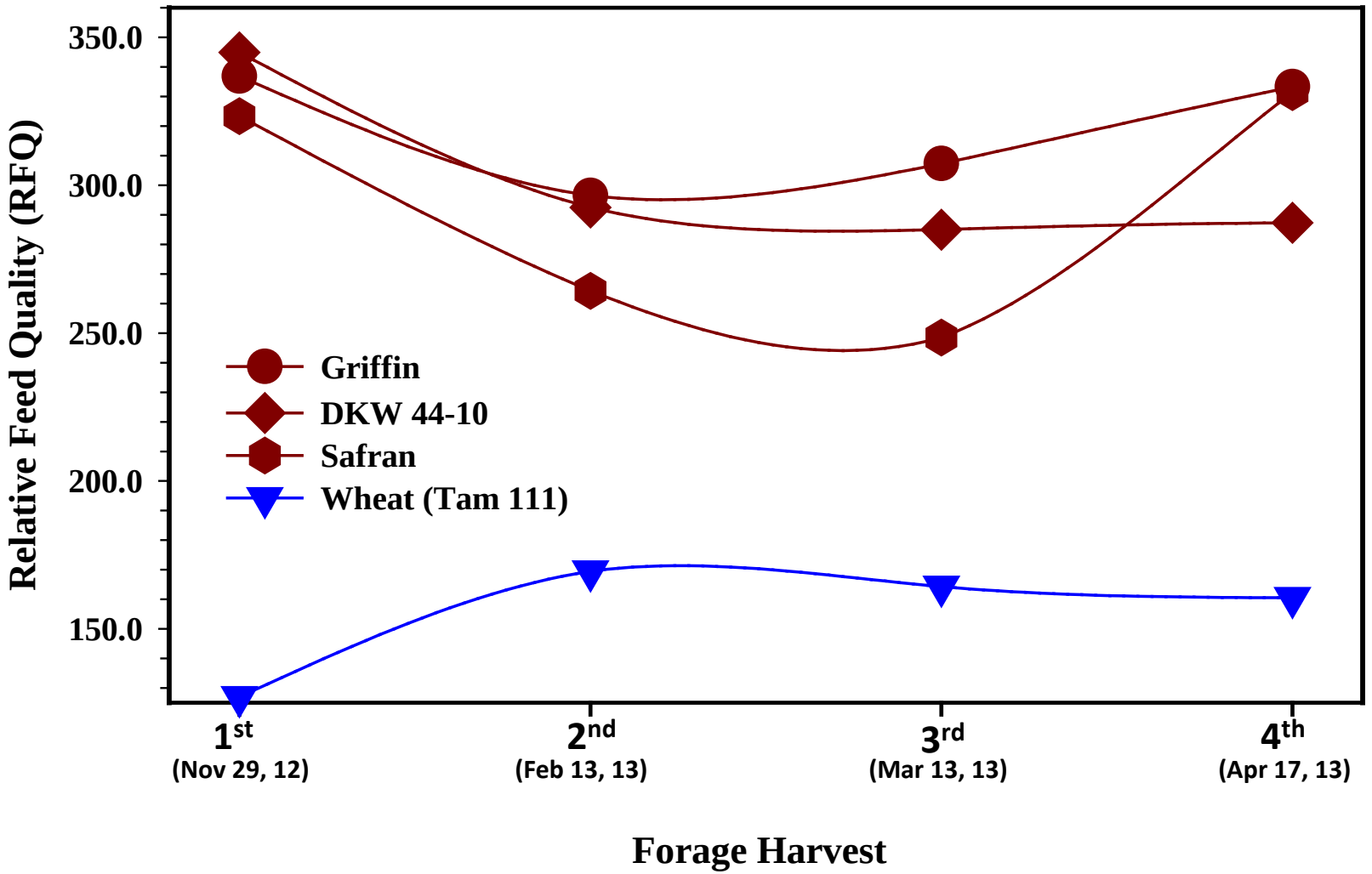
(Clovis, 2013)

Forage Productivity



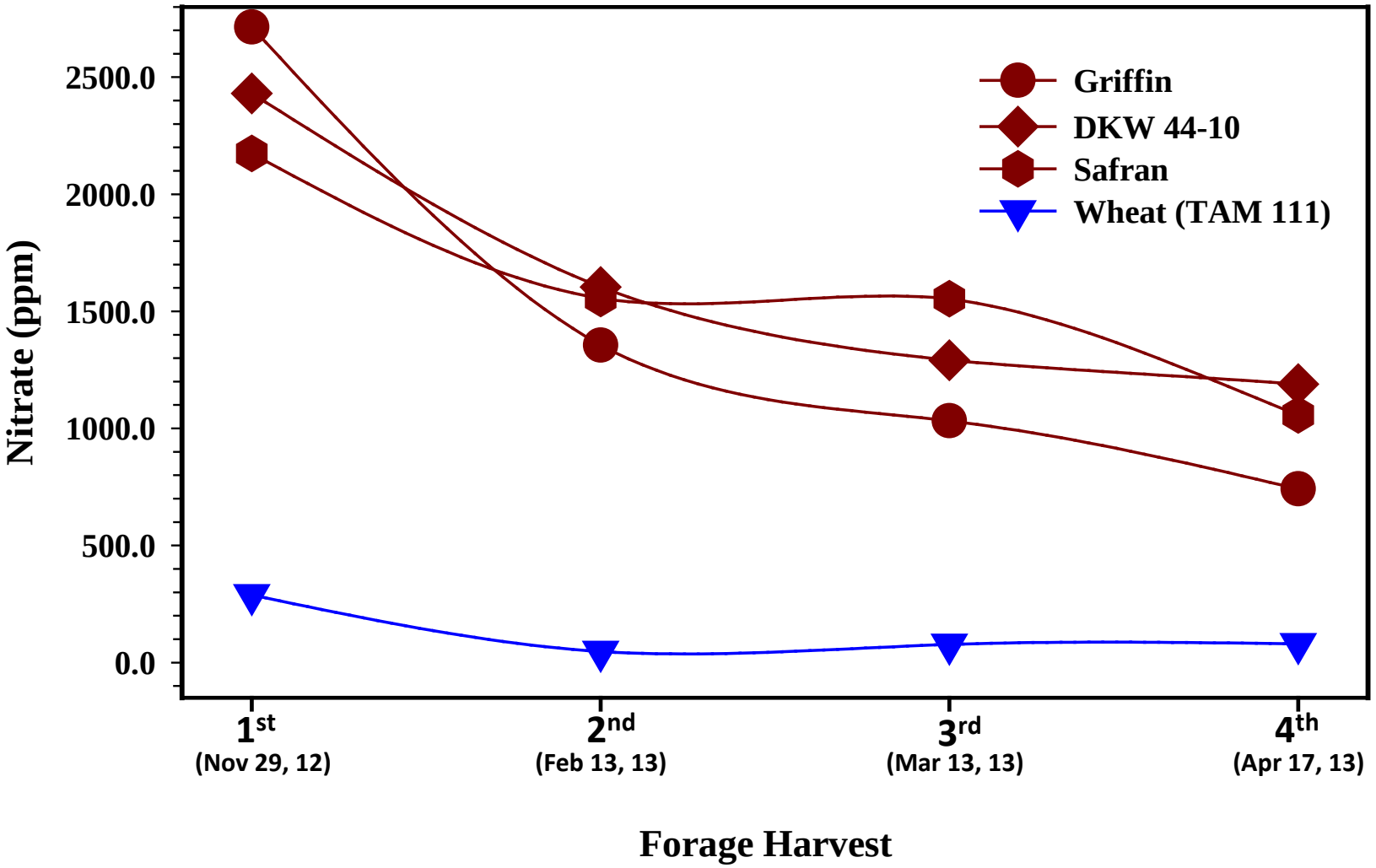
(Clovis, 2012-13)

Forage Quality



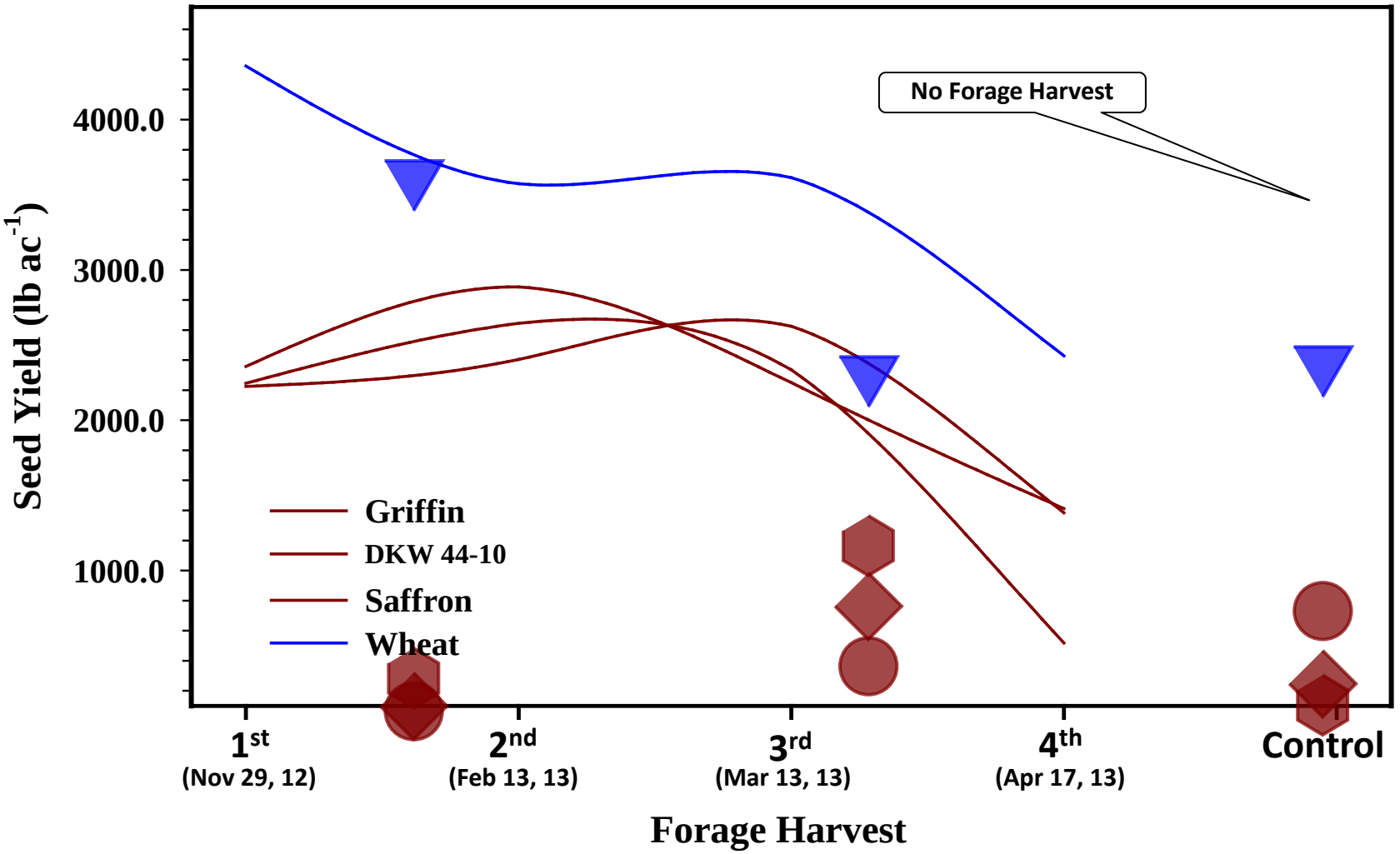
(Clovis, 2012-13)

Forage Nitrate Content



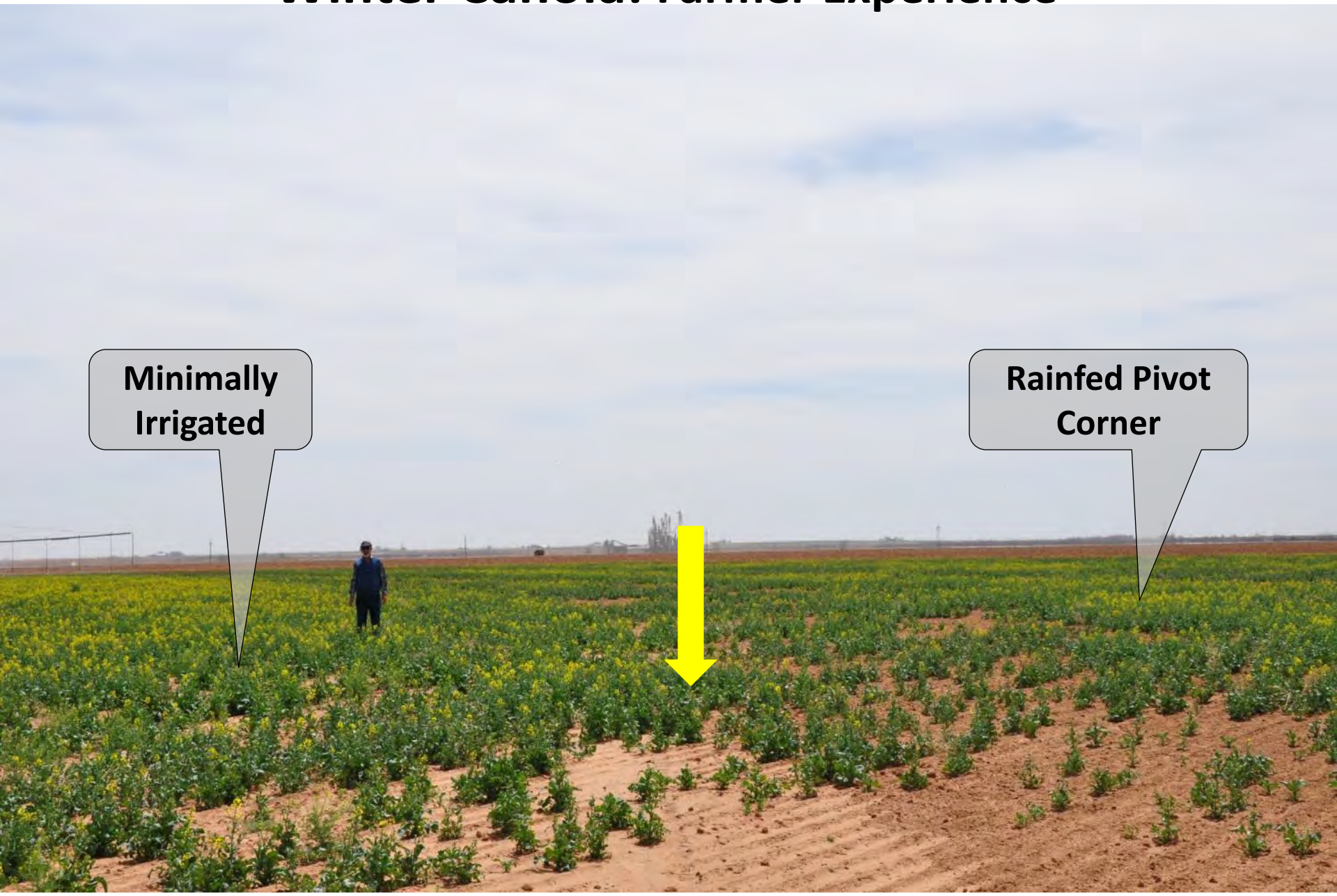
(Clovis, 2012-13)

Grain Production



(Clovis, 2012-13)

Winter Canola: Farmer Experience



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.

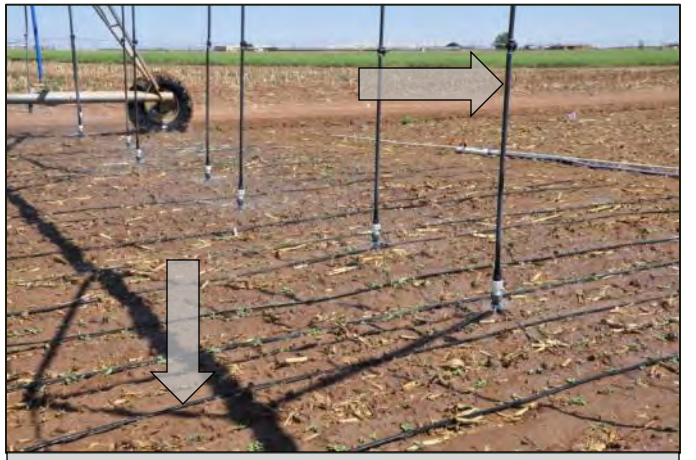
A New Generation of Desert Crops

Pre-season and in-season irrigation management in safflower

- **Experimental Design: Split Plot**
  - **Main plot: Soil Profile**

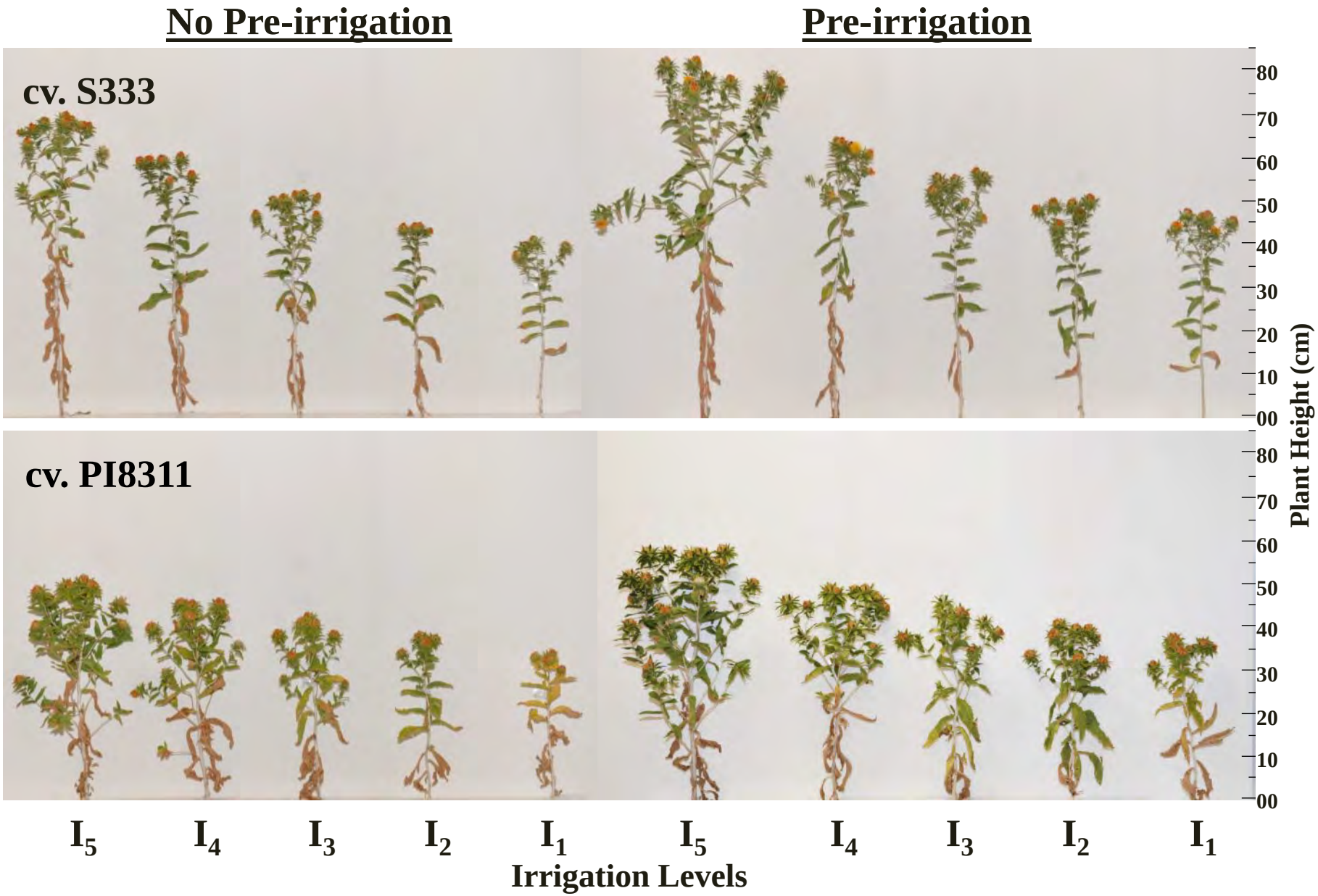
    1. Pre-irrigation (**PI**) (160 mm)

    2. No-pre-irrigation (**NPI**) (depleted soil profile)
  - **Sub plot: cultivars and irrigation levels**
    - Cultivars: 2 (S333 & PI8311)
    - Irrigation levels: 5
      - I_1, I_2, I_3, I_4 and I_5
      - (75, 150, 225, 300 and 375 mm)

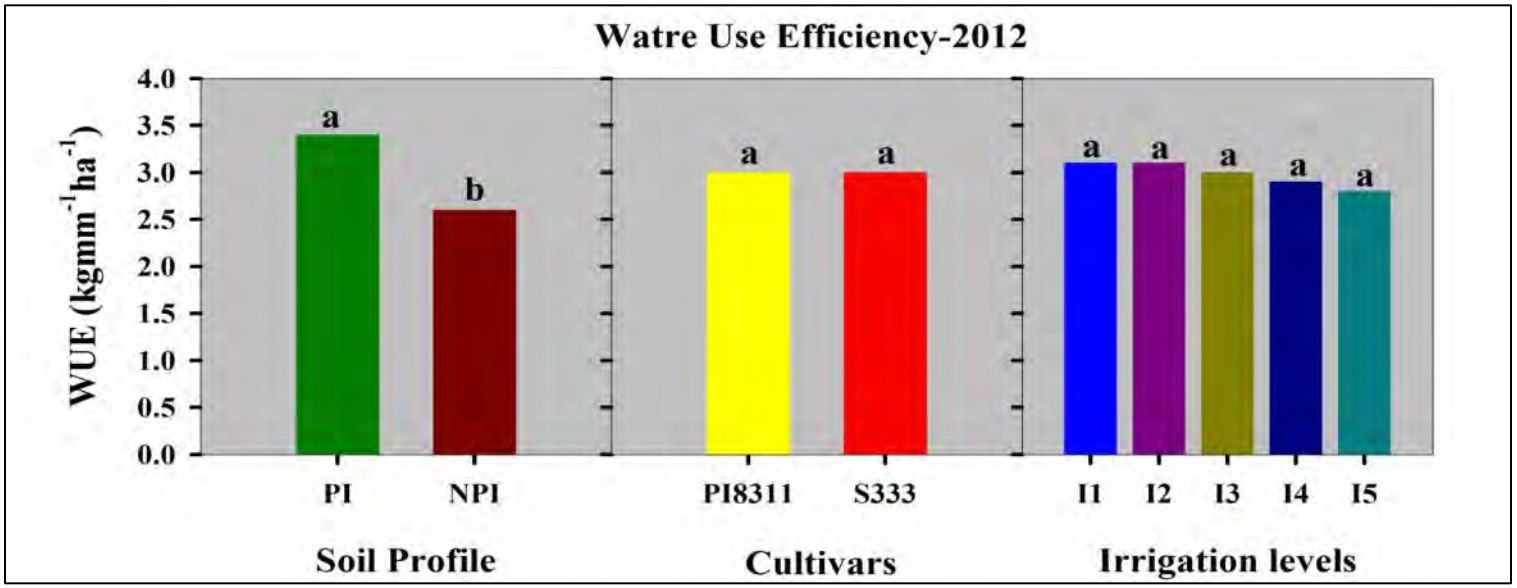


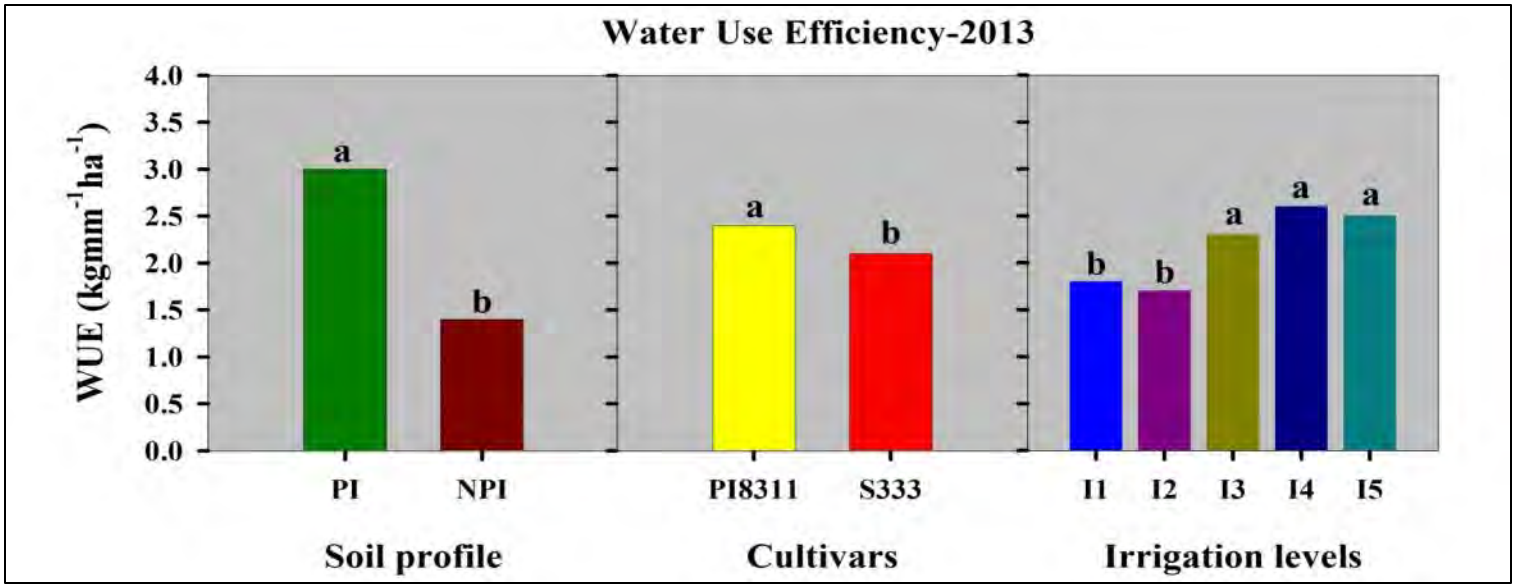
Drip & central pivot irrigation

Safflower response to pre- and in-season irrigation



Water Use Efficiency





Yield and Yield Attributes

	2012				2013			
Treatment	**Heads plant $^{-1}$**	**Seeds head^{-1}**	**Seed yield (kg ha^{-1})**	**Oil yield (kg ha^{-1})**	**Heads plant $^{-1}$**	**Seeds head^{-1}**	**Seed yield (kg ha^{-1})**	**Oil yield (kg ha^{-1})**
PI	**7.3 a**	**25.9 a**	**1459 a**	**525.2 a**	**5.5 a**	**23.6 a**	**1284 a**	—
NPI	**5.5 b**	**22.7 b**	**1047 b**	**372.0 b**	**3.7 b**	**18.3 b**	**589 b**	—
Irrigation levels								
I_1	**4.9 d**	**21.2 c**	**880 d**	**319.9 d**	**3.2 d**	**18.4 b**	**510 c**	—
I_2	**5.3 d**	**22.7 bc**	**1079 cd**	**391.7 cd**	**4.3 c**	**19.1 b**	**584 c**	—
I_3	**6.2 c**	**24.6 ab**	**1253 bc**	**447.2 bc**	**4.6 c**	**21.5 a**	**936 b**	—
I_4	**7.1 b**	**26.1 a**	**1426 ab**	**513.0 ab**	**5.2 b**	**22.3 a**	**1269 a**	—
I_5	**8.4 a**	**26.7 a**	**1626 a**	**571.2 a**	**5.8 a**	**23.7 a**	**1383 a**	—
Cultivars								
PI8311	**6.6 a**	**22.7 b**	**1280 a**	**458.8 a**	**4.6 a**	**21.9 a**	**995 a**	—
S333	**6.2 a**	**25.9 a**	**1226 a**	**438.5 a**	**4.6 a**	**20.0 b**	**878 b**	—

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.

Safflower: Farmer Experience

Thank You

(Clovis, 2013)