

Low Lignin Trait in Alfalfa – What are the Possibilities?

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Are we just producing “Stuff that cows eat?”

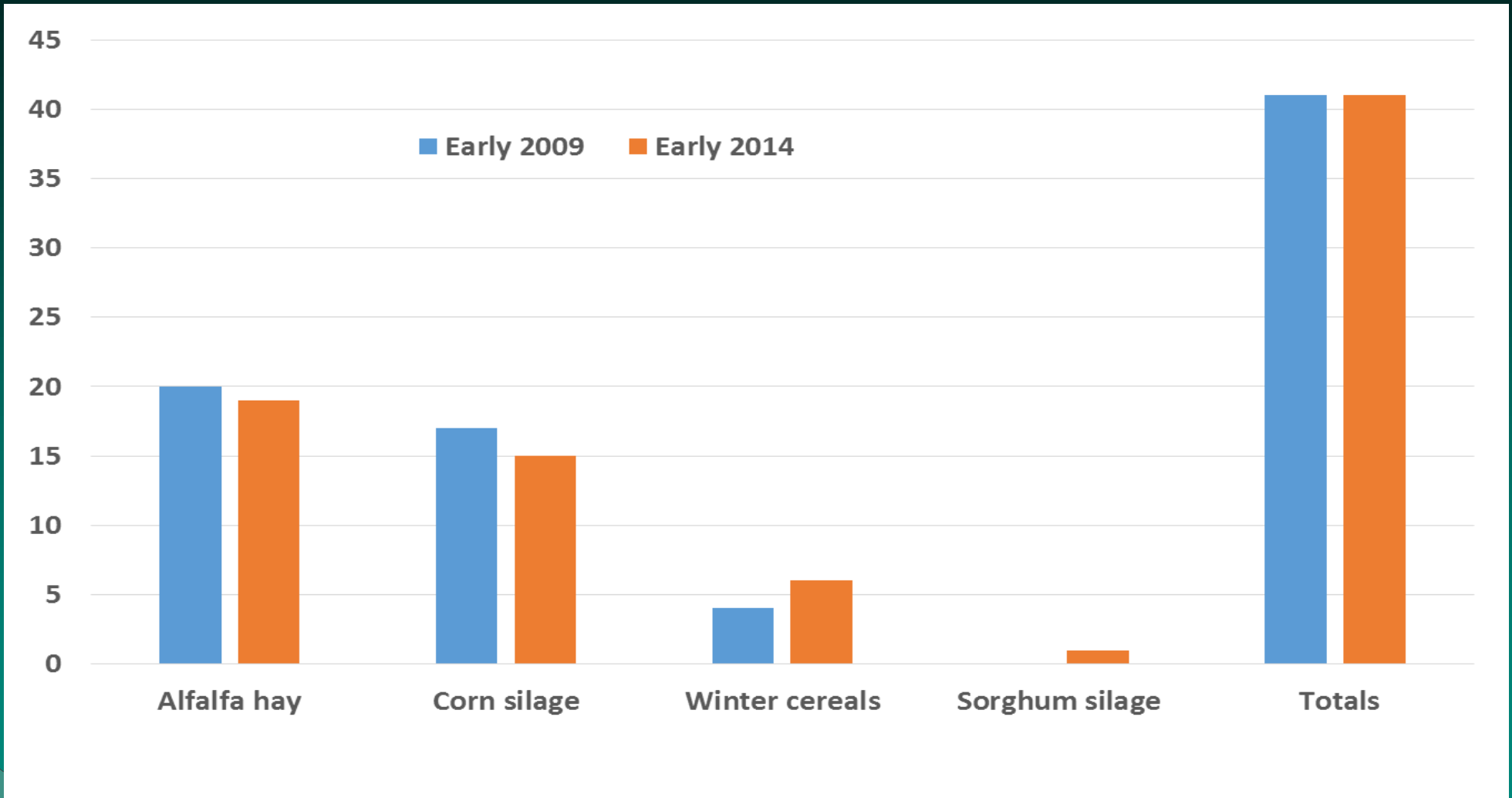


Or specific nutrients that produce a result (milk ,growth or meat)?



Inclusion of forages (%) in high group dairy rations

(Peter Robinson, UCD)



What Is Forage Quality?

Ask a Nutritionist!

1. Total Digestible Energy (TDN, NEL, Total potential biological energy of forage)
2. Energy per unit time (Intake Potential)
3. Effectively Absorbed Protein (both rumen available and rumen undegradable)
4. Nutritionally Effective Fiber (physical value)

5. Mineral Conte

Problem: Total Digestible Energy and feed intake are the most important issues, but cannot be directly measured (only predicted)!!!

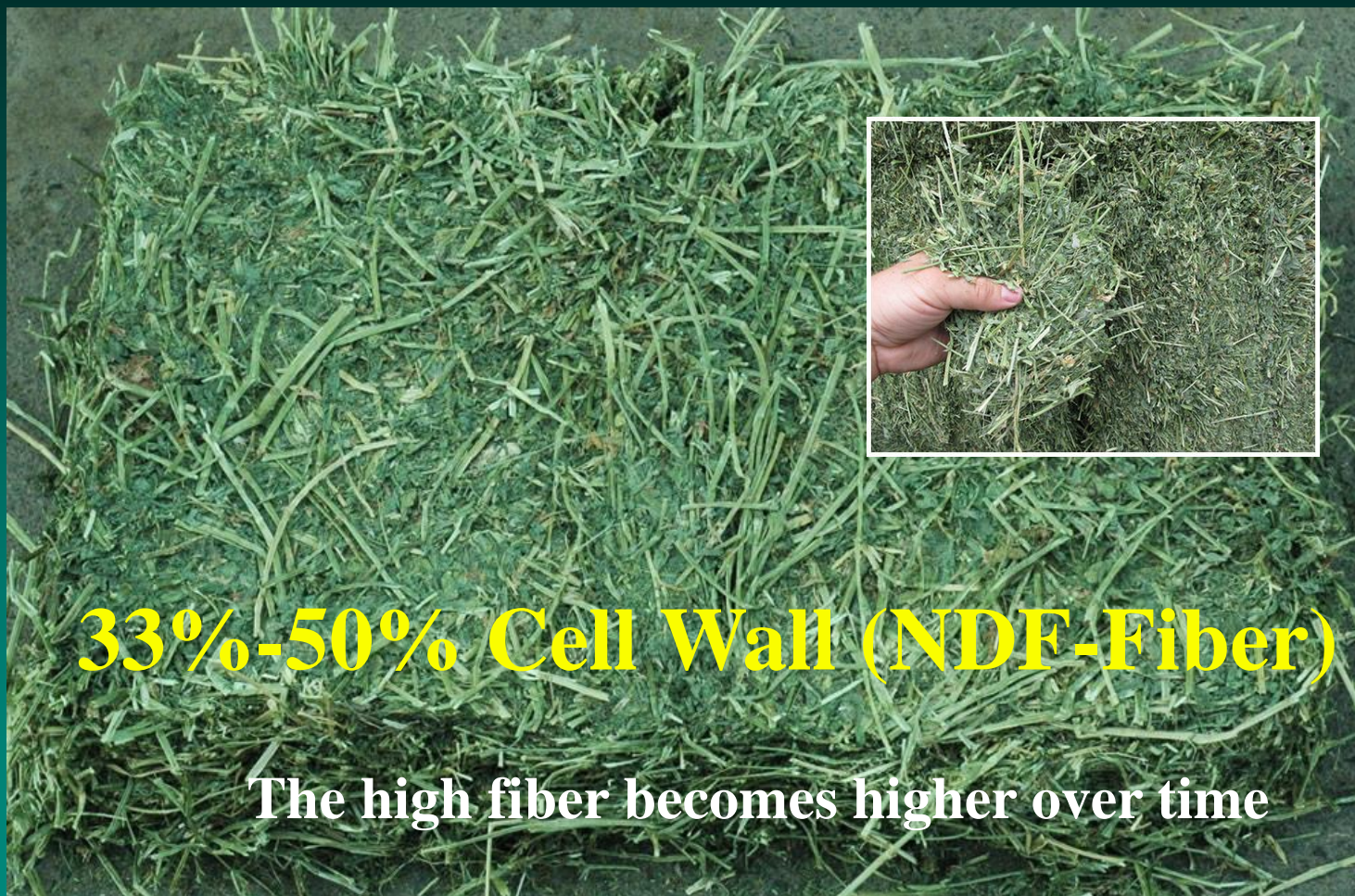
Price of Alfalfa Hay (November 2016)

(The Hoyt Report)

	Tulare, Hanford		Modesto, Escolon, Turlock	
Quality Category	Volume	Price	Volume	Price
Superior				
Prime				
Good	650	\$165-185	475	\$160-180
Fair	1950	\$140-145	1600	\$135-150
Difference top-bottom		\$103		\$98

Probably \$250-\$300 million per year gained or lost due to quality (California)

What about Fiber?

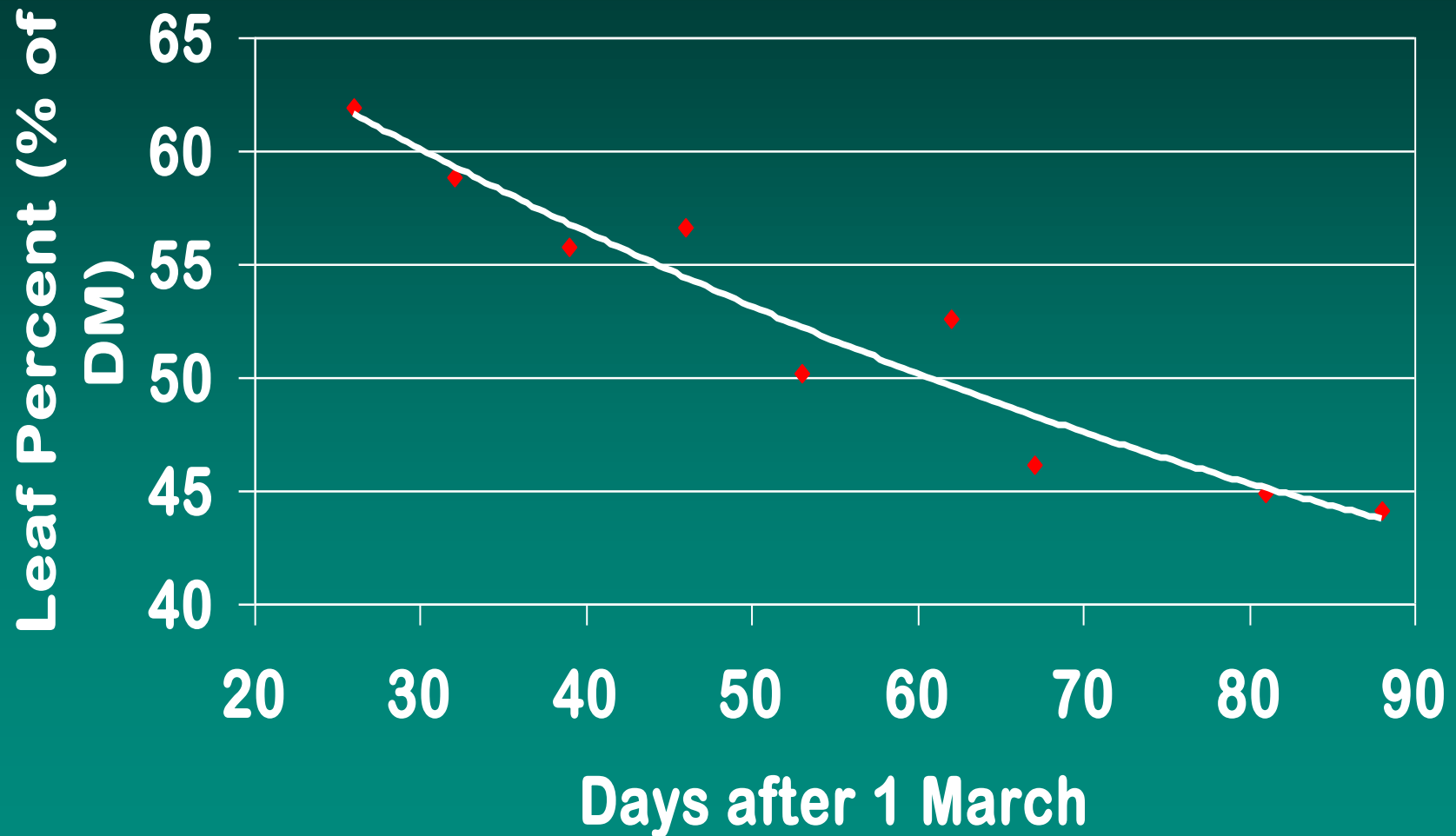


33%-50% Cell Wall (NDF-Fiber)

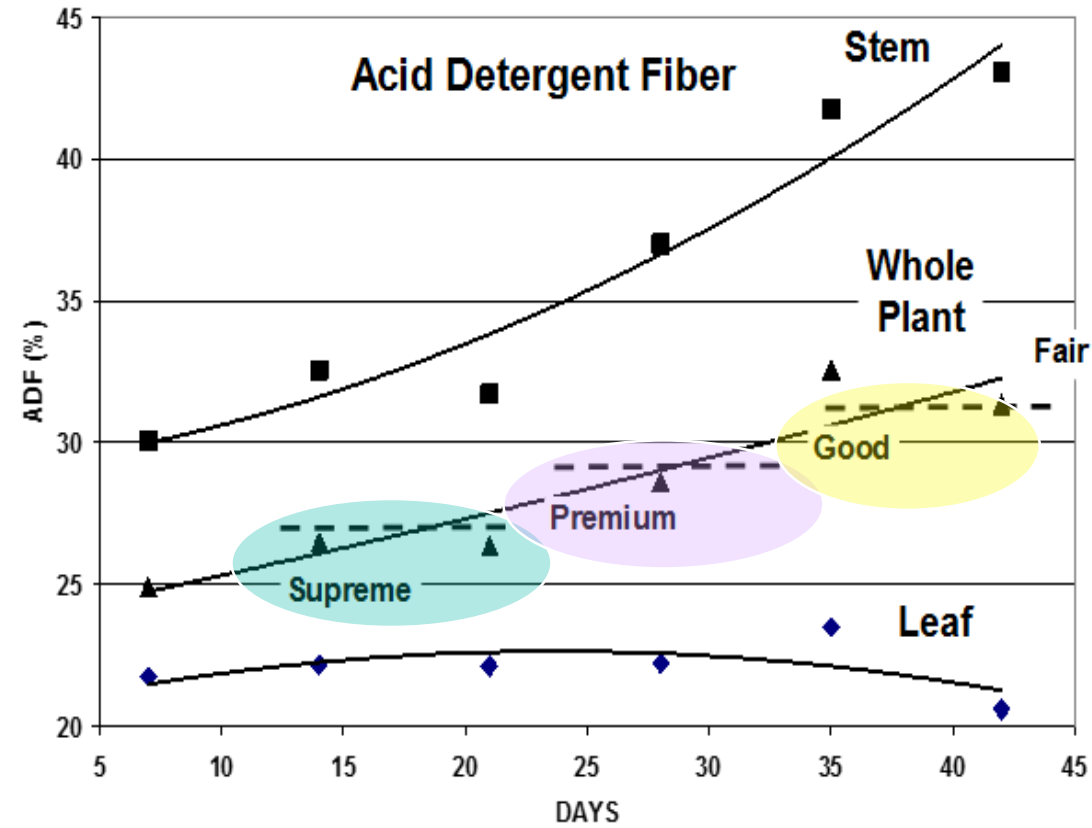
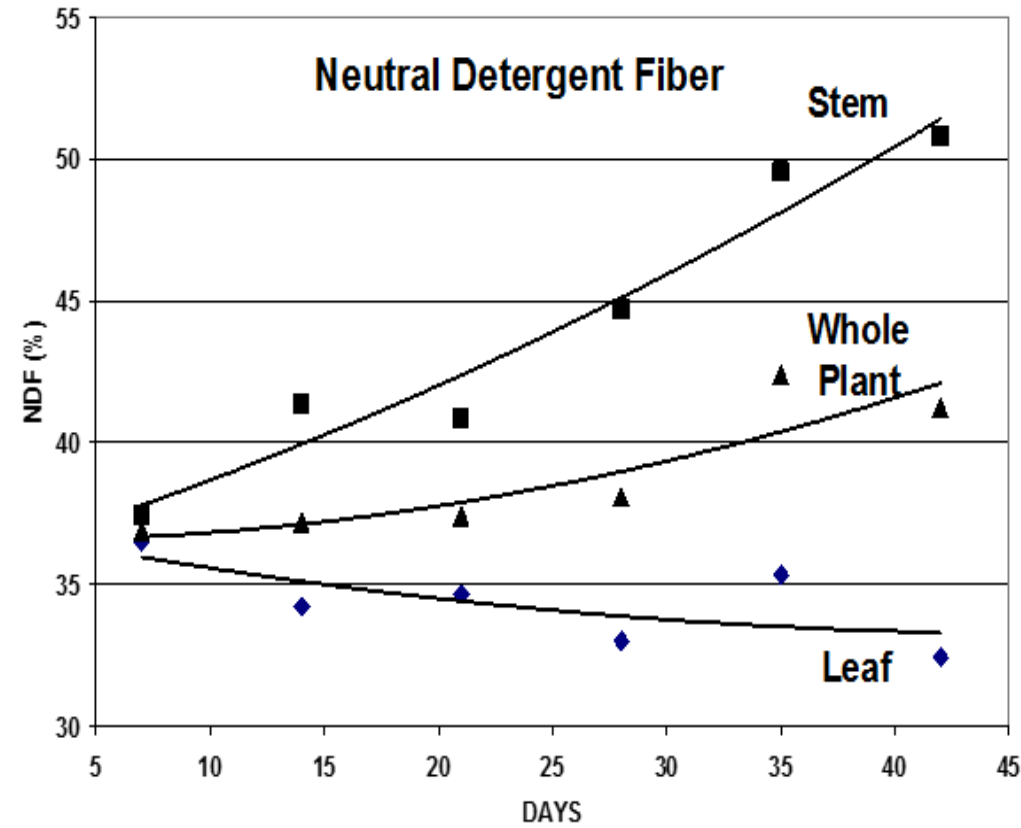
The high fiber becomes higher over time



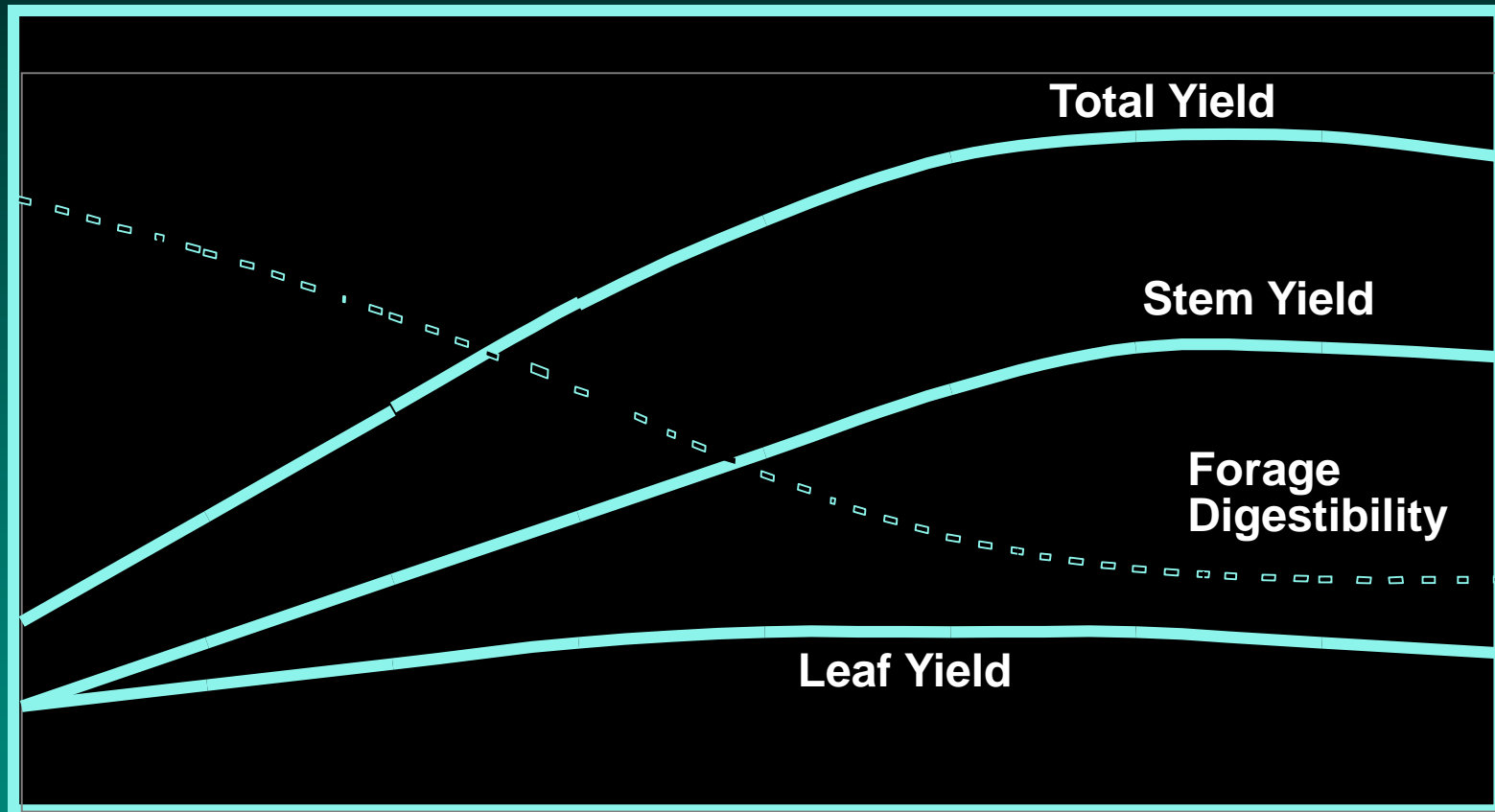
Effect of Plant Maturity on Leaf Percentage:



NDF/ADF increases each day



Relationship between yield and quality



Vegetative

Bud

First Flower

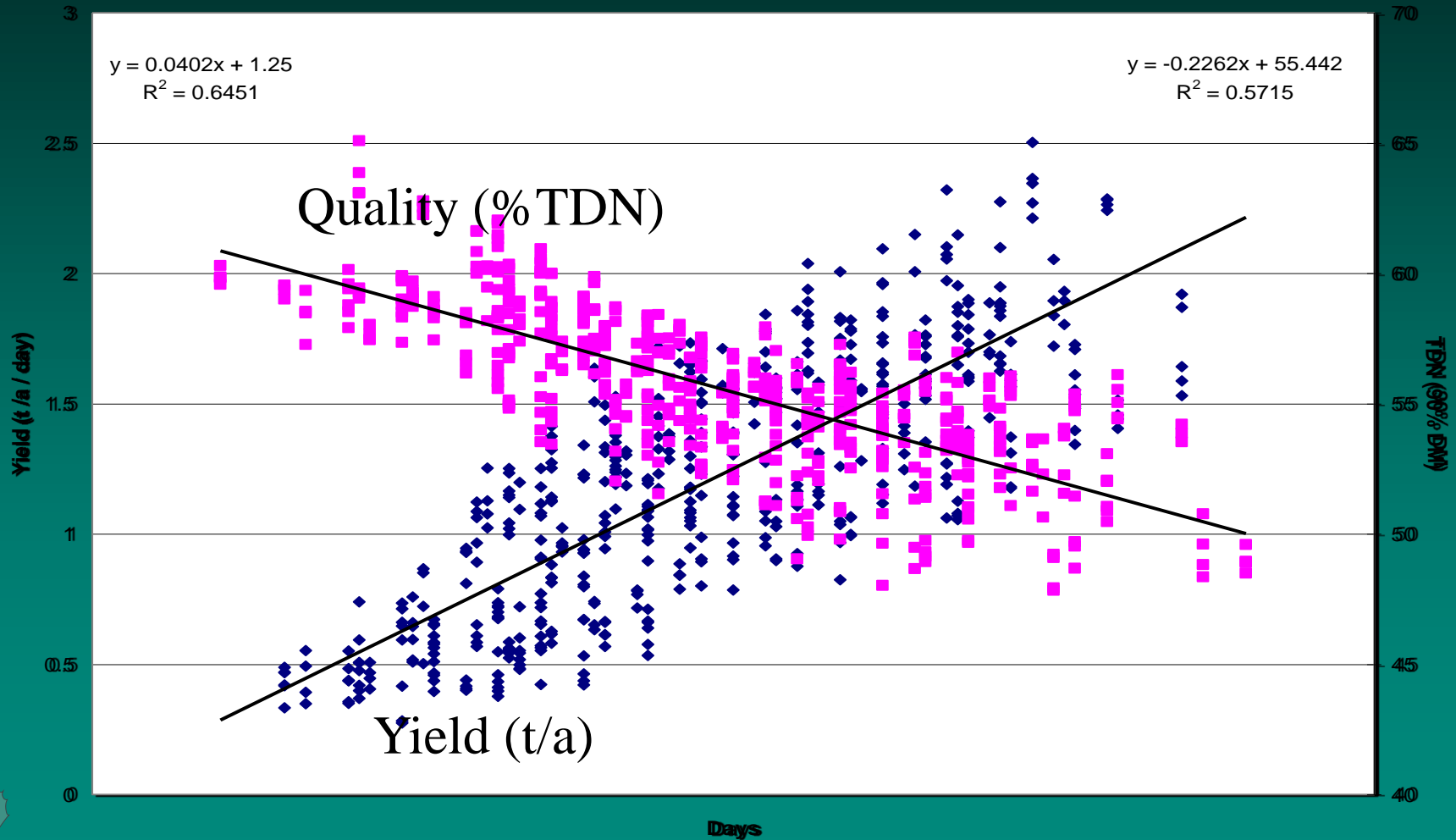
Full Flower

Post-Flower

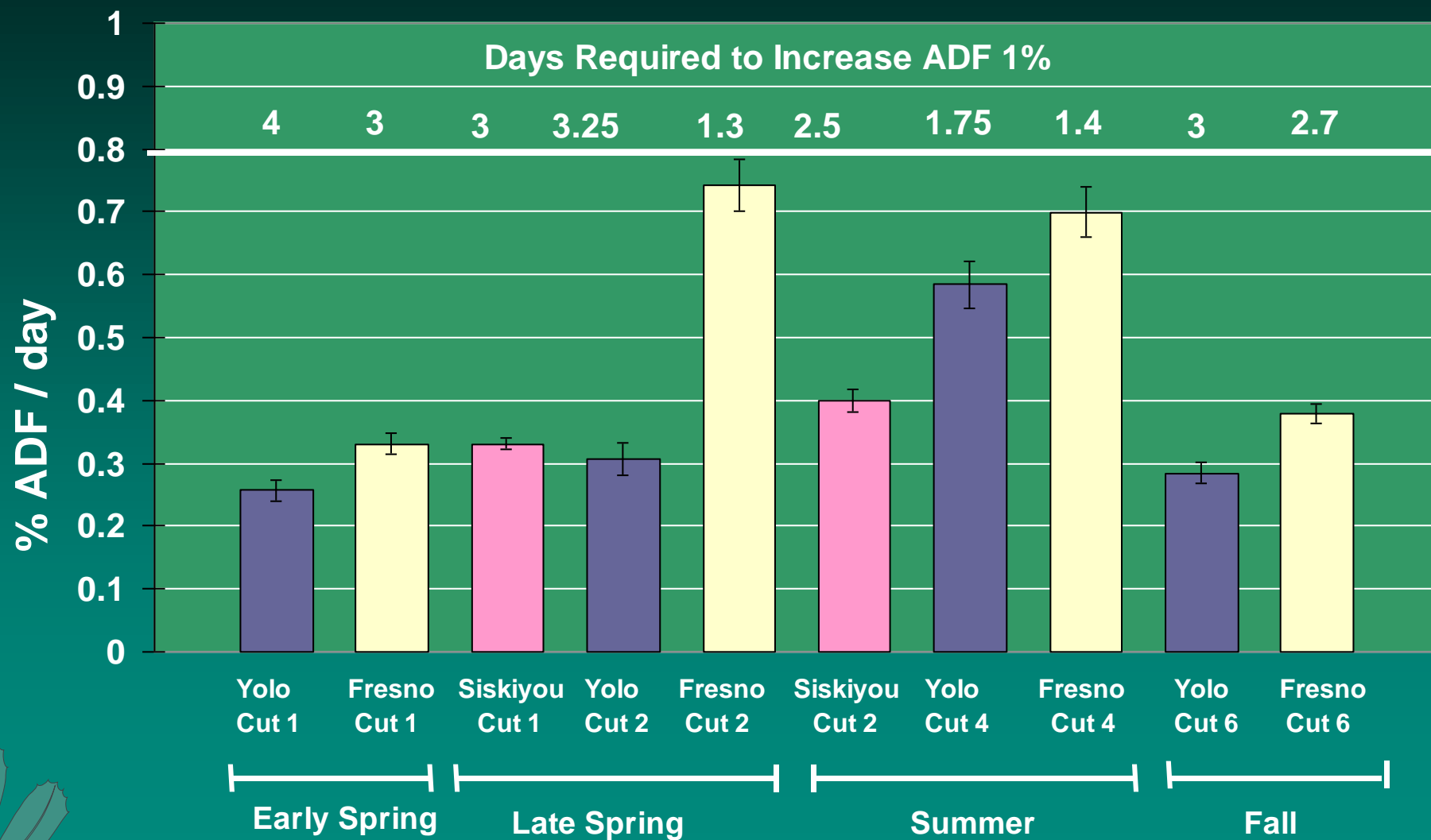
Time (days)

The Yield/Quality Tradeoff (Yolo County)

The Yield/Quality Tradeoff



Daily changes in ADF for all cuts and locations.



Influence of Harvest Schedule on Yield and Quality

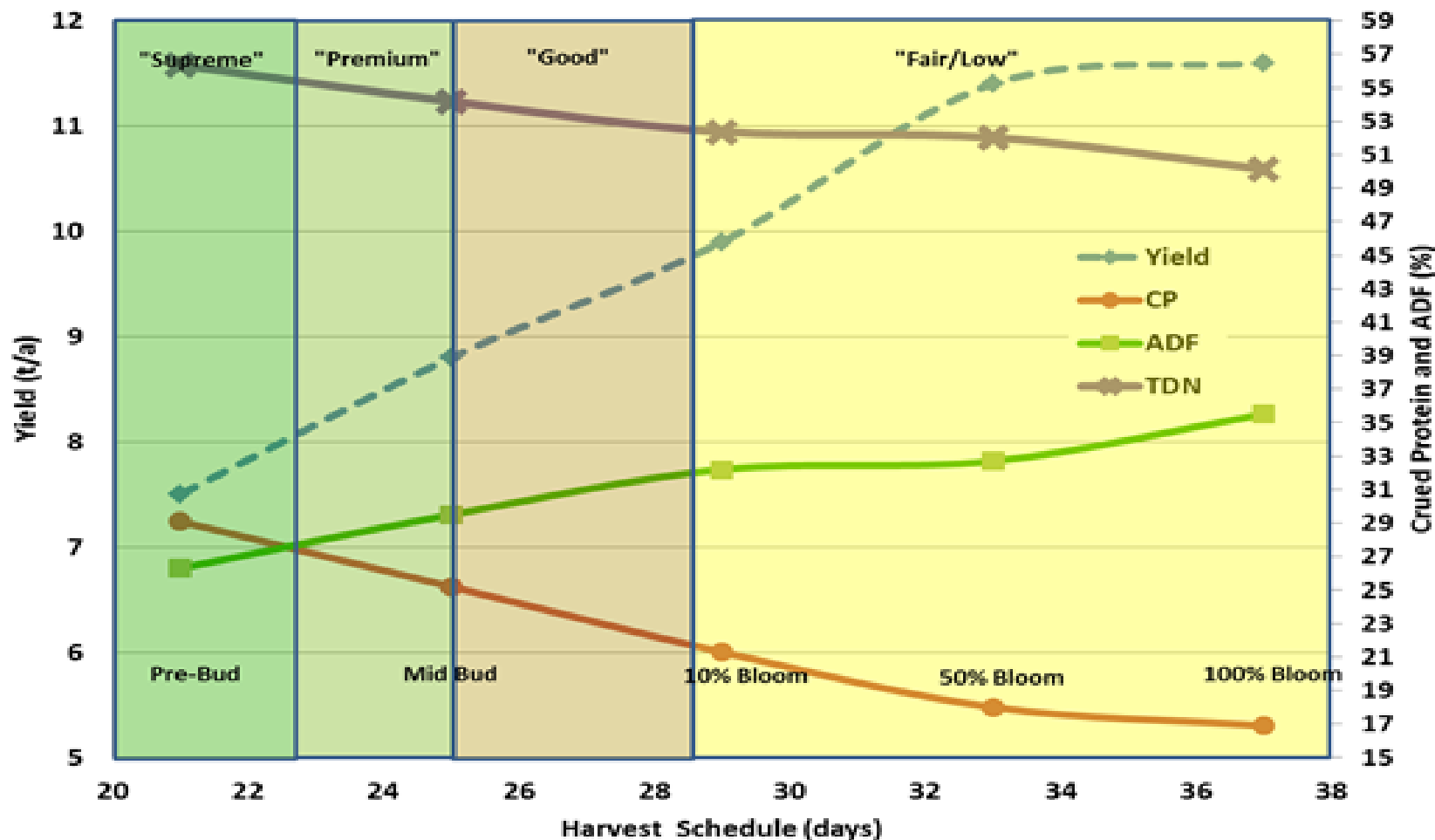


Figure 4. Effect of harvest scheduling on yield and quality (Data from Marble, 1974, Davis, CA). Classifications are as per USDA-Hay Market Guidelines (2016). Note that most nutritionist desire additional analyses to predict quality, particularly fiber digestibility estimates.

Lignin in Alfalfa



- **Alfalfa has ~ 6-8% (%DM) lignin**
- **Structural support**
- **Lignin increases with maturity**
- **Negatively related to fiber digestibility**
- **Limits NDFD, DMI, and energy production efficiency**



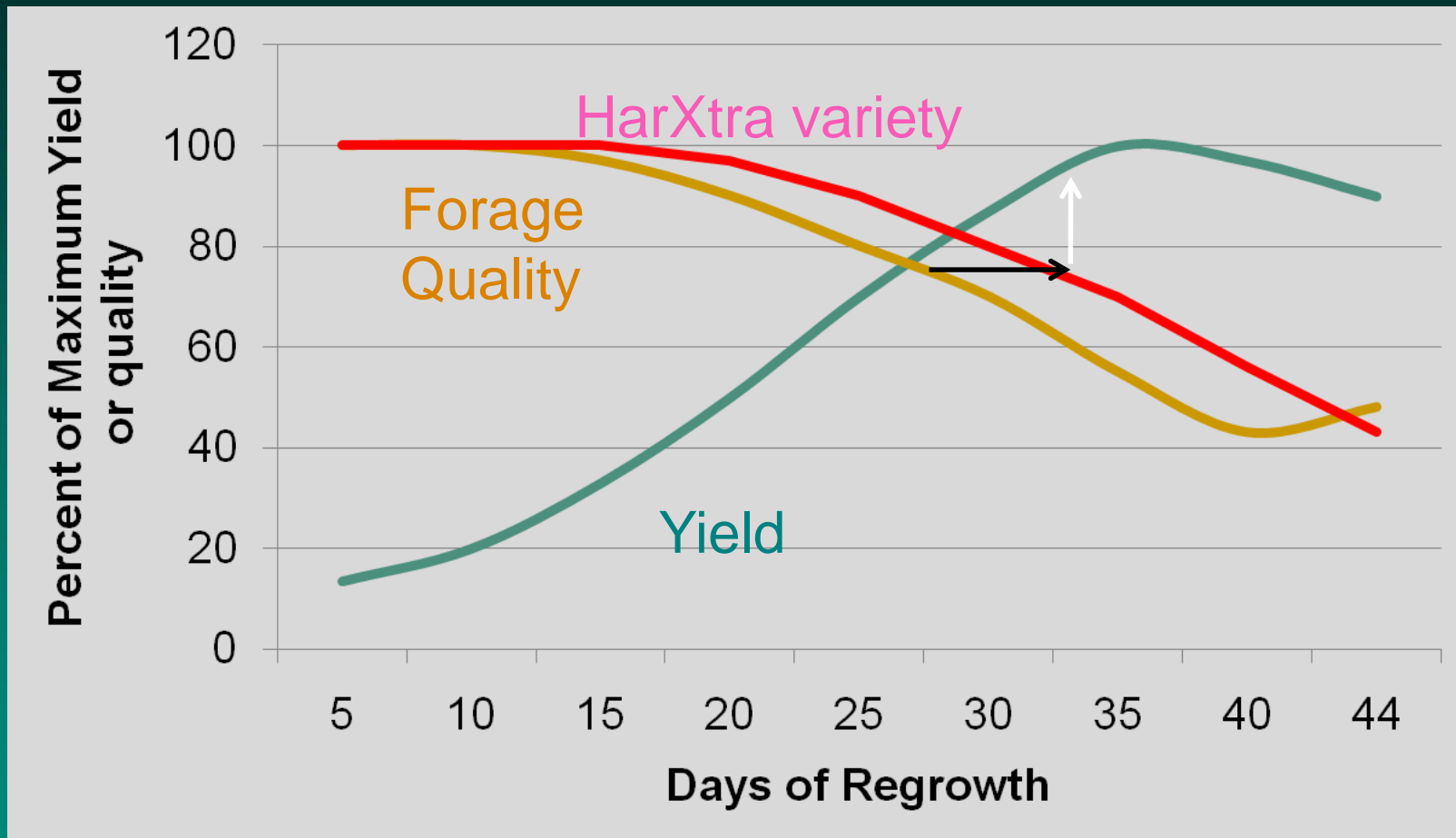
Why Lignin?



- 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 2.8MT/yr

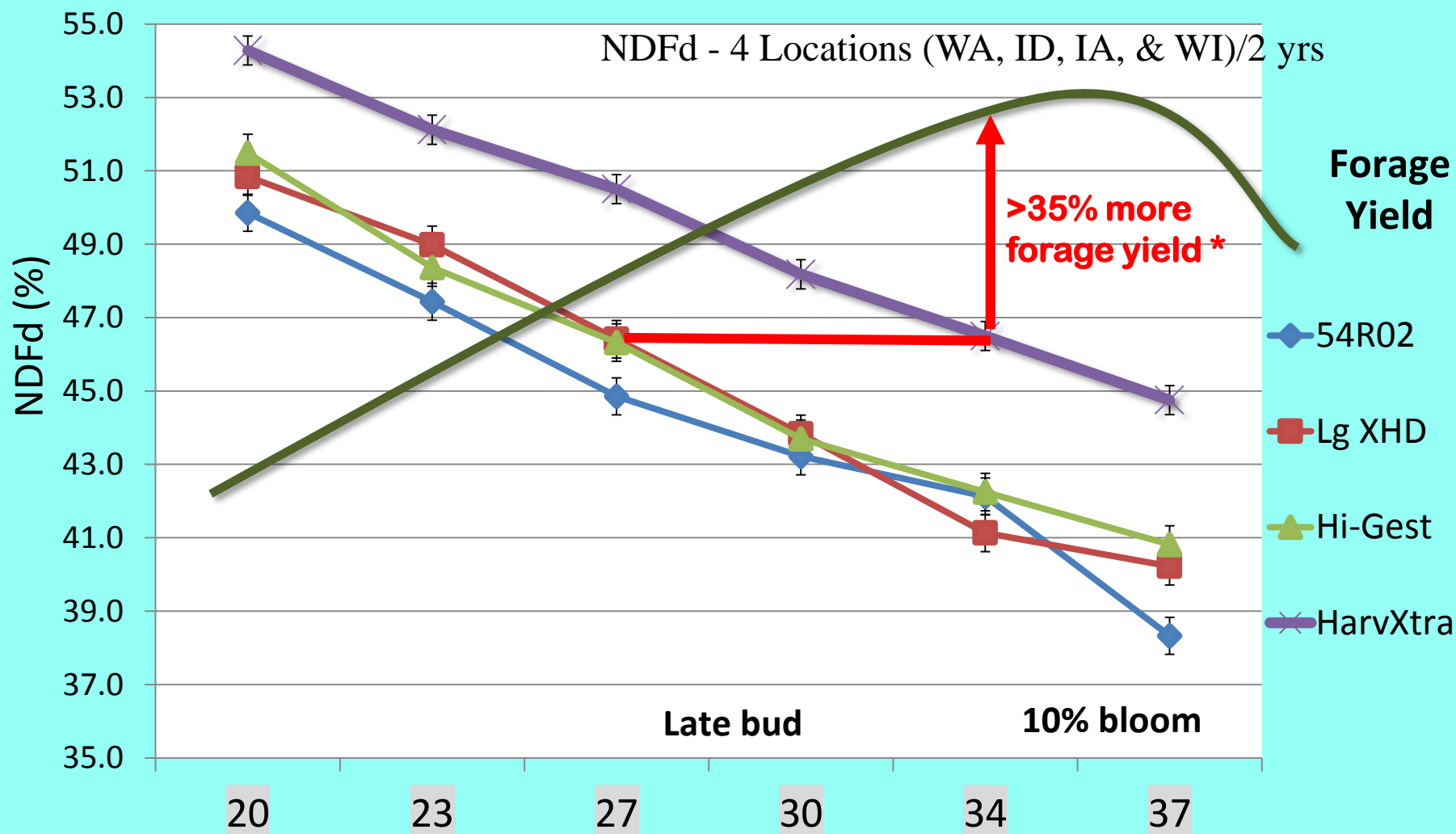
Consortium
for
Alfalfa Improvement

Alleviating the Dilemma



SOURCE: Undersander et al., 39th Western Alfalfa & Forage Conference, 2-4 December 2009, Reno, Nevada, Department of Agronomy and Range Science Extension, University of California, Davis, CA 95616

Harvest for Yield/Quality



Cutting Interval (Days)

* Undersander, et. al. Low lignin alfalfa: Redefining the yield /quality tradeoff, 2009 Western Alfalfa & Forage Conference



Field Studies at 6 Universities (Mark Sulc et al., CA Alfalfa Symposium 2016)

- 
1. Is forage nutritive value of HarvXtra superior to that other alfalfa varieties as the crop matures?
 2. How does HarvXtra compare with other varieties when managed under 28-, 33-, and 38-day harvest schedules?

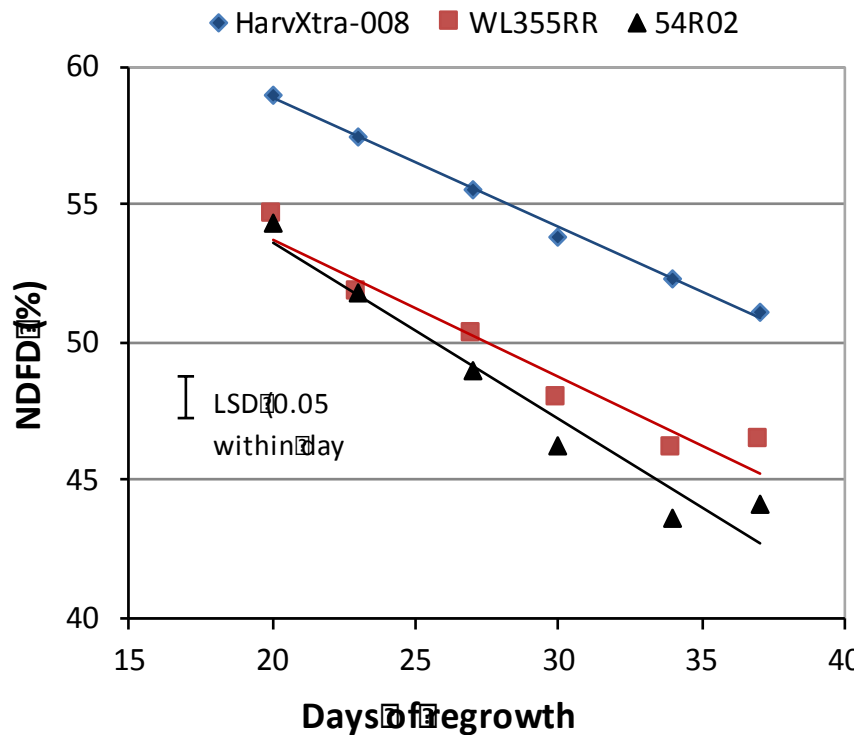
Field Studies

- **Six locations: CA, KS, WI, MI, OH, PA**
- **Alfalfa varieties**
 - **HarvXtra-008 FD 4**
 - **54R02 – FD 4**
 - **WL 355RR – Quality FD 4**
 - **Hi-Gest 360 – conventional FD 3 (CA & PA only)**
- **Sown at 18 lbs/acre pure live seed**
- **Replicated 4 times each location**

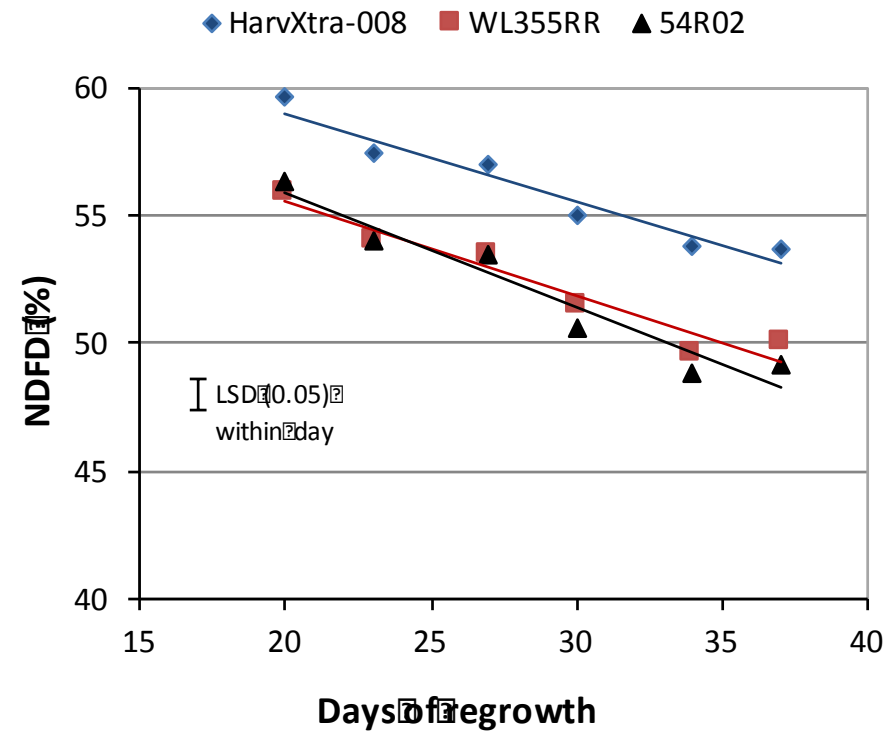


NDFD in 2015 – 6 location average

2nd growth cycle



3rd growth cycle



Average in 2015 (2 cuttings & 6 locations)

Variety	ADL	NDF	RFQ	CP
HarvXtra-008	4.0 b	26.7 c	297 a	26.4 a
WL355RR	4.9 a	28.7 b	262 b	25.8 b
54R02	5.0 a	30.5 a	243 c	25.0 c

-19%

-7%

+13%

-12%

+22%



Average of 3 cuttings in 2016 CA only

Variety	NDFD	ADL	NDF	RFQ	CP
HarvXtra-008	51.9**	4.3**	31.9 *	228*	23.6
WL355RR	48.8	5.0	32.6	216	23.6
54R02	49.3	5.0	33.5	209	23.1
Hi-Gest	50.1	4.8	31.3 *	230*	24.4*

+3.5%
to 6%

-10%
to -14%

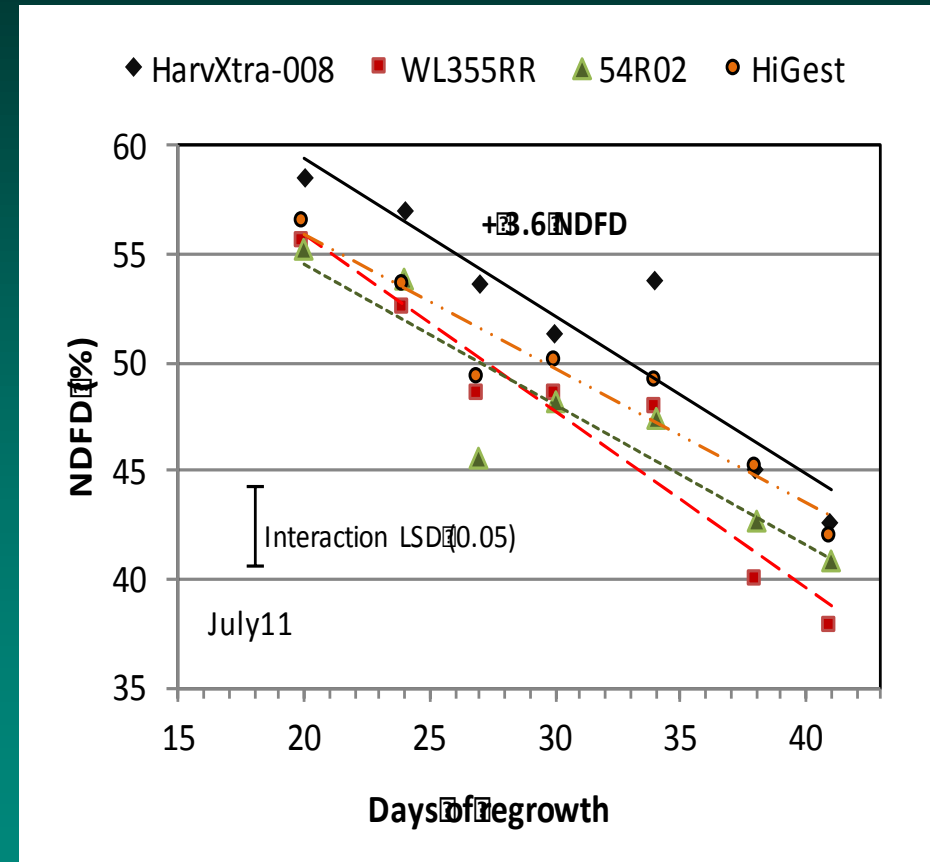
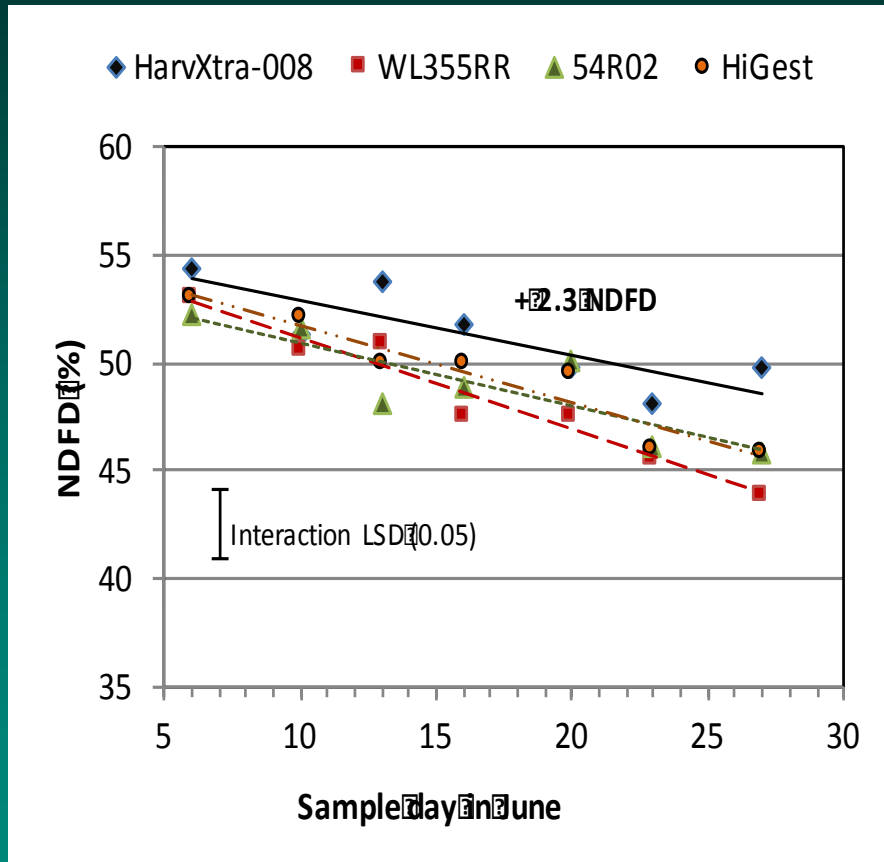
Source: Sulc et al., CA Alfalfa Symposium, 2016



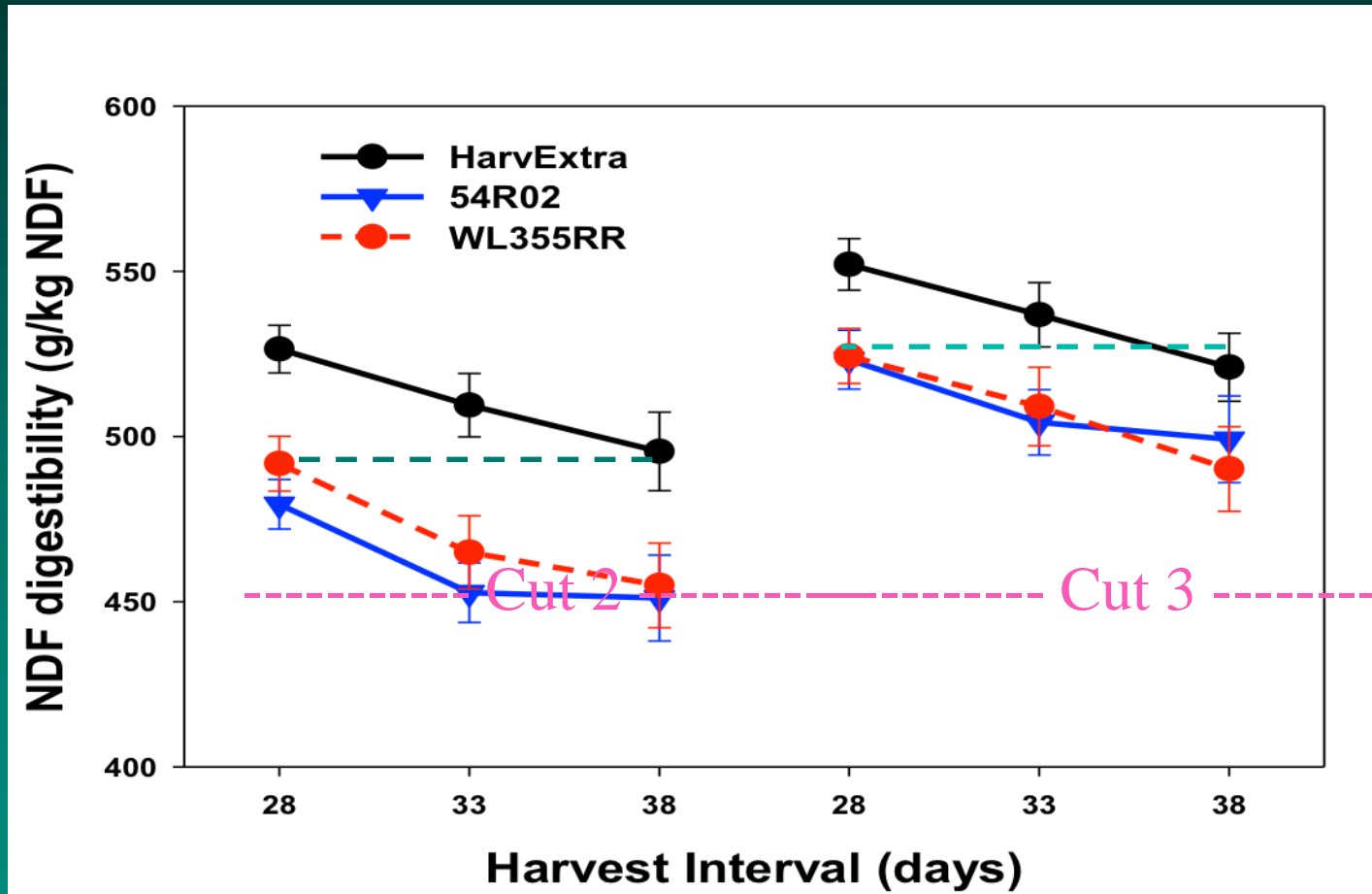
NDFD in 2016 – CA only

1st growth cycle

2nd growth cycle

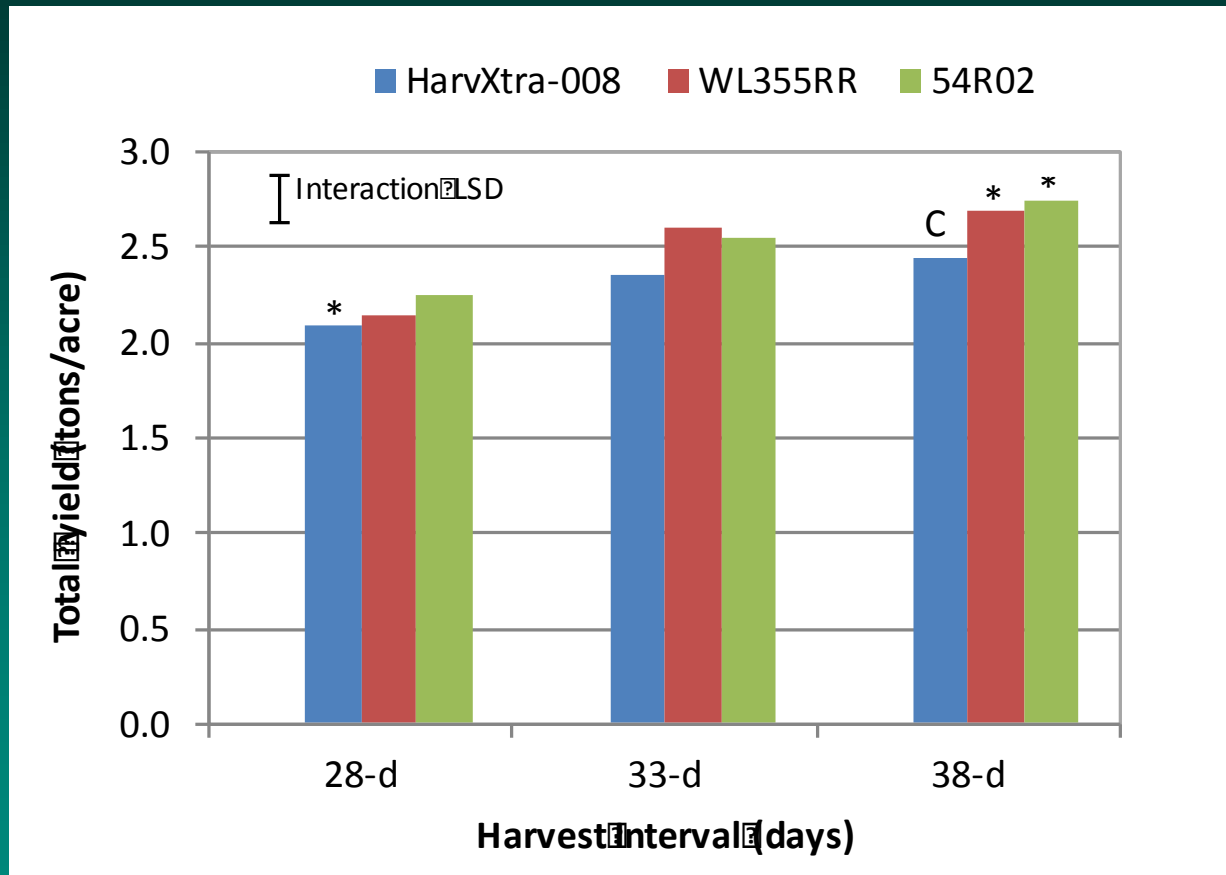


Effect of Harvest Schedules – Seeding Year NDFD (6 location average)



Source: Sulc et al., CA Alfalfa Symposium, 2016

Effect of Harvest Schedules – Seeding Year Total Yield (6 location average)

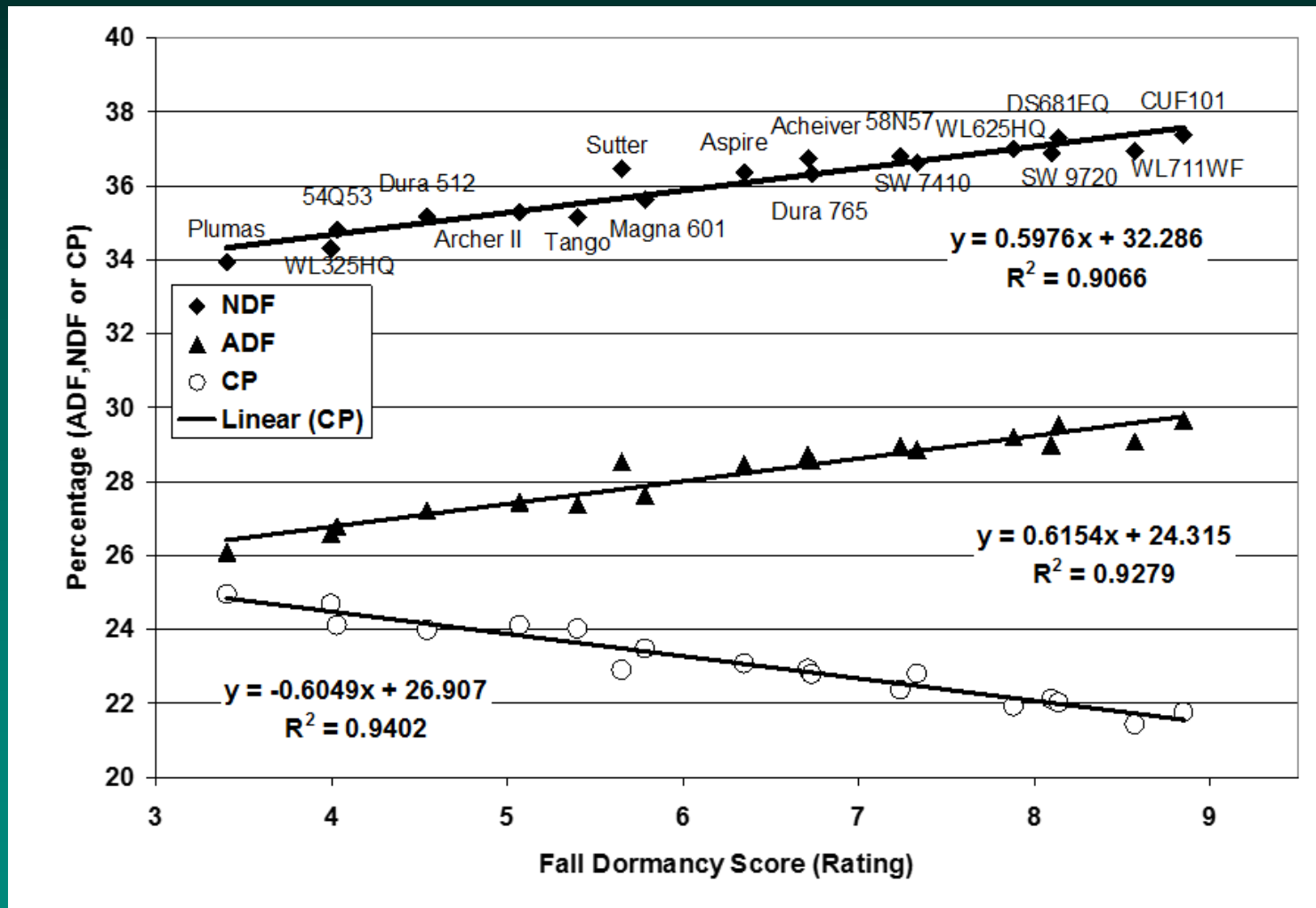


** = different than HarvXtra at 38-d*

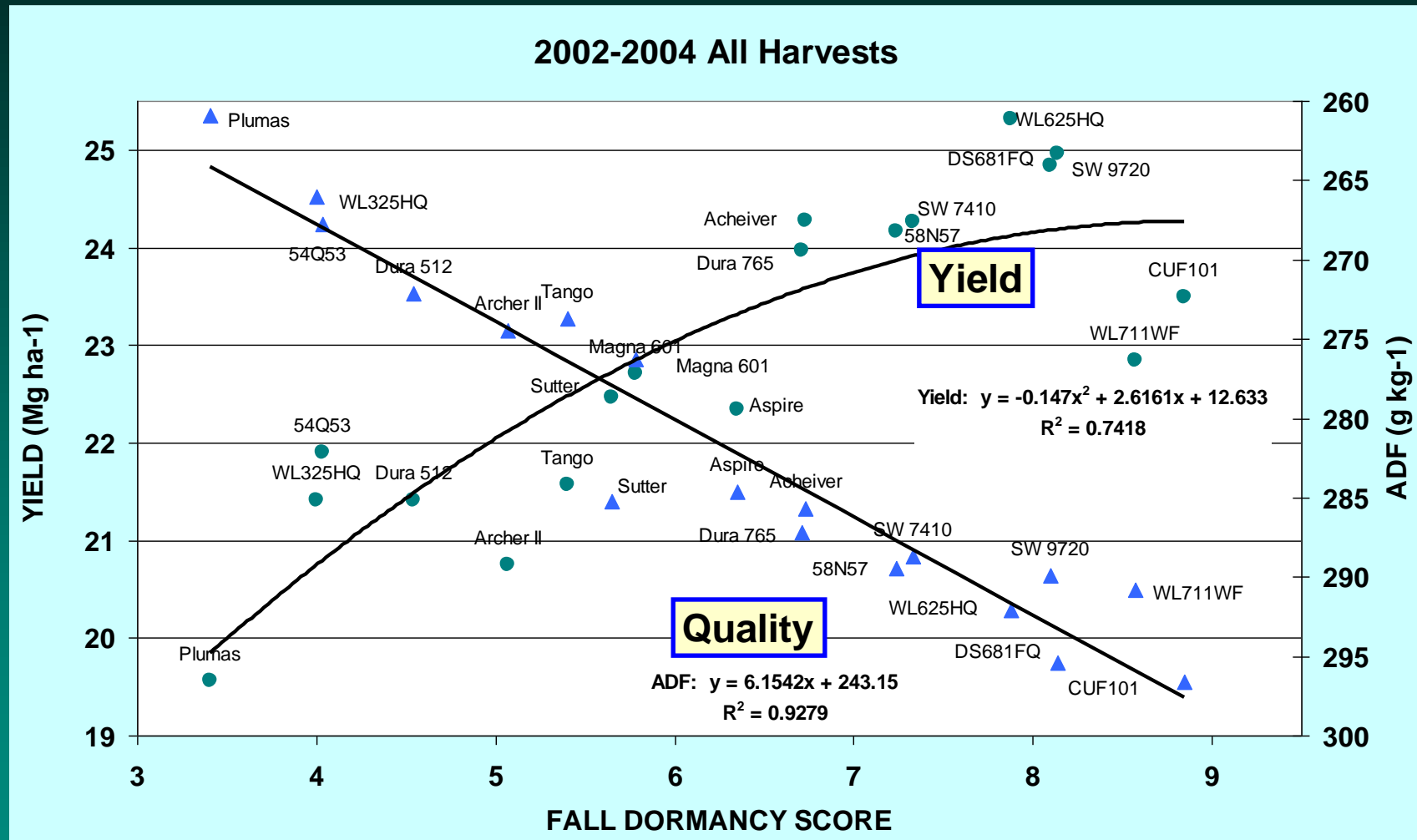
HarvXtra trait (4 exp. Varieties, 2 years, 5 harvests/year), UC Davis, CA – 35 day schedule (FD 4 varieties)

Variety	ADF	NDF	CP	ADL	NDFD
54R01 (control)	26.2	30.8	23.4	5.0	48.8
Ameristand 405TRR (control)	27.9	32.6	22.8	55.3	47.3
Liberator (control)	26.8	31.5	23.0	5.1	48.3
WL 355RR (Control)	27.5	32.2	22.8	5.3	47.4
12RRL-1	25.6	30.1	22.9	4.5	51.3
12RRL-2	26.3	31.2	23.0	4.5	51.3
12RRL-3	25.4	30.3	23.2	4.4	51.8
12RRL-4	26.0	31.0	22.9	4.6	51.1
Sign. Of Variety:	***	**	n.s.	***	***

Remember: Fall Dormancy Affects Quality (3 yr average)



Variety, Quality and Yield



Is this a quality trait or a yield trait?

- **Both**
- **Delayed harvests = higher yields with similar quality to earlier harvests**
- **Reports of survey of Midwest: 75% primarily interested in yield aspects, 25% in quality improvement (FGI market report)**



New Low Lignin/Cutting Schedule Trial (Kearney)

- HarvXtra and HiGest lines vs. control (8 varieties)
- Planting 9/20/17 (today)
- Fall dormancies 6 and FD 9.
- Cutting Schedules:
 - “Normal” – 28 day all season (7 cuts)
 - “Late” - 35 days (6 cuts)
 - Staggered – 22/35/21/35 (8 cuts)



Summary

- **So Far: HarvXtra alfalfa maintained consistently less lignin and greater NDFD than standard alfalfa varieties. HiGest varieties were more similar to conventional varieties, different than HarvXtra**
- **HarvXtra had higher or similar nutritive value to standard alfalfas harvested 5 to 10 days earlier.**
- **Two year results suggest it should be possible to harvest HarvXtra alfalfa later and still maintain similar yield and nutritive value to standard alfalfas that are harvested earlier and more frequently.**
- **Implications: Effects on yield, water use efficiencies, harvest costs?**

Issues – Remaining questions

- GE trait (approval sought in China, Japan)
- Measurements: Measuring of digestibility of fiber not just fiber (ADF, NDF)
- Markets: Recognition in market of different measurements of quality (e.g. NDFD, digestibility)
- How do non-dormant & semi-dormant varieties perform?
- What is the value of quality? What is the value of yield?



Hay Quality Guidelines -Alfalfa

Range of Hay Quality Analysis for Alfalfa Quality Marketing Groups

Supreme									
Premium									
Good									
Fair									
NDF%	<33	35	39	>42					
NDFD%	>48	42	38	<35					
CP	>22	20	18	<16					
ADF%	<27	29	32	>35					
Calculated Values:									
RFV	>180	150	125	100					
TDN (90%)	55.9	54.5	52.5	50.5					

A few other points

- **Seed cost – scary?**
 - **PERFORMANCE much more important than seed cost (true with all seed decisions)**
 - **Reduce seeding rates and do a better job of soil prep, seed depth, early fall planting, etc.**
 - **The Value aspect-a little complicated since both yield and quality could be impacted.**



A few other points

- **The changing role of alfalfa in rations:**
 - Although energy yield (TDN, ME, NEL) per kg. still important, as alfalfa is fed at lower percentages, the functional role of digestible fiber for proper rumen function may be more important.
 - Yield opportunities and reduced costs of production (fewer harvests) may be more important than the quality trait per-se.
- **Game Changer?**



