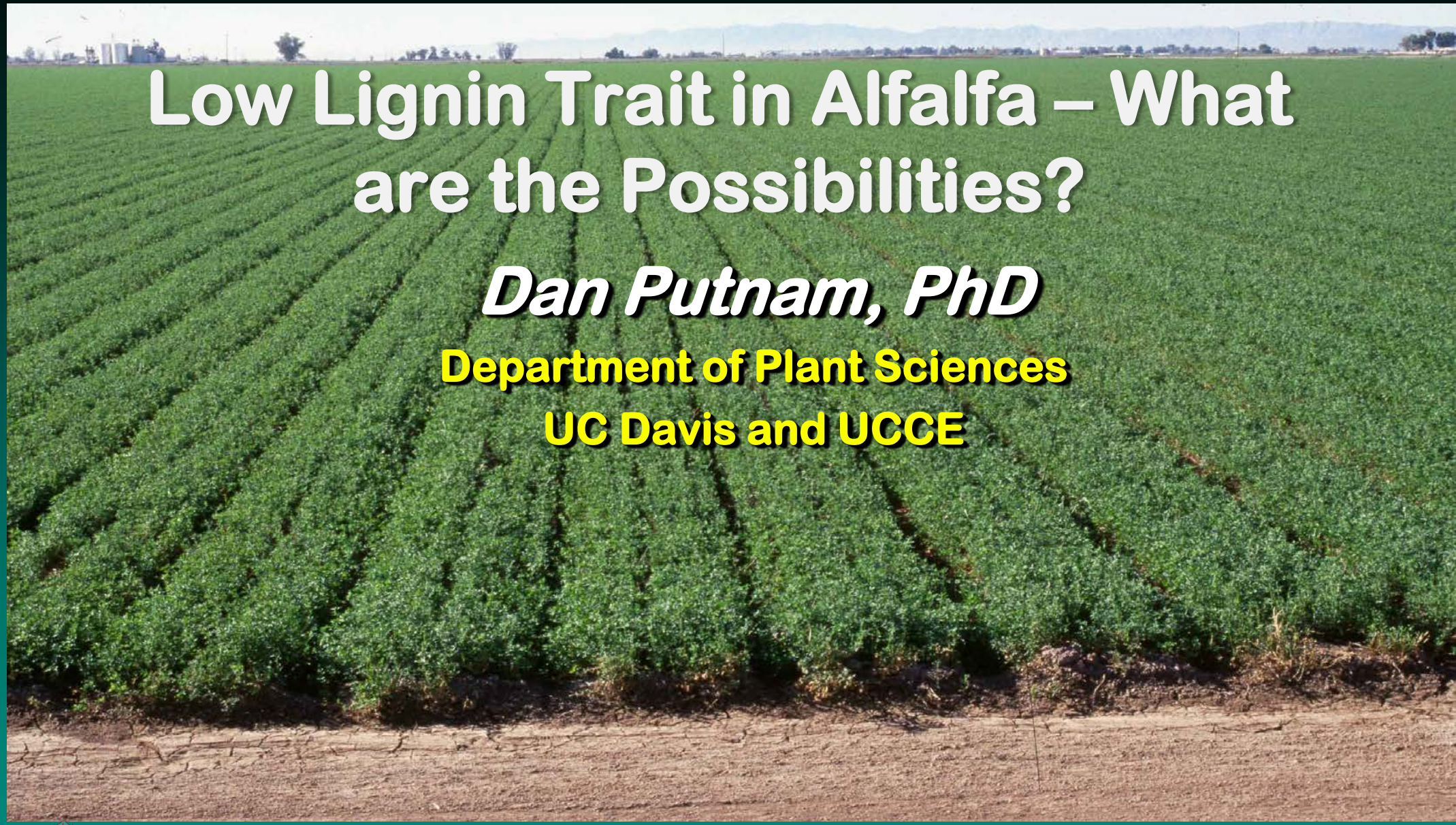
Low Lignin Trait in Alfalfa – What are the Possibilities?



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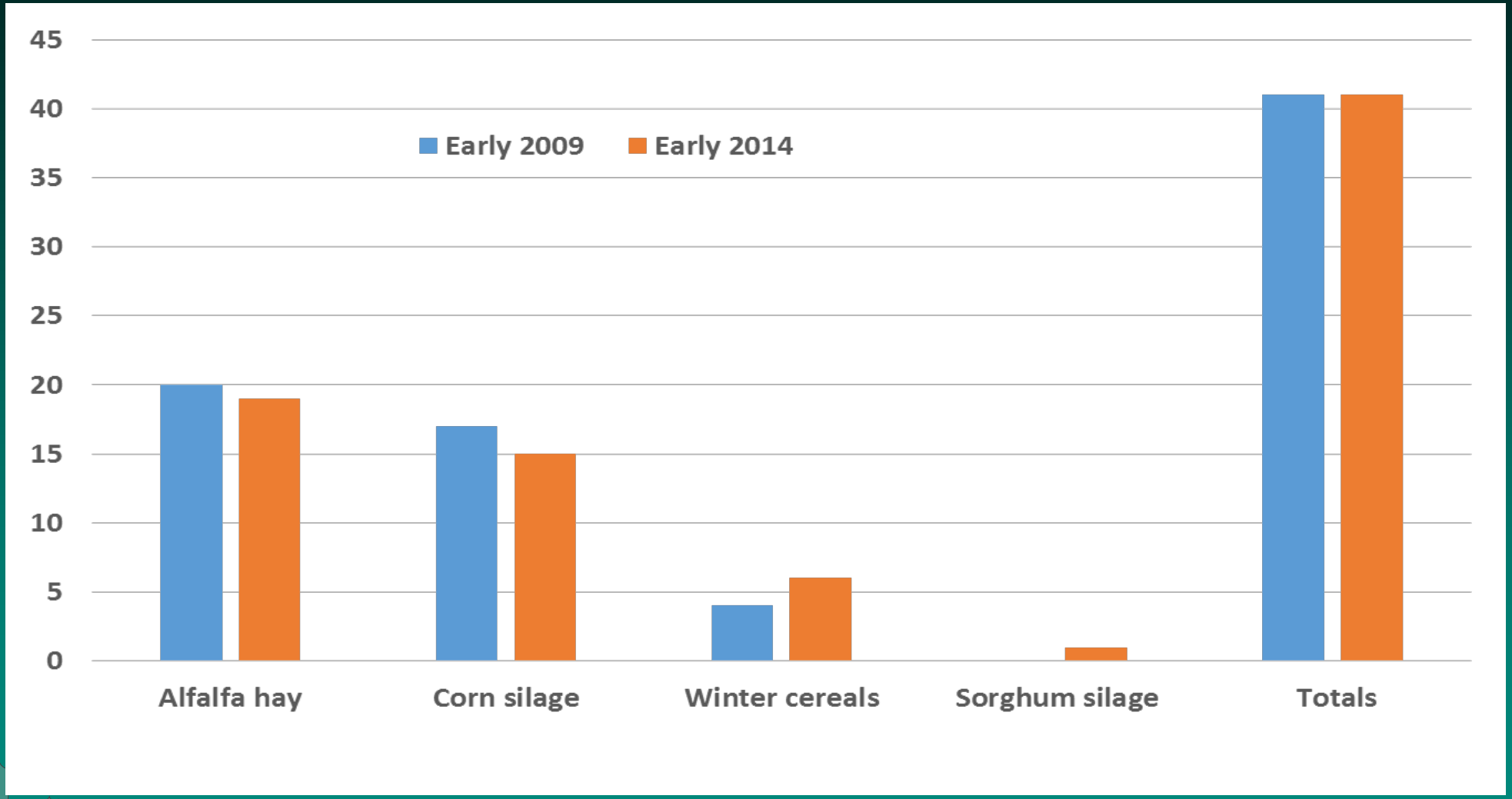
UC Davis and UCCE

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)



Price of Alfalfa Hay (February 2018)

(The Hoyt Report)				
	Tulare, Hanford		Modesto, Escolon, Turlock	
Quality Category	Volume	Price	Volume	Price
S				
P				
Good	50	$240-250	50	$250
Fair	300	$225-230	-	-
Difference top-bottom		$70 $103 (‘17)		~$50-60 $98 (‘17)

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

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)!!!

What's in a Forage Plant?

Non-Fiber (NS) Carbohydrates (25-35%)

Lipid (1-2%)

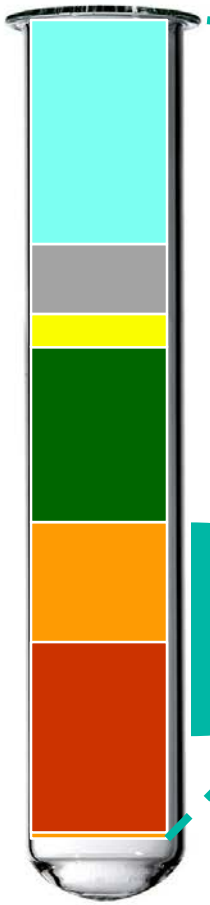
Protein (17-25%) (8-16% grasses)

NDF (35-45%) (-70% grasses)

Cellulose

Hemicellulose

lignin



Dry Matter

Ash (7-14%)

Rumen digestible, Rumen 'by pass'

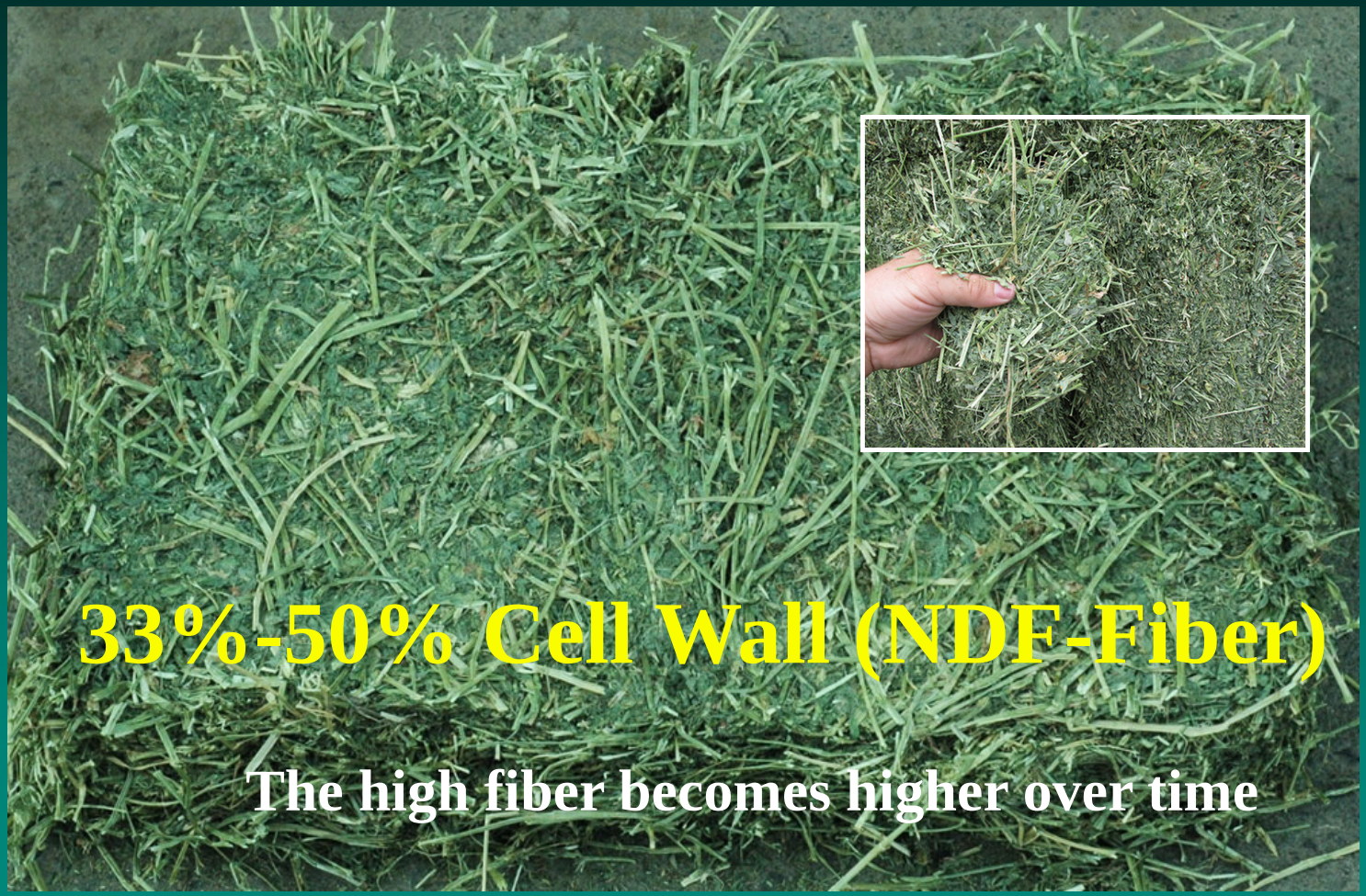
Digestibility 35-60%

ADF (25-70%)

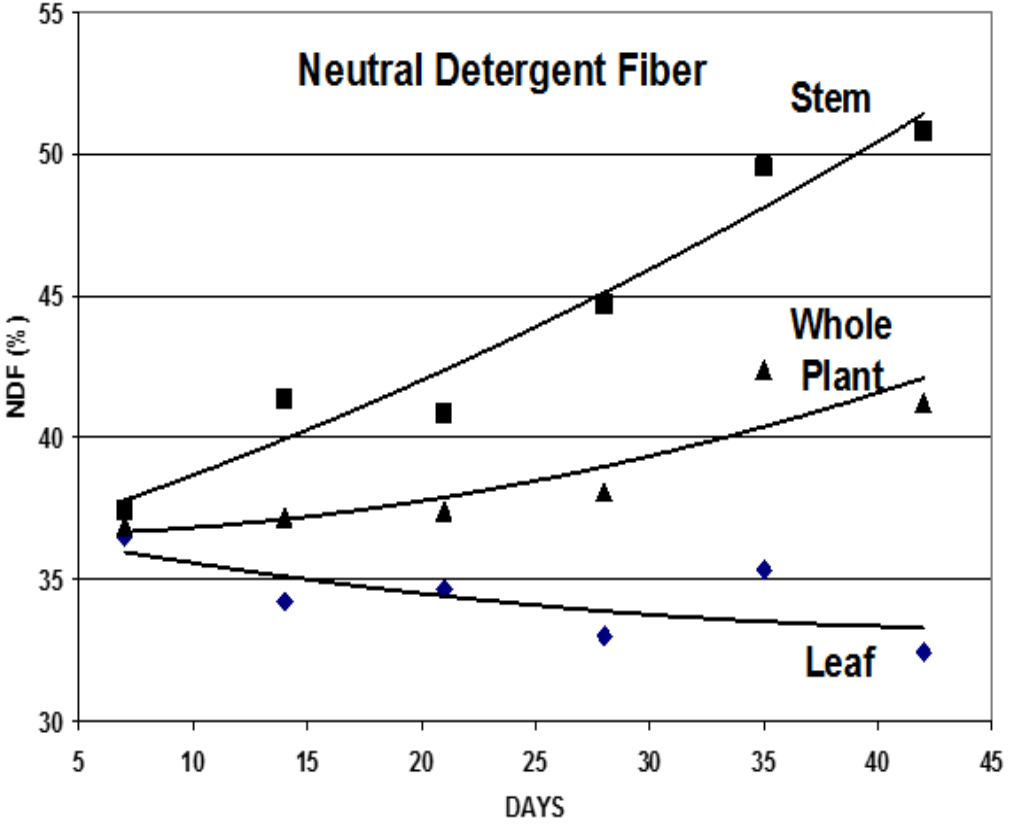
Cellulose

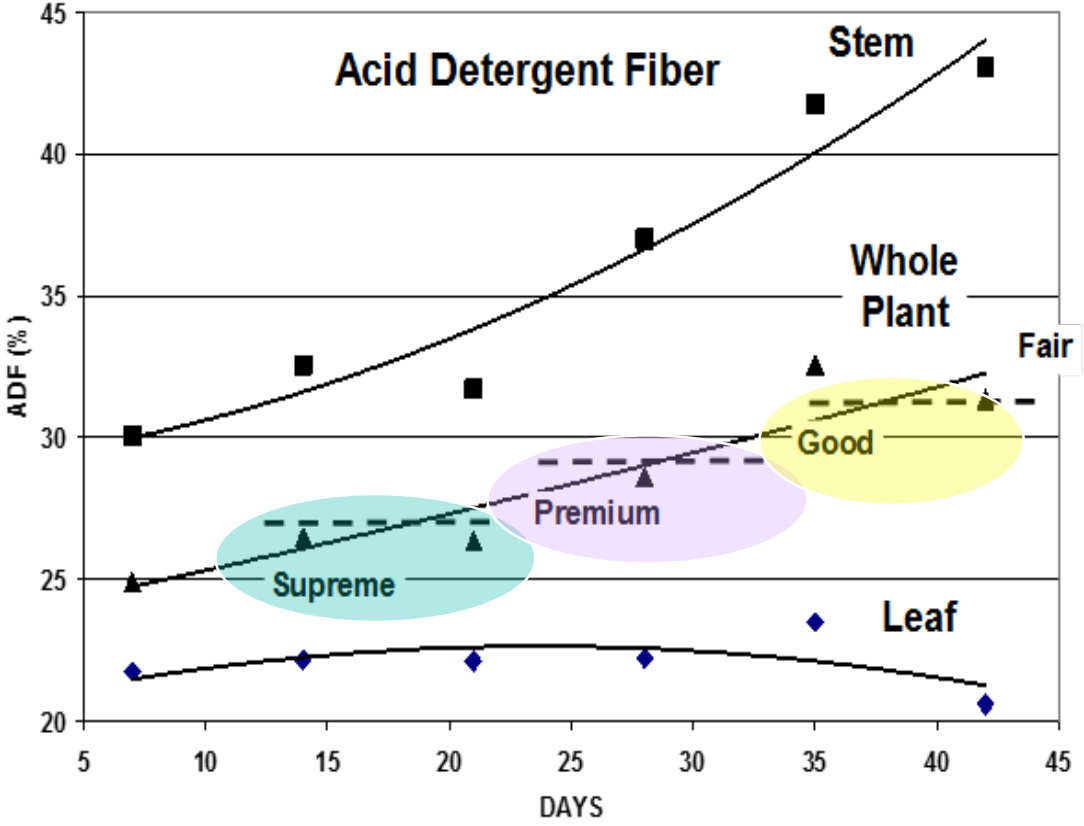
lignin

What about Fiber?

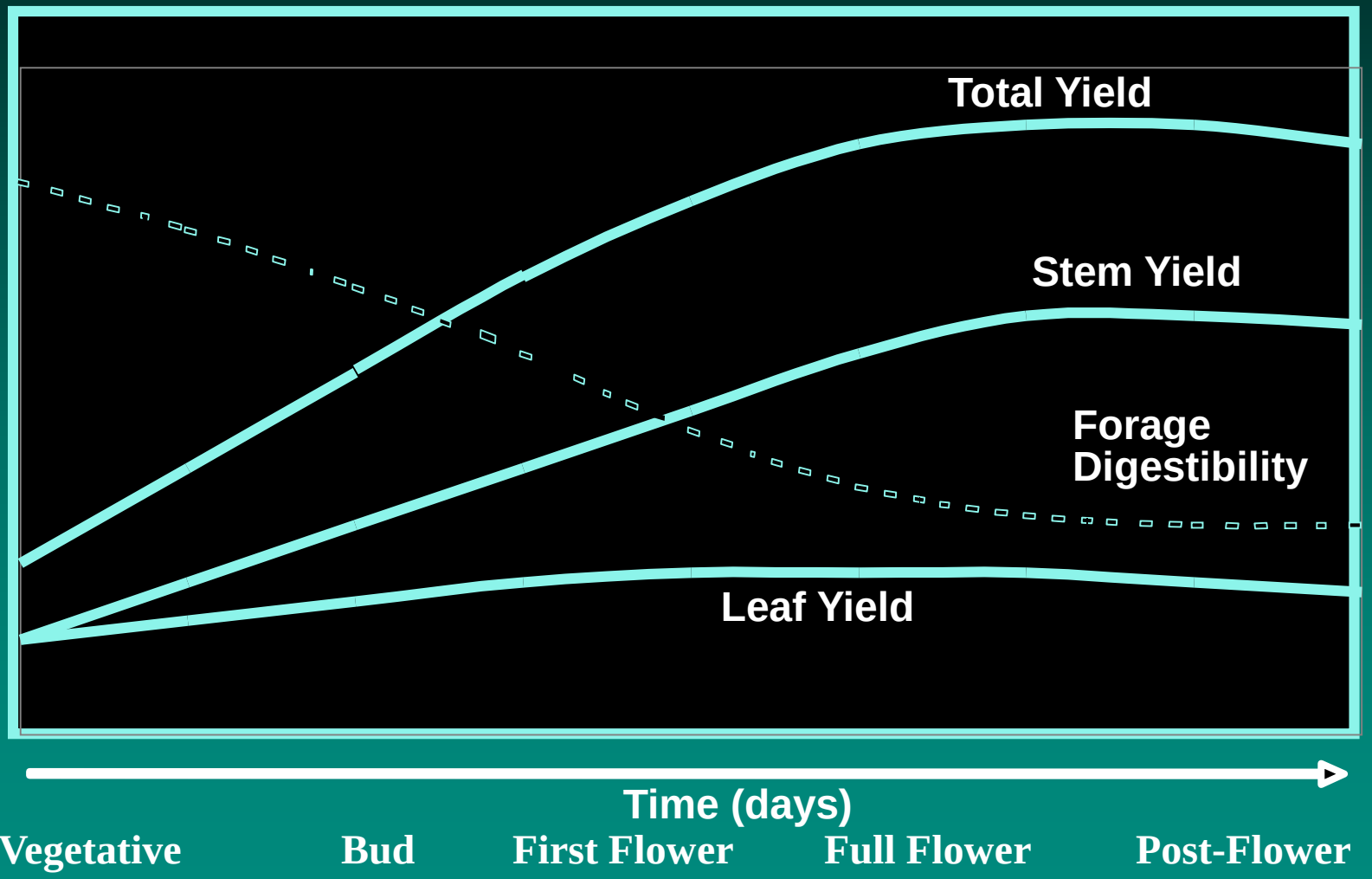


NDF/ADF increases each day

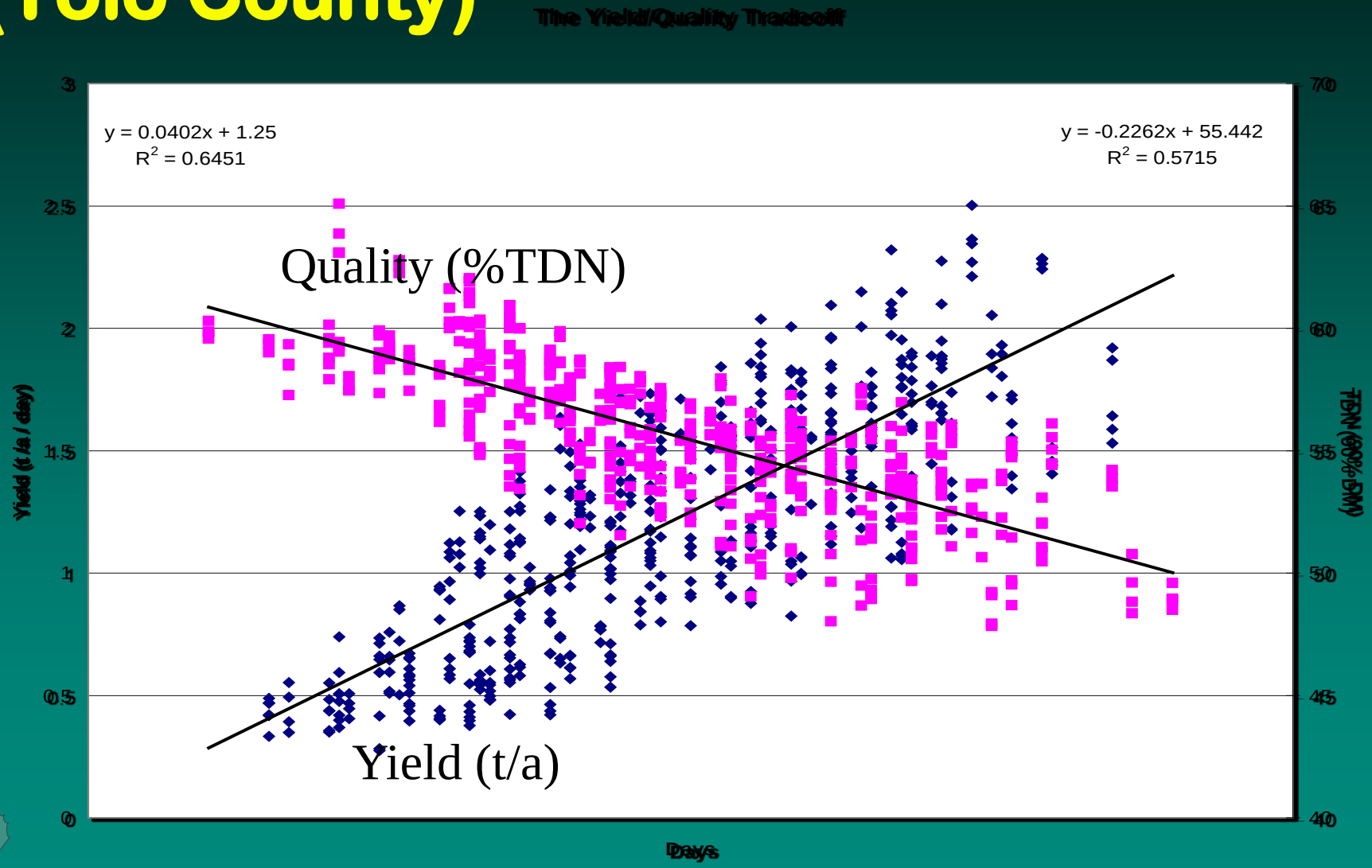




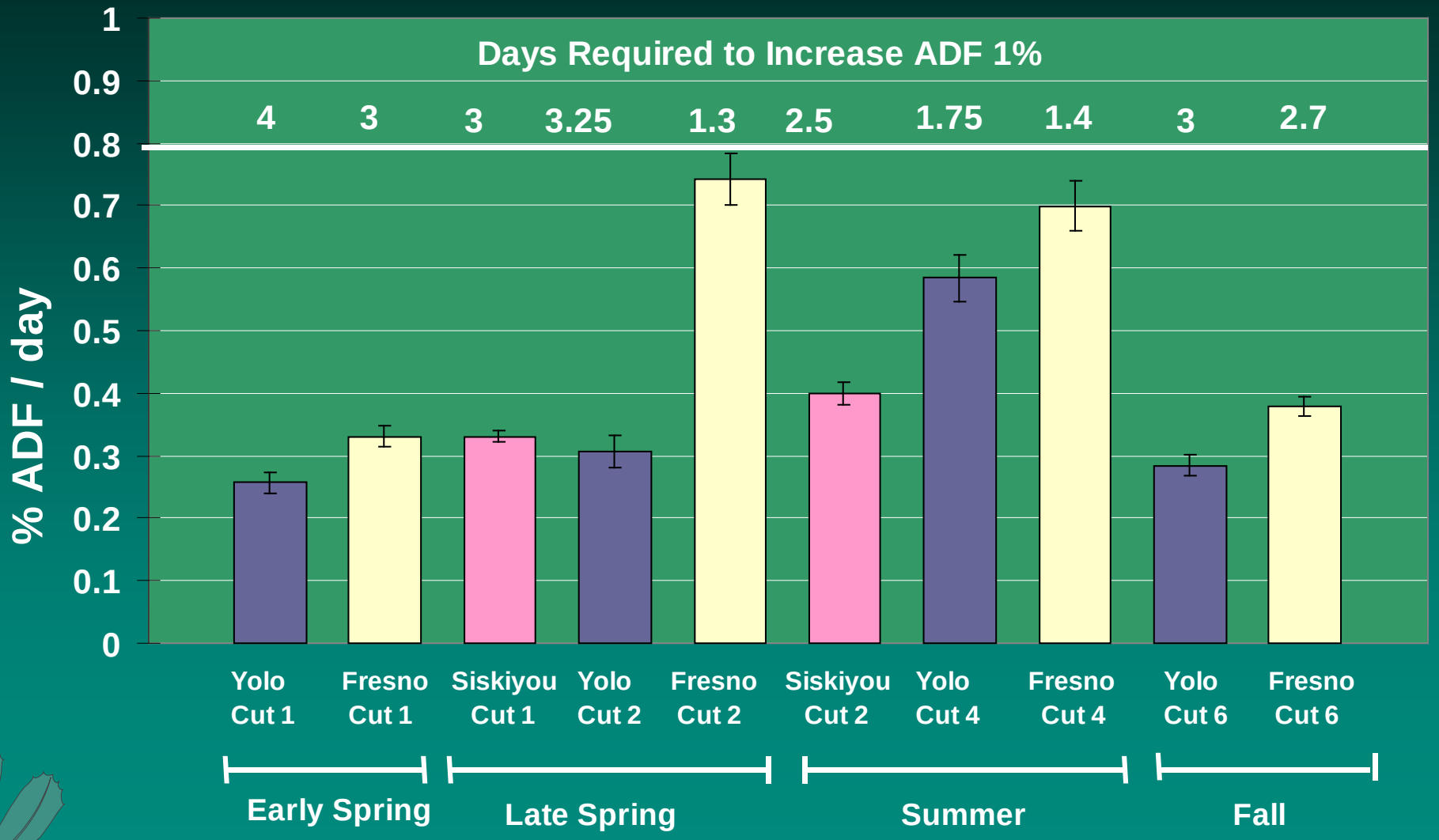
Relationship between yield and quality



The Yield/Quality Tradeoff (Yolo County)



Daily changes in ADF for all cuts and locations.



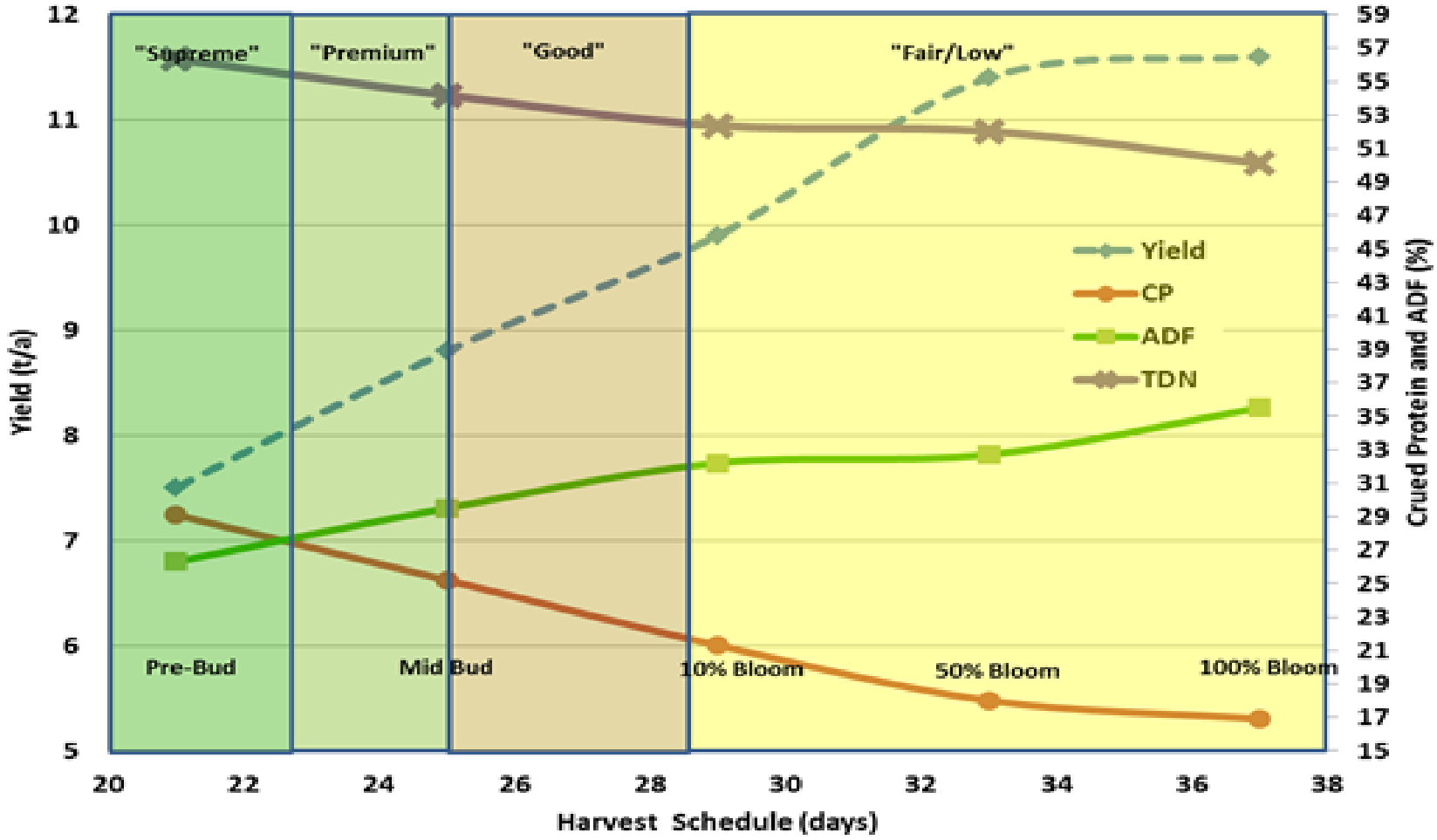
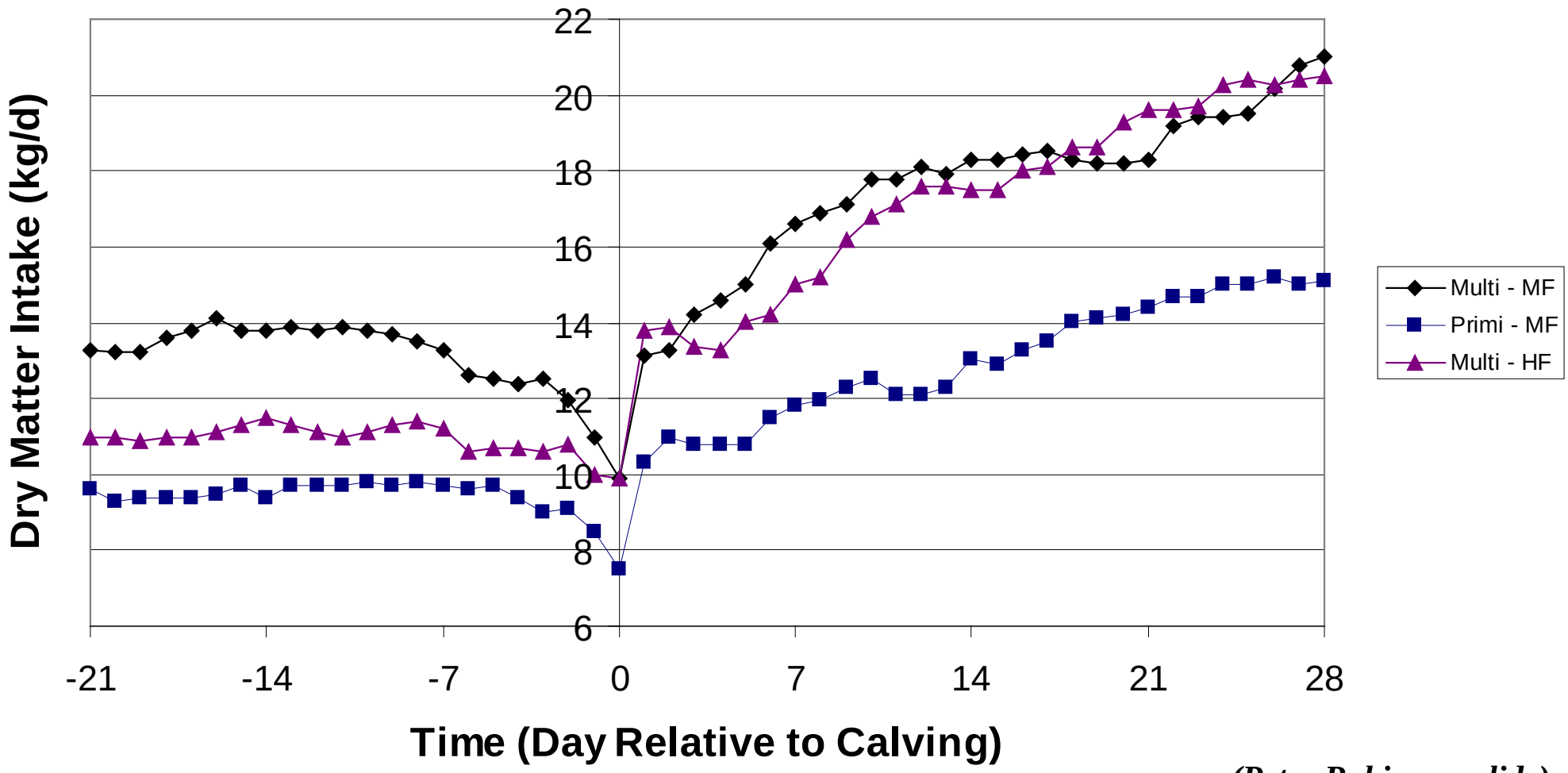


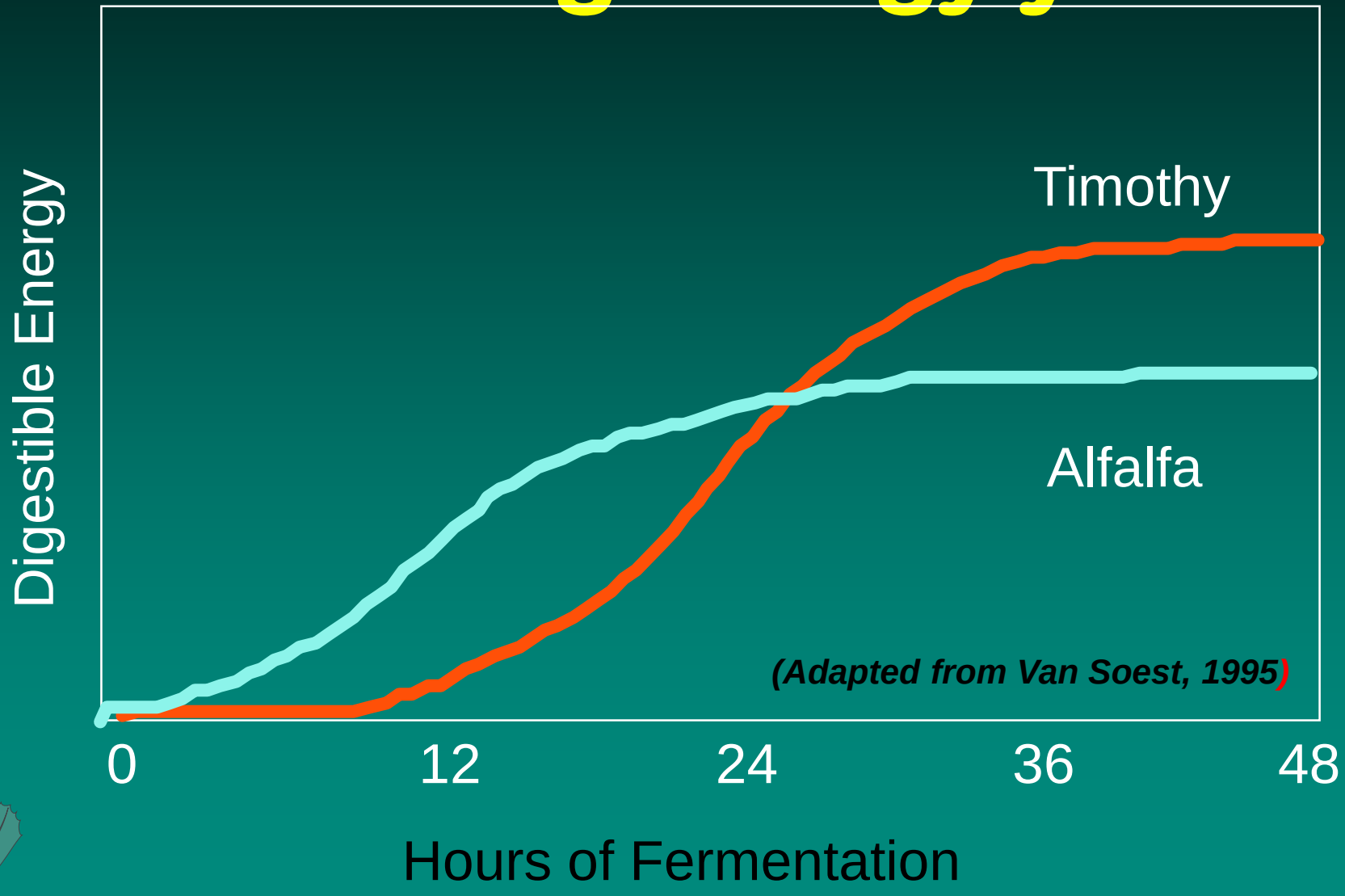
Figure 4. Effect of harvest scheduling on yield and quality (Data from Marble, 1974, Davis, CA). Classifications are as per USDA-Hay Market Guidelines (2016). Note that most nutritionist desire additional analyses to predict quality, particularly fiber digestibility estimates.

What about Intake??



(Peter Robinson, slide)

The importance of time in estimating energy yield



Why is fiber digestibility important?

- **Dairy producers are 'in tune' with the advantages of feeding forages with higher fiber digestibility**

Oba and Allen (1999)
A 1% change in vitro or in situ NDF digestibility (primarily 30-h or 48-h NDFD) was correlated with:

- ✓ 0.4 lb increase in dry matter intake
- ✓ 0.5 lb increase in 4% fat corrected milk yield

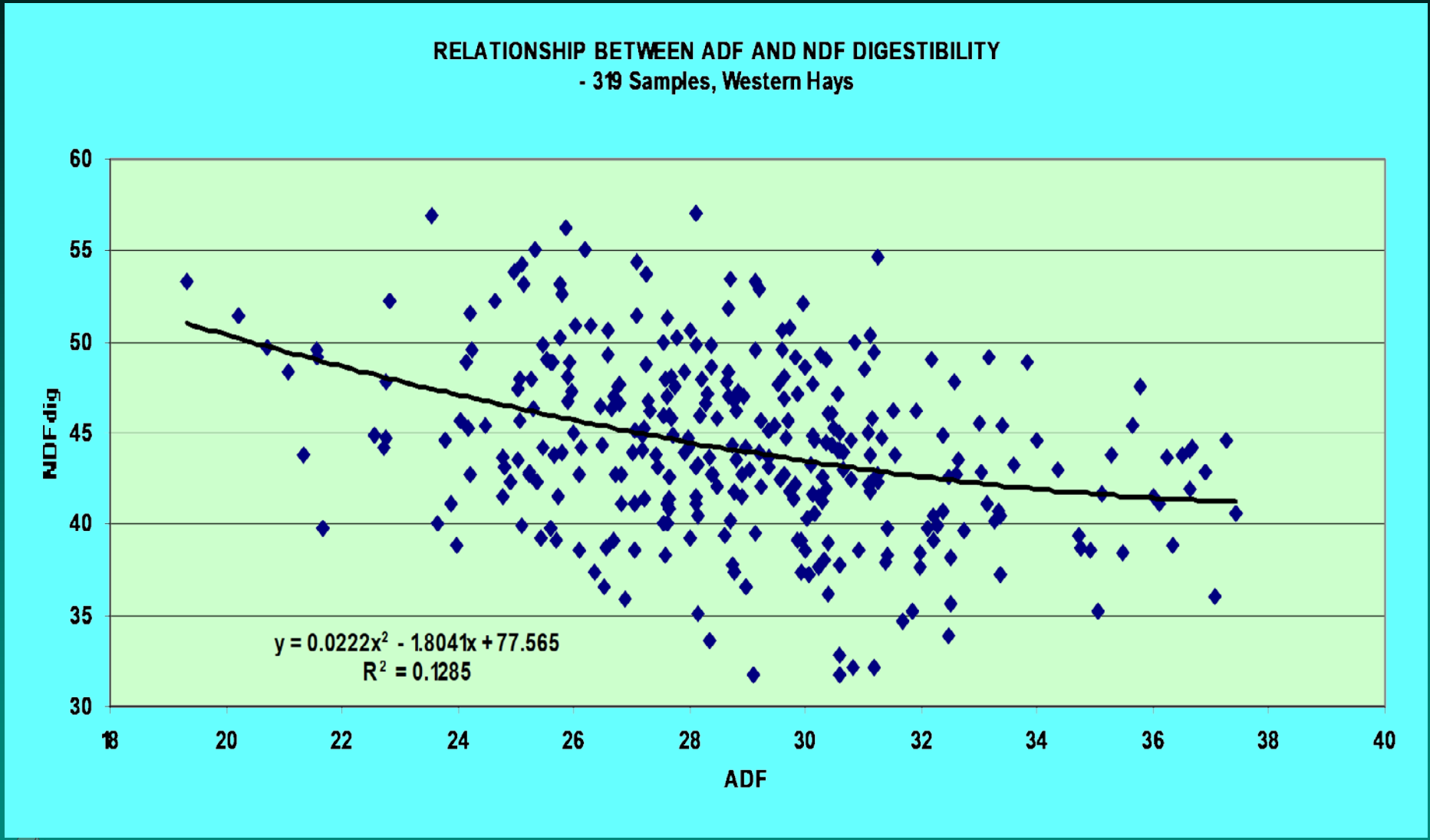
(Dave Combs, slide)

Alfalfa's Value in a Ration

	Alfalfa	Corn	Bermuda
Milk kg/day	23	20	18
Concentrate (%)	30	45	60
Intake (kg/day)	24	20	19
TDN (mix)	65	72	71
Net Energy (NEL)	1.50	1.61	1.53
TDN Intake (kg/d)	14.6	12.7	11.8
Milk (kg)/Mcal NE	1.44	1.40	1.37

(Data from Mertens, 1983)

NDF Digestibility



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 does fiber digestibility vary? Maturity!

	NDF	Lignin	TTNDFD
	% of DM	% of DM	% of NDF
Immature	33	5.4	54
Vegetative	37	6.2	50
Mid-maturity	43	7.3	47
Mature	50	8.4	46

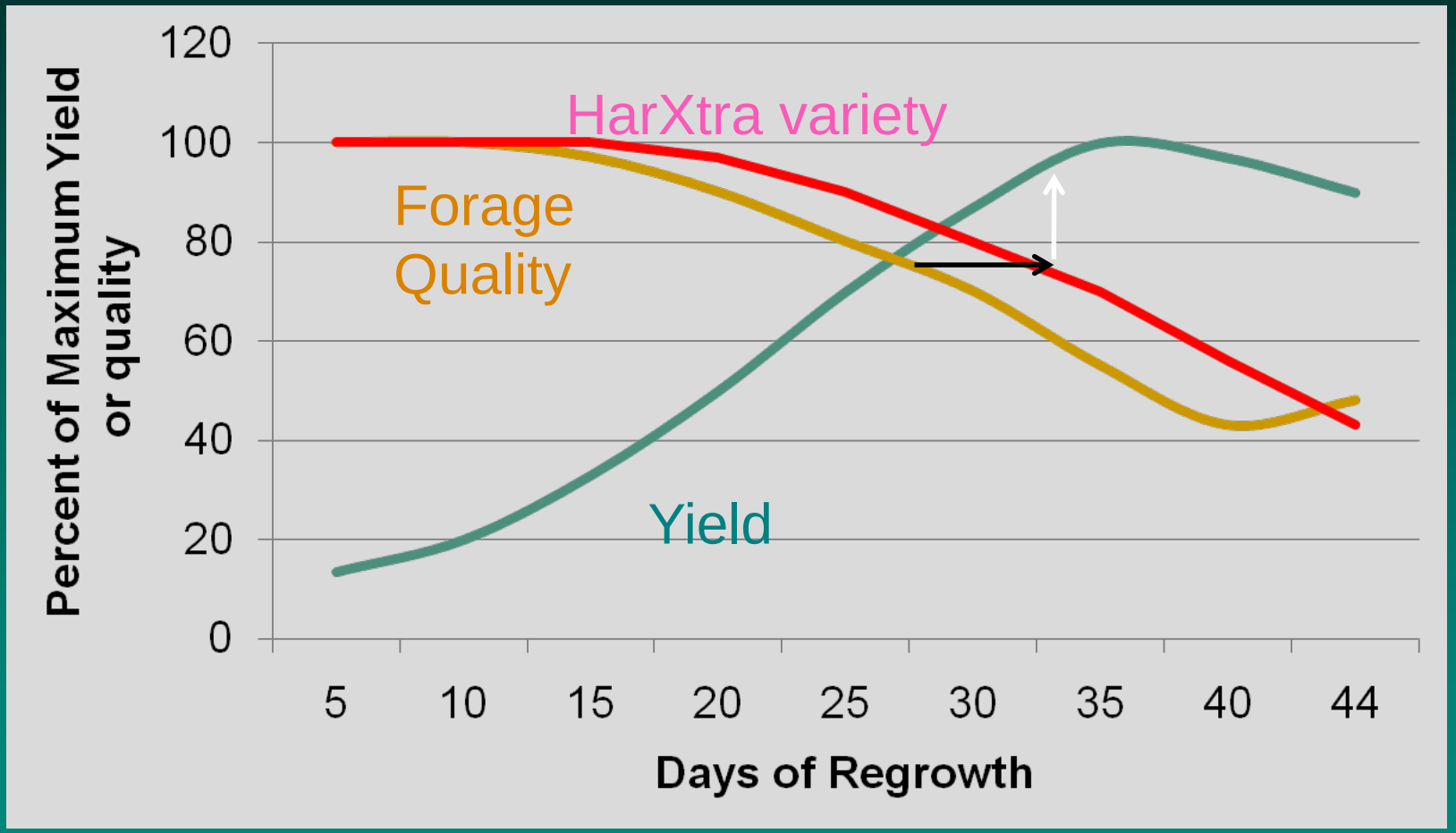
(Dave Combs, UW)

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)
- A10% increase in fiber digestibility
  - Increase milk/beef by $350M/yr
  - Decrease manure by 2.8MT/yr

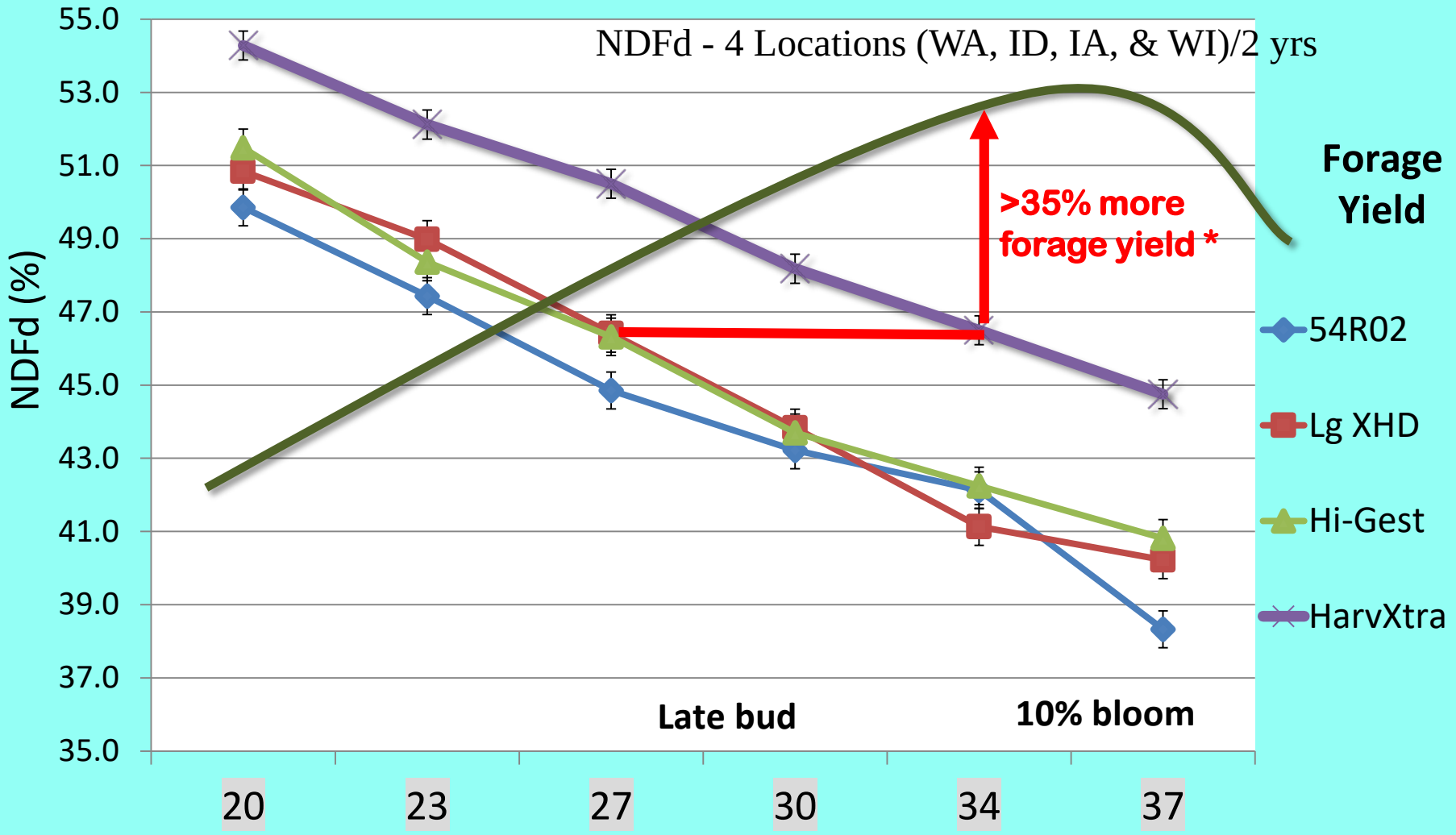
Consortium *for* Alfalfa Improvement

Alleviating the Dilemma



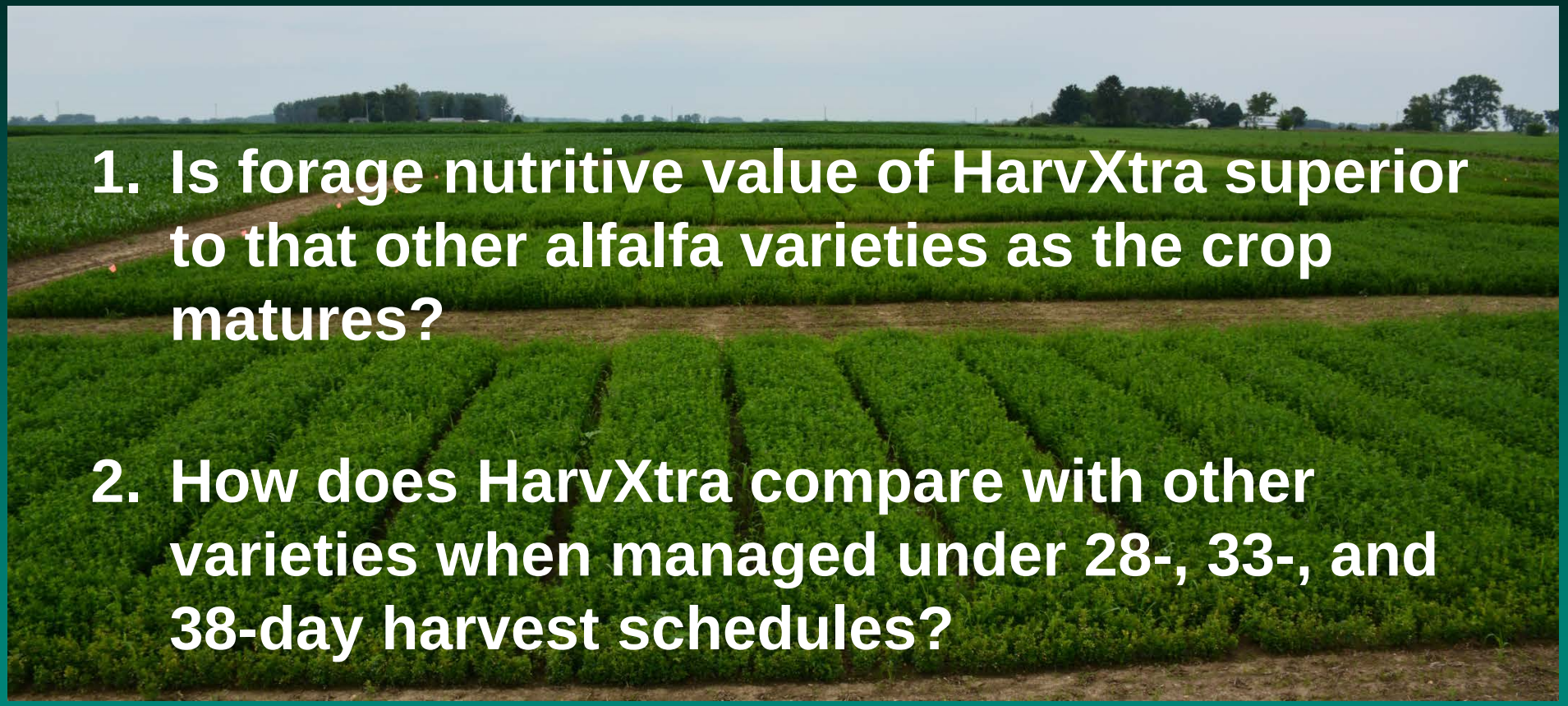
SOURCE: Undersander et al., 39th Western Alfalfa & Forage Conference, 2-4 December 2009, Reno, Nevada, Department of Agronomy and Range Science Extension, University of California, Davis, CA 95616

Harvest for Yield/Quality



* 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?

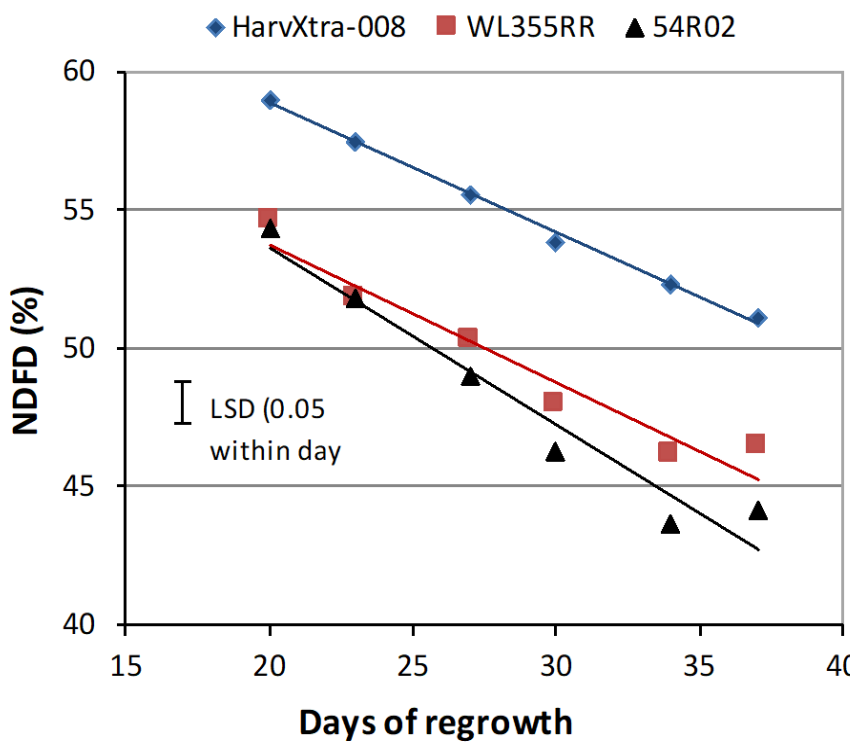
Data Mark Sulc - 2016

Field Studies

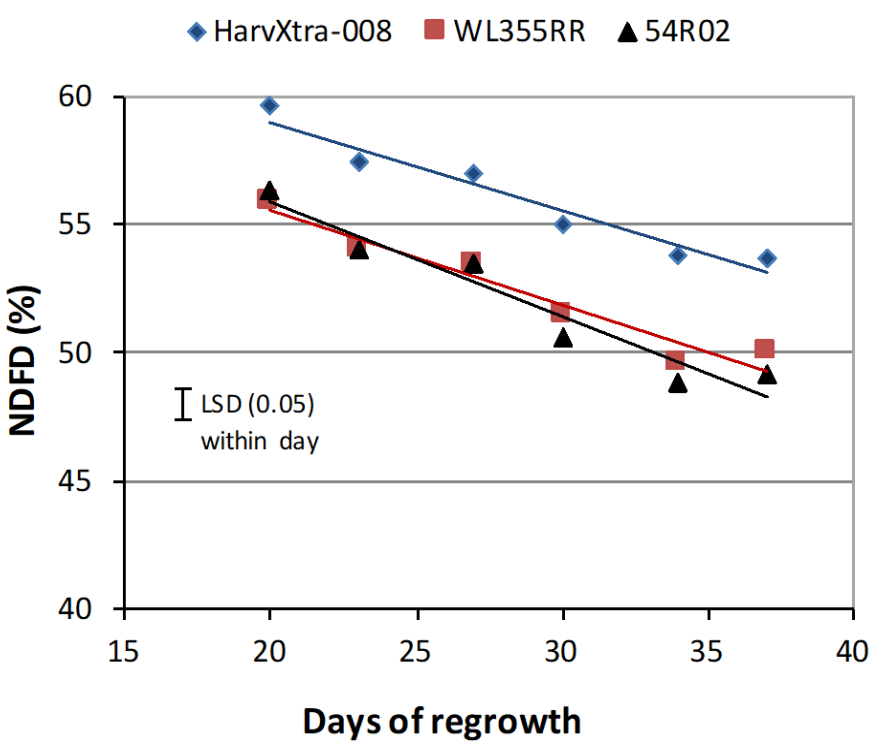
- Six locations: CA, KS, WI, MI, OH, PA
- Alfalfa varieties
  - HarvXtra–008 FD 4
  - 54R02 – FD 4
  - WL 355RR – Quality FD 4
  - Hi-Gest 360 – conventional FD 3 (CA & PA only)
- Sown at 18 lbs/acre pure live seed
- Replicated 4 times each location

NDFD in 2015 – 6 location average

2nd growth cycle



3rd growth cycle



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

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%** **-12%**	**+13%** **+22%**	

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

Average of 3 cuttings in 2016
CA only (Tulelake)

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*

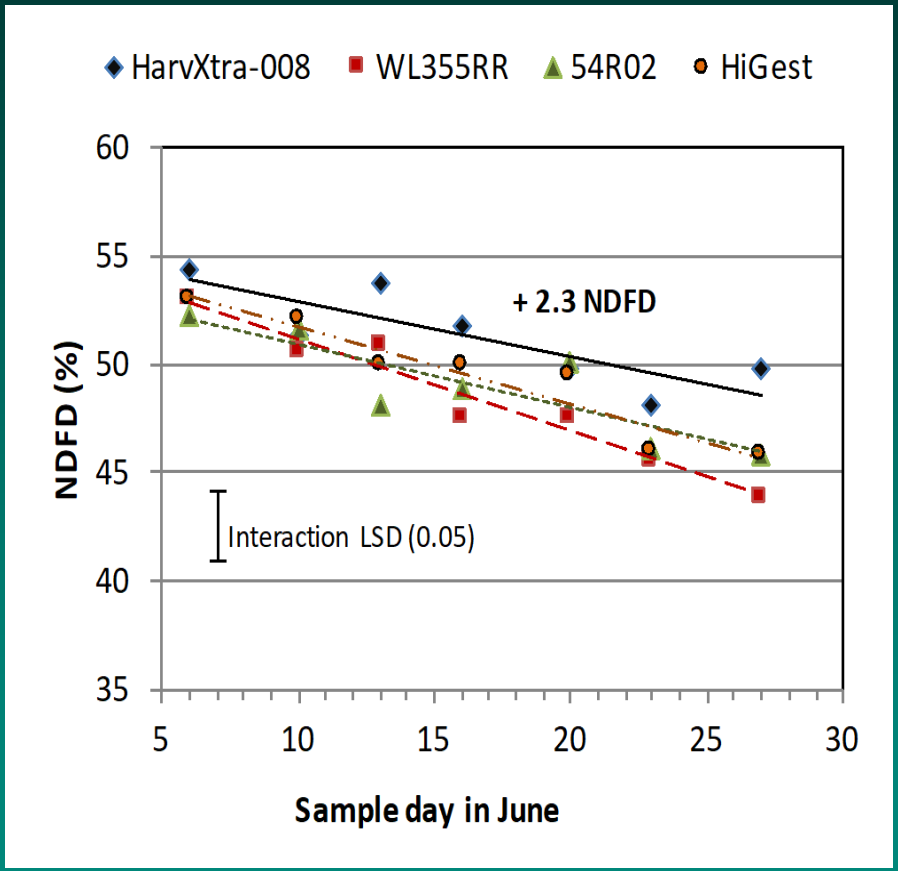
+3.5% to 6%

-10% to -14%

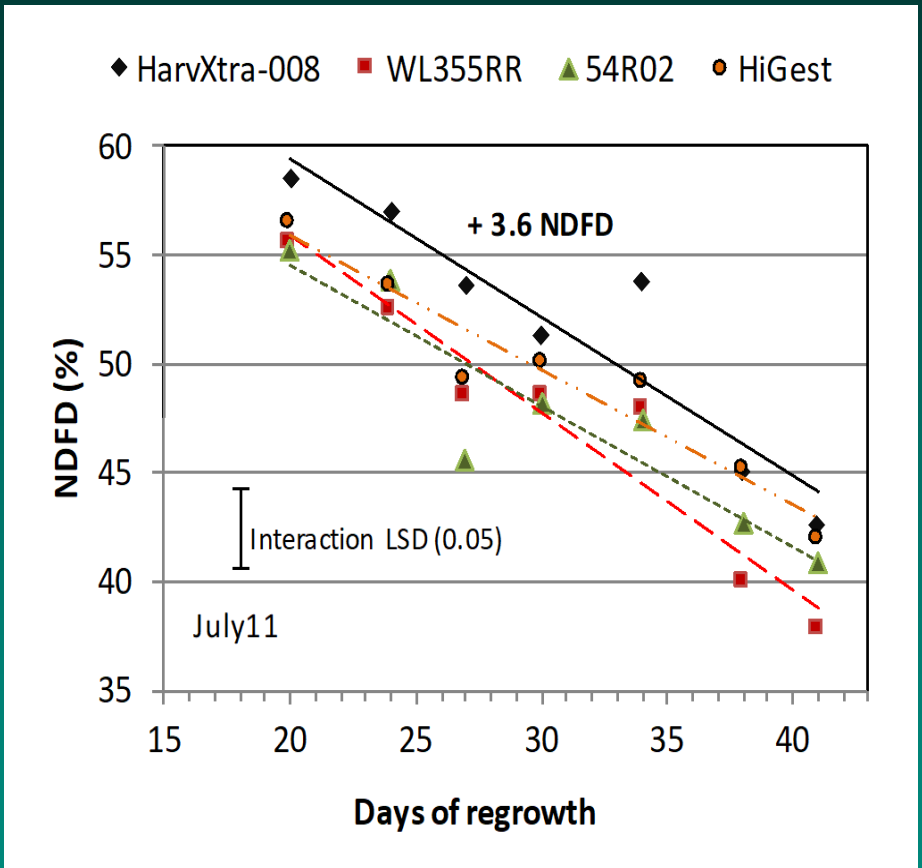
Source: Sulc et al., CA Alfalfa Symposium, 2016

NDFD in 2016 – CA only

1st growth cycle

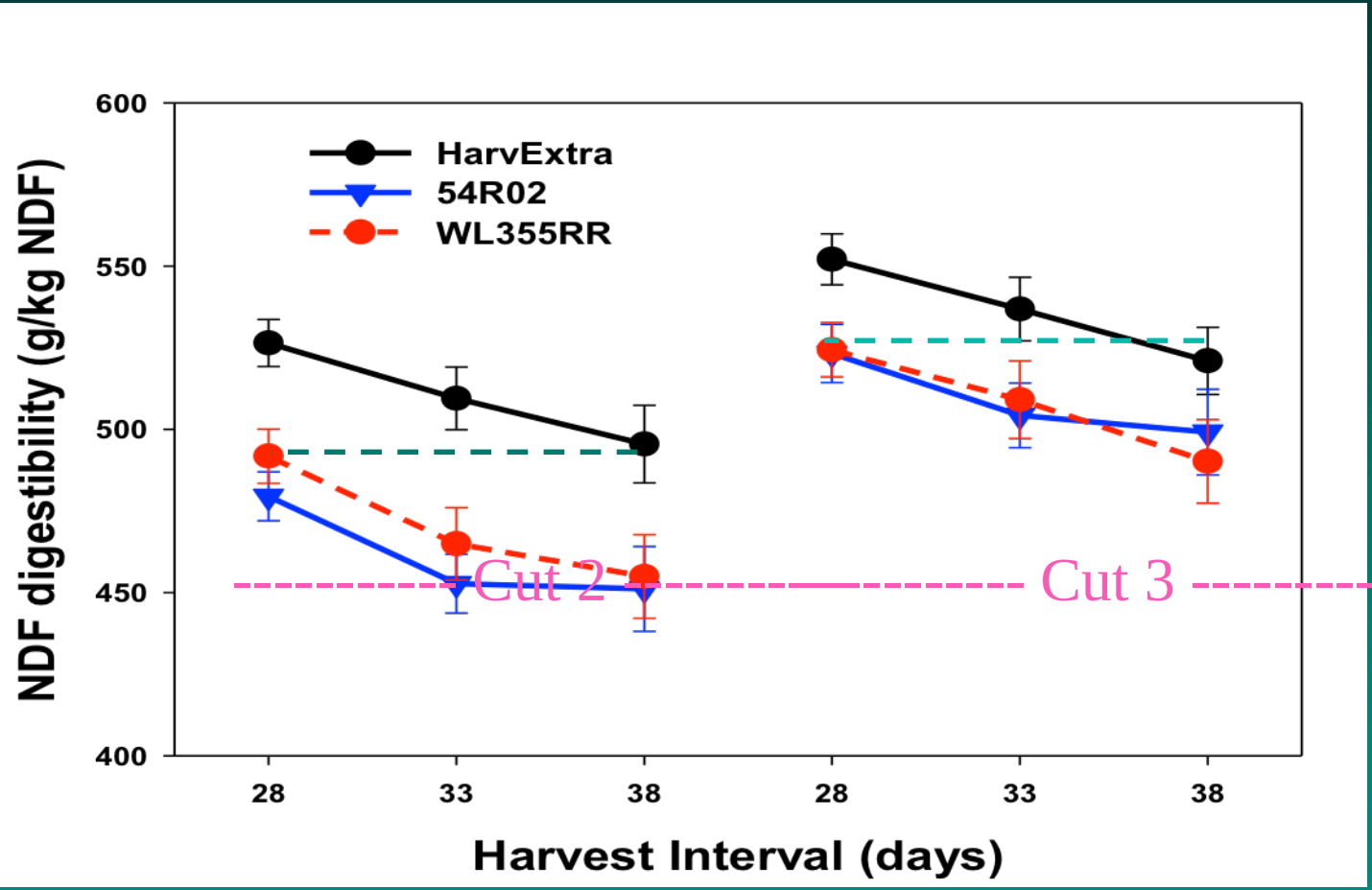


2nd growth cycle



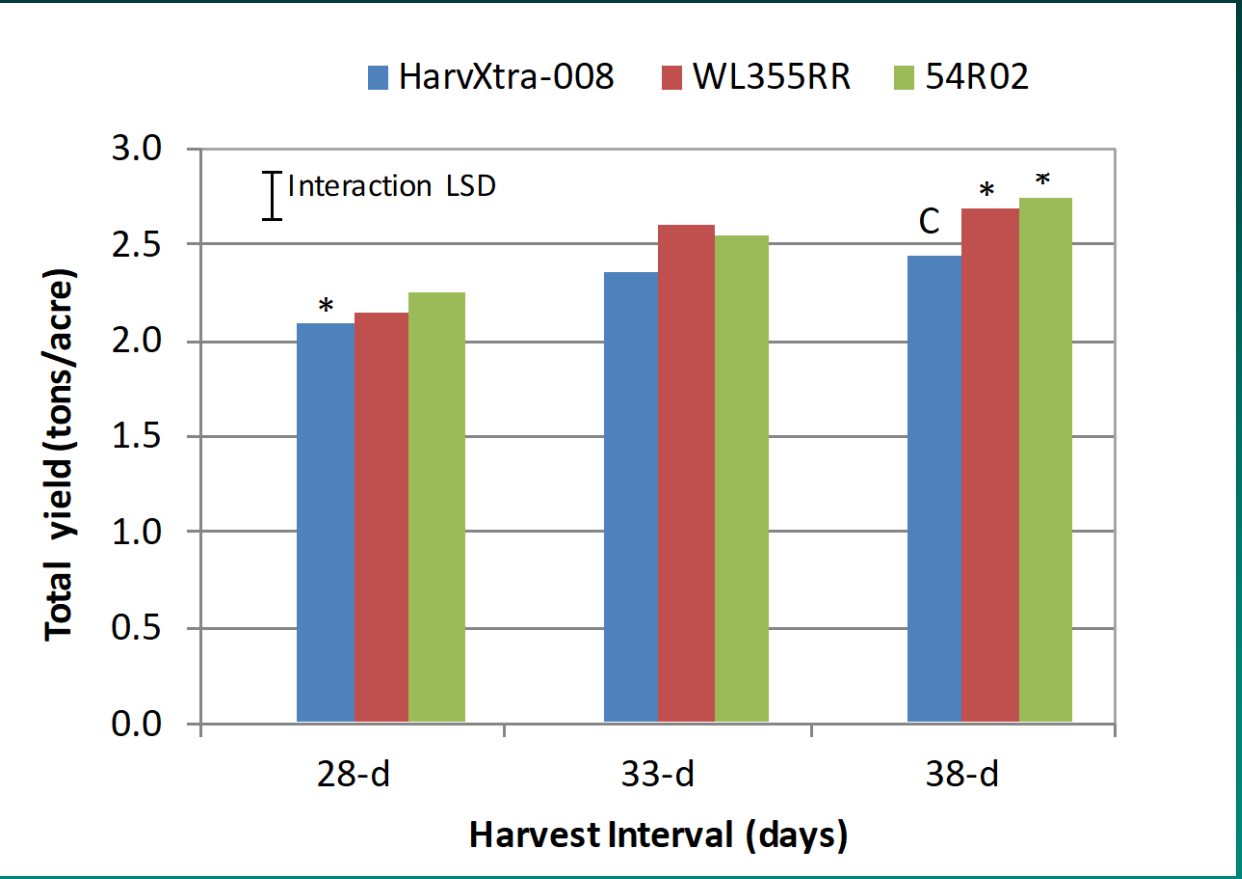
Source: Sulc et al., CA Alfalfa Symposium, 2016

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)



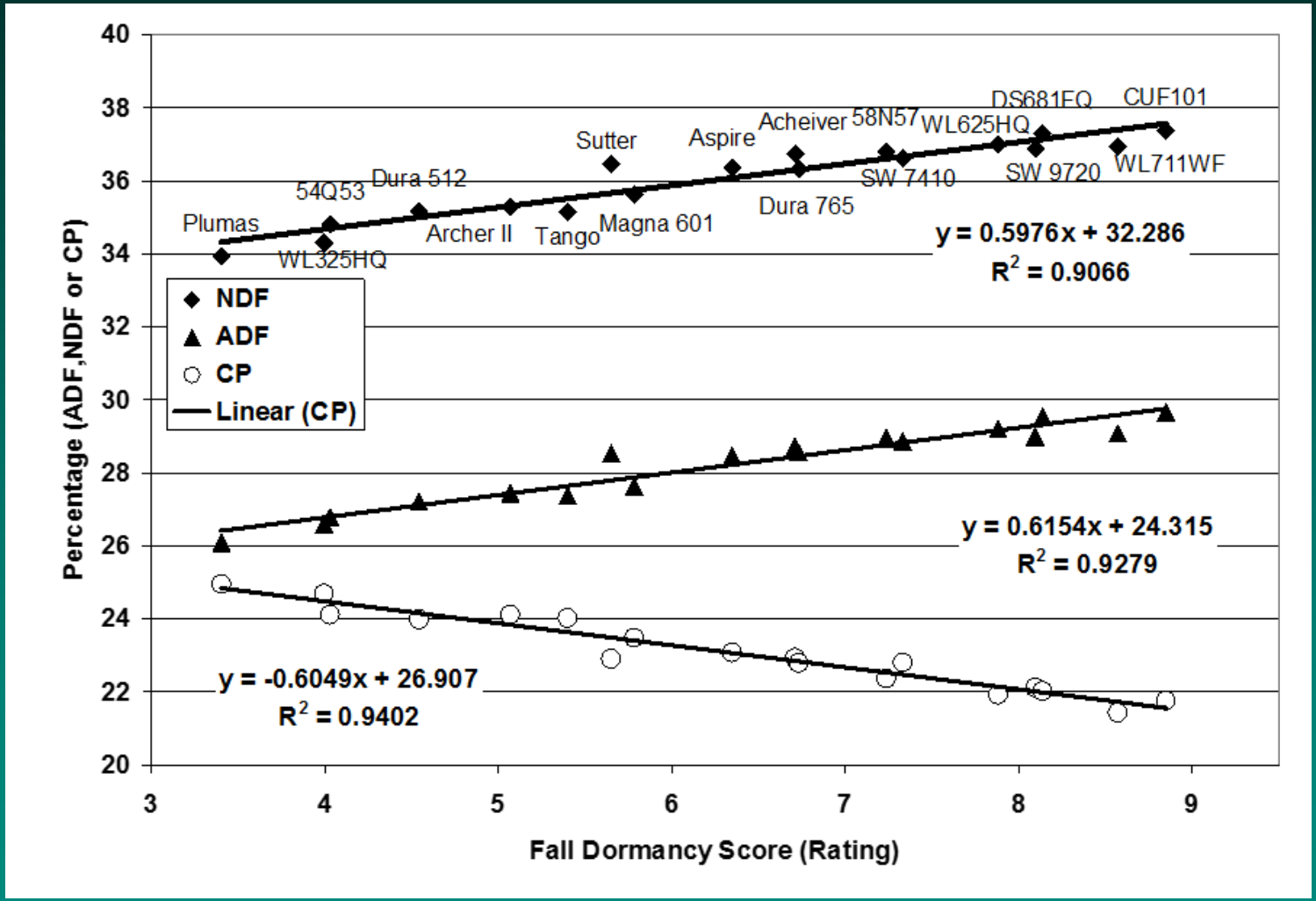
** = different than HarvXtra at 38-d*

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

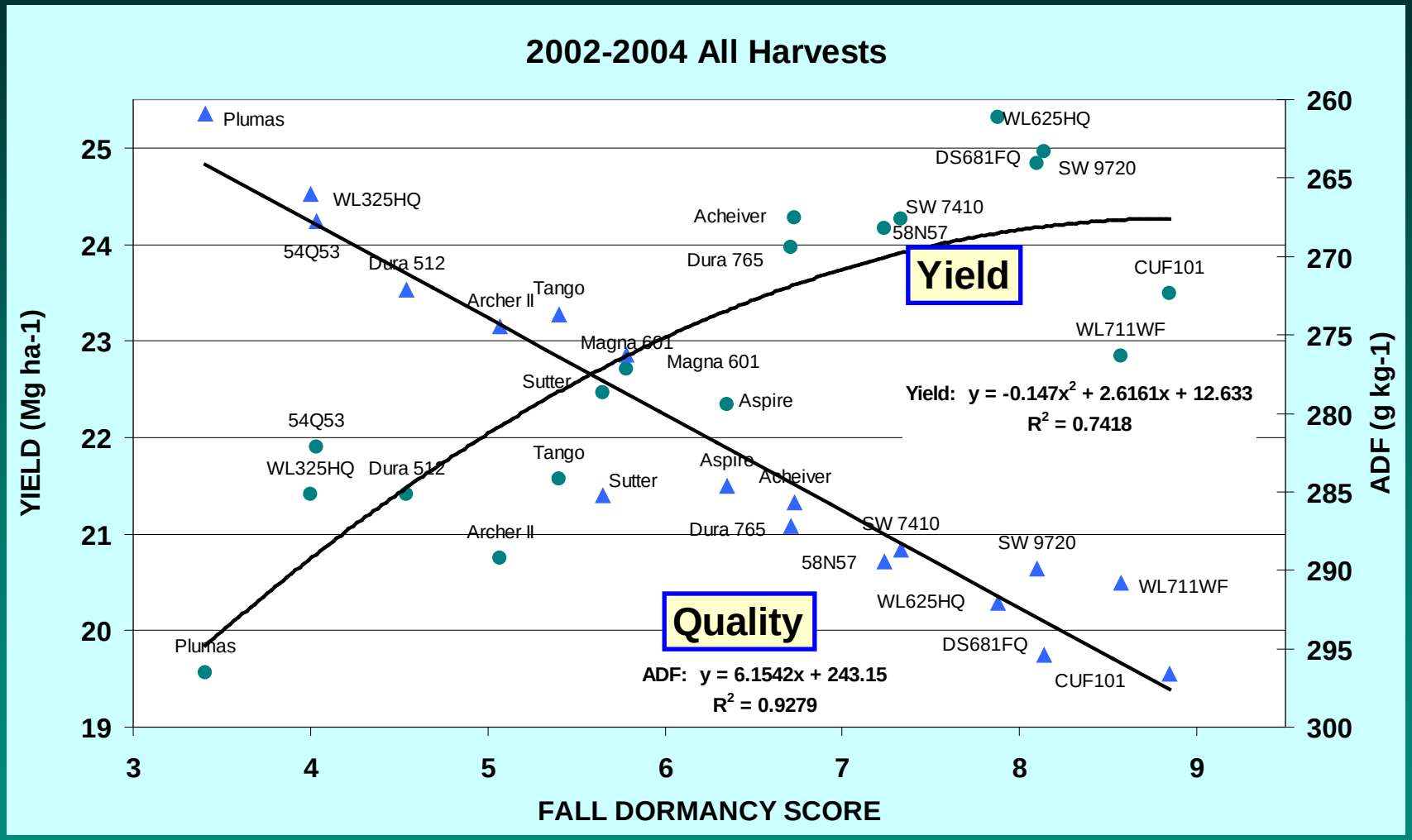
HarvXtra trait (4 exp. Varieties, 2 years, 5 harvests/year), UC Davis, CA – 35 day schedule (FD 4 varieties)

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% of growers primarily interested in yield aspects, 25% in quality improvement (FGI market report)

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.
- Multi-year results suggest it will 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

- Feeding trials – will HarXtra trait result in higher milk? (UCD)
- GE trait (approval sought in China, Japan)
- Measurements: Measuring of digestibility of fiber not just fiber (ADF, NDF)
- What is the value of quality? What is the value of yield?
- Markets: Recognition in market of different measurements of quality (e.g. NDFD, digestibility)

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. (we don't need 30 lbs. seed per acre!)
  - 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.

A few other points

- Could be a game changer