



*Effects of Climatic Stress and Variety Type on
Rice Yield and Grain Quality*

L. T. (Ted) Wilson

*Professor, Center Director, Jack B. Wendt Endowed Chair
Texas A&M University System*

Rice Quality Workshop

Williams, California

July 18, 2024

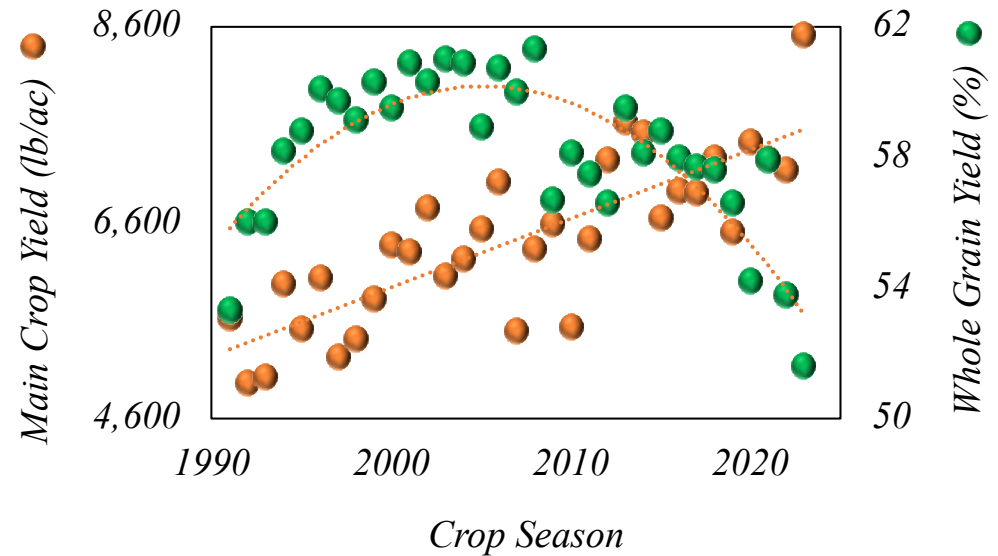


Presentation Overview

- *Year-to-year variation in yield and grain quality*
- *Within-season variation in grain yield and quality*
- *How quality is determined by a variety's pattern of grain production*
- *Tradeoffs between selecting for yield versus selecting for grain quality*

Year-to-Year Variation in Yield and Grain Quality

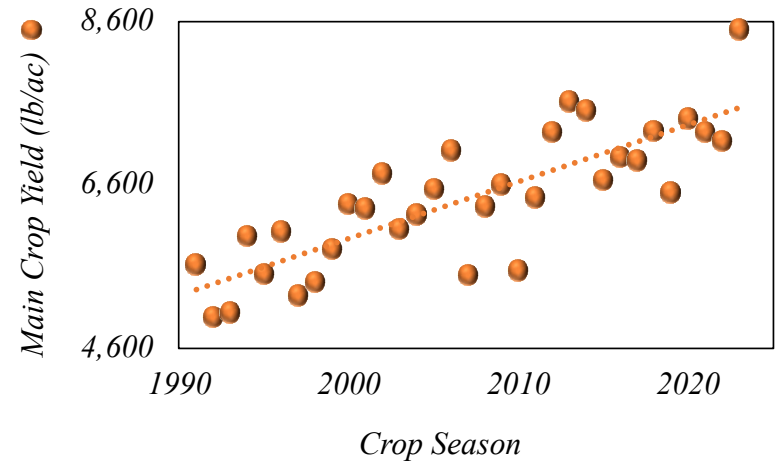
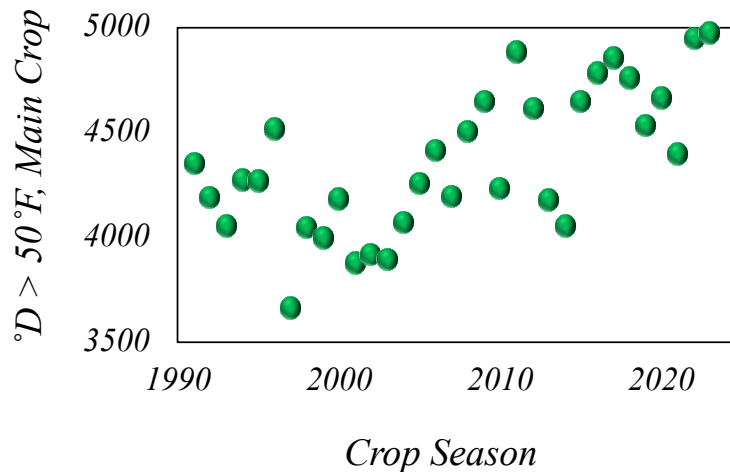
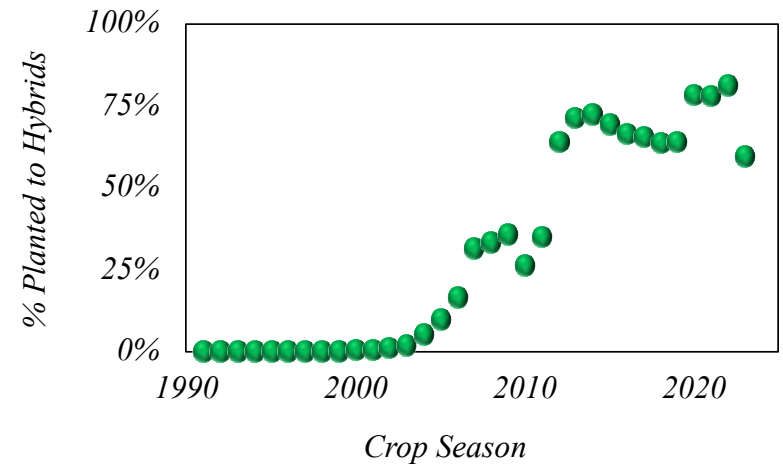
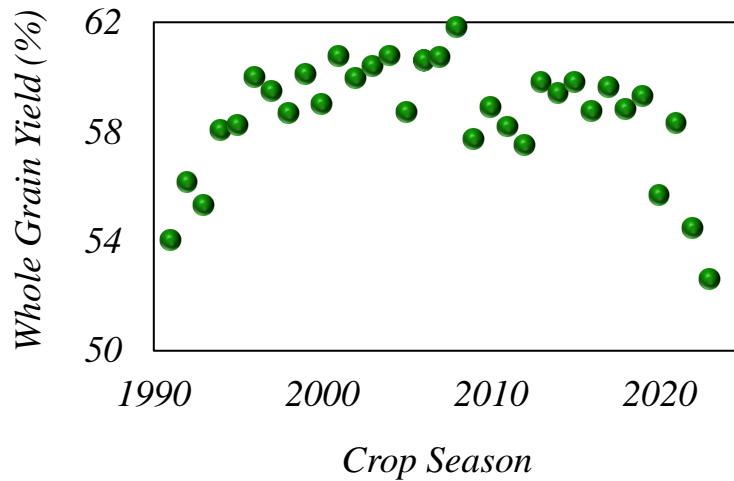
- *The 2023 season was the highest main crop yield on record for Texas*
- *This is part of a long-term trend with yield increasing an average of 69 lbs/ac/yr from 1991-2023*



- *Whole grain milling yields similarly steadily increased until the early 2000s, but since then it has steadily decreased reaching a record low in 2023*
- *Total milling yield for 2023 tied for the lowest over the last 25 years*
- *Why has yield steadily increased and why have grain quality traits decreased since the early 2000s?*



Year-to-Year Variation in Yield and Grain Quality



Year-to-Year Variation in Yield and Grain Quality

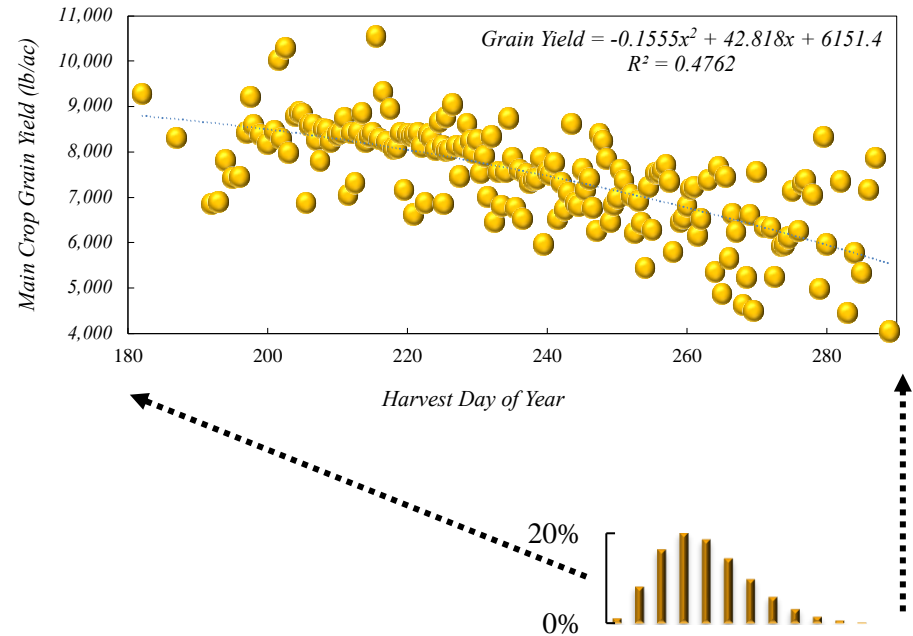
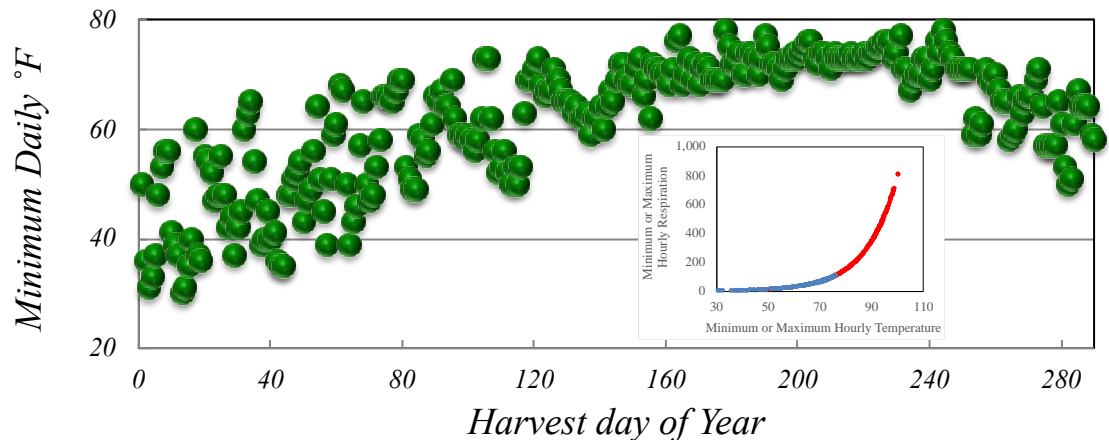
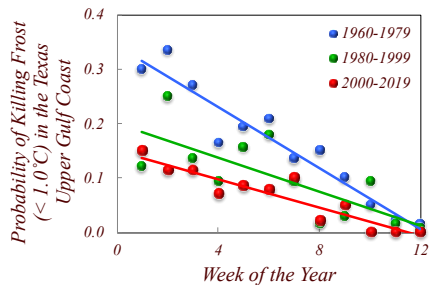
Lock		Entered	Parameter	Estimate	nDF	SS	"F Ratio"	"Prob>F"
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		Intercept	-160.71041	1	0	0.000	1
<input type="checkbox"/>	<input type="checkbox"/>		Cumulative °D >10°C, February 15-October 31 Eagle Lake, Texas	0	1	0.83804	0.778	0.3883
<input type="checkbox"/>	<input type="checkbox"/>		Cumulative Rainfall (cm)	0	1	2.498632	2.513	0.12863
<input type="checkbox"/>	<input checked="" type="checkbox"/>		% Hybrid	-0.0651619	1	43.41572	40.724	2.51e-6
<input type="checkbox"/>	<input checked="" type="checkbox"/>		Main Crop Yield (lbs/ac)	-0.0008547	1	4.434035	4.159	0.05419
<input type="checkbox"/>	<input checked="" type="checkbox"/>		Total Milling Yield (%)	3.22406237	1	54.1498	50.793	4.99e-7

What do these numbers mean?

- *Total Milling Yield has a direct positive impact on WG% independent of whether a hybrid or an inbred is produced*
- *Hybrid rice production has decreased the Texas industry-wide whole grain milling yield by about 5.4%*
- *Increases in main crop yield since the mid-2000s is largely due to hybrid rice planting, which has indirectly decreased WG% by an additional 2.2%*

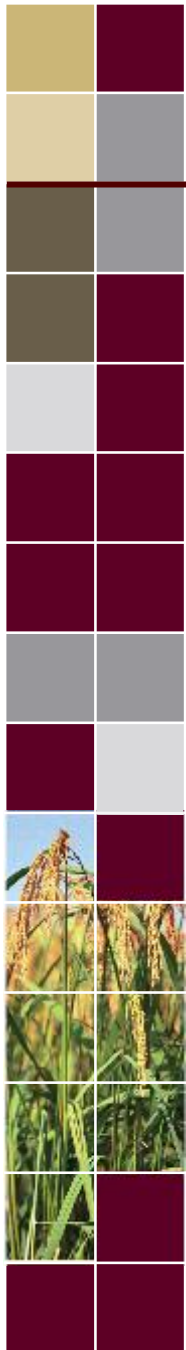
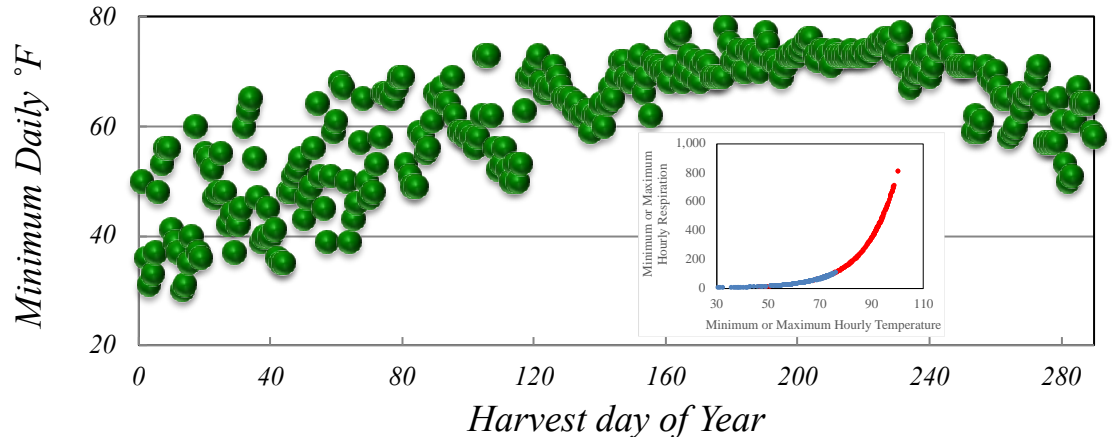
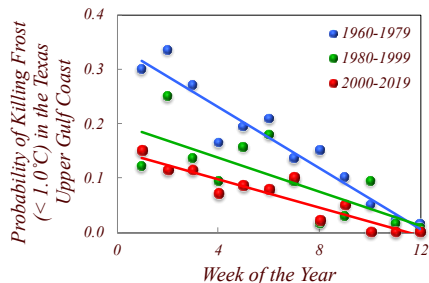
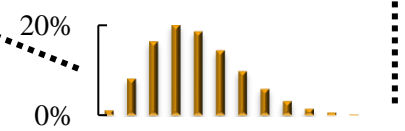
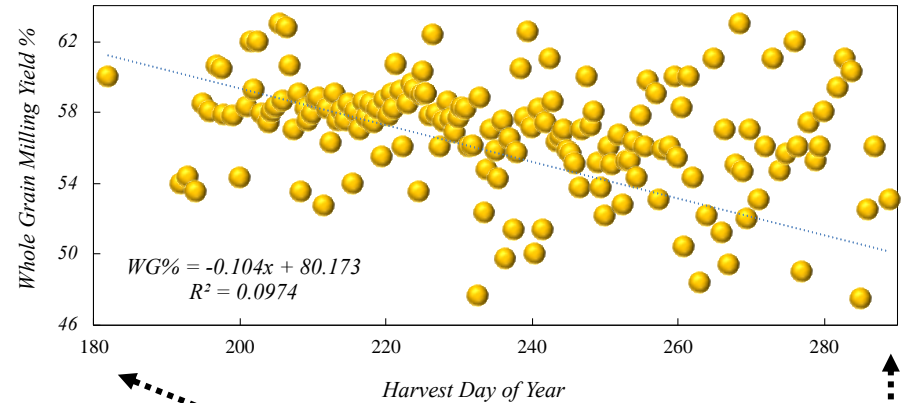
Within-Season Variation in Grain Yield and Quality

- Average grain yield for commercially produced rice progressively decreases later the planting date and as a result later the crop's development
- An average loss of 32 lb/ac/day delay in crop maturity



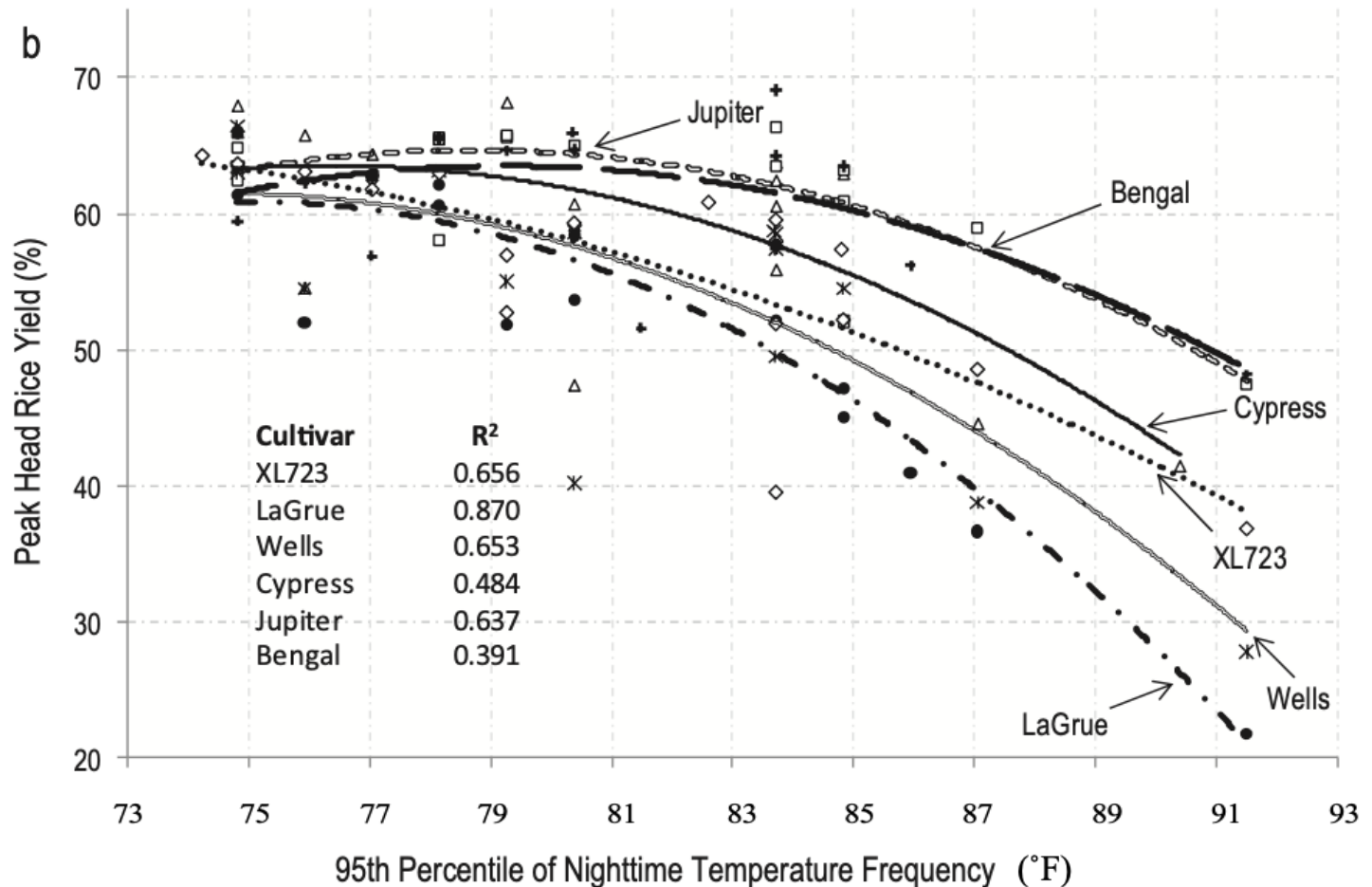
Within-Season Variation in Grain Yield and Quality

- Average whole grain milling yield for commercially produced rice also progressively decreases later the planting date
- On average 0.1 % decrease in WG% for each day crop maturity is delayed, but data are much more variable



Within-Season Variation in Grain Yield and Quality

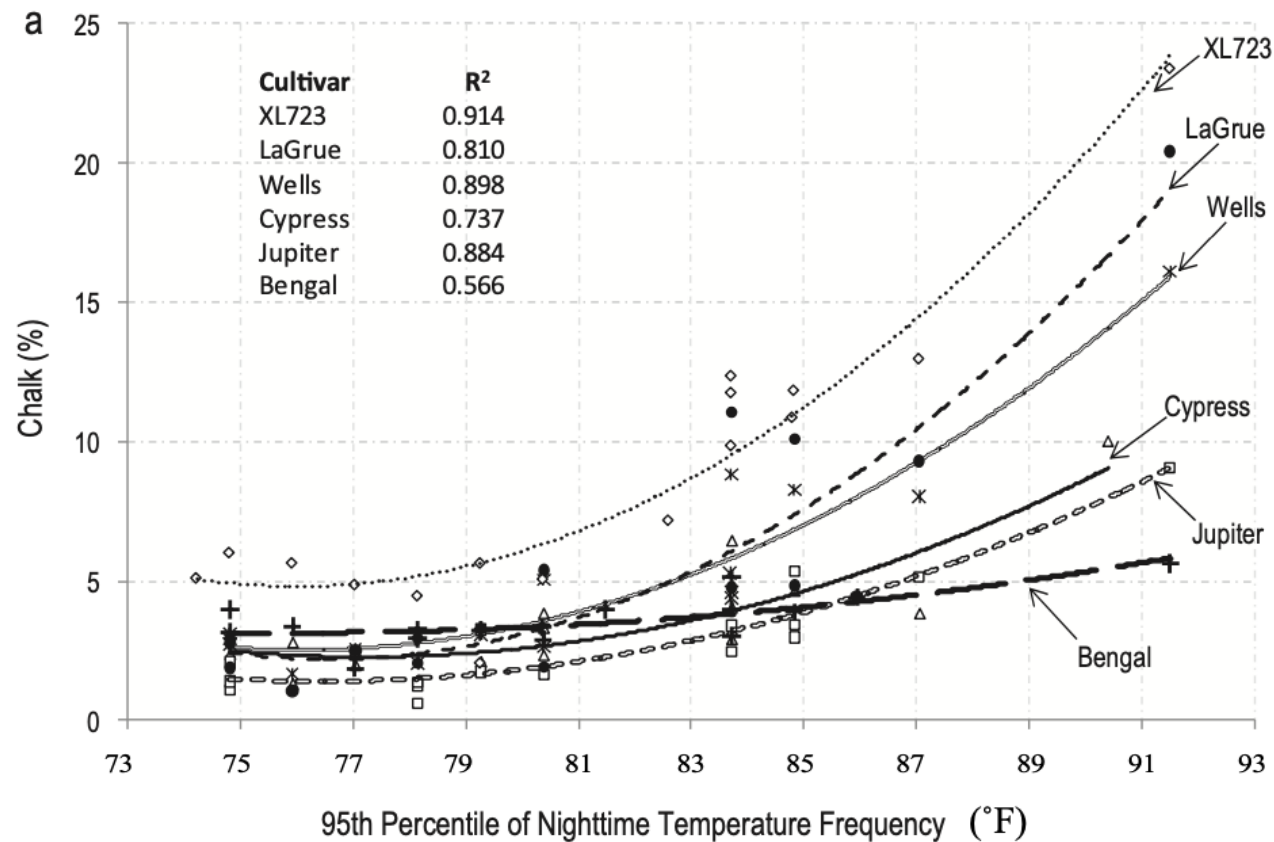
The effect of nighttime temperatures during grain filling



Within-Season Variation in Grain Yield and Quality

The effect of nighttime temperatures during grain filling

S.B. Lanning et al. / *Field Crops Research* 124 (2011) 132–136

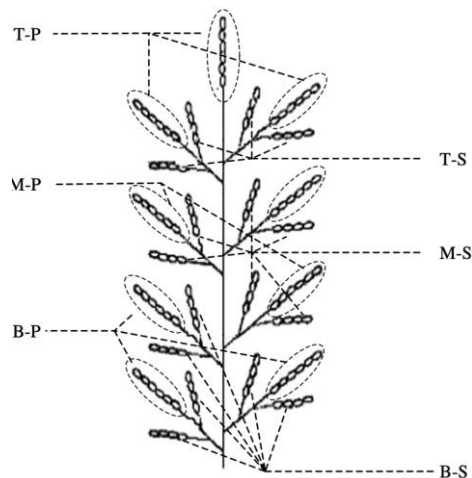


How Quality is Determined by a Variety's Pattern of Grain Production

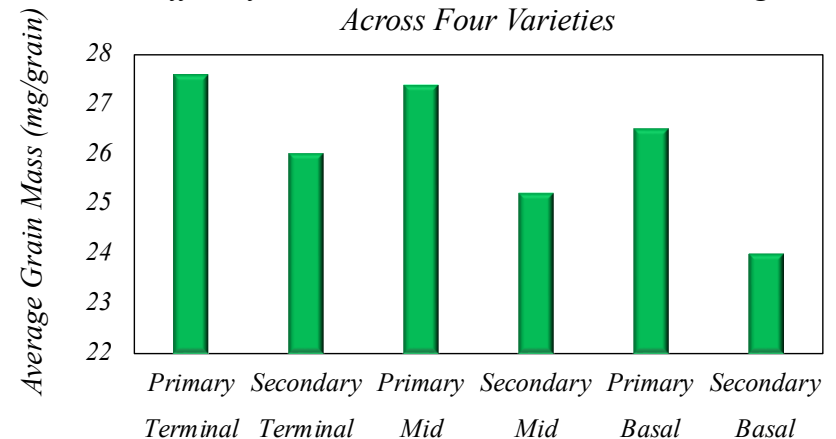
- *Position within a panicle greatly affects the size of individual rice grain due to seasonal change in metabolic stress*



- *Grain size at a panicle's maturity is progressively smaller the later the grain is produced on a panicle*
- *Later a panicle is produced the smaller the size of its grain, with the latest produced grain on the latest produced panicles usually the smallest*

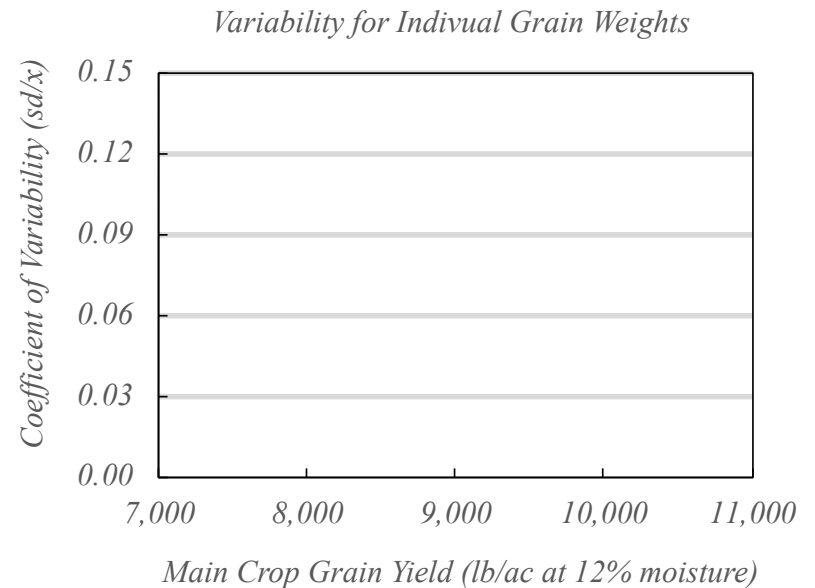
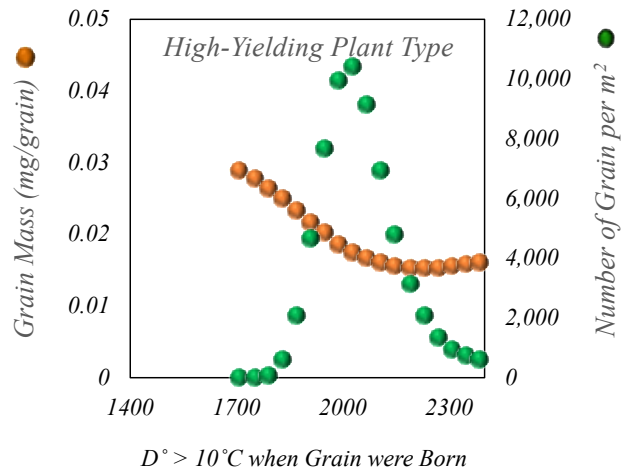
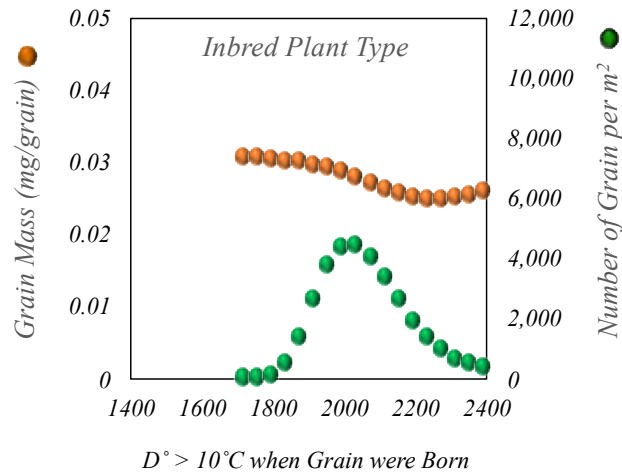


Effect of Grain Position within a Panicle Averaged Across Four Varieties



How Quality is Determined by a Variety's Pattern of Grain Production

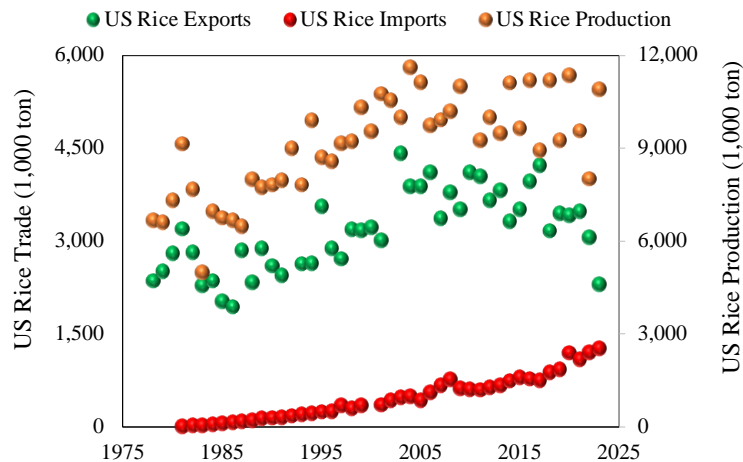
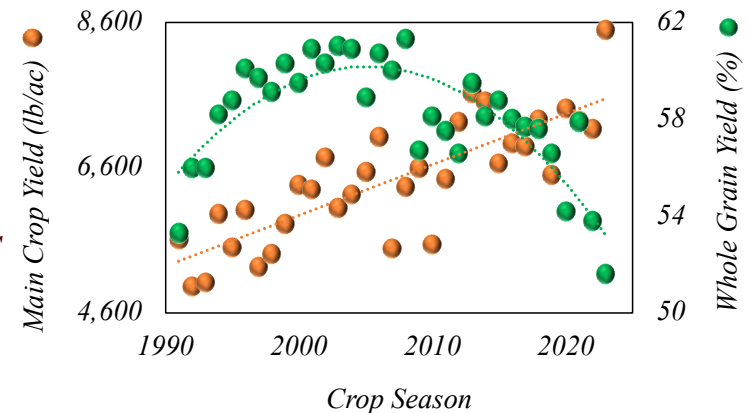
- A variety's yield potential greatly affect grain size and uniformity



Tradeoffs Between Selecting for Yield versus Selecting for Grain Quality

Focus on developing high-yielding plant types

- Higher yields with a major decrease in milling quality and increase in chalkiness and grain size variability
- Marginal decreases in market prices
- Continued increases in losses of global long grain markets



Estimated from USDAS Economics, Statistics and Market Information System 2024

- From 2018 to 2023 the U.S. experienced the greatest decrease of any rice exporting country in net rice exports (-67.3%)
- During this timespan, U.S. rice exports also decreased by an average of 3.49%/year



Tradeoffs Between Selecting for Yield versus Selecting for Grain Quality

Focus on developing plant types that balance yield and grain quality which would result in

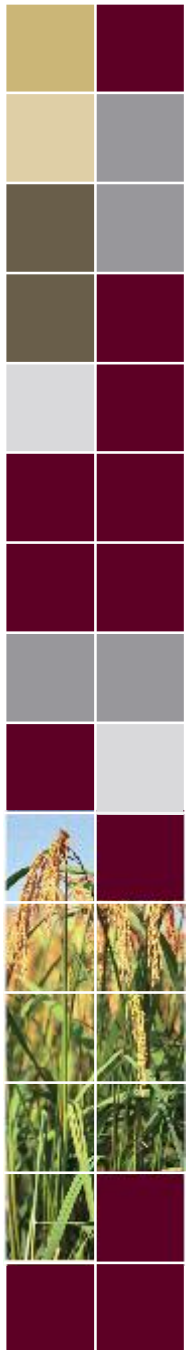
- *Modest yield increases for future inbreds and a modest decrease for future hybrids*
- *Increase whole grain milling yield, decrease chalkiness, and decrease grain size variability*
- *Reverse the current trend in losses of global rice export markets*
- *Would require a modification to the current pricing structure to place greater emphasis on grain quality*
 - *Hybrid net profits average \$121.17/ac more than inbreds*
 - *For inbred average net profit to achieve parity with hybrids would require a premium of \$1.25/cwt in place of the current premium which often reaches this level but typically drops to zero when demand for rice matches or exceeds supply*
 - *A premium/discount of \$0.16/WG% above/below 58% would also favor increased production of rice with high WG%, lower chalkiness, and less variability in grain dimensions, which would also improve US long grain exports*



Acknowledgments

Special thanks to

- *Beaumont Center staff, county extension agents, growers, seedsman, crop consultants, and millers who contributed to the 21,000 yield records and 44,000 crop development stage records spanning 34 crop seasons*
- *Texas A&M AgriLife Research and the Jack B. Wendt Endowed for Rice Rice which funding this research and the breeding value research*
- *The Texas Rice Research Foundation for continued support of the research conducted by Beaumont Center scientists*



Thank You!

<http://beaumont.tamu.edu>

lt-wilson@tamu.edu