AgriLIFE RESEARCH
Texas

Reducing Groundwater Use in the Texas High Plains

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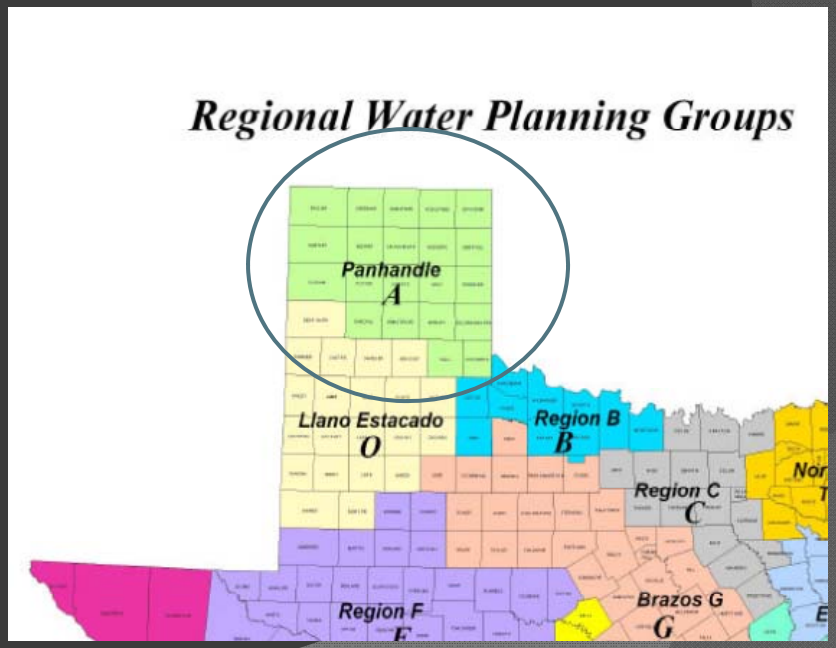
Improving Life through Science and Technology

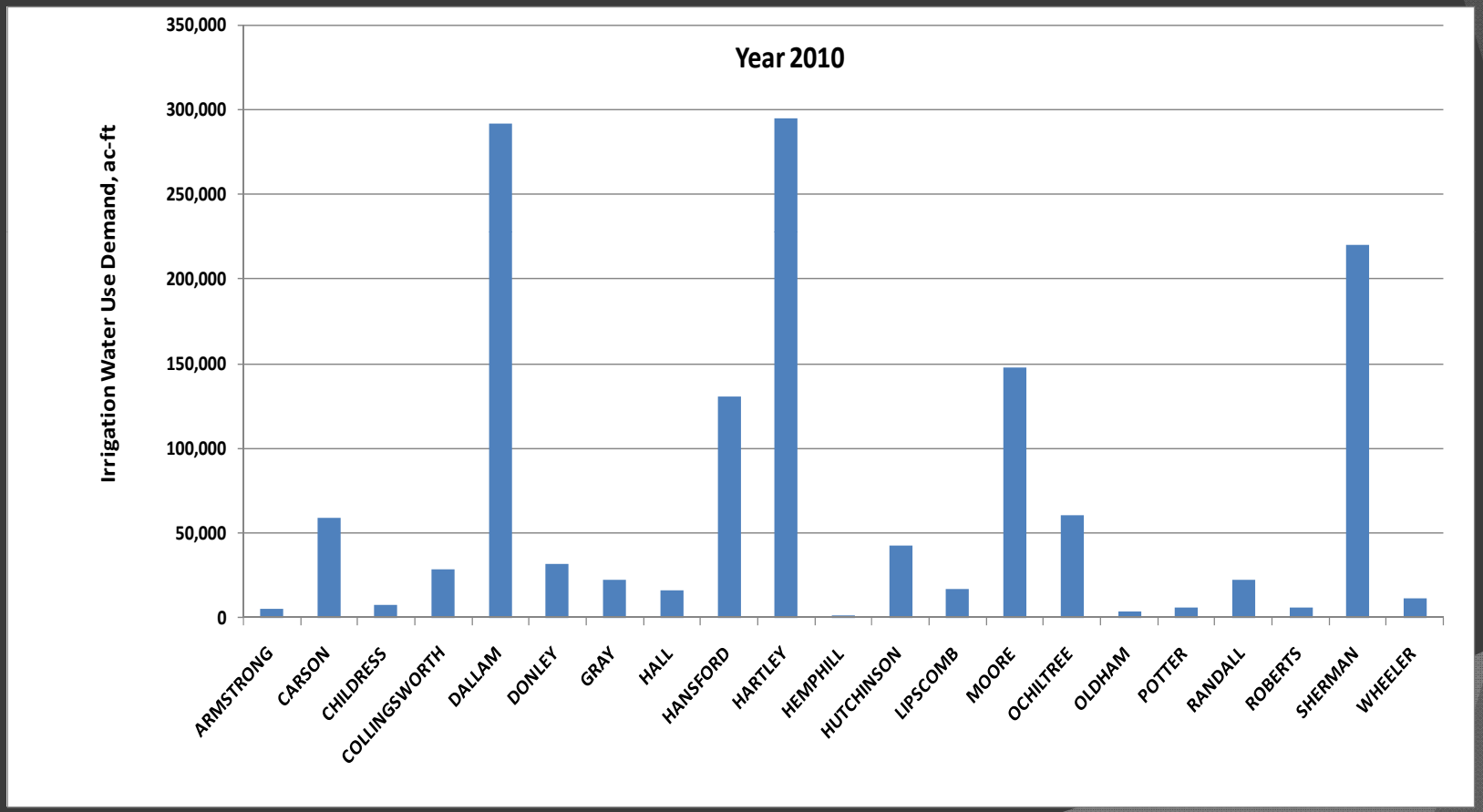
Region A: Texas Panhandle Production

Use: Texas High Plains is the largest water-consuming region in Texas with ~90% of the water used for agriculture. It overlays the vast Ogallala aquifer.

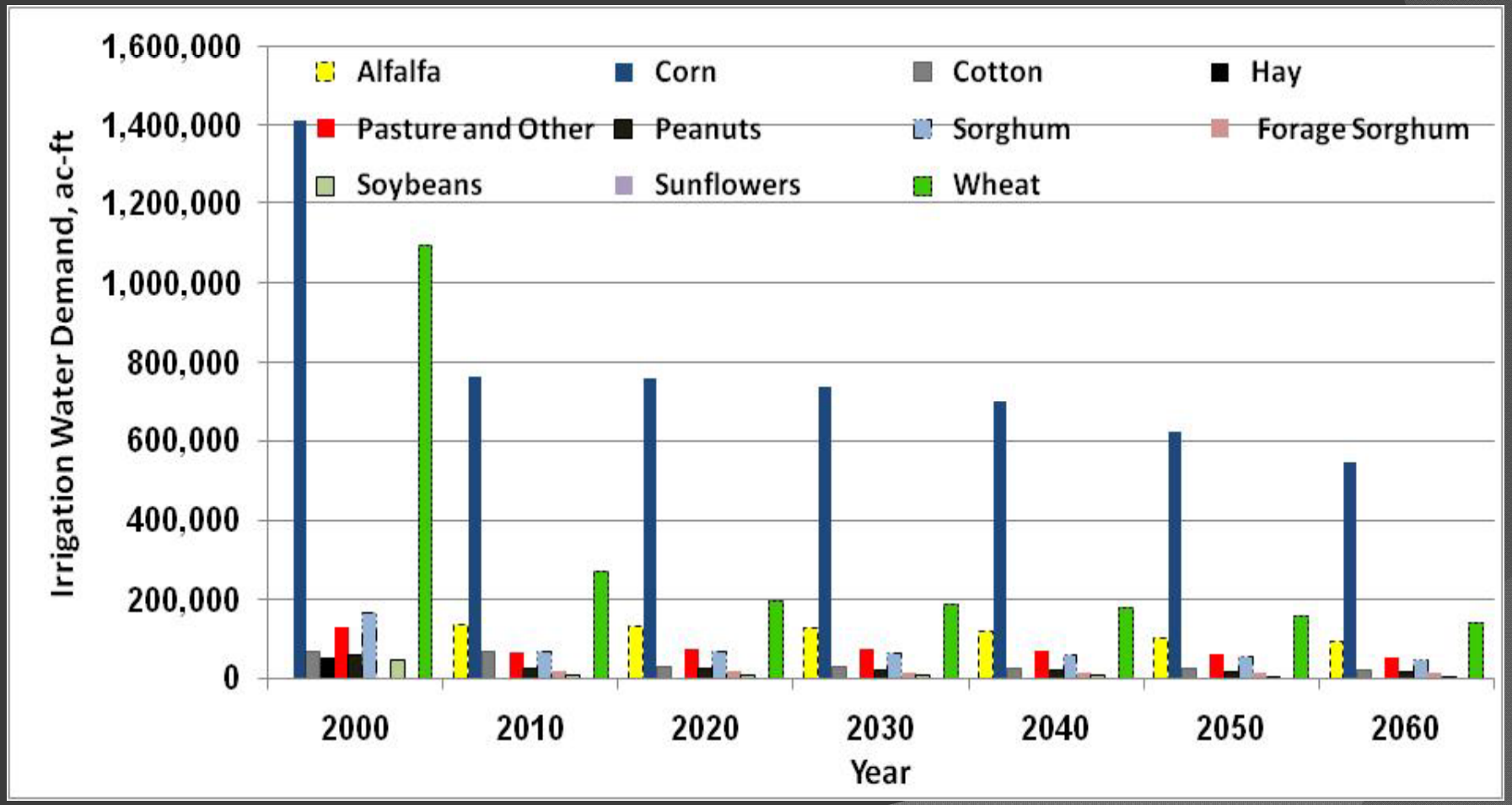
- Benefit: Region A (21 cntys) results in production of state crops:
- 53% of corn,
- 51% of wheat,
  11% of cotton,
  61% of ensilage,
  19% of grain sorghum,
  74% of cattle on feed,
  94% of swine, and
  24% of dairy.
- Irrigation is responsible for ~90% of production: in 2011-~ALL.



Region A County water use



Water and Corn



Why corn (and breeding pgm) is important in Texas ?

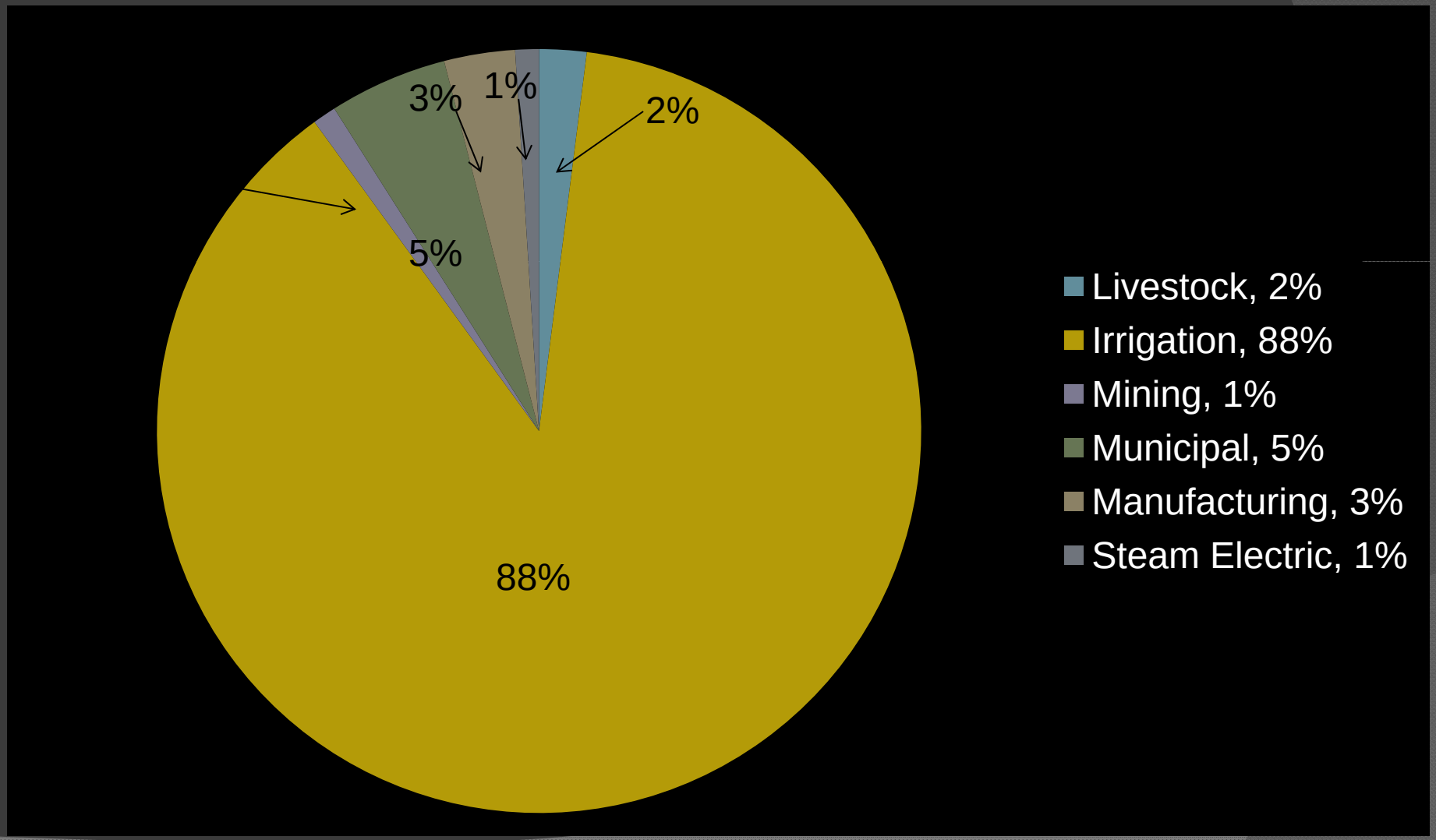
- ~30% of nation's feed beef within 125-150 mile radius of Amarillo

- They require lots of grain (preference is corn)
- That grain production requires lots of water!!! (4,000gal/bu)

- Texas production provides 1/3 of FB need
- 66% of FB demand shipped from Midwest

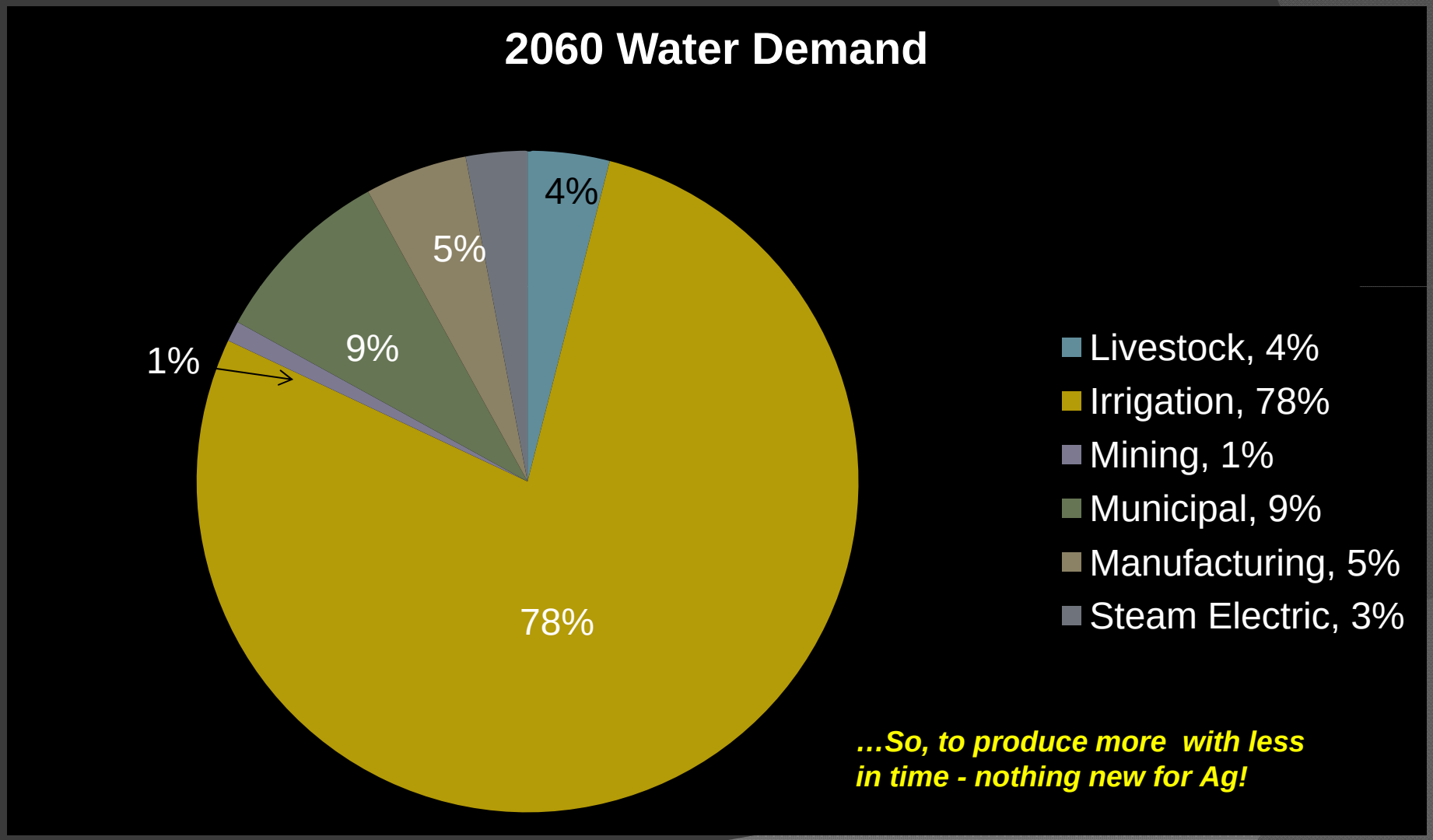
- Other demands from ethanol and fuel mandates

2010 Water demand



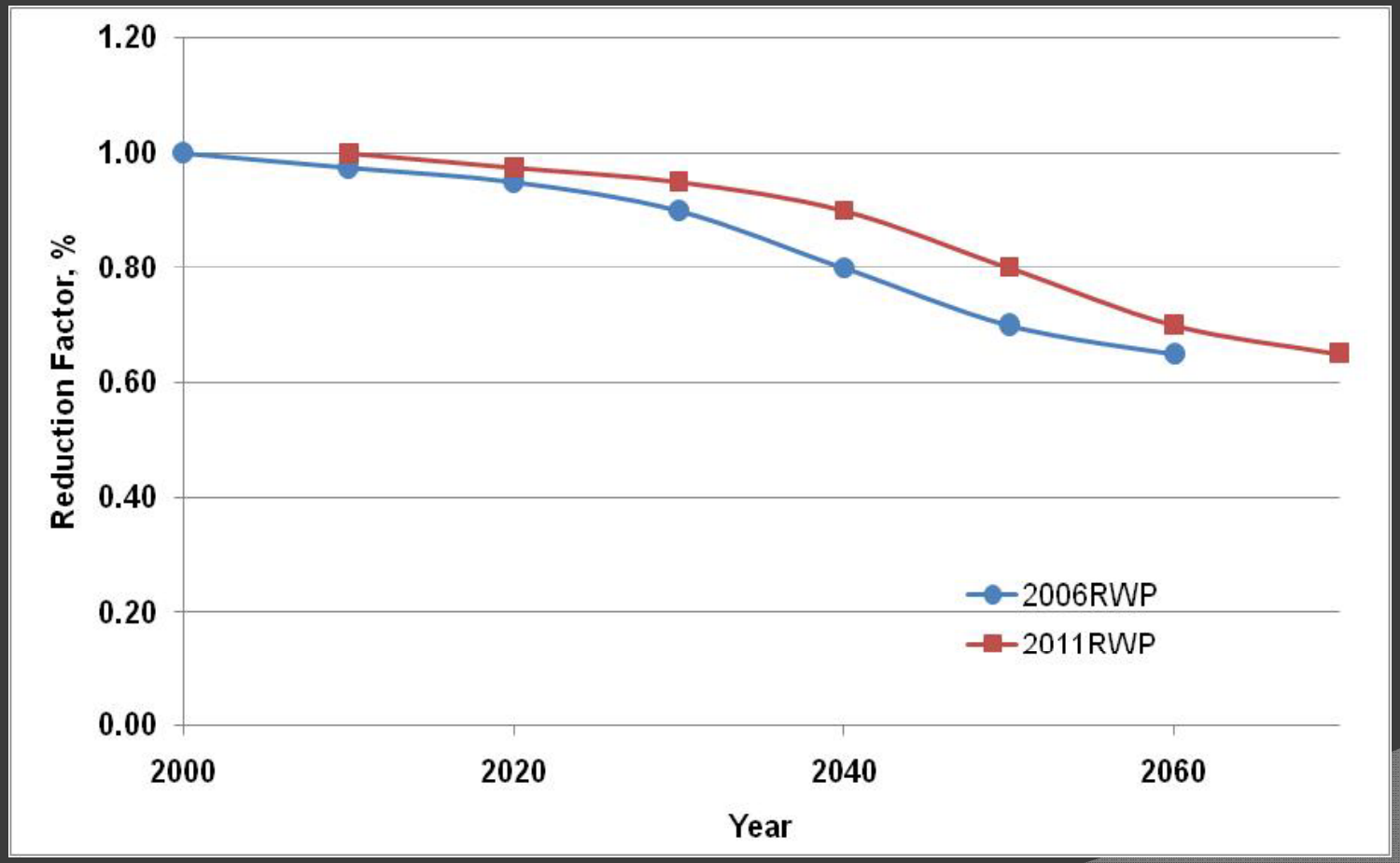
Source: 2011 PRWP

2060 Projected water demand



Source: 2011 PRWP

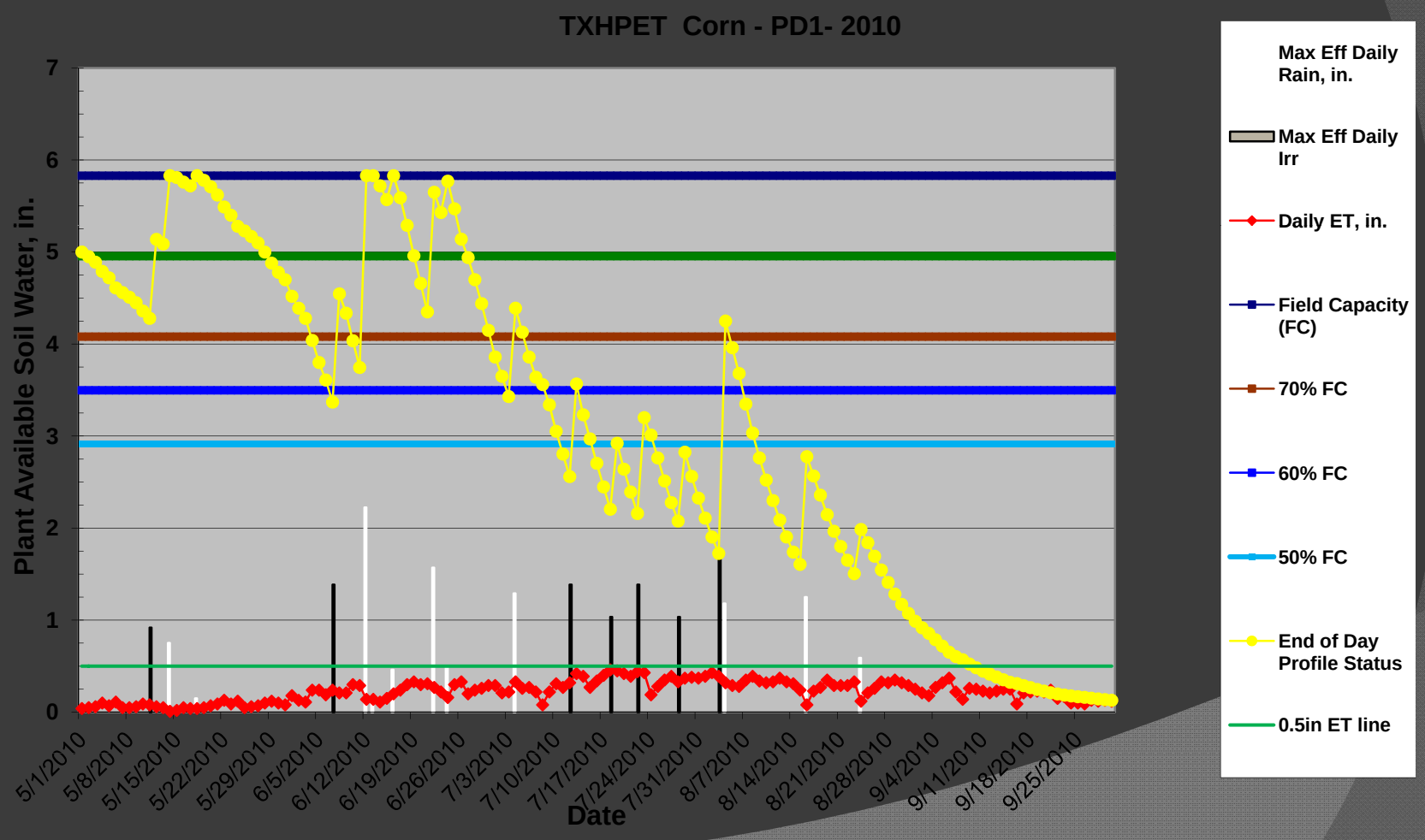
More with less…same story for Ag.

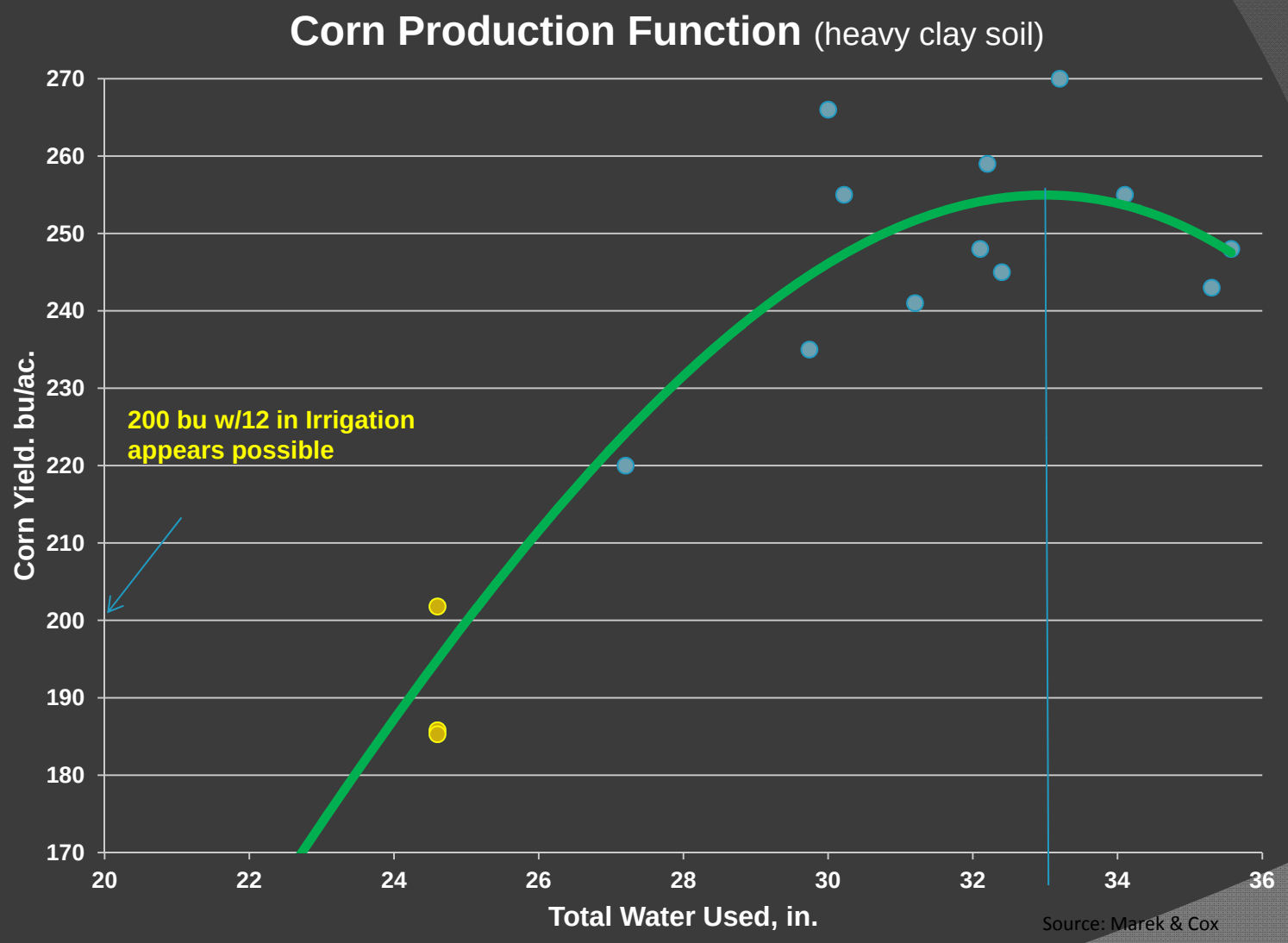


Groundwater Reduction Strategies

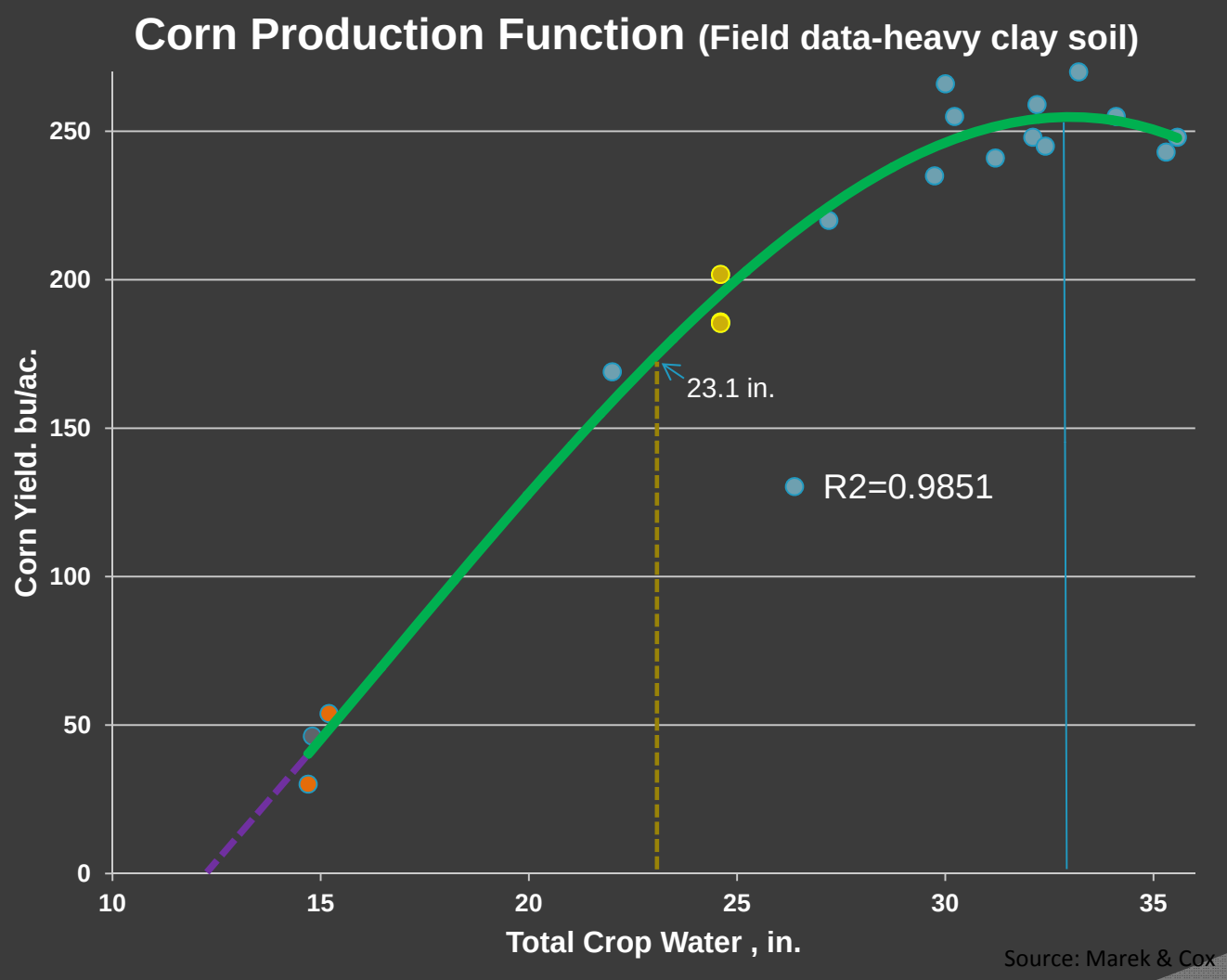
- ~10 ways in 3 Reg A RWP's on file…
- …the Hows are key and essential
- ET networks & scheduling– 10% (adoption)
- Classical Corn Breeding – surprising?
- Transgenic corn – 10 to 12% (maybe)
- Regulation - DFC's

Corn seasonal limited water balance with irrigation scheduling





Corn Production F(x) of new hybrids…new data



Corn Production F(x) …updated 2011 data

Corn Breeding Program

(headquartered at Texas AgriLife-Lubbock)

Drought

Heat

Insects - CEW

Insects - Mites

Mycotoxins - Aflatoxins

1st: Development process of a corn hybrid

Corn Hybrid Development

- A corn hybrid is the first generation of progeny between two parent inbred lines. P1 x P2 → F1
- The F1 progeny is more vigorous than their two pure lines (→ hybrid vigor or heterosis).

Step 1: Evaluate germplasm.

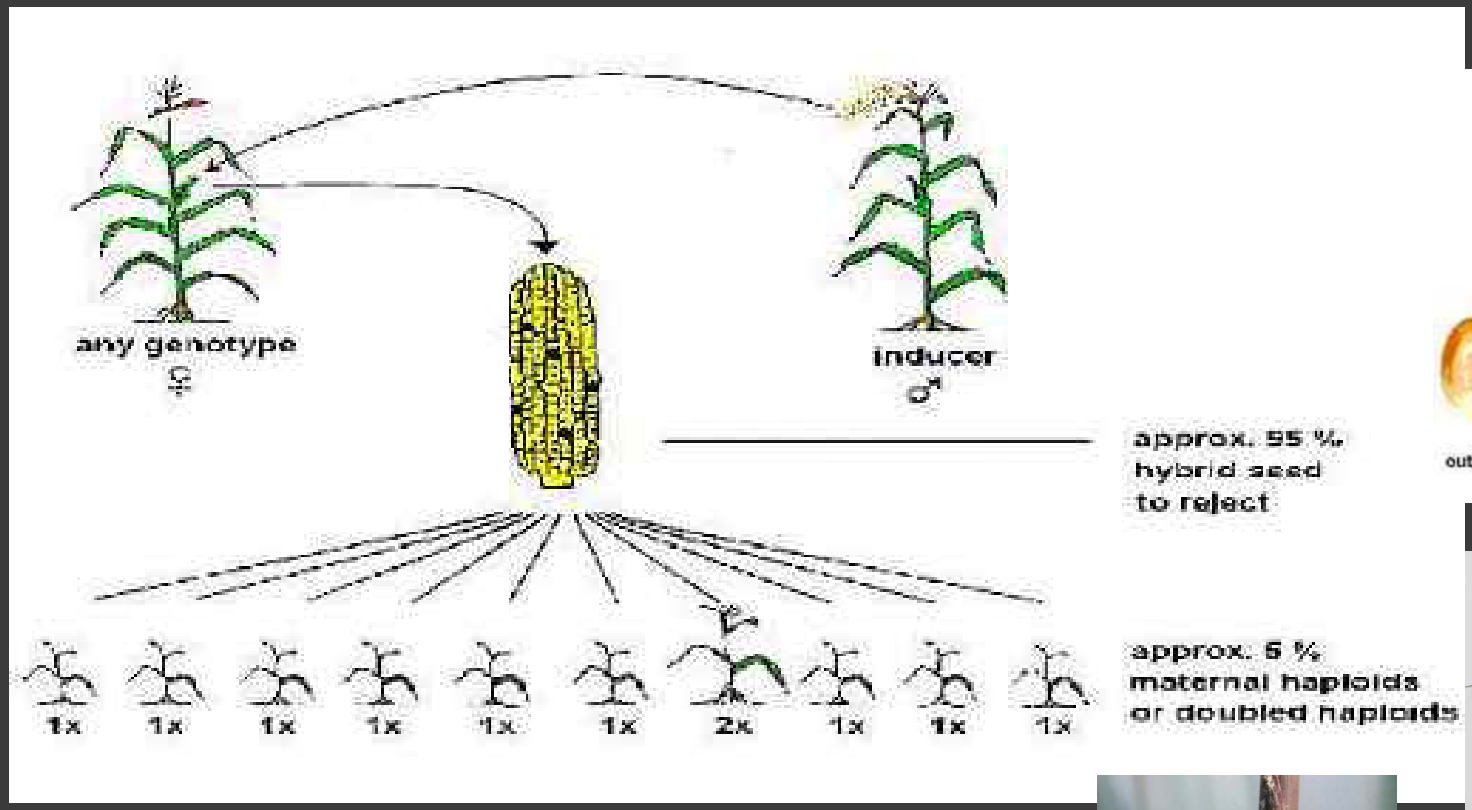
Step 2: Develop an inbred line.

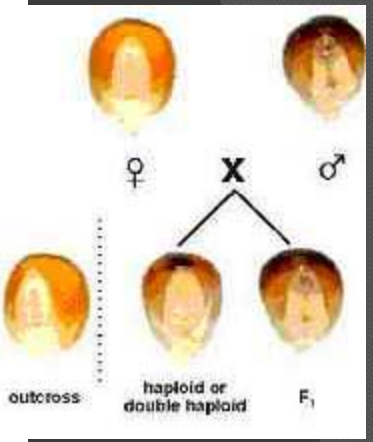
Step 3: Cross two inbred lines,
test the crosses,
identify the <u>best</u> crosses
(→ commercial hybrid)

Inbred Line Development by 2 methods

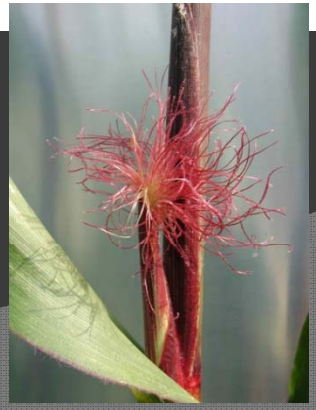
	Pedigree Selection	Doubled haploid
Season 1	F_1 Breeding Cross	F_1 Breeding Cross
	↓ Self	↓ x Haploid inducer
Season 2	F_2 population: > 500 plants	Haploid seeds
	↓ Select and self	↓ Select and self
Season 3	F_3 families: 180 rows	Doubled haploid plants = Pure line
	↓ Select and self	
Season 4	F_4 population: 80 rows	
	↓ Select and self	
Season 5	F_5 population: 40 rows	
	↓ Select and self	
Season 6	F_6 population: → Select and self →	Inbred lines

Doubled Haploid Methods for Inbred Line Development





- Quick way to reach homozygosity
- Gamete selection



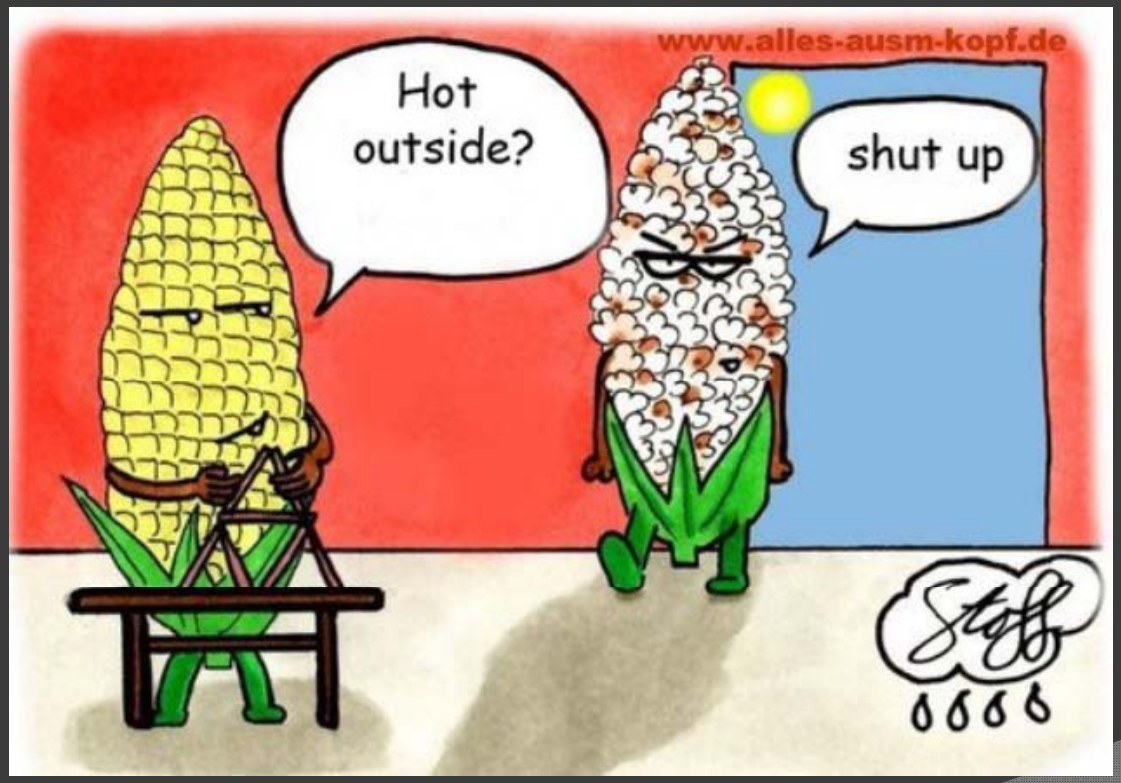
Cross Lines to Make Corn Hybrids

- Cross two inbred lines P1 x P2 → F1 (last step to stack genes)
- Test many F1 crosses in multiple environments.
- Identify the best crosses (→ commercial hybrid)
- Increase parent line seeds and produce hybrid seeds.

→ Takes 2-4 years

Improving Drought Tolerance

- Selection process for heat tolerance trait.



Field Evaluation of Heat Tolerance

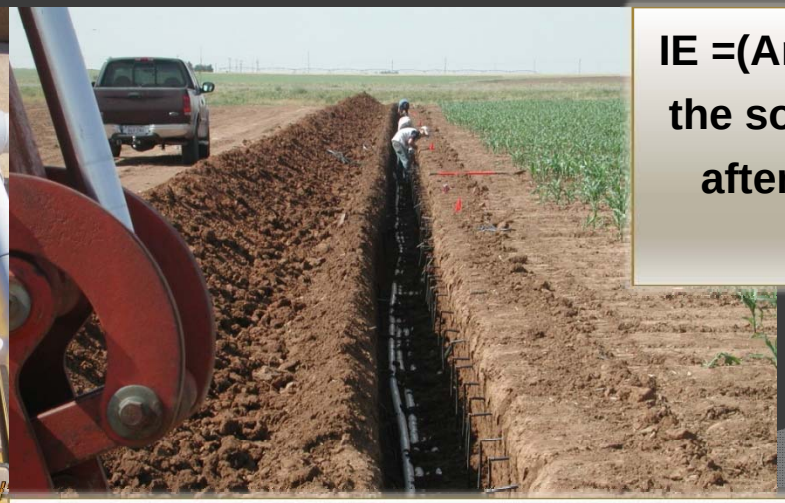
How to Evaluate and Improve Drought Tolerance?

- Select for heat tolerance.
- Measure physiological and biochemical traits under controlled stress in a greenhouse and growth chambers.
- Subject plants to controlled drought stress in the fields.
- Integrate genomic and transgenic tools to transfer drought tolerance genes to elite germplasm.

Irrigation Systems, Efficiency & Stress

Furrow irrigation: 40-60%

Center pivot irrigation: LEPA 95-98%



IE =(Amount of water stored in the soil available for crop use after irrigation)/(amount of water pumped).

Subsurface drip irrigation: 98-100%

Drought Stress Symptoms In Corn

Leaf rolling

Shorter plant

Early senescence

Stalk lodging

Aspergillus flavus

Poor seed set, short ear, small kernel, molded kernels (high aflatoxins)

…and YES, severe drought stress can and does cause total crop loss!

Xu “Stay green” rating system

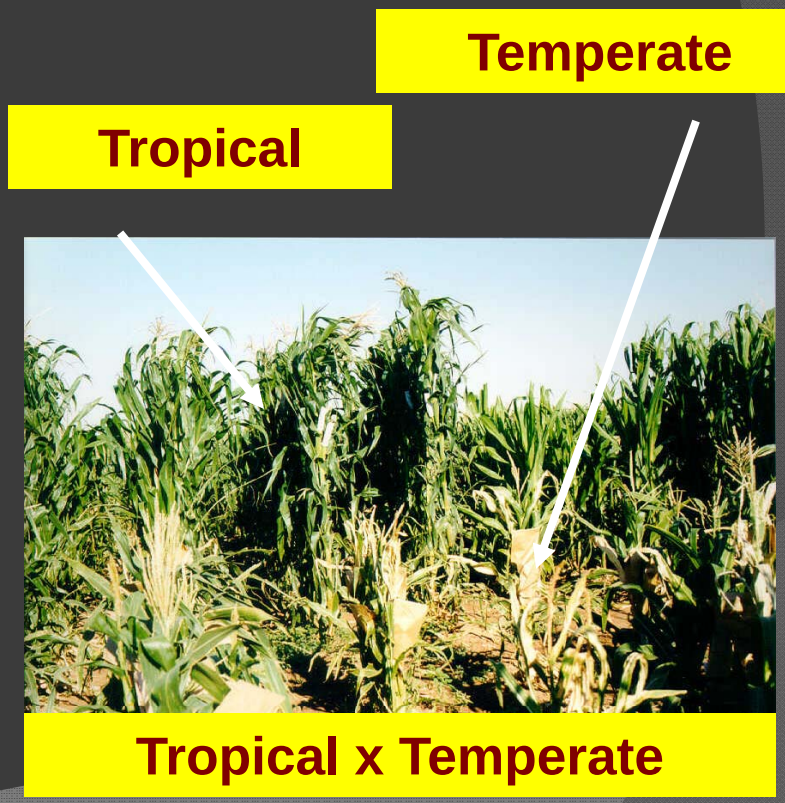
1 = 100% green, 2 = 75%, 3 = 50%, 4 =25%, 5 = 0% green leaves

Native Drought Tolerance Genes

- **Tropical and exotic germplasm**:
  - ➔ GEM (Germplasm Enhancement of Maize) Project
  - ➔ CIMMYT

- Evaluate for drought and heat tolerance, insect resistance, grain mold resistance, yield and other agronomic traits.

➔ **Develop multiple stress tolerant corn.**



Teosinte as a Potential Source of Rust Resistance?

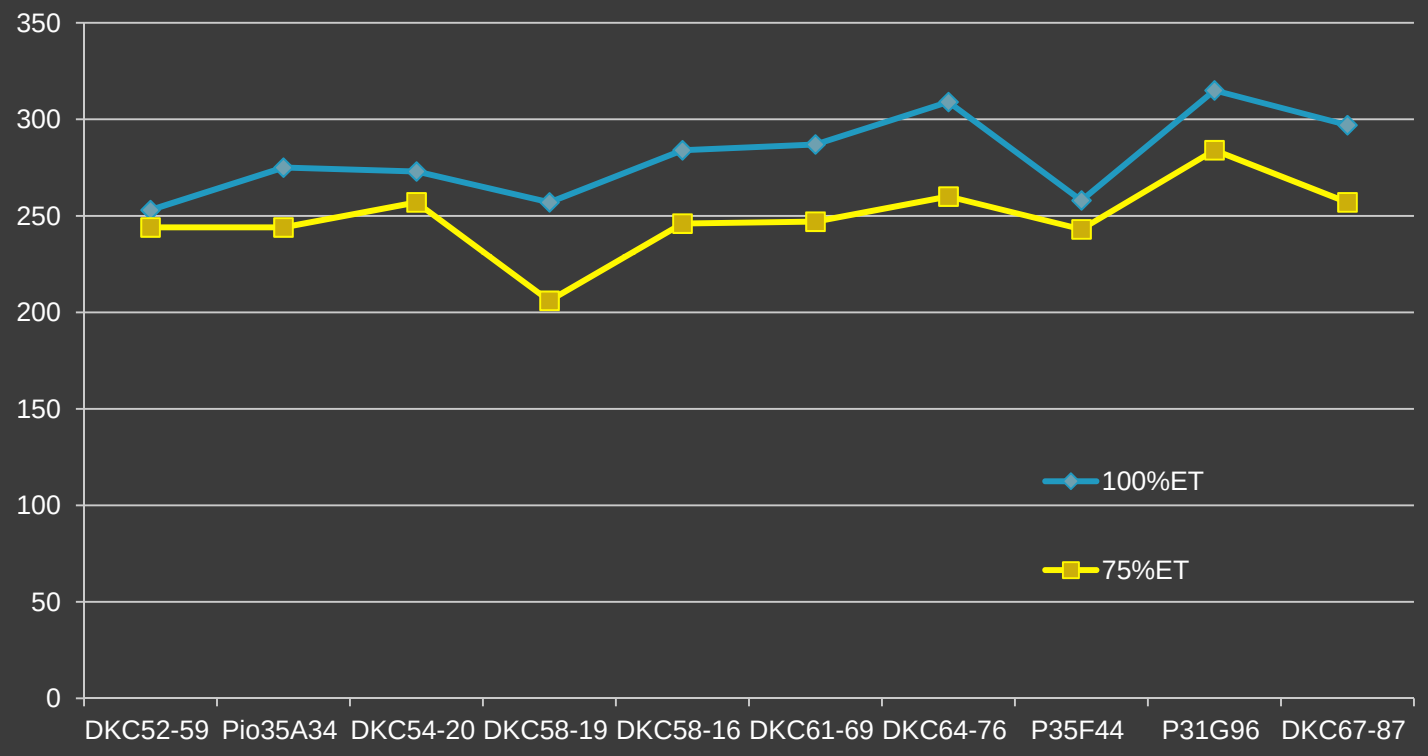
Selfed ears of F_1 plants

Ears of BC_3F_1 plants with 6.25% teosinte germplasm.

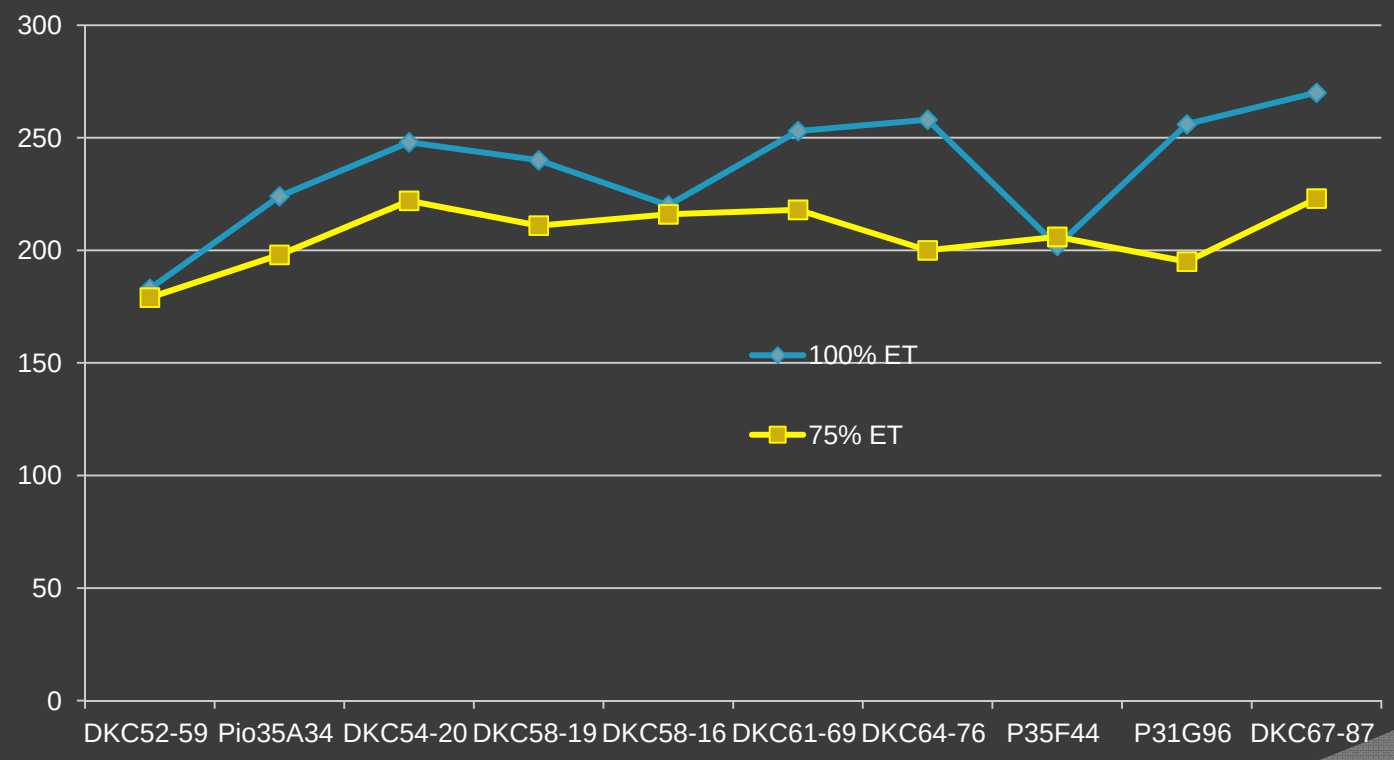
Teo-Lines

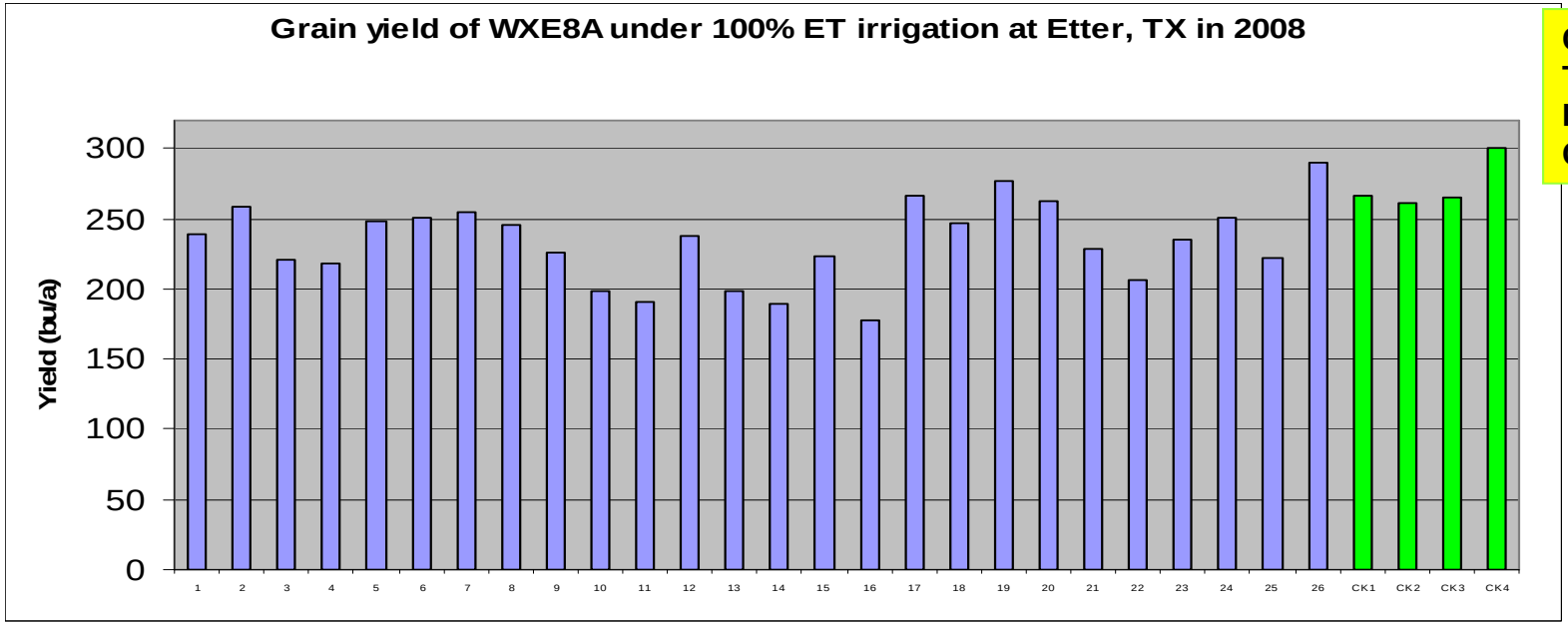
PERFORMANCE OF EXPERIMENTAL AND COMMERCIAL HYBRIDS UNDER DIFFERENT STRESS

2009 Commercial Results- Etter, TX

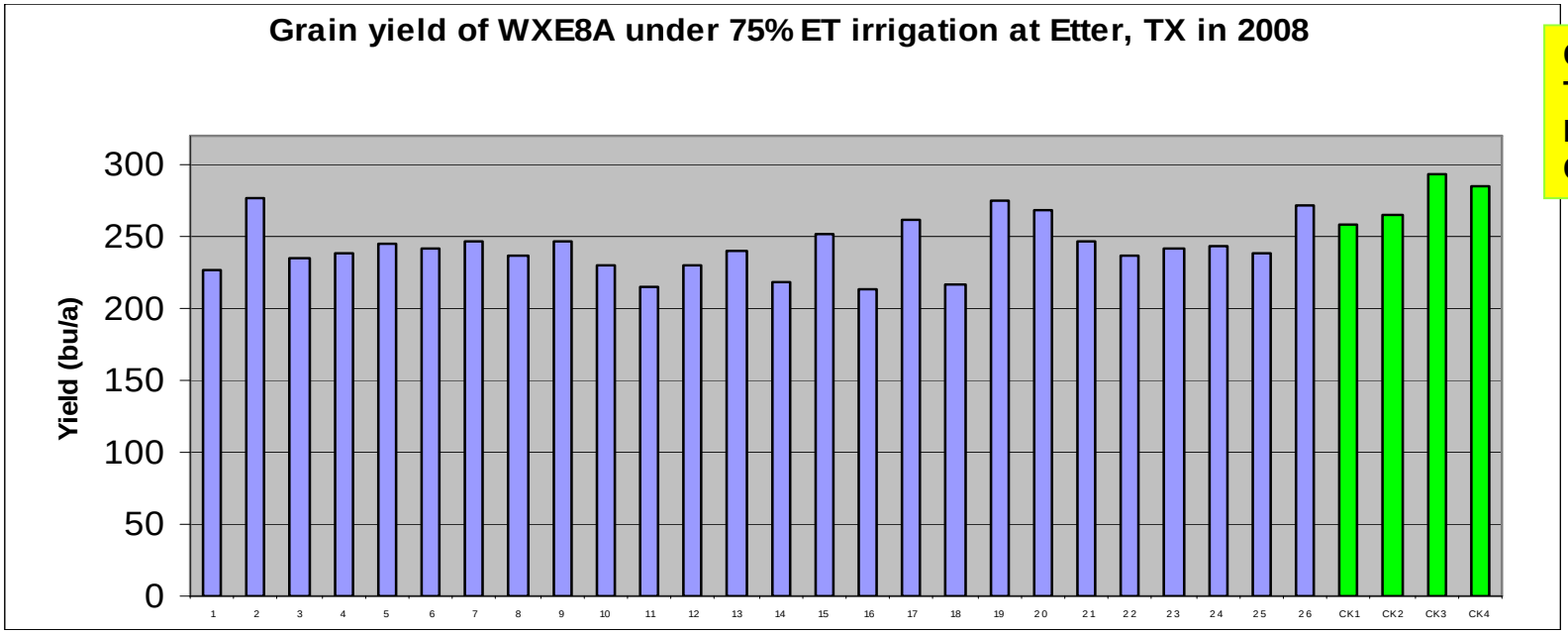


2010 Commercial Results- Etter, TX



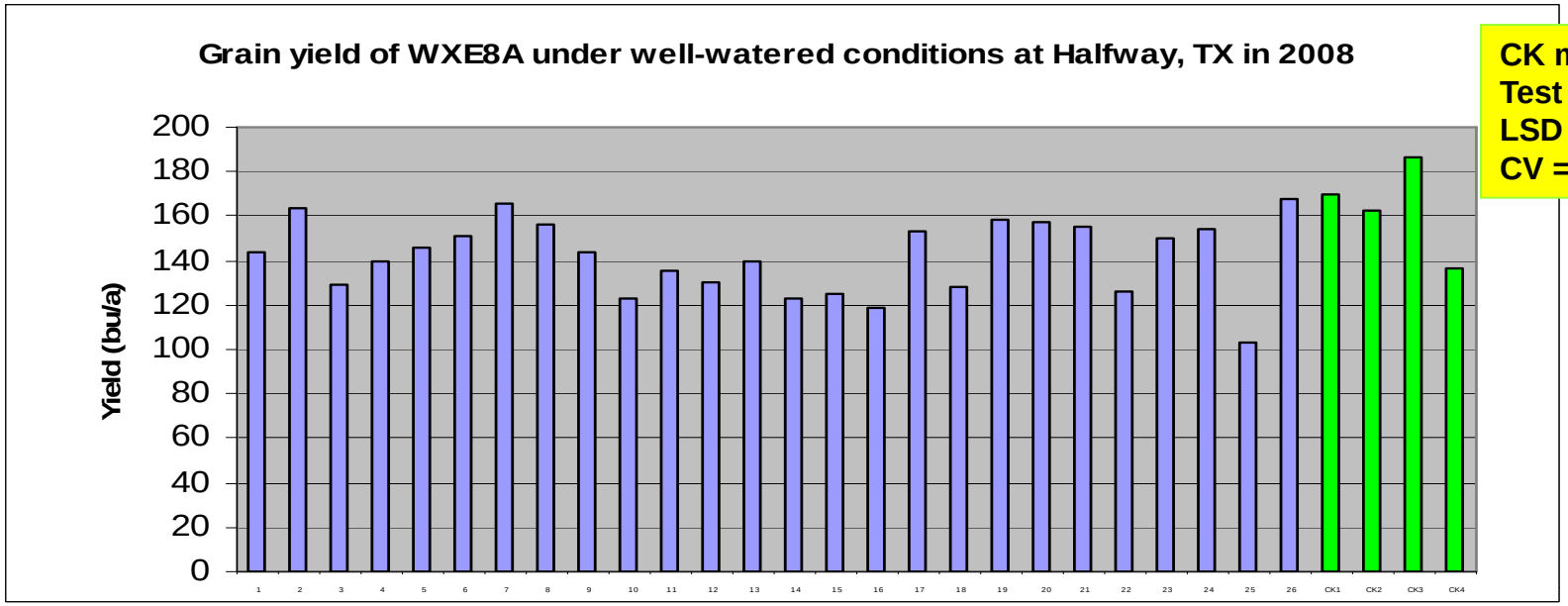


CK mean = 273.5
Test mean = 238.5
LSD $_{0.05}$ = 57.5
CV = 7.4%

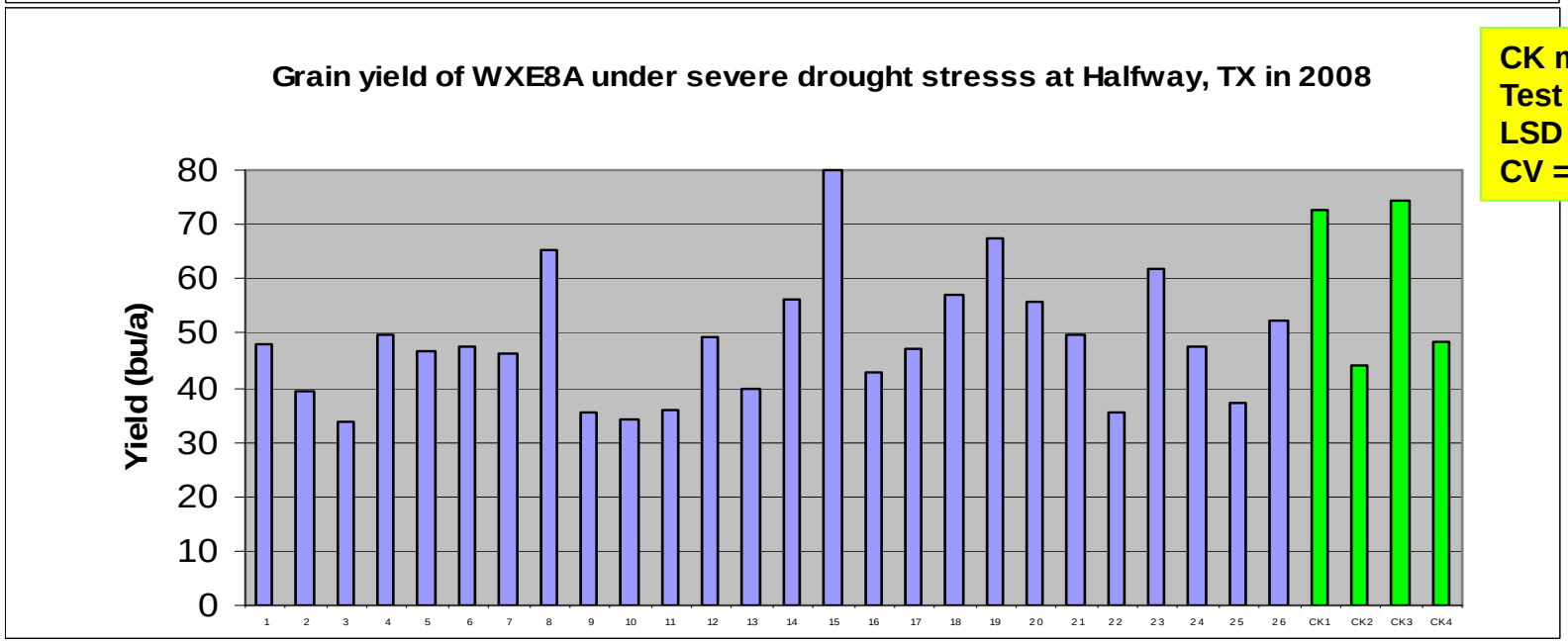


CK mean =285.5
Test mean = 246.5
LSD $_{0.05}$ = 29.7
CV = 5.9%

CK1 = BH8913RR/YGCB, CK2 = DKC 66-23, CK3 = DKC 67-87, CK4 = P31G96

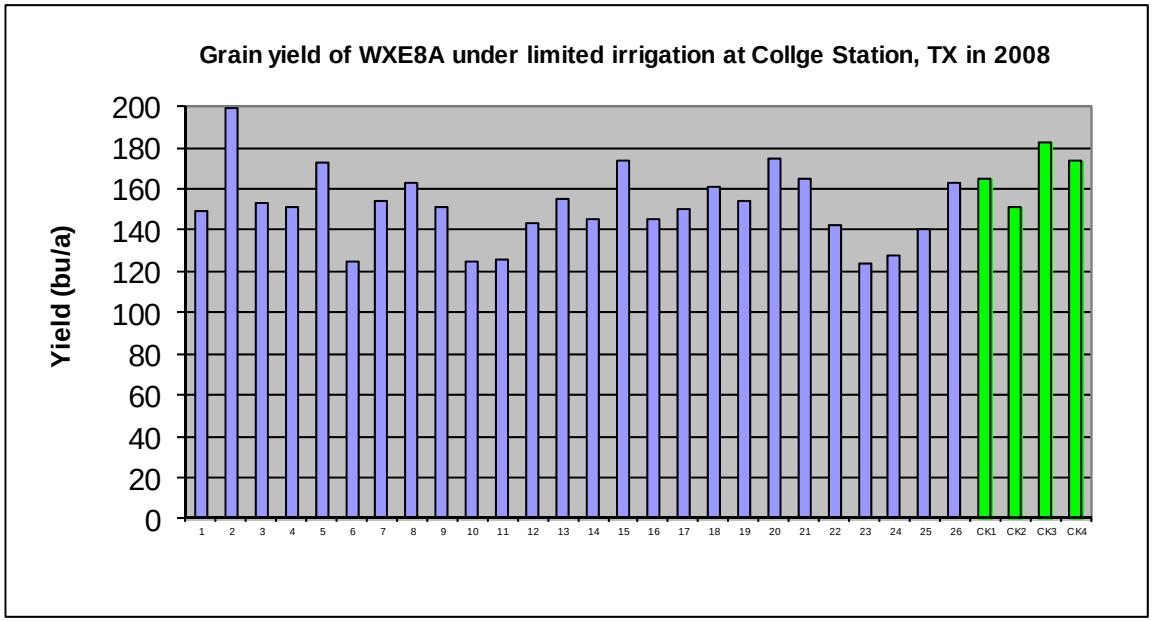


CK mean = 163.7
Test mean = 144.8
LSD $_{0.05}$ = 24.5
CV = 8.3%

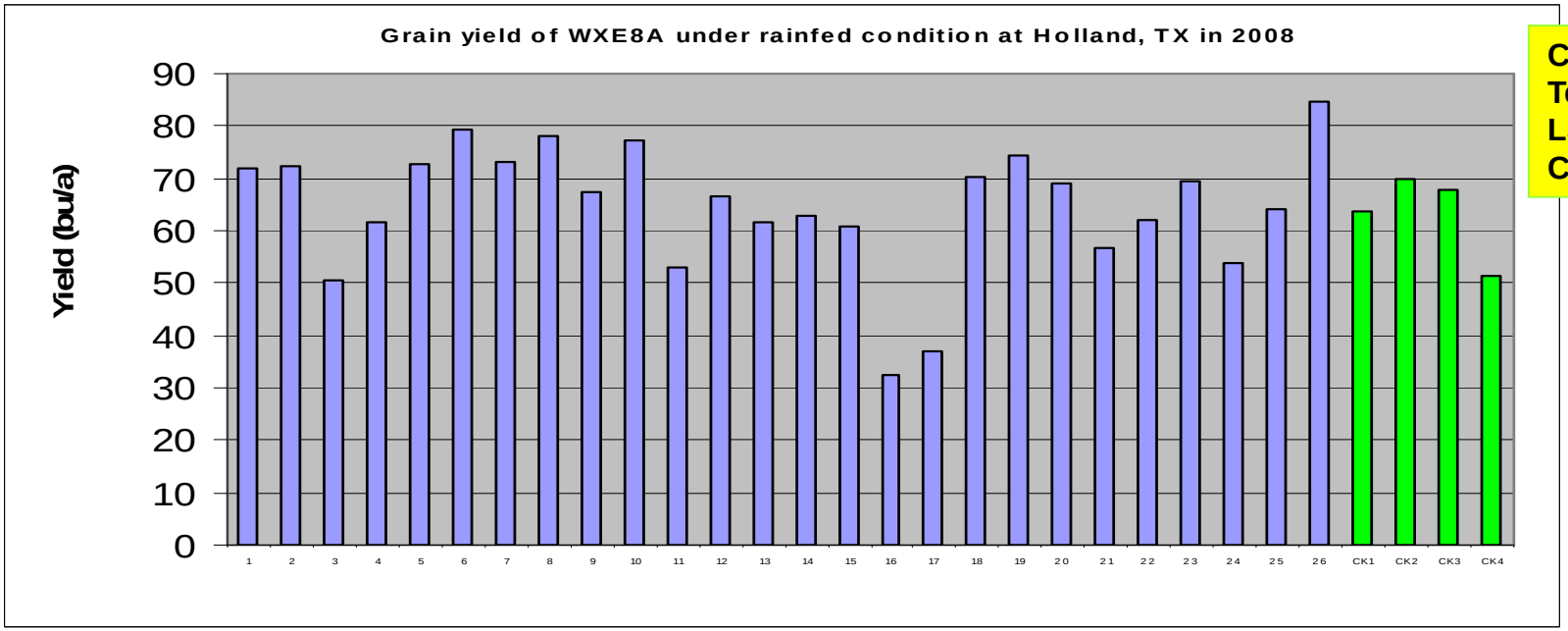


CK mean = 59.9
Test mean =50.0
LSD $_{0.05}$ = 25.4
CV = 24.4%

CK1 = BH8913RR/YGCB, CK2 = DKC 66-23, CK3 = DKC 67-87, CK4 = P31G96

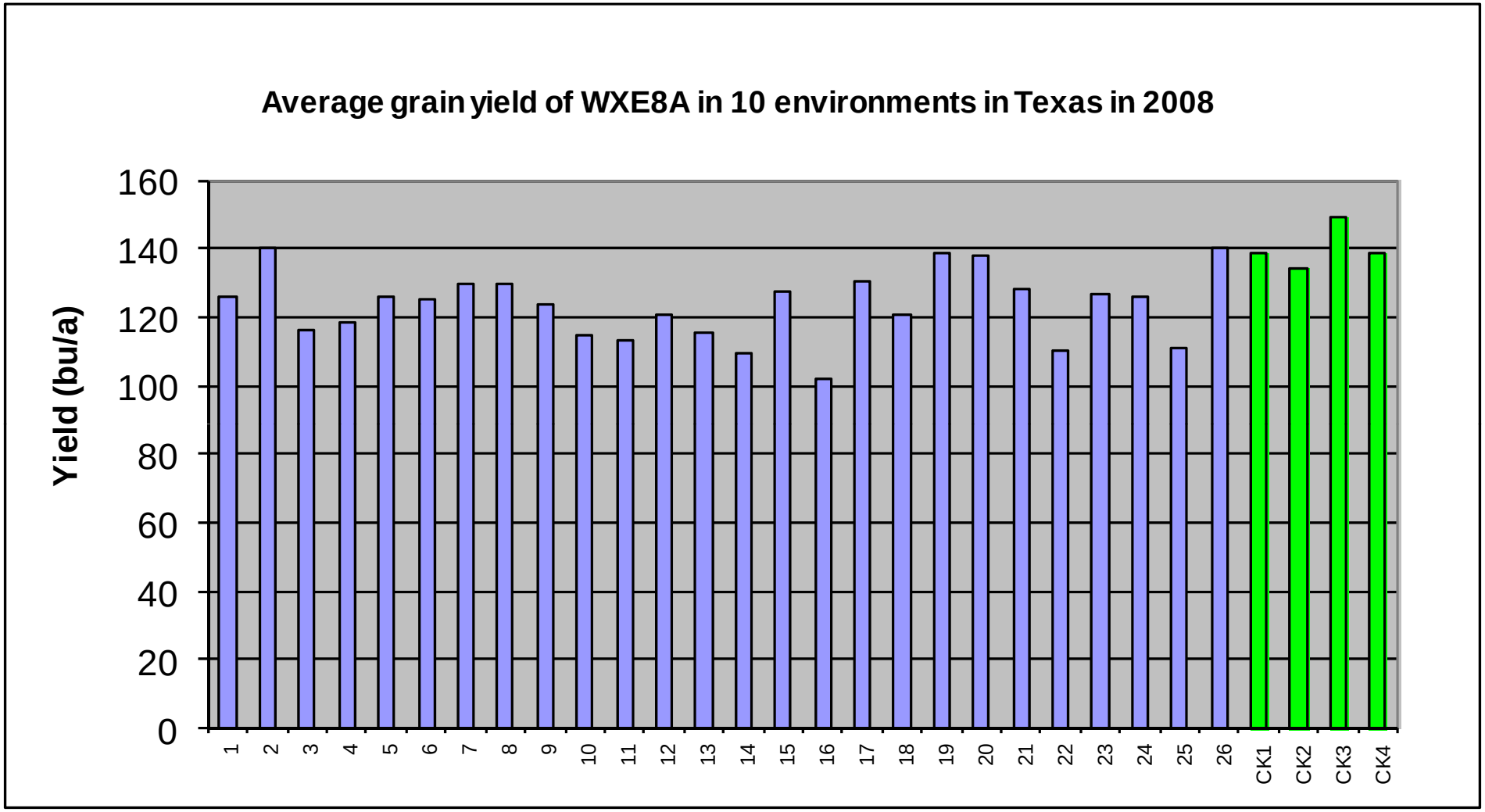


CK mean = 167.9
Test mean = 153.5
LSD $_{0.05}$ = 32.7
CV = 10.4%

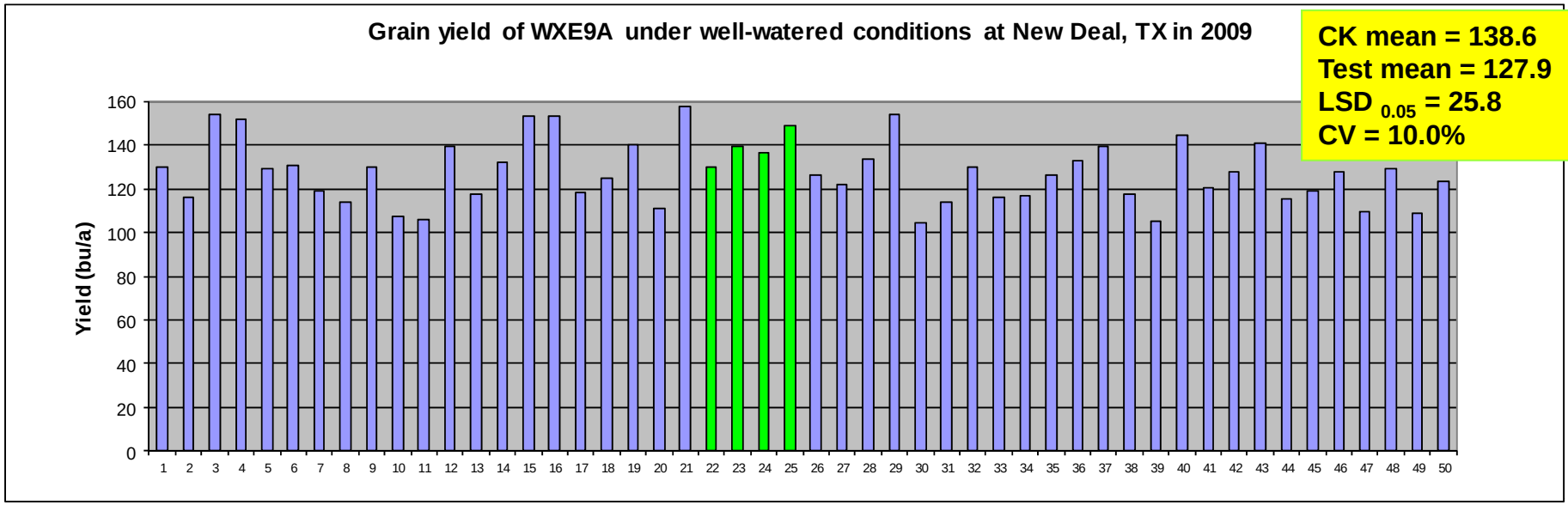


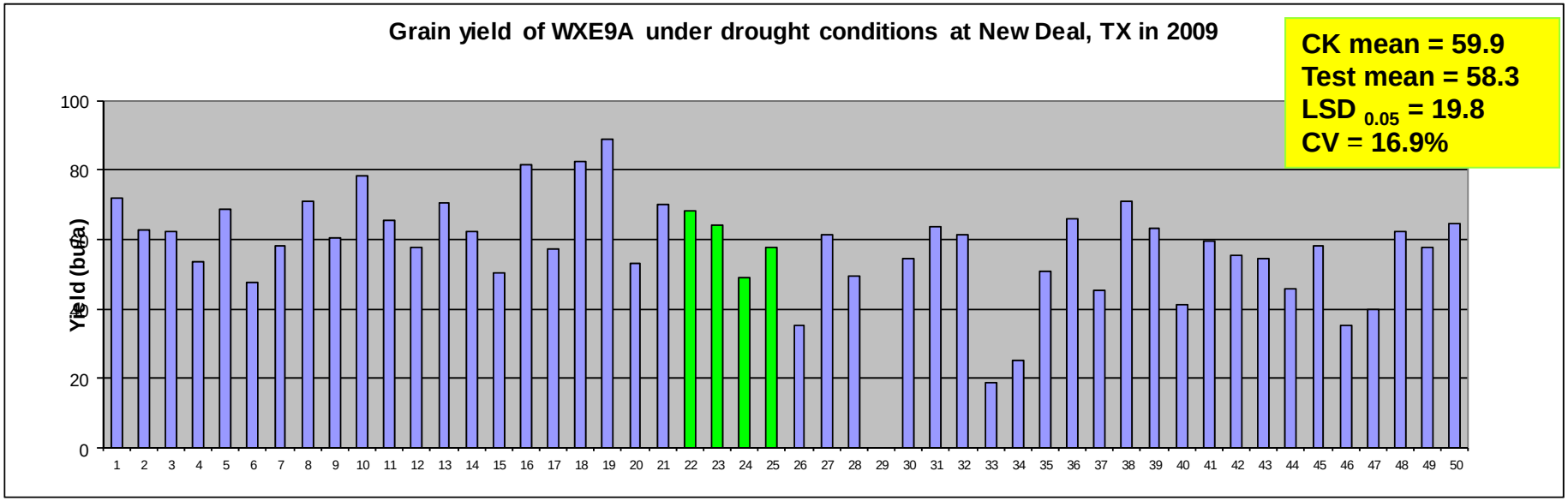
CK mean = 63.1
Test mean = 53.8
LSD $_{0.05}$ = 24.4
CV = 18.5%

CK1 = BH8913RR/YGCB, CK2 = DKC 66-23, CK3 = DKC 67-87, CK4 = P31G96



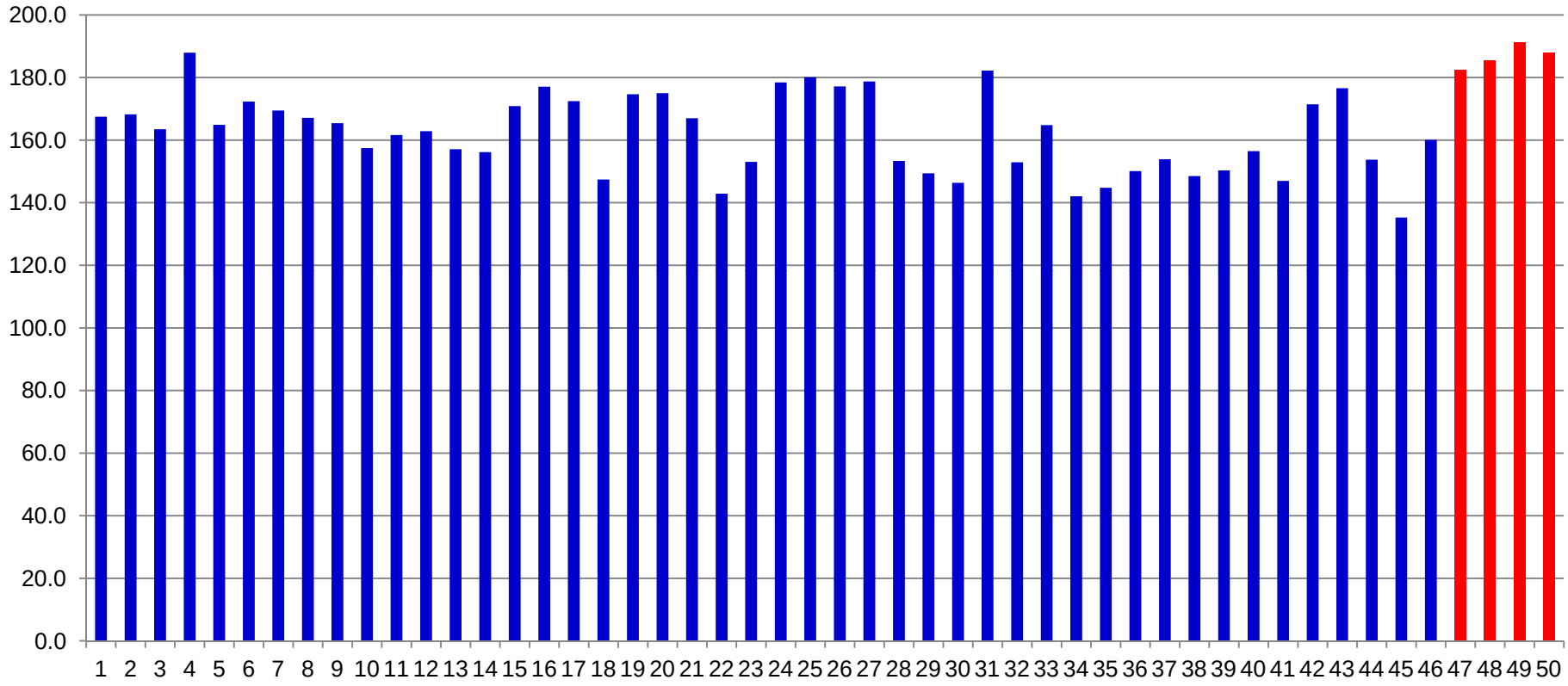
CK1 = BH8913RR/YGCB, CK2 = DKC 66-23, CK3 = DKC 67-87, CK4 = P31G96





CK1 = BH8913RR/YGCB, CK2 = DKC 66-23, CK3 = DKC 67-87, CK4 = P31G96

Average grain yield (bu/a) in nine environments in 2010

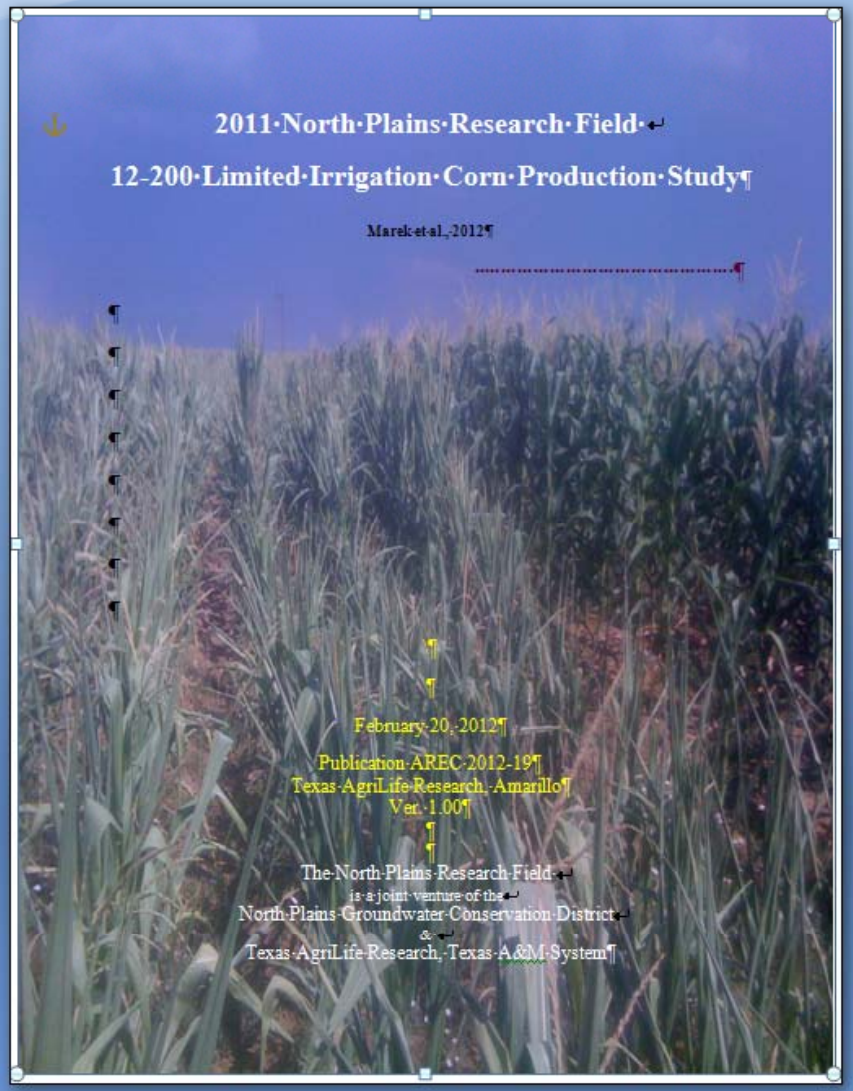


CK1 = BH8914VT3, CK2 = DKC 66-23, CK3 = DKC 67-87, CK4 = P31G96

My Summary and What it all means…

- We have solutions for water reduction in the works and can maintain our ag way of life.
- Is the water going to run out?...Not soon
- Need to educated & work together?...Absolutely
- Research ,Technology and Conservation is our short and long term solution answers.
- We can solve this if politics don’t go awry and all use common sense approach.

Some have asked about 2011 12-200..and it's now out…



2011 North Plains Research Field

12-200 Limited Irrigation Corn Production Study

Marek et al., 2012

February 20, 2012

Publication AREC 2012-19
Texas AgriLife Research, Amarillo
Ver. 1.00

The North Plains Research Field
is a joint venture of the
North Plains Groundwater Conservation District
&
Texas AgriLife Research, Texas A&M System