WORKSHOP

CROP MANAGEMENT TECHNIQUES FOR A BETTER PERFORMANCE

# THE PRODUCTION OF SORGHUM IN WATER-RESTRICTED CROP SYSTEMS IN THE USA

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# OUTLINE OF PRESENTATION

- Why Sorghum
- Sorghum Yield Components
- Local Climate and Crop Water Use
- Sorghum Water Use
- Sorghum in Cropping Systems

# WHY SORGHUM?

- Drought tolerant crop, but responds well to additional water
- Long planting window
- Uses the same farming equipment as maize and other crops
- Rotational benefits with other crops
  - Yield increase to proceeding broadleaf crops (soybean)
  - Disease, insect and nematode reduction
- Can plant in narrow rows for weed suppression

# CONTRIBUTION TO YIELD

**Limited Water:**

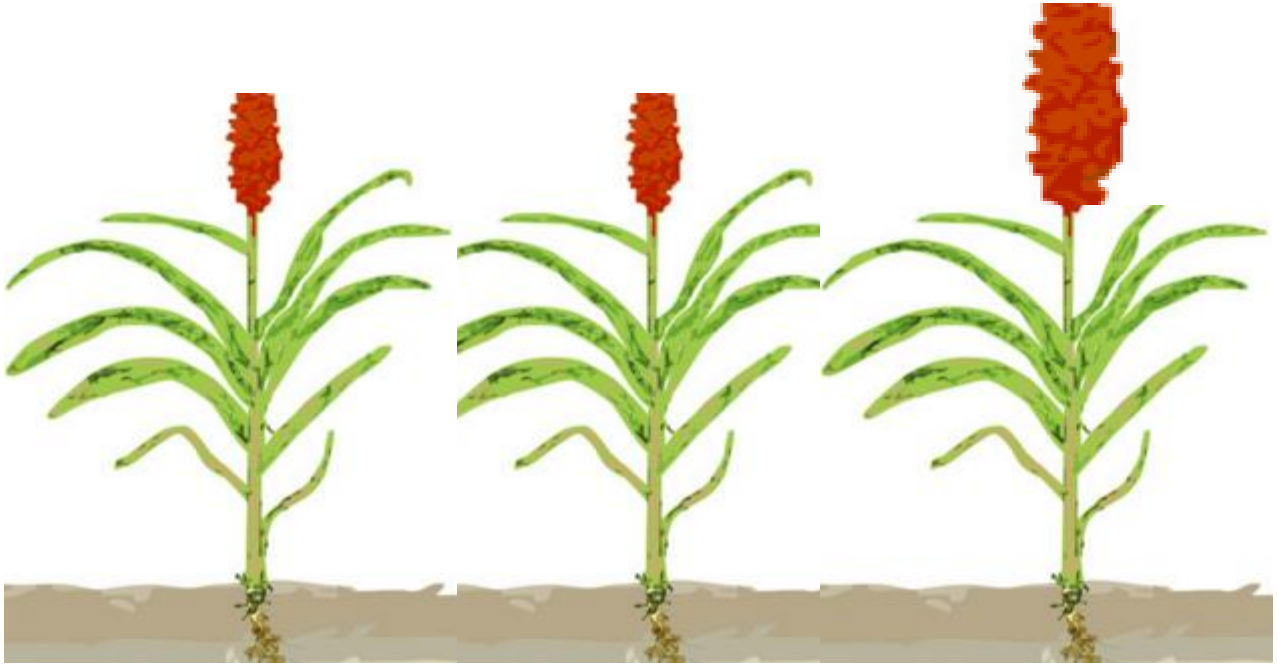
- **Seeds per panicle – 63%**
- **Panicles per ha – 30%**
- **Seed mass – 7%**

**Plenty of Water:**

- **Seeds per panicle – 40%**
- **Panicles per ha – 32%**
- **Seed mass – 23%**

# HARVEST INDEX

- **Harvest Index is the ratio of grain produced VS total above ground plant mass**
- **Range: 0.35 to 0.55**



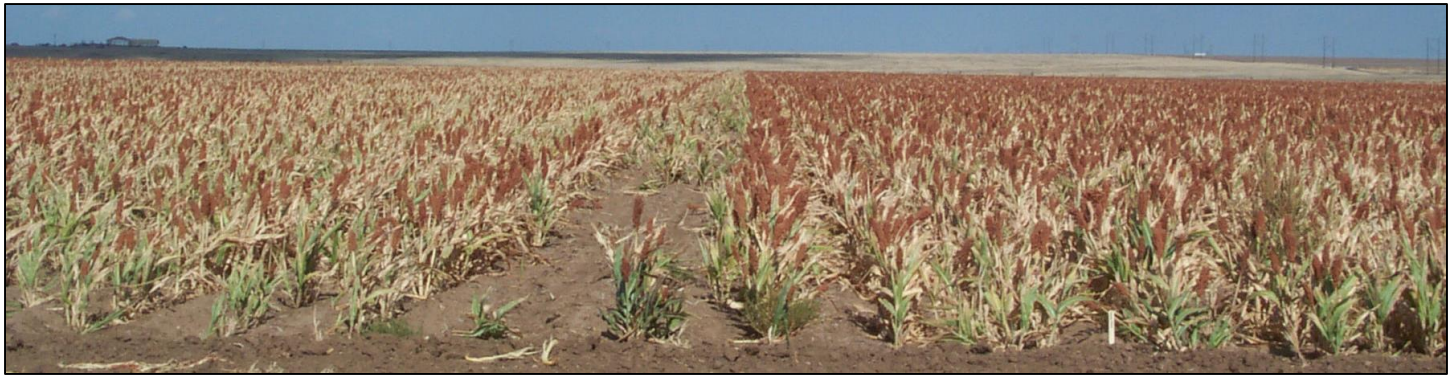
Low Harvest Index

High Harvest Index

# SEEDING RATE

## TWO YEAR AVERAGE YIELD AT THREE PLANT POPULATIONS

| Plant Population | Beltsville, KS | Manhattan, KS |
|---|---|---|
| Plants ha $^{-1}$ | Grain Yield, t ha $^{-1}$ | |
| 75,000 | 6.33 | 6.55 |
| 150,000 | 6.65 | 6.83 |
| 225,000 | 6.71 | 6.72 |

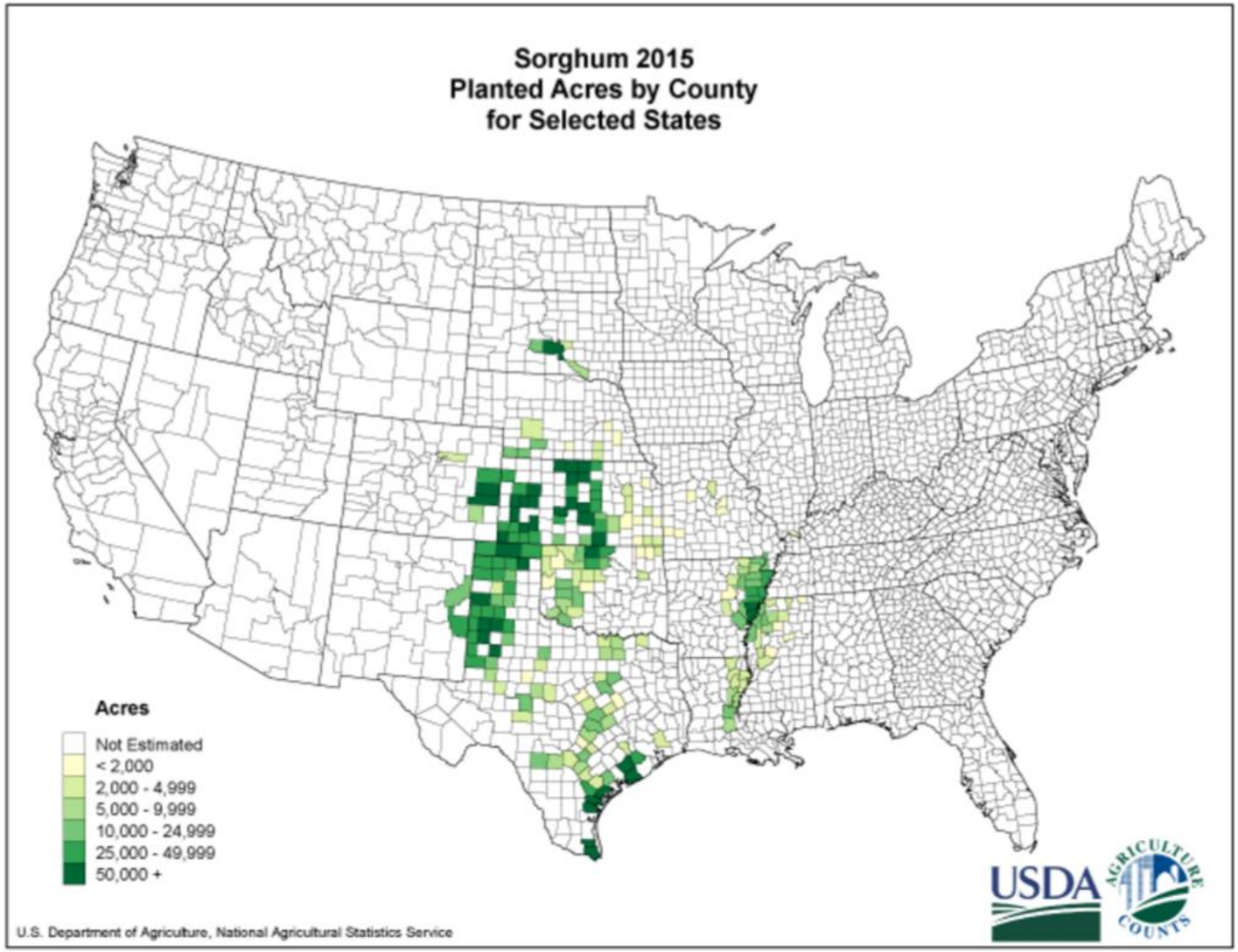


# SEEDING RATE

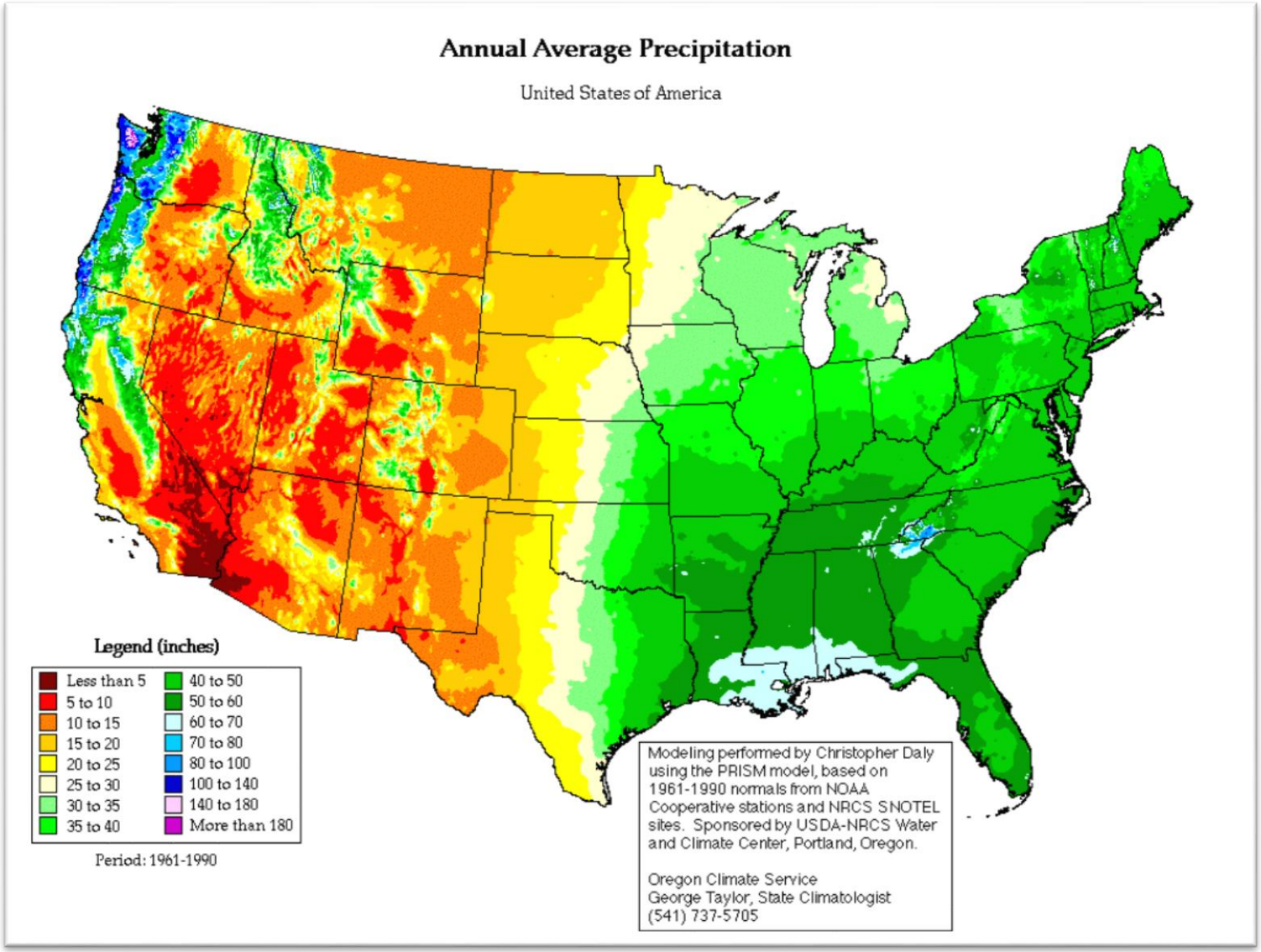
## SEEDING RATE BASED ON YIELD POTENTIAL

| Seeding Rate per hectare | Yield Potential or Goal |
|---|---|
| 75,000 | 3,000 – 4,750 lb/ac<br>3.4 – 5.3 t $ha^{-1}$ |
| 125,000 | 4750 – 7,550 lb/ac<br>5.3 – 8.5 t $ha^{-1}$ |
| 175,000 | 7,550 - 10,000 lb/ac<br>8.5 – 11.2 t $ha^{-1}$ |
| 225,000 | Greater than 10,000 lb/ac<br>Greater than 11.2 t $ha^{-1}$ |

# SORGHUM GROWING AREAS IN USA



# PRECIPITATION MAP OF USA



# SORGHUM WATER USE

## DEPENDS ON LOCAL CLIMATE

| Climate Factor | Crop Water Need (ET-Evapotranspiration) | |
|---|---|---|
| | HIGH | LOW |
| Temperature | Hot | Cool |
| Humidity | Low (dry) | High (humid) |
| Wind speed | Windy | Calm |
| Sunshine | Sunny | Cloudy |

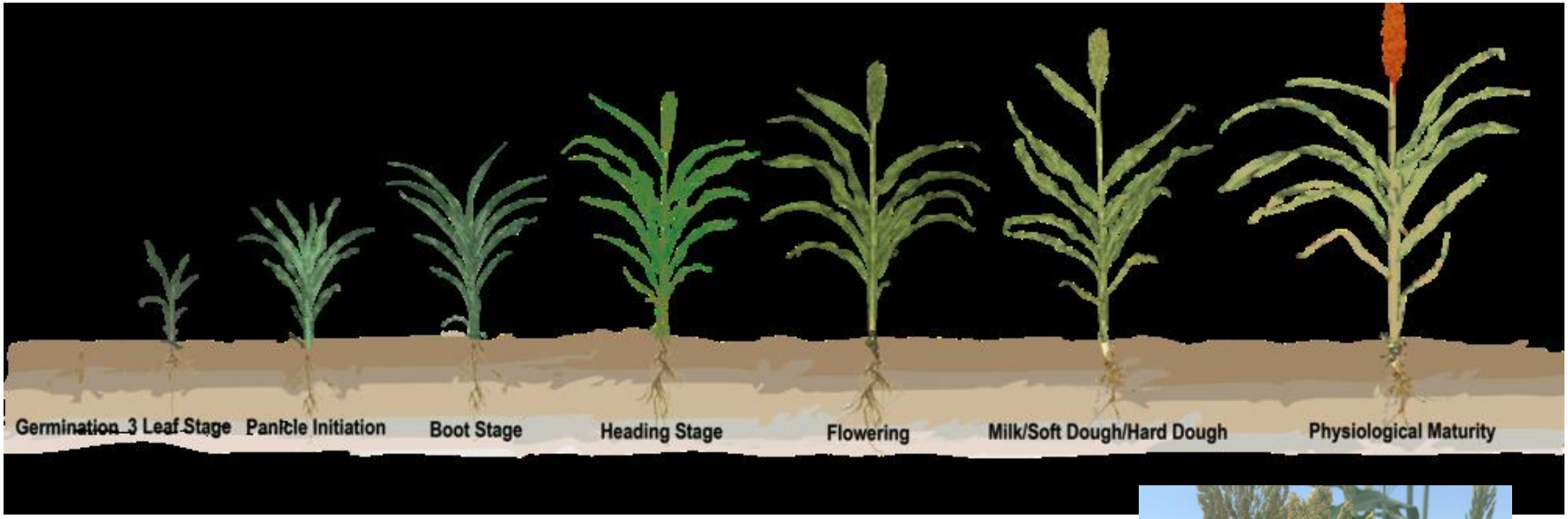
| Climate Factor (July) | Amarillo, Texas, USA | Bucharest, RO |
|---|---|---|
| Temperature (c) | 32.7 | 29 |
| Humidity (AVG Daily) | 78% High, 32% Low | 96% High, 42% Low |
| Wind speed Avg (m/s | 6 m/s | 2 m/s |
| % Median Cloud Cover | 25% | 35% |
| % AVG Sunlight hr/Day | 11.03 | 10.5 |

# WATER USE EFFICIENCY

## SORGHUM WATER USE EFFICIENCY AT DIFFERENT RAINFALL OR IRRIGATION LEVELS

| Irrigation Amount (% of ET) | Water Use Efficiency kg $m^{-3}$ | Water Use Efficiency lb $ac\text{-}in^{-1}$ |
|---|---|---|
| 0 | 0.45 | 102 |
| 25 | 1.23 | 279 |
| 50 | 1.85 | 420 |
| 75 | 1.86 | 422 |
| 100 | 1.70 | 385 |

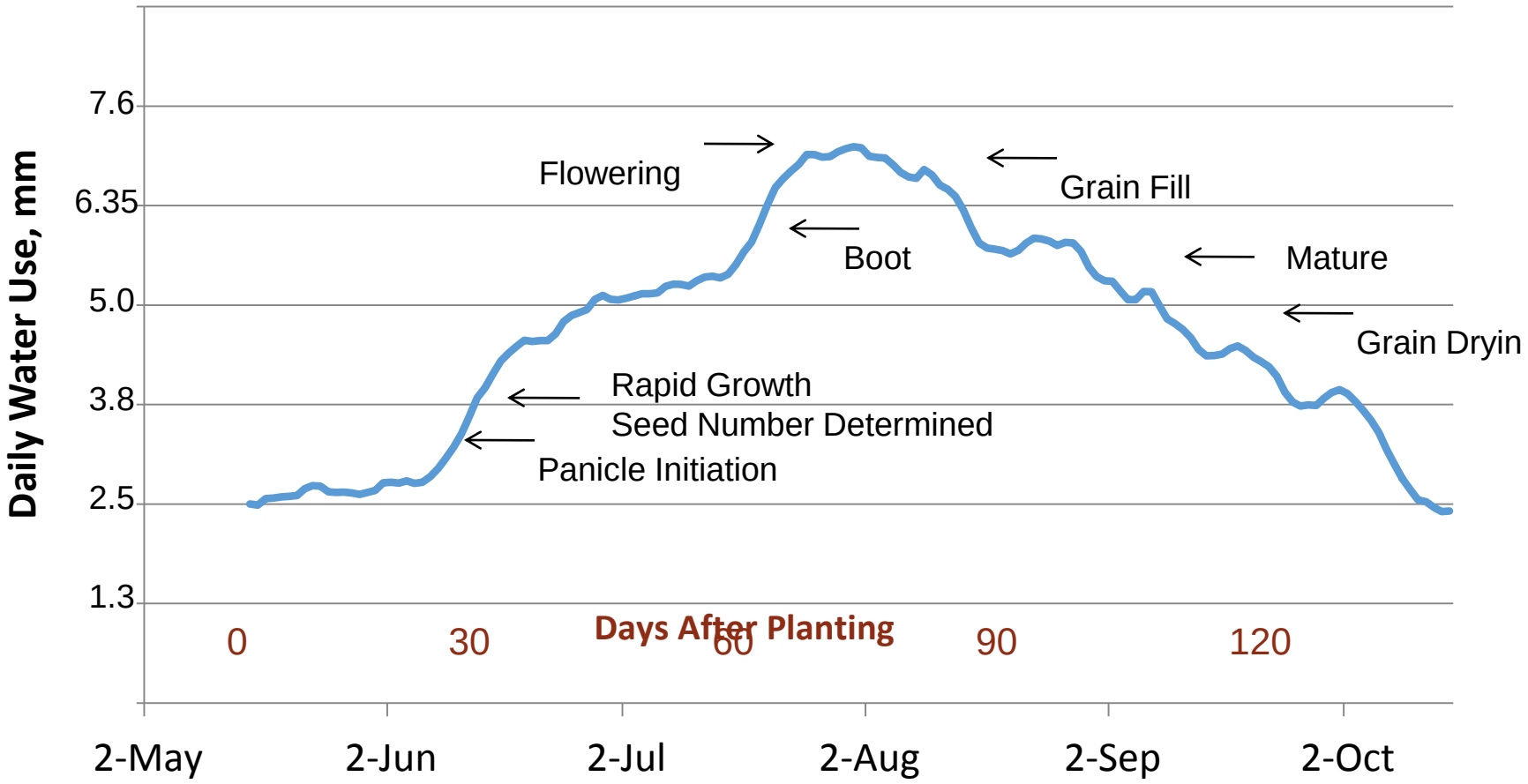
# SORGHUM GROWTH STAGES




- Growing Point Differentiation: ~ 30 days past emergence. Panicle size begins to be determined.
- Boot: Rapid growth and nutrient uptake. Panicle enclosed in flag leaf.
- Half Bloom: 50% of plants in a field are blooming

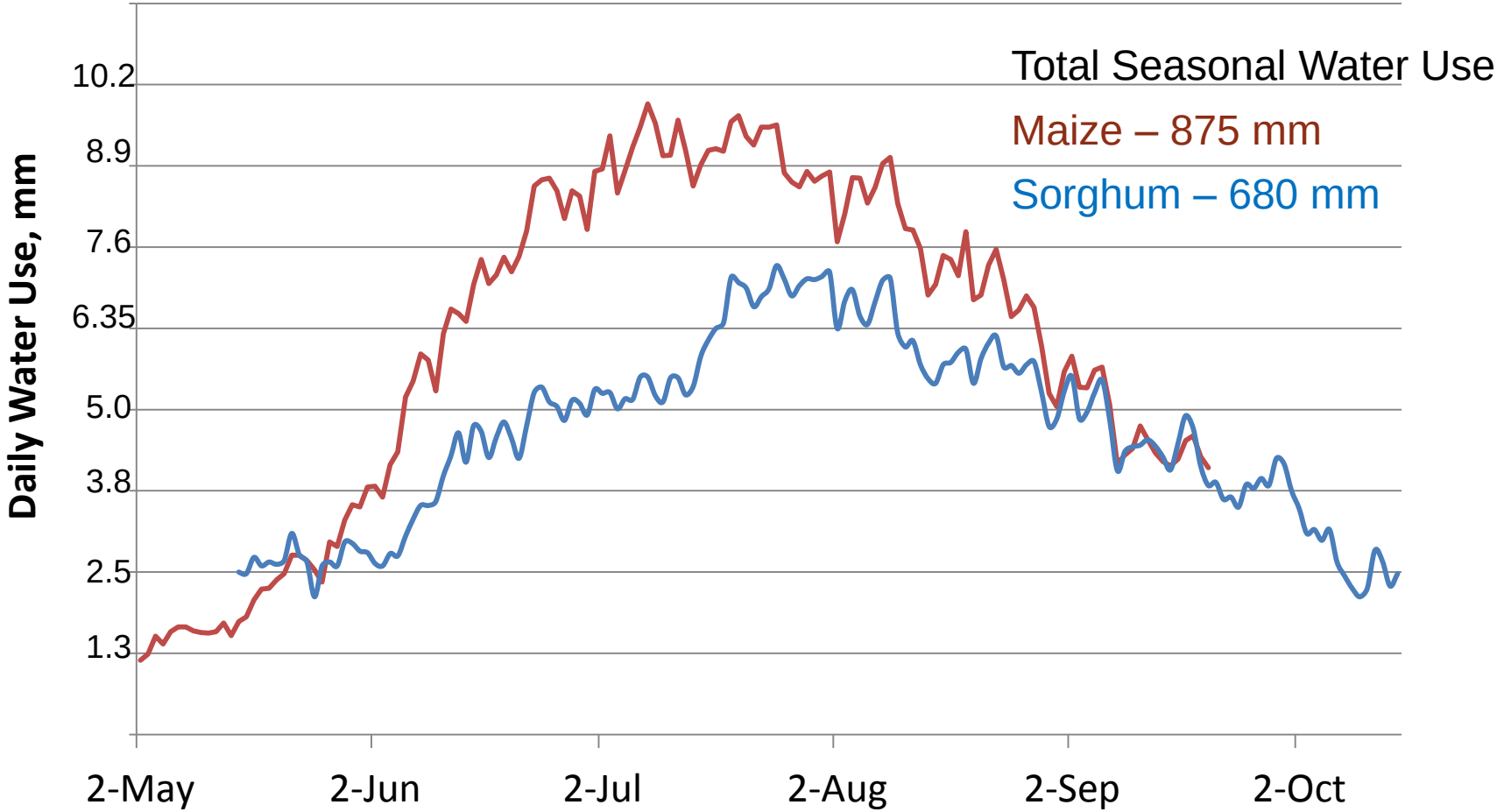
# DAILY WATER USE

## SORGHUM DAILY WATER USE AND KEY GROWTH STAGES

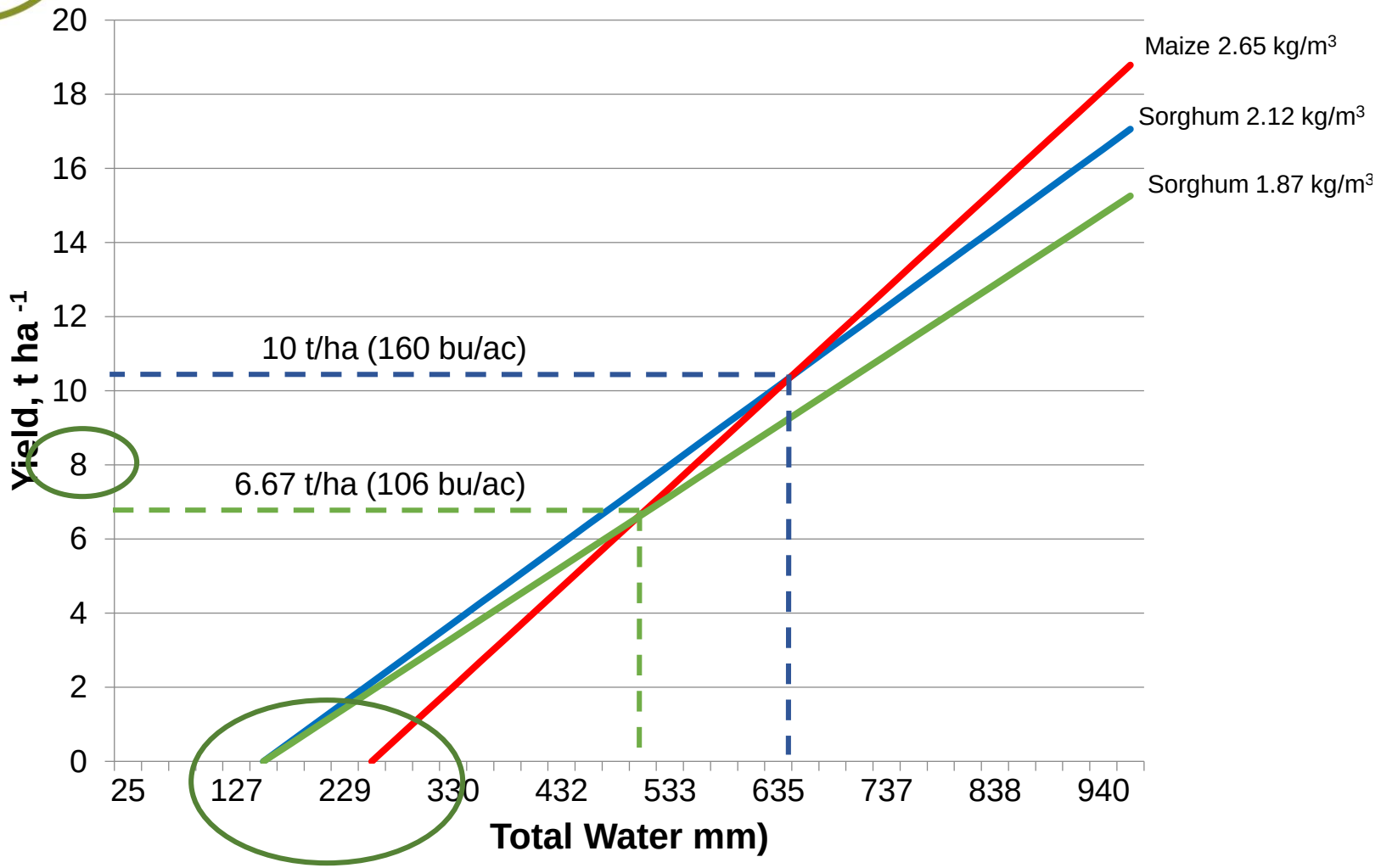


# DAILY WATER USE

## DAILY WATER USE OF MAIZE AND SORGHUM
## 20 YEAR AVERAGE 1991-2010, AMARILLO, TX



# SORGHUM AND MAIZE RESPONSE TO WATER



# CROP WATER USE COMPARISON

## YIELD VS ET RELATIONSHIP FOR CROPS IN KANSAS, USA

| Crop | Max. ET | Threshold ET | Slope of Yield vs ET |
|---|---|---|---|
| | mm | mm | kg $m^{-3}$ |
| Maize | 635 | 275 | 3.29 |
| Grain Sorghum | 535 | 175 | 2.32 |
| Sunflower | 560 | 140 | 0.66 |
| Winter wheat | 610 | 255 | 1.22 |
| Soybean | 610 | 200 | 1.00 |

# SORGHUM CROPPING SYSTEMS IN USA

## Dryland or low rainfall

- Rotation with wheat
  - 11 month fallow between crops
- Rotation with cotton or soybeans
  - Reduction in disease, weeds and nematodes

## Limited Irrigated or regions with moderate rainfall

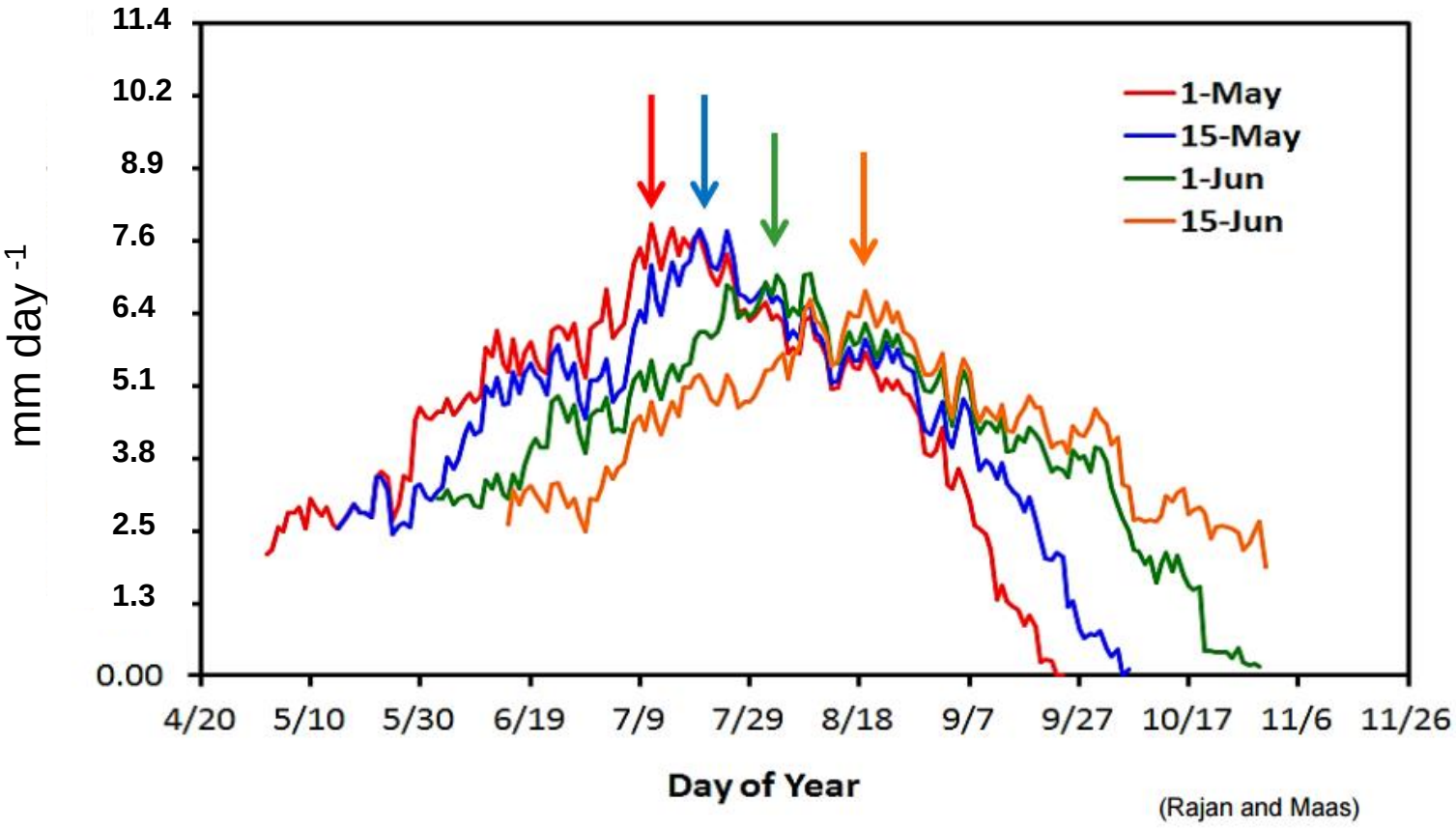
- Rotation with soybean
- Double crop with sorghum planted after wheat harvest
- Split irrigation circle
  - Maize/Sorghum
  - Cotton/Sorghum

## Fully Irrigated or regions with high rainfall

- Rotation with soybean or cotton

# SORGHUM WATER USE – PLANTING DATE

## Sorghum Evapotranspiration Long-term Average (1997-2011)

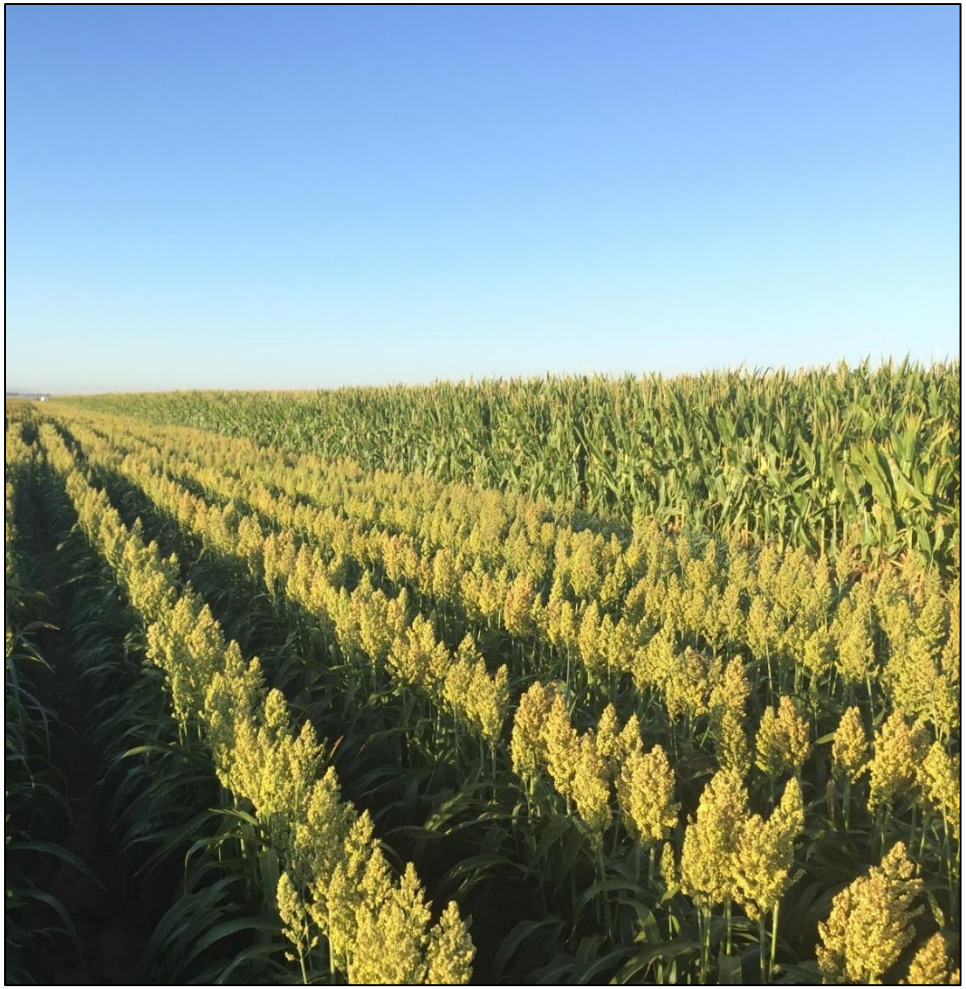



(Rajan and Maas)

# GRAIN SORGHUM/MAIZE

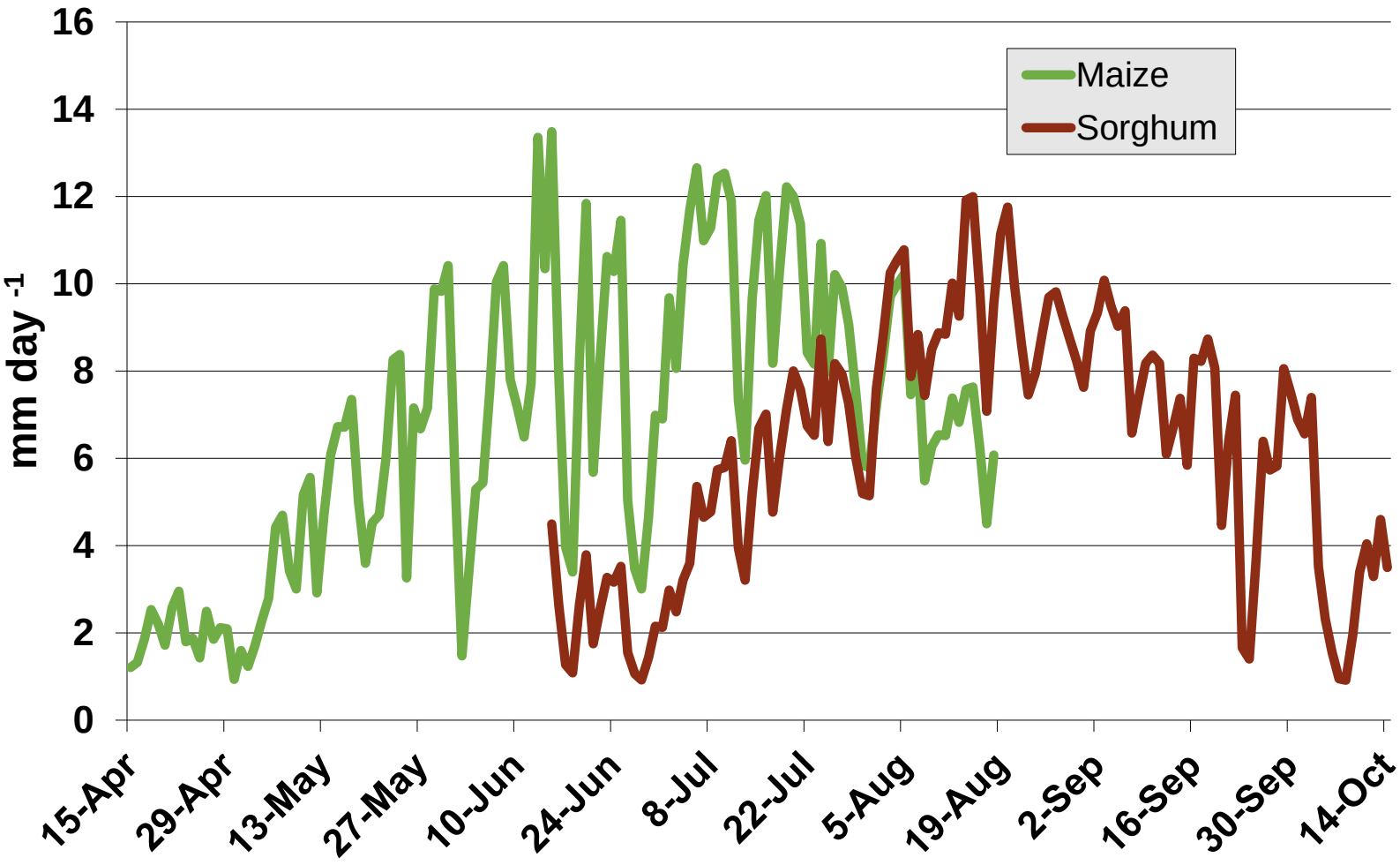
## USE IN OPTIMIZING IRRIGATION CAPACITY

- Utilize planting dates to apply irrigation during key growth stages
- Since sorghum will tolerate short periods of drought, more water can be applied to the maize if needed



# DAILY WATER USE

## MAIZE VS SORGHUM



# SUMMARY

- Sorghum water use efficiency is improved by using a seeding rate that matches the environment's yield potential
- Sorghum water use depends on local climate
- Sorghum has a maximum water use of approximately 75% of maize
- Sorghum yields better than maize in low rainfall environments
- Sorghum benefits the yield of broadleaf crops in a rotation
- Sorghum can be planted with other crops to maximize water use efficiency in fields with limited irrigation water capacity

# THANK YOU!