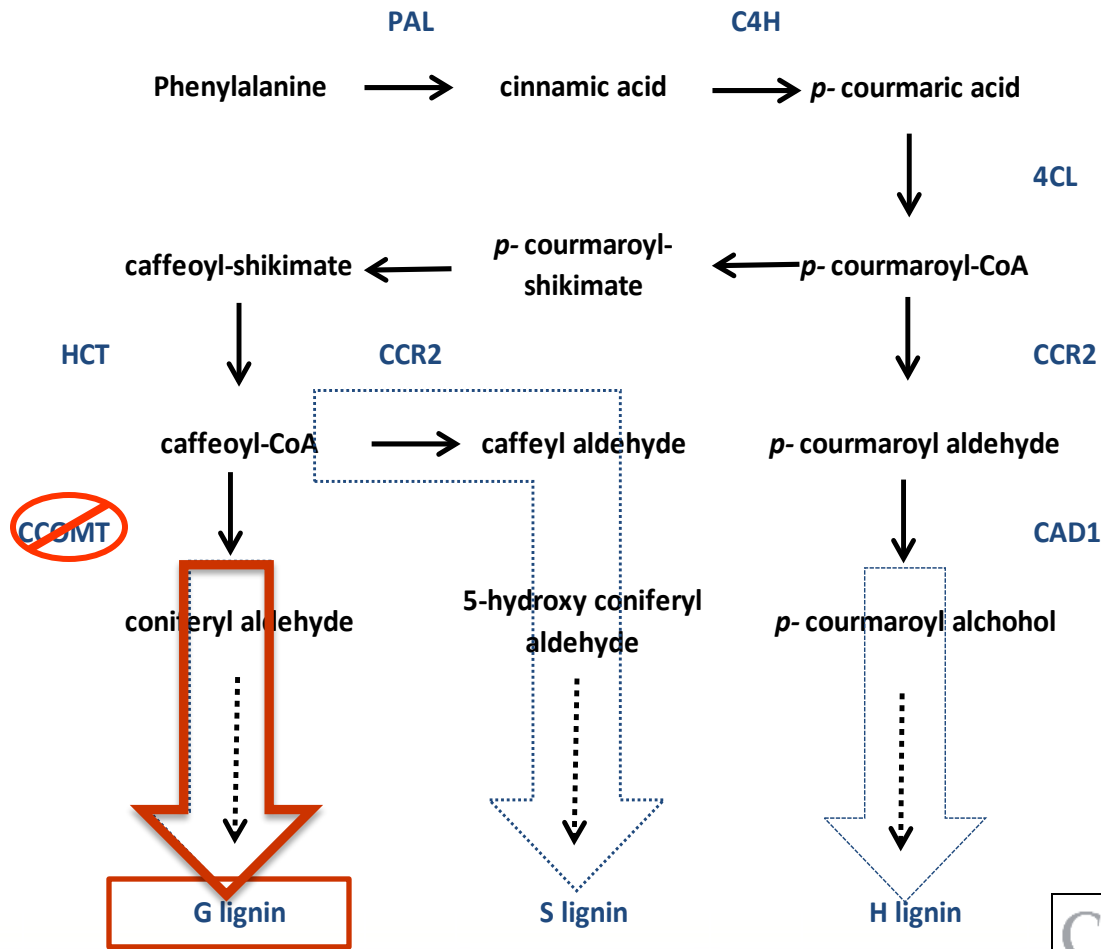


# WHY LIGNIN?

- Lignin is an indigestible phenolic compound in alfalfa cell walls
- As alfalfa matures, lignin content increases.
- Lignin cross-links with cellulose which decreases digestibility of fiber (dNDF)
- A 10% increase in fiber digestibility
  - Increase milk/beef by \$350M/yr
  - Decrease manure by 2.8M T/yr



# LIGNIN BIOSYNTHEtic PATHWAY

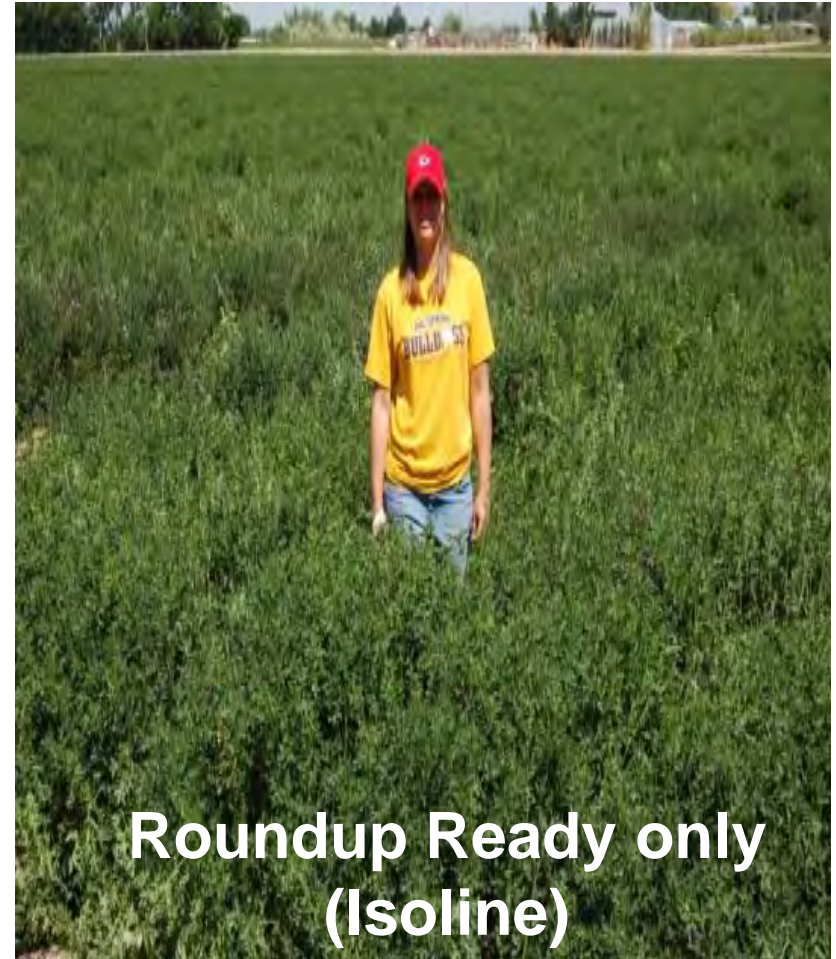


Dr. Richard Dixon

Suppress lignin expression through gene silencing

Consortium *for* **Alfalfa Improvement**

# PROOF OF CONCEPT REDUCED LIGNIN ALFALFA



May 30, 2007



# Proof of Concept Reduced Lignin Alfalfa



Two period crossover design  
12 multiparous cows in each period

6 cows/treatment/period

60 to 200 days in milk

> 90 lbs milk

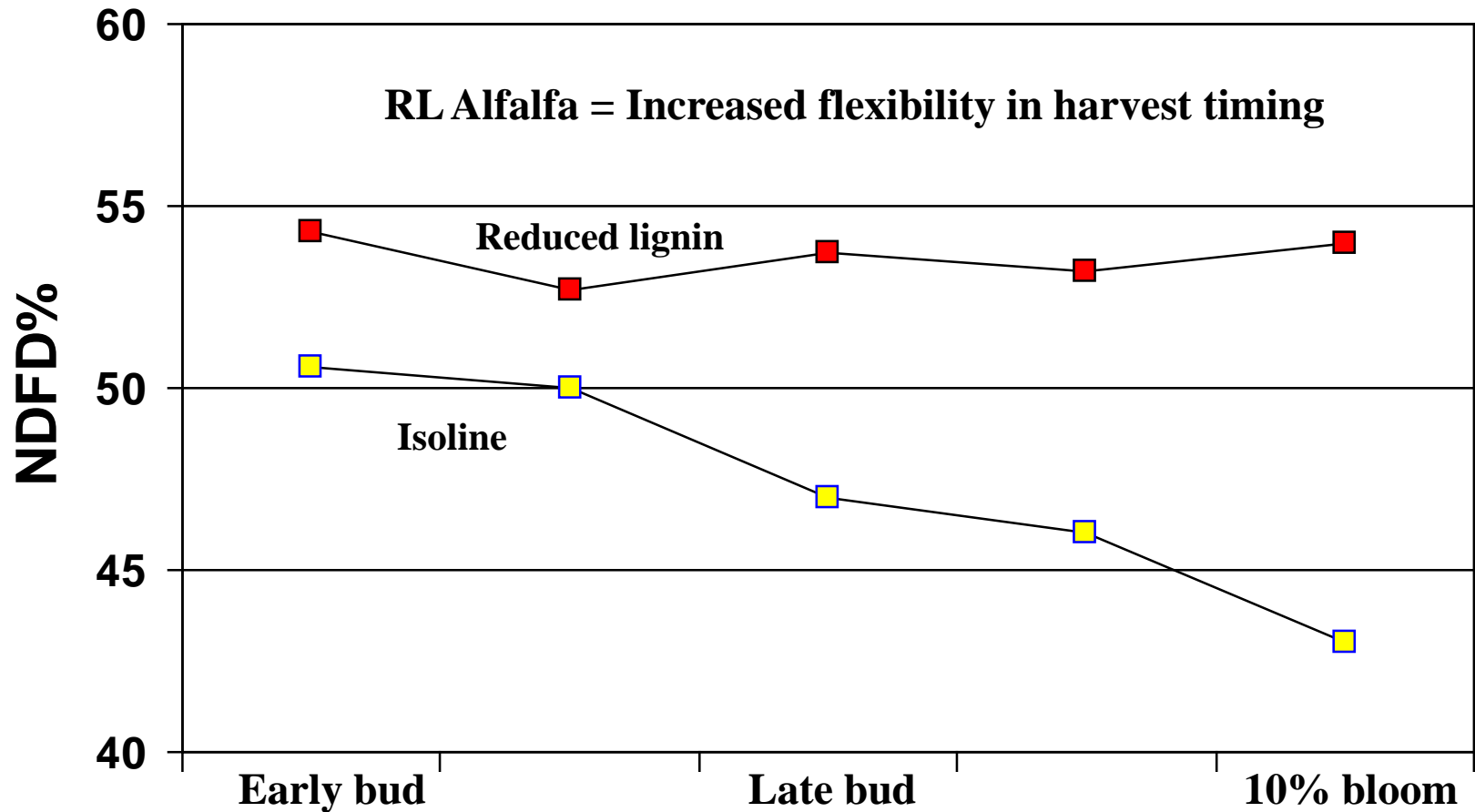
Switched (crossover) in second period



Down-regulated lignin hay significantly  
increased NDF digestibility



# REDUCED LIGNIN ALFALFA CHANGES IN NDF DIGESTIBILITY OVER TIME



# CUTTING MANAGEMENT TEST

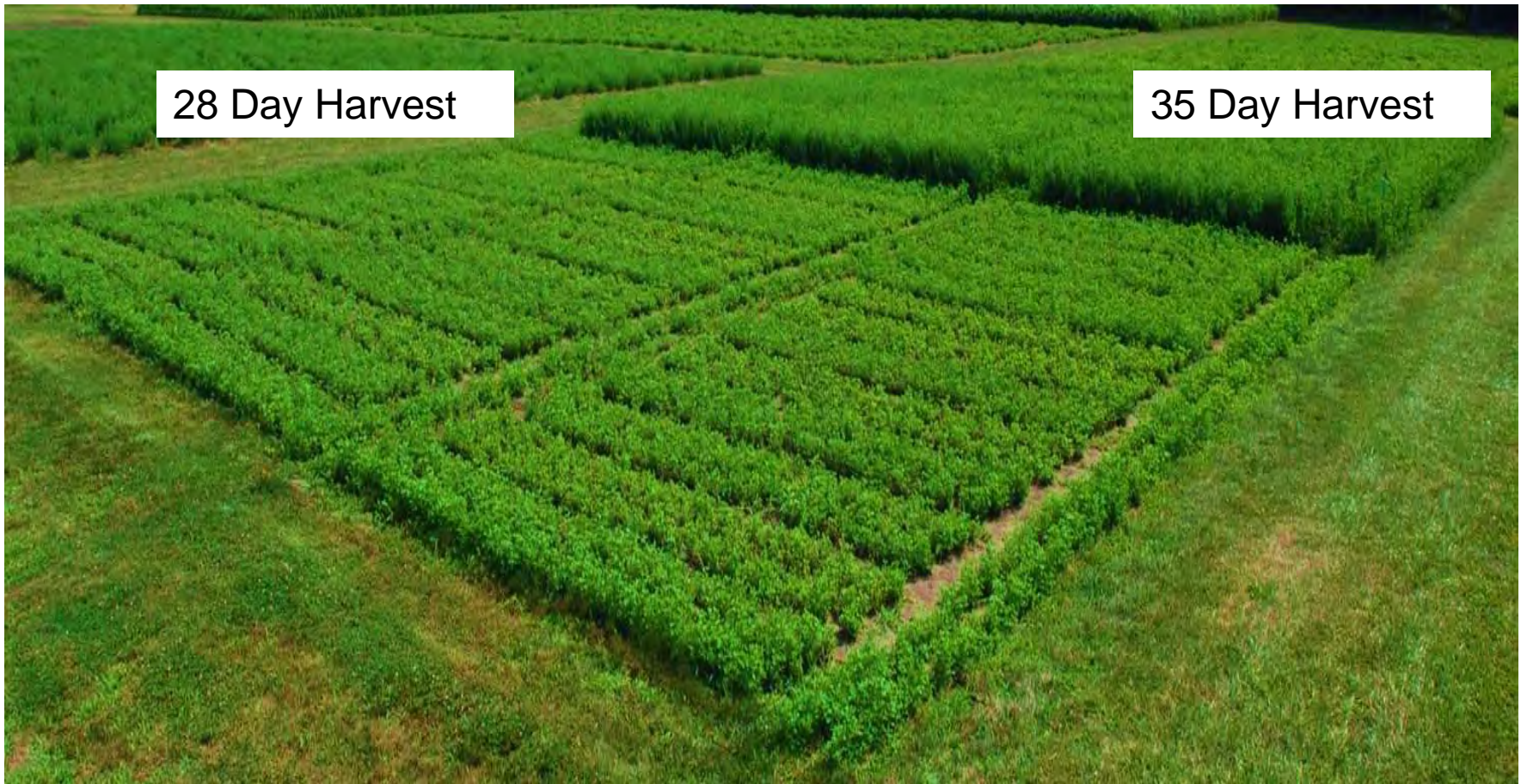
- Compare harvest at 28 vs 35 day harvest schedule.
  - Reduced Lignin + Roundup Ready<sup>®</sup> alfalfa versus commercial varieties
  - Measure yield, persistence and forage quality
- 2010 trial at West Salem, WI
- 2011 trials at six locations

Consortium  
*for*  
Alfalfa Improvement





# WSALEM, WI 2011 CUTTING MANAGEMENT TRIAL

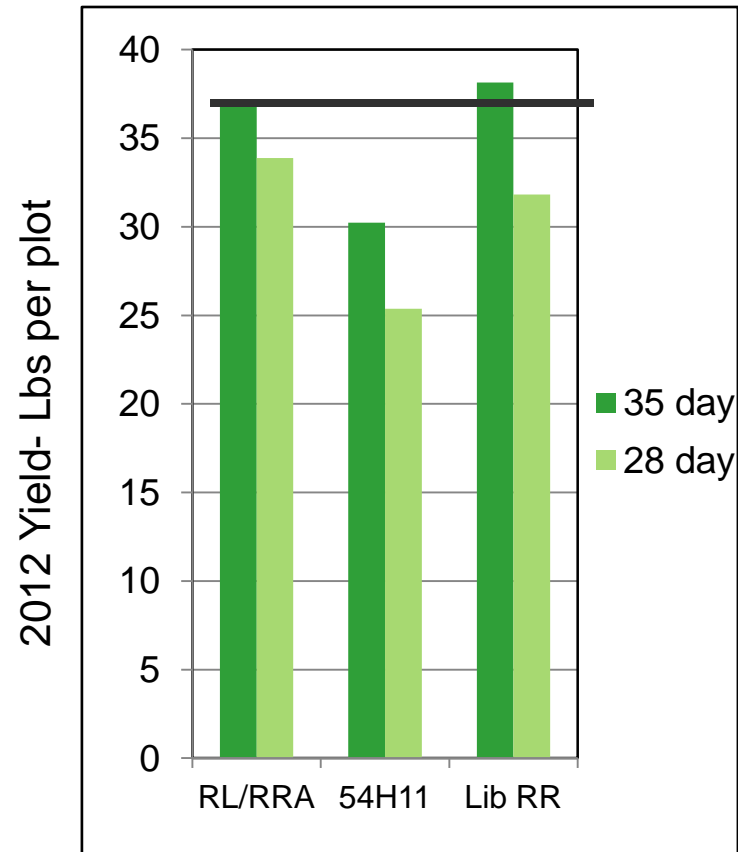
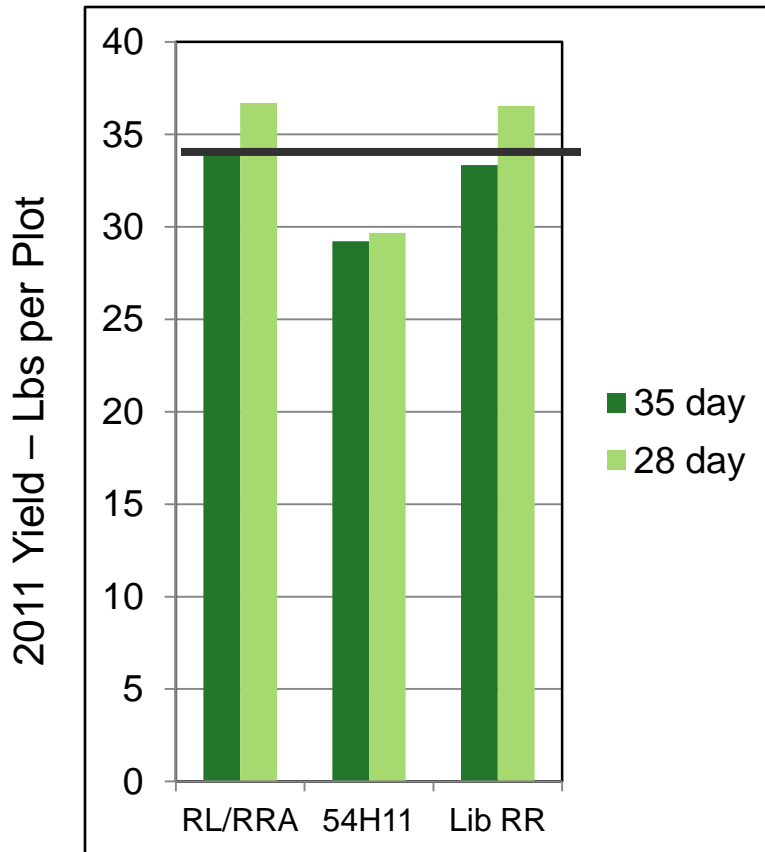


28 Day Harvest

35 Day Harvest

# FGI 2010 CUTTING MANAGEMENT

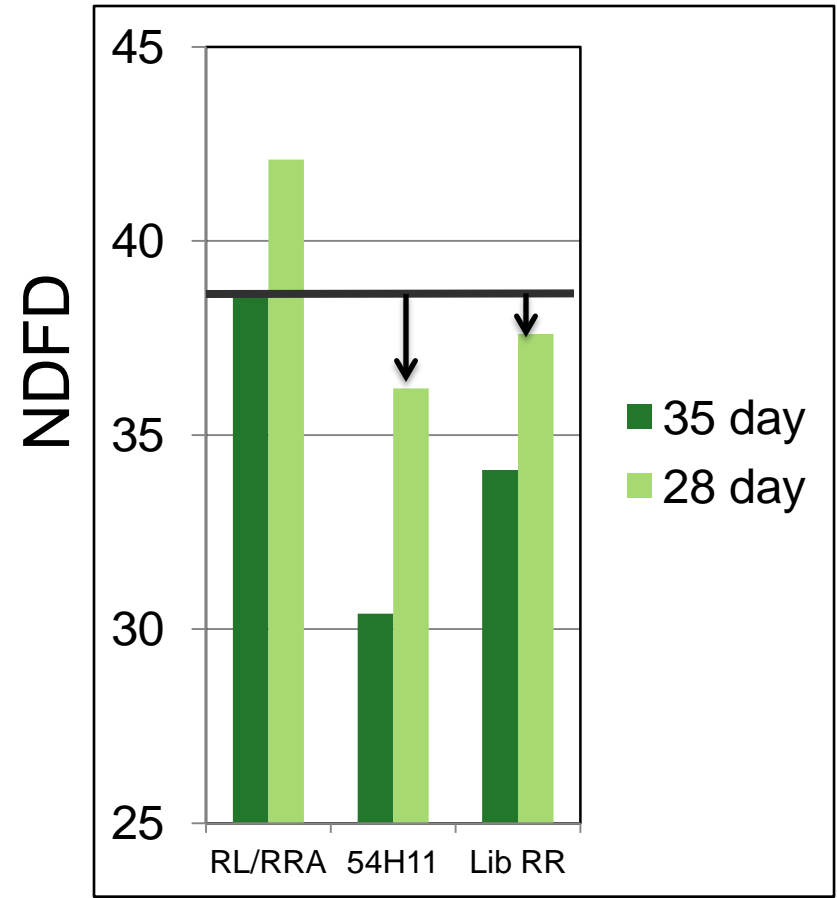
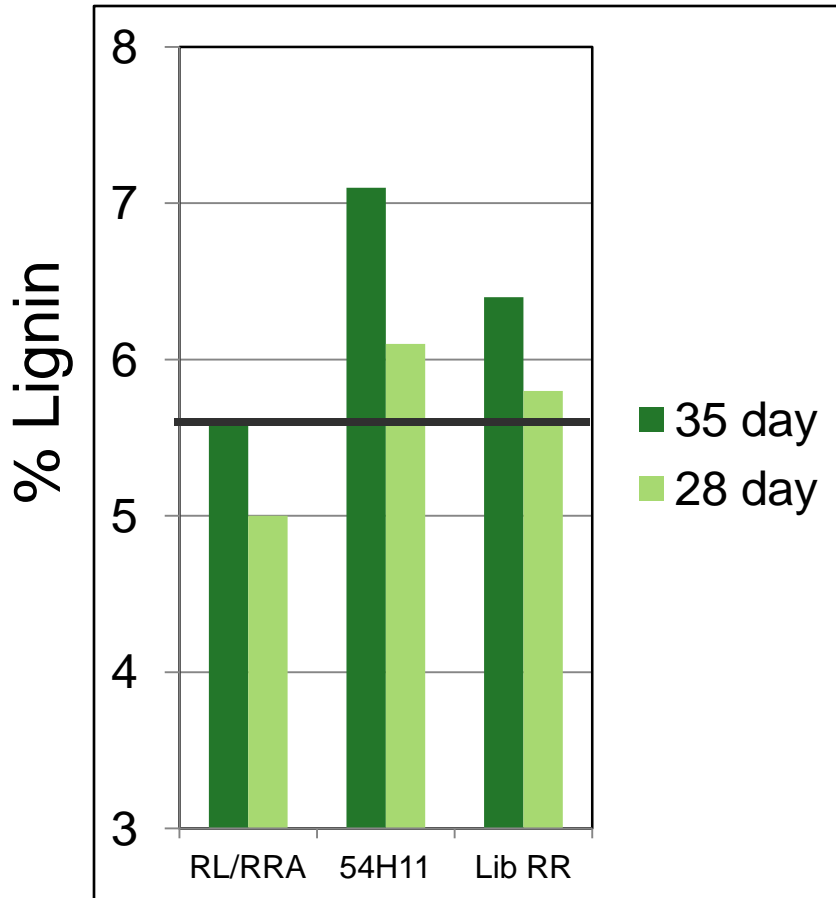
Reduced Lignin yield = Competitive Checks



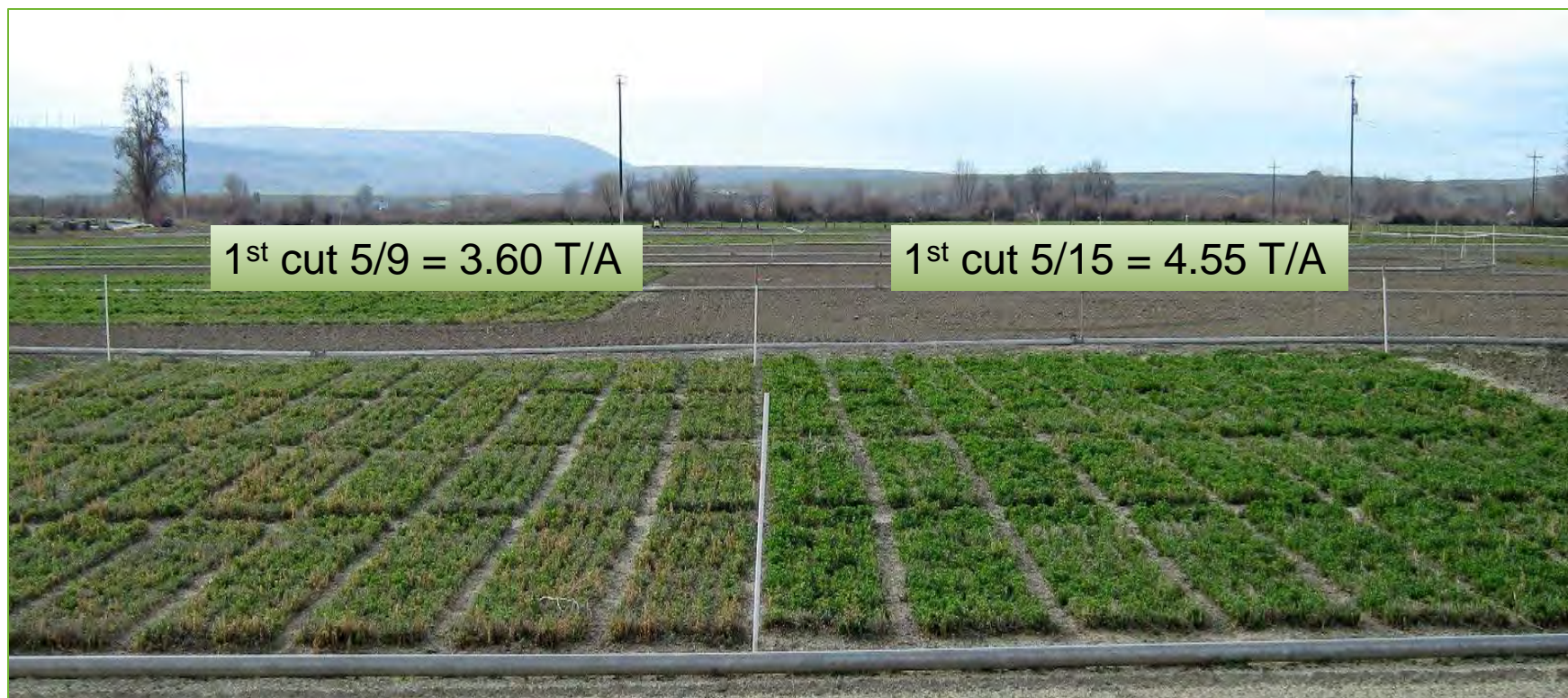


# 2011-12 COMBINED DATA

Late cut Quality Reduced Lignin > Early Cut Quality of Competitive Checks



# 2011 RL CUTTING MANAGEMENT TEST TOUCHET, WA



Six Harvests

Five Harvests

Spring Regrowth: 03-05-2013

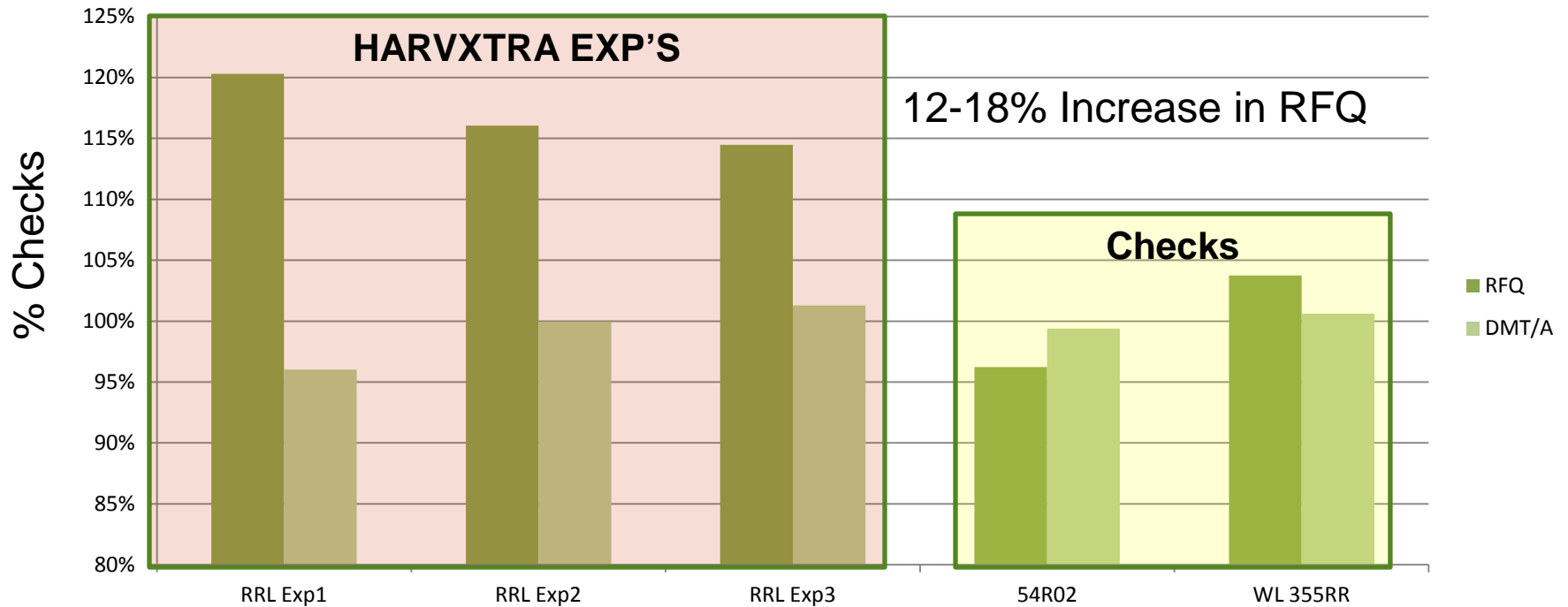
# SUMMER SLUMP IN ALFALFA

- Reduction in yield due to:
  - Fall dormancy response
    - Shorter day length = reduced growth
      - especially in FD 3-5 groups
  - High temperatures
- Reduction in quality due to:
  - High temperatures
  - Increased lignification





# FALL DORMANT REDUCED LIGNIN EXP'S 4 LOCATION AVERAGE JULY HARVESTS FORAGE YIELD AND QUALITY



Entry	07/23/14 Mt. Joy, PA		07/09/14 Boone, IA		07/23/13 Nampa, ID		07/11/13 Touchet, WA	
	RFQ	DMT/A	RFQ	DMT/A	RFQ	DMT/A	RFQ	DMT/A
RRL Exp1	196	1.50	157	1.27	213	1.69	216	1.80
RRL Exp2	196	1.65	162	1.33	211	1.71	199	1.83
RRL Exp3	182	1.64	162	1.31	206	1.73	196	1.82
54R02	148	1.62	128	1.24	193	1.78	185	1.77
WL 355RR	183	1.54	122	1.36	180	1.75	190	1.84



- In an effort to bring the industry's first quality-enhancing trait to market, FGI has announced that the reduced lignin trait will be known as HarvXtra™ alfalfa.

# HARVXTRA™ ALFALFA UPDATE

- 10-15% increase in whole plant NDFD\*
- RL/RRA trait purity  $\geq$  90% trait purity both traits
- Competitive agronomic performance
  - Excellent forage yield
  - No increase in lodging incidence
  - Pest resistance, winter survival & persistence best in class

\*NDFD should not be interpreted as a direct measurement or prediction of animal performance potential, but simply as one of several forage quality metrics commonly used by the forage community





# COMMERCIAL VARIETIES IN WIDE SCALE PRODUCT TESTING 2013-2015



- Over 150 New experimental varieties
  - Private and University Testing in >60 trials in ten states plus Mexico & Argentina

# BENEFITS OF HARVXTRA™ ALFALFA

- For growers today, harvest timing is a critical decision in determining quality for alfalfa forage
  - HarvXtra™ alfalfa gives growers the option to:
    - maintain harvest schedule routines to obtain forage that is likely to meet or exceed the intended forage quality,
- OR
- delay a harvest a few days to obtain higher tonnage without sacrificing acceptable forage quality.

# HARVXTRA™ ALFALFA TIMELINE

- HarvXtra™ alfalfa was recently deregulated by the United States Department of Agriculture (USDA).
- It is not currently available for sale and is still pending regulatory approvals in key export markets with functioning regulatory systems.
- We anticipate a limited introduction in 2016 to allow growers the opportunity to experience the value and benefit of the technology





# BREEDING FOR SALINITY TOLERANCE IN ALFALFA

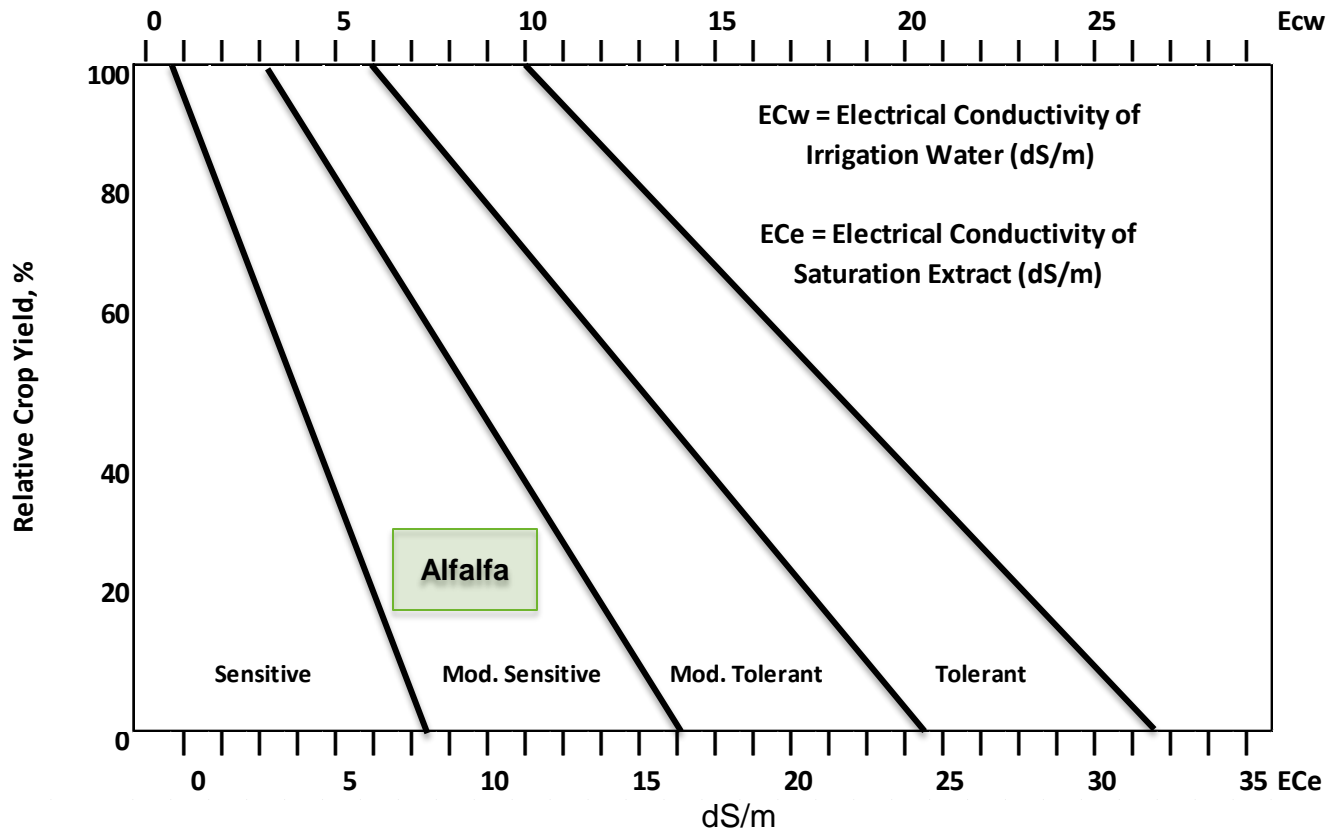
# RELATIVE CROP SALINITY TOLERANCE RATING\*

- Sensitive: < 1.3 ds/m
  - Mod. Sensitive: 1.3 – 3.0 ds/m
  - Mod. Tolerant: 3.0 – 6.0 ds/m
  - Tolerant: 6.0 – 10.0 ds/m
  - Unsuitable: > 10.0 ds/m
- Alfalfa

\*Soil salinity (ECe) at which yield loss begins

R.S. Ayers and Westcot, D.W.. Revised 1994. Water quality for Agriculture. FAO IRRIGATION AND DRAINAGE PAPER 29

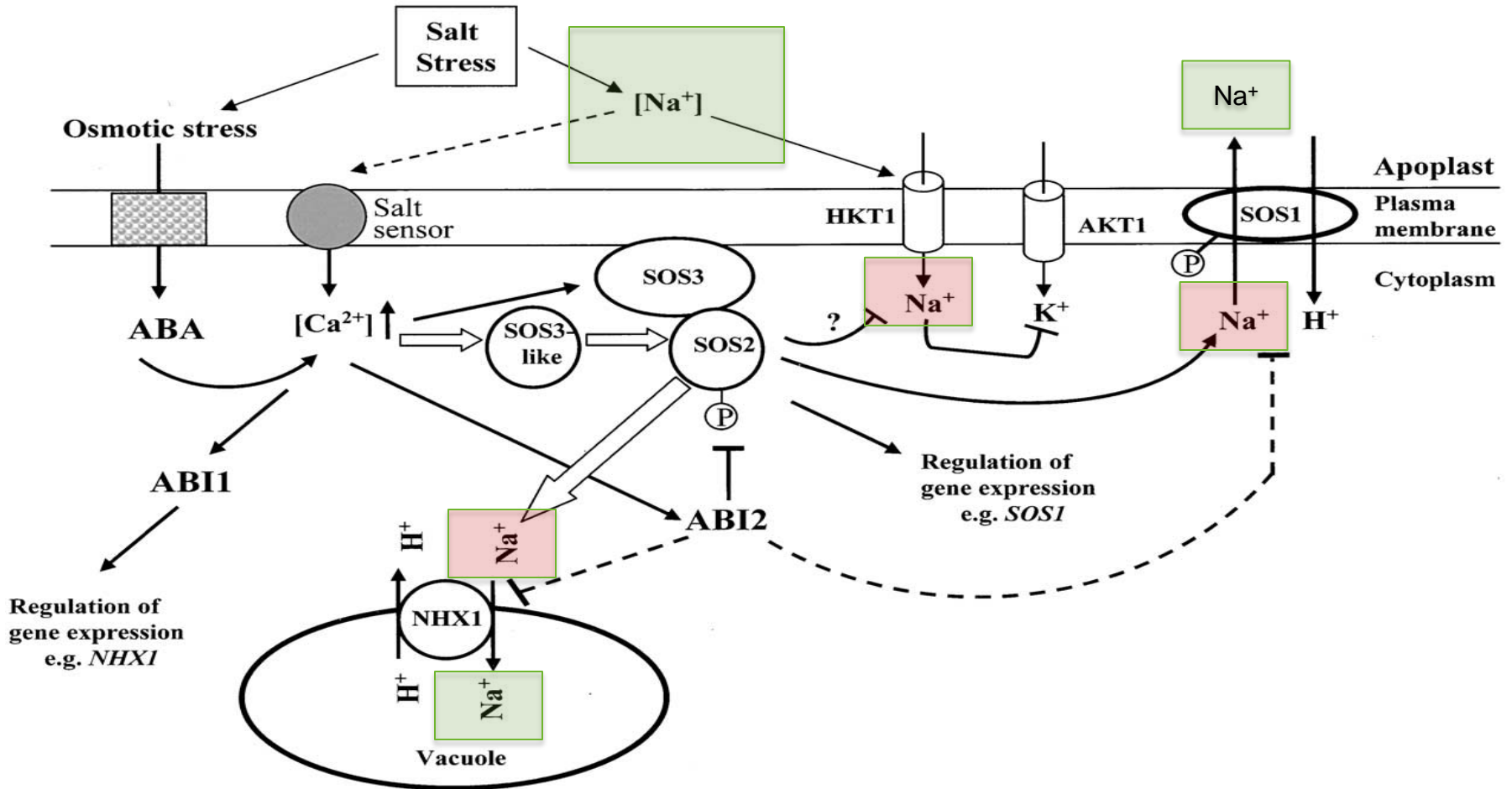
# SALINITY IMPACT ON CROP YIELD



Alfalfa	100%		90%		75%		50%		0%	
	EC <sub>e</sub>	EC <sub>w</sub>	EC <sub>e</sub>	EC <sub>w</sub>	EC <sub>e</sub>	EC <sub>w</sub>	EC <sub>e</sub>	EC <sub>w</sub>	EC <sub>e</sub>	EC <sub>w</sub>
	2	1.3	3.4	2.2	5.4	3.6	8.8	5.9	16	10

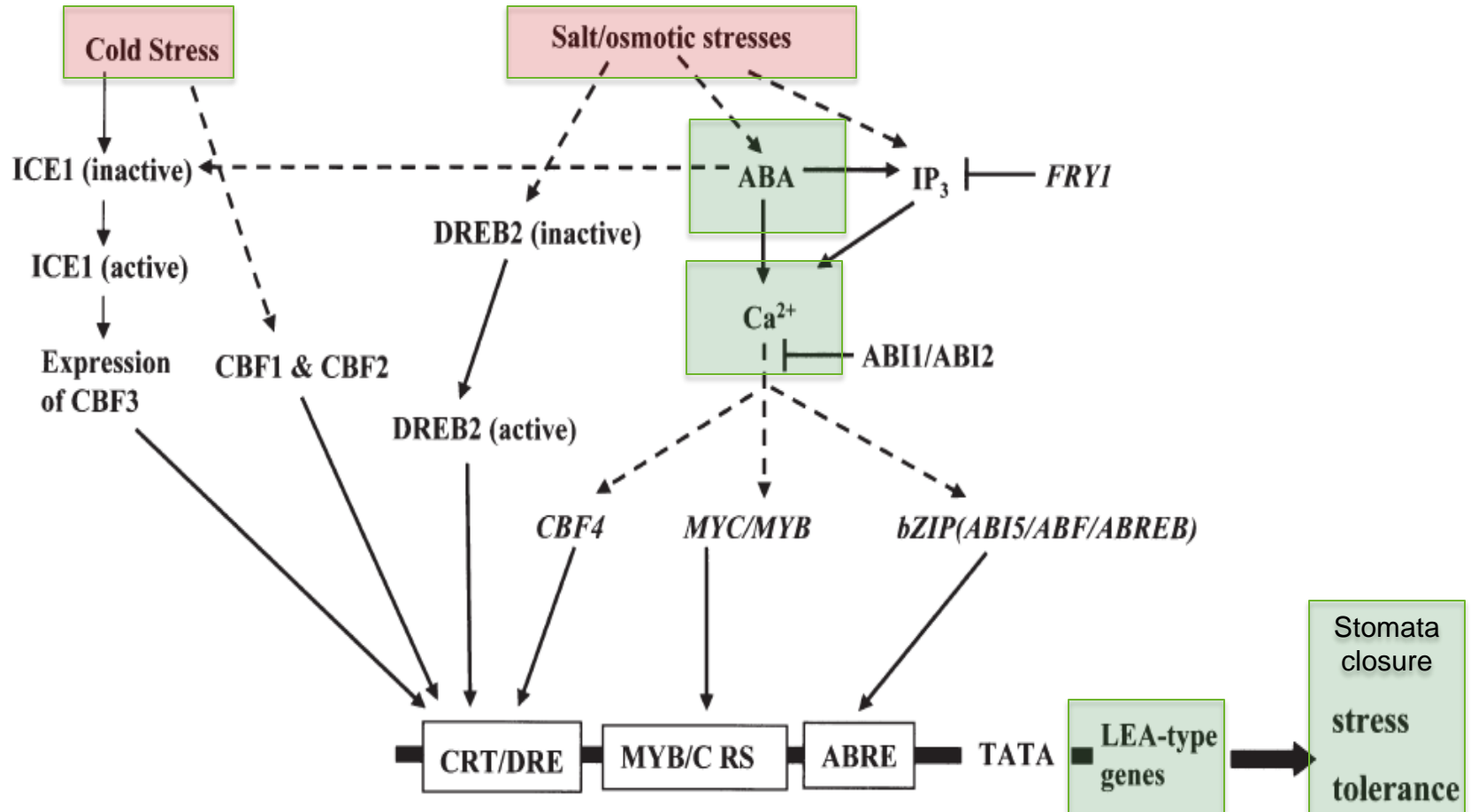


# IONIC SALT STRESS



Understanding and Improving Salt Tolerance in Plants. V. Chinnusamy, et al. Crop Sci. 45:437-448 (2005).

# OSMOTIC SALT STRESS



Understanding and Improving Salt Tolerance in Plants. V. Chinnusamy, et al.  
Crop Sci. 45:437-448 (2005).