Changing Forage Quality Testing for Alfalfa Hay Markets

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Thesis:
Hay Quality and Markets:

- Current System is nearly entirely based upon low fiber (ADF, NDF) = high quality
- This system is effective to some degree, but misses important quality attributes
- Prone to Abuses

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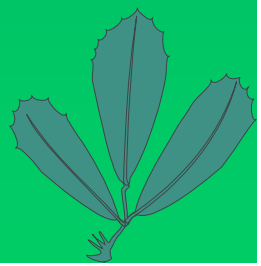

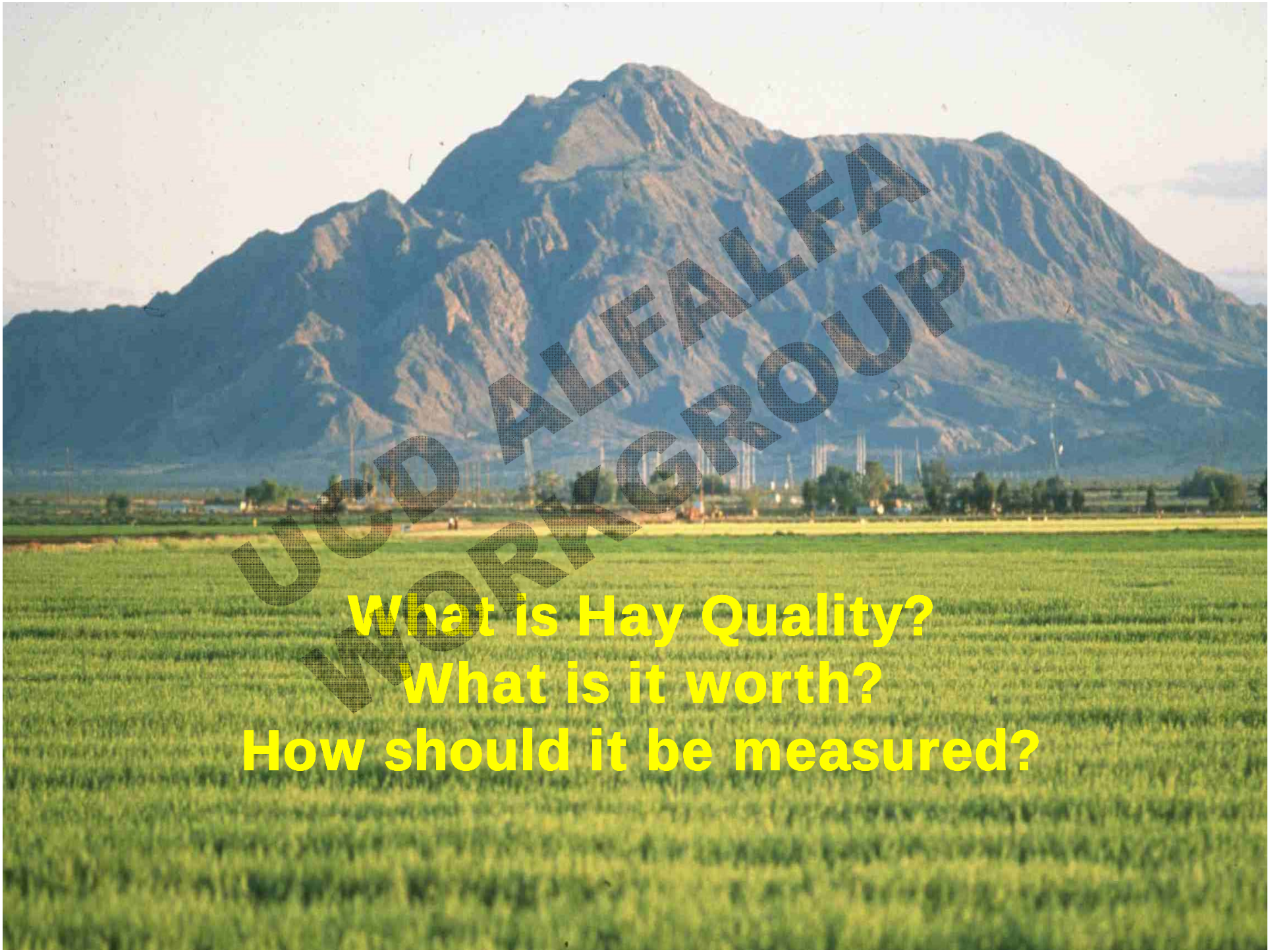
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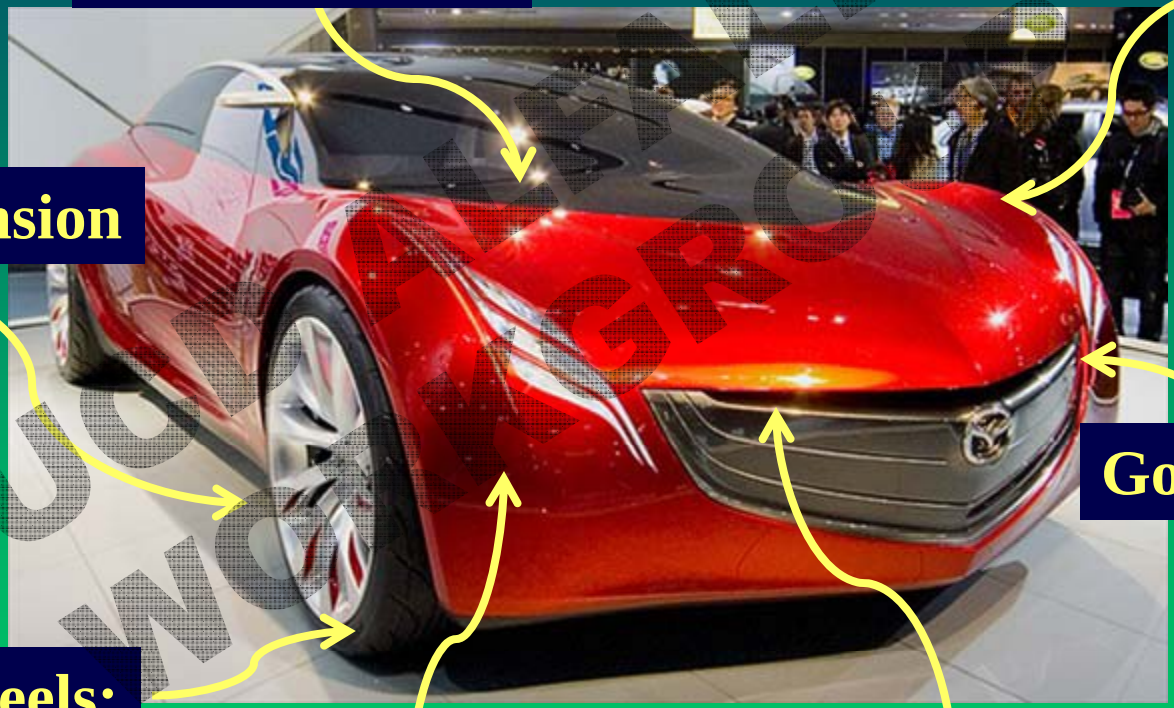
What is Hay Quality?
What is it worth?
How should it be measured?

What is a quality Car?



Safety Airbags

Nice Styling

Great Suspension

Good Milage

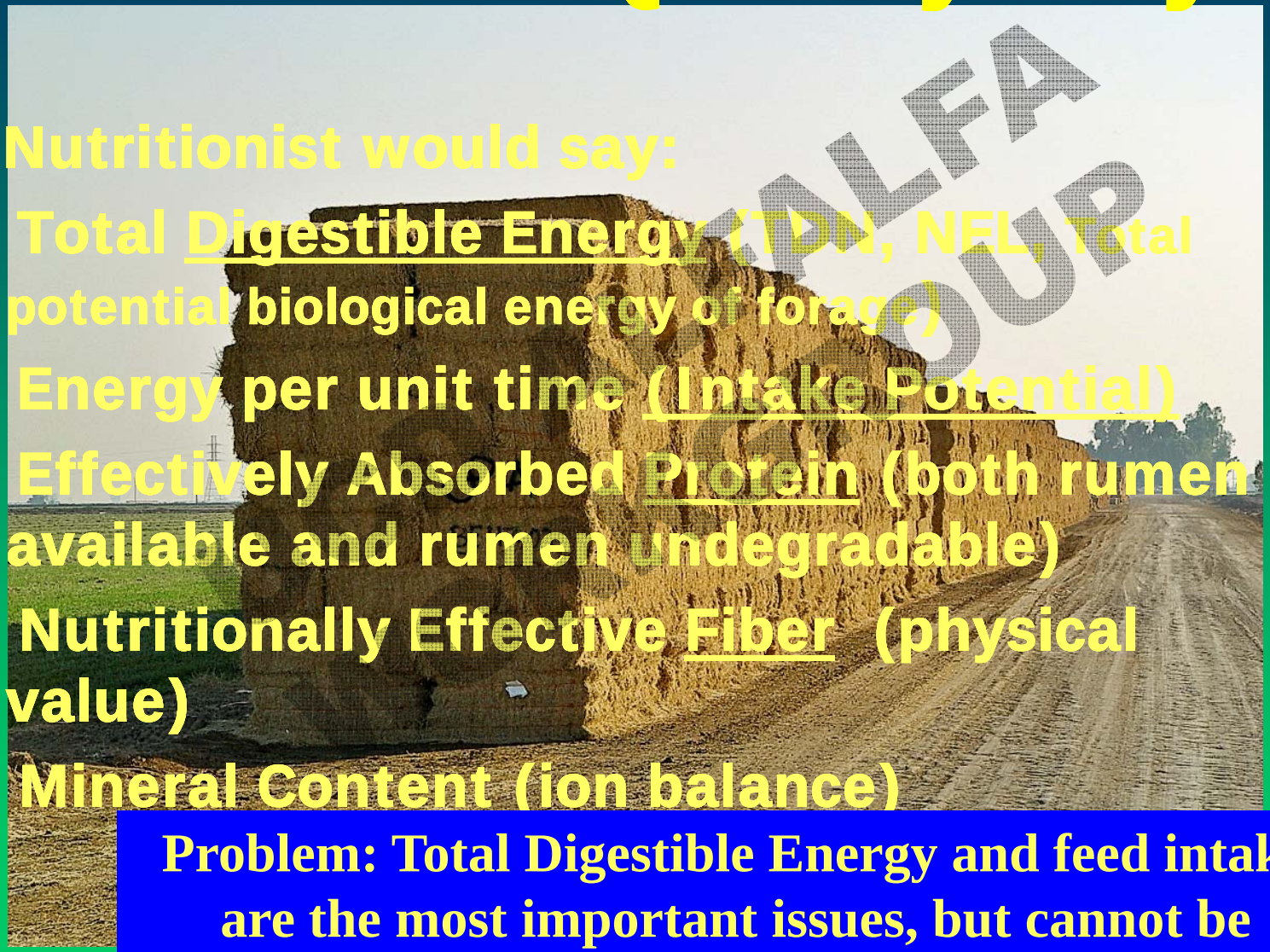
Quality Wheels:

Engine Power

Good Paint Job:

Many Aspects of Quality!

What is Quality Hay?



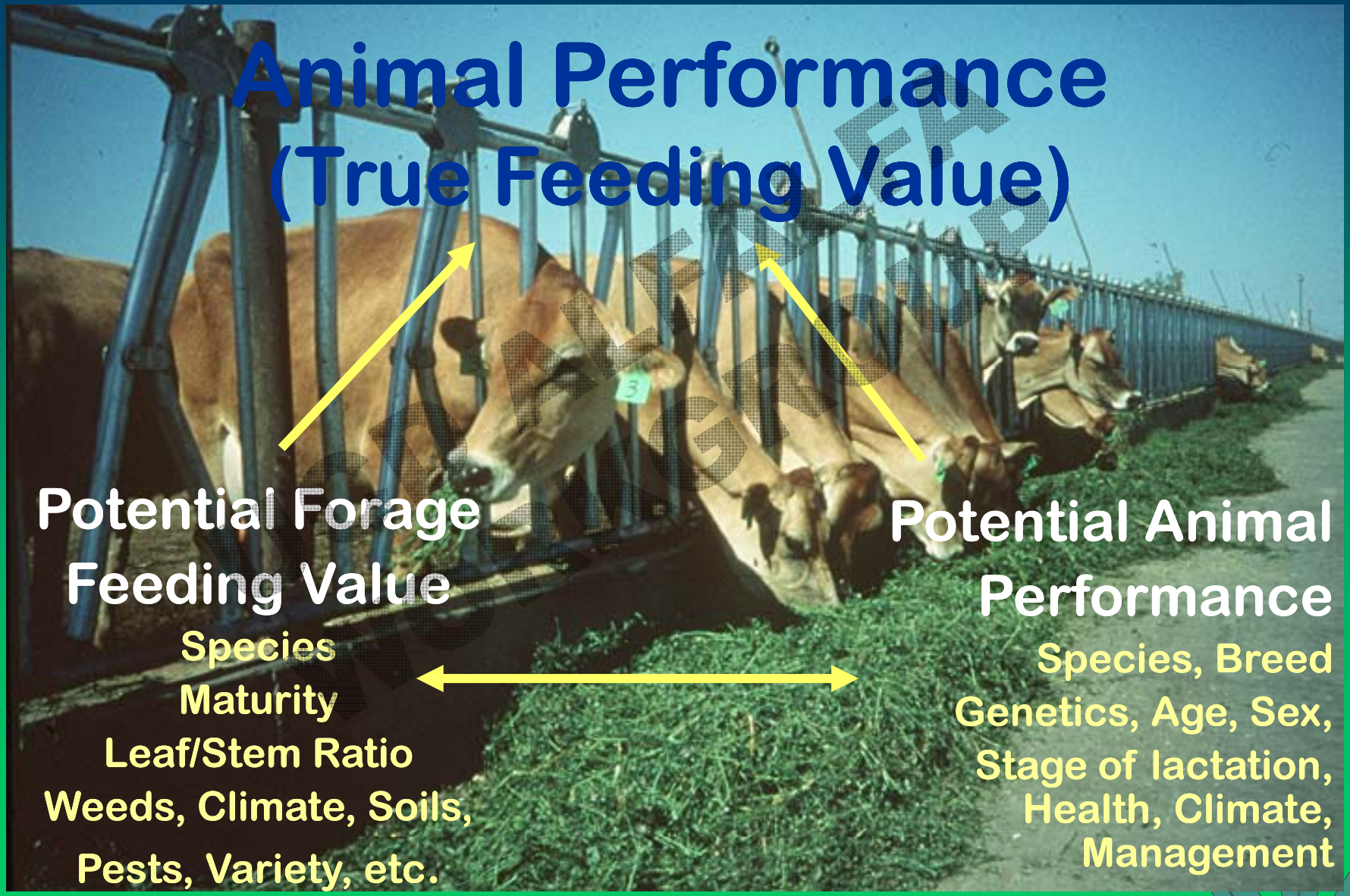
A Nutritionist would say:

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 Content (ion balance)

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

lity!

Animal Performance (True Feeding Value)



Potential Forage Feeding Value

Species
Maturity
Leaf/Stem Ratio
Weeds, Climate, Soils,
Pests, Variety, etc.

Potential Animal Performance

Species, Breed
Genetics, Age, Sex,
Stage of lactation,
Health, Climate,
Management

Forage Quality is Multi-Faceted

- High Crude Protein
- Low Fiber
- High Fiber Digestibility
- High TDN
- Good mineral balance
- No Weeds
- Good texture/odor

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But…

- Does our marketing System incorporate important aspects of quality?
- Is it subject to abuse?

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What is Hay Quality Worth?

- California markets more hay than any other state
- >95% of hay is bought, sold
- Likely >80% of hay is tested at least once
- Fiber Based Marketing System
- Domestic: 95%, export <5%

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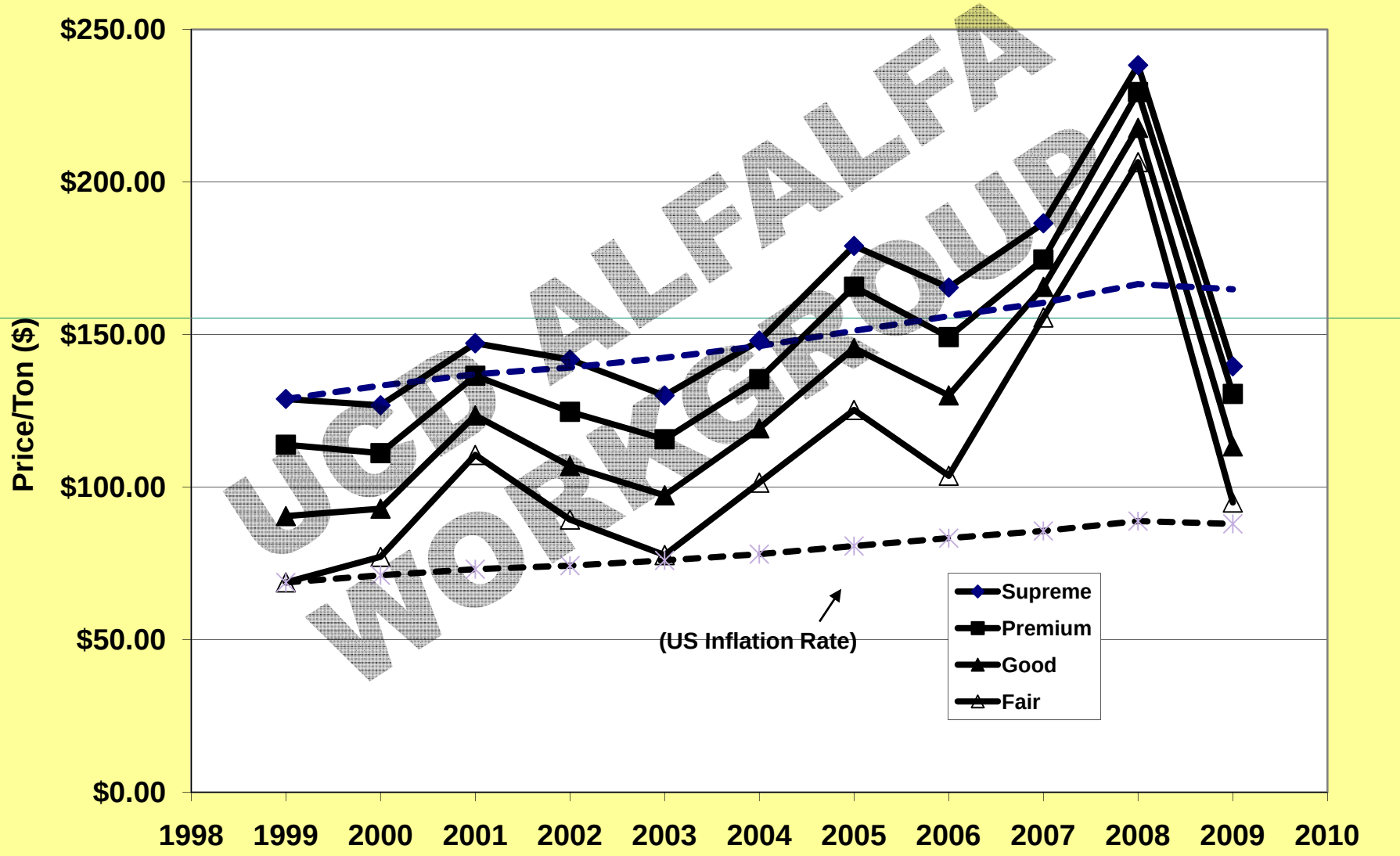
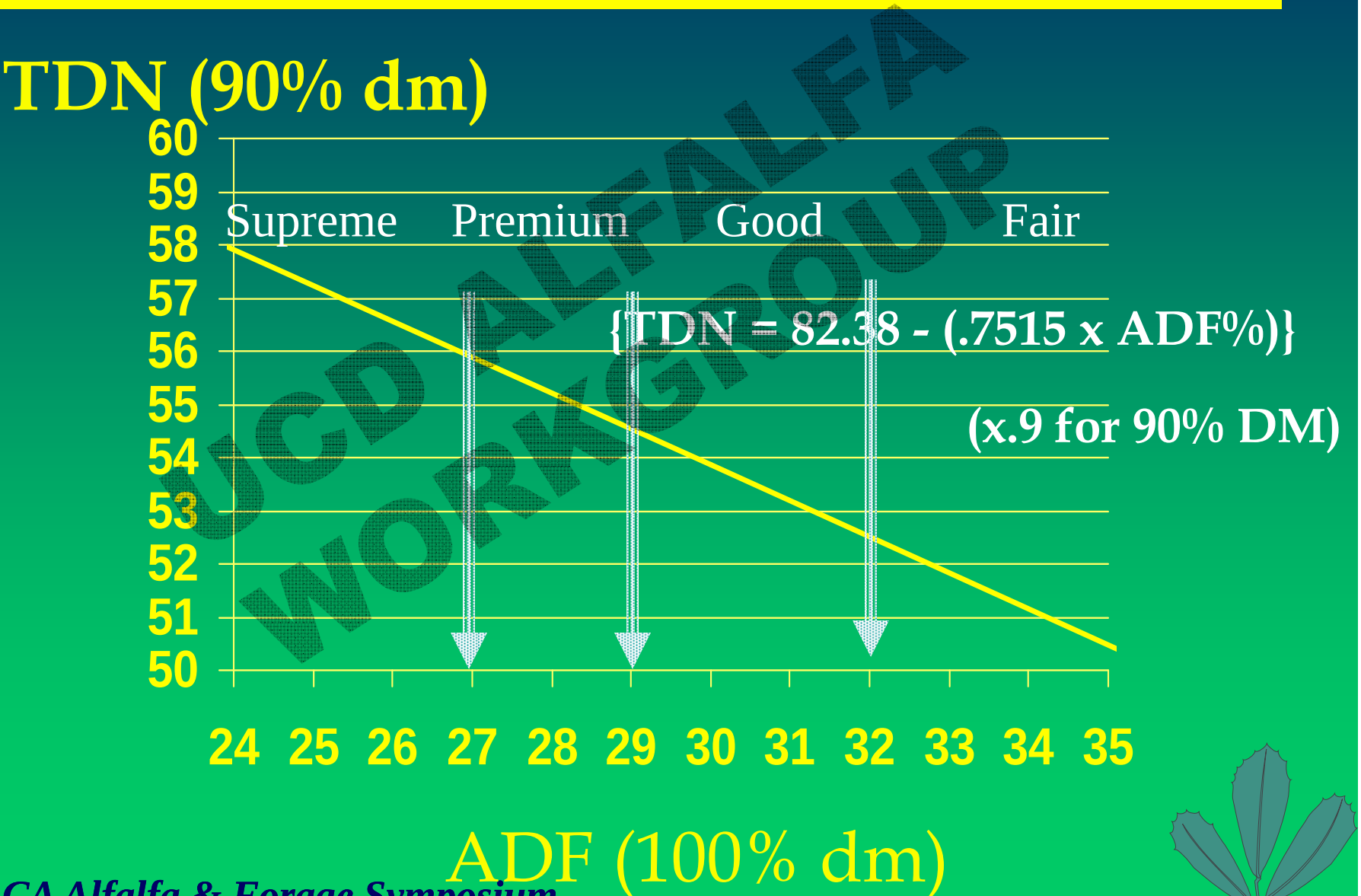
Long-Term California Hay Prices (1999-2009, all markets)



TDN is Predicted from ADF



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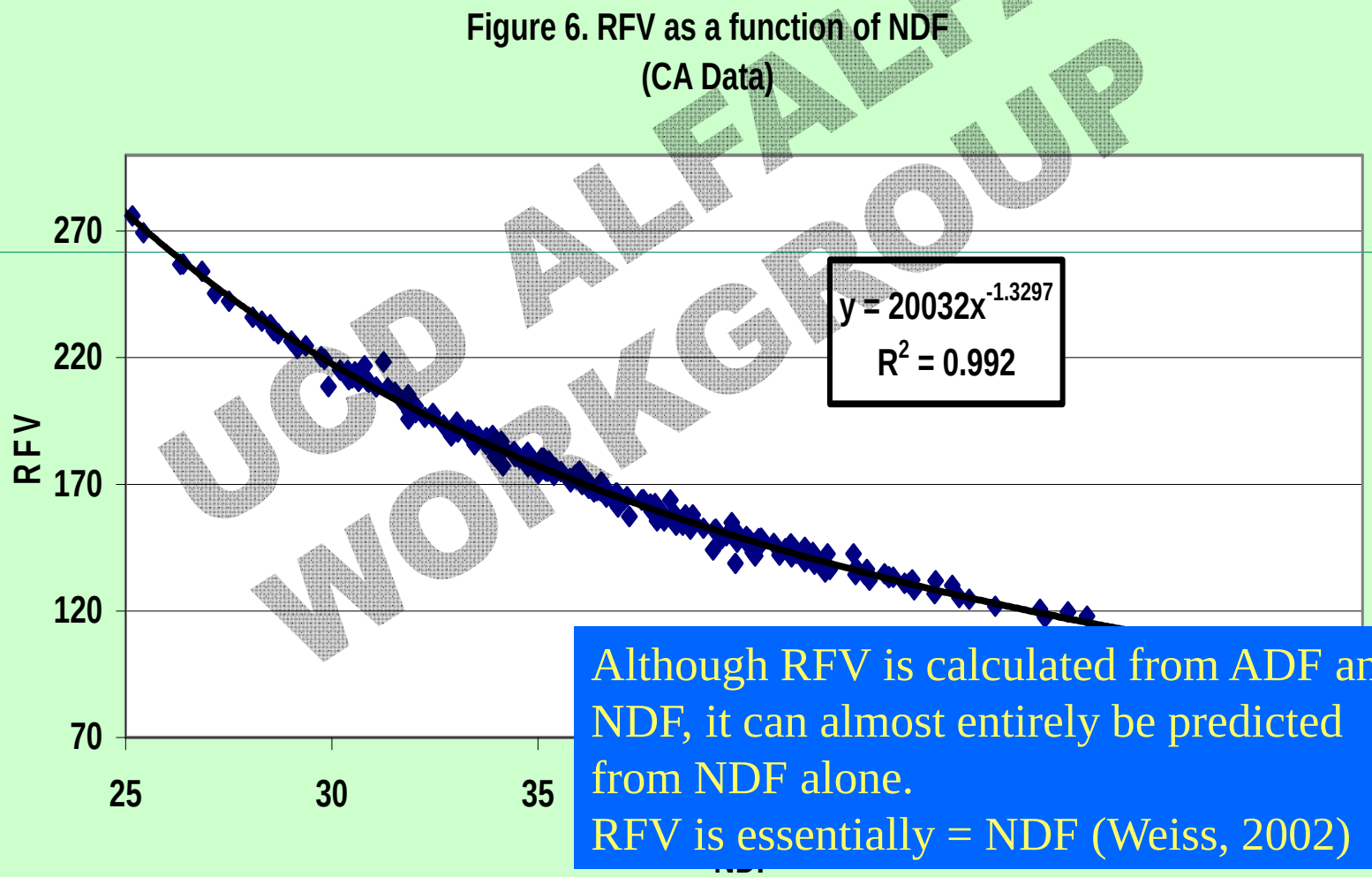
RFV is calculated from NDF & ADF



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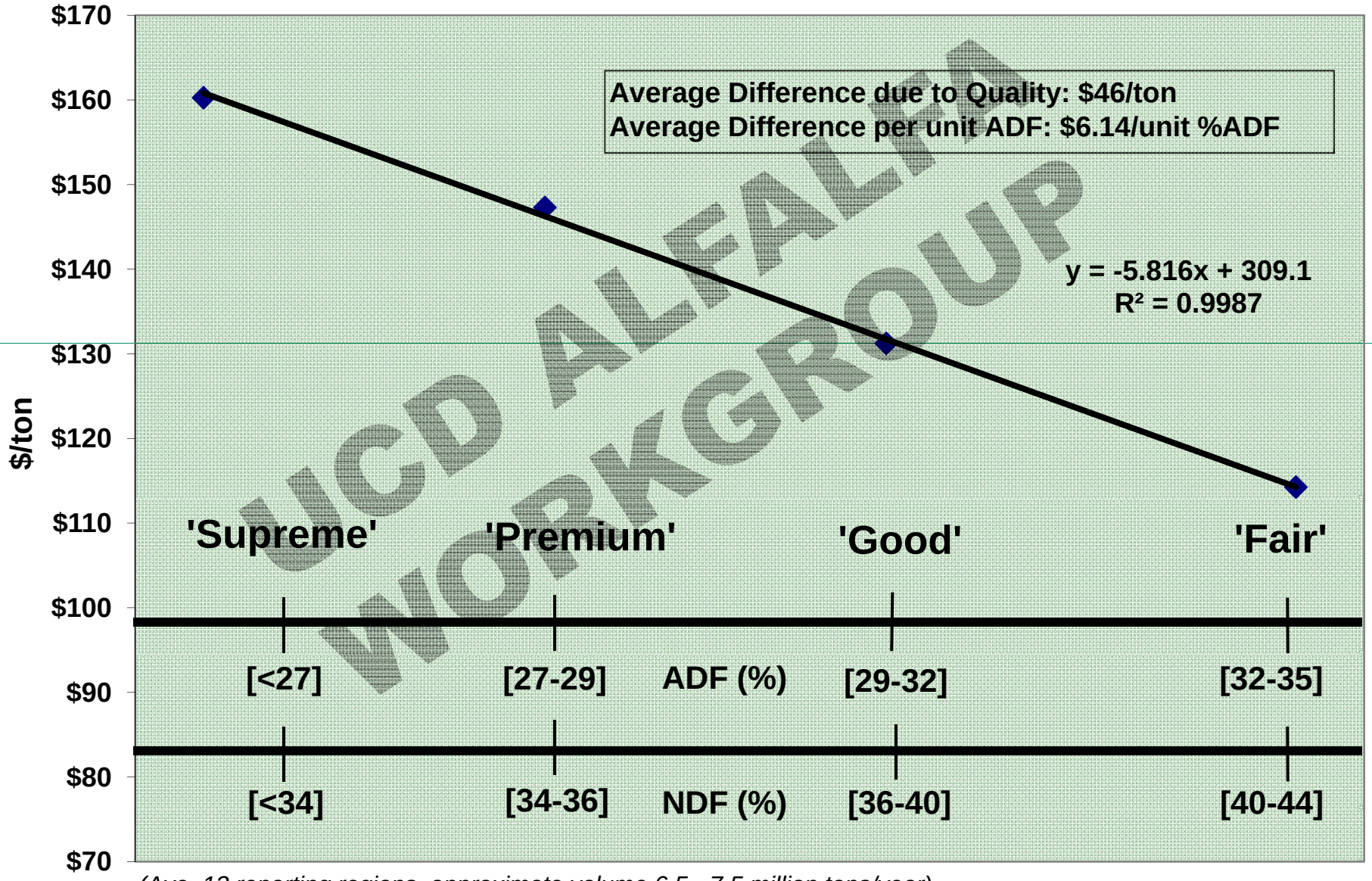
Although RFV is calculated from ADF and NDF, it can almost entirely be predicted from NDF alone.
RFV is essentially = NDF (Weiss, 2002)

Influence of Quality on Alfalfa Hay Price
- Ten Year Average, all California Markets, 2000-2009



(Ave. 13 reporting regions, approximate volume 6.5 - 7.5 million tons/year)

Does the Fiber-Based Marketing System Work?

- It works mostly, since low fiber hays are largely better in quality
- Does not incorporate other analysis
- Prone to Abuses

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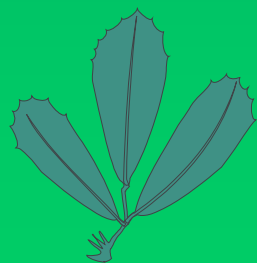

Abuses of Current System

- Demanding Unrealistic Precision in lab tests
- Arguments over a few tenths of a percent in lab values

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Commonly- Observed Variation in Hay Testing

	Sampling Variation	Between Labs	Within Labs
	Probe-Probe	Lab-Lab	Run-Run
ADF	3.0 - 8.0	0.7 - 3.0	0.3 - 1.6
NDF	4.0 – 9.0	1.0 – 4.0	0.4 – 2.0
CP	2.0 – 6.0	0.5 – 2.0	0.2 – 1.0
TDN	2.0 – 6.0	0.3 – 2.0	0.2 – 1.5

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Abuses of Current System

- Taking a Poor Sample
  - Follow Proper Protocols
  - 20 cores, sampling protocols
  - Certify your hay sample

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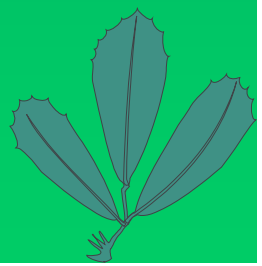
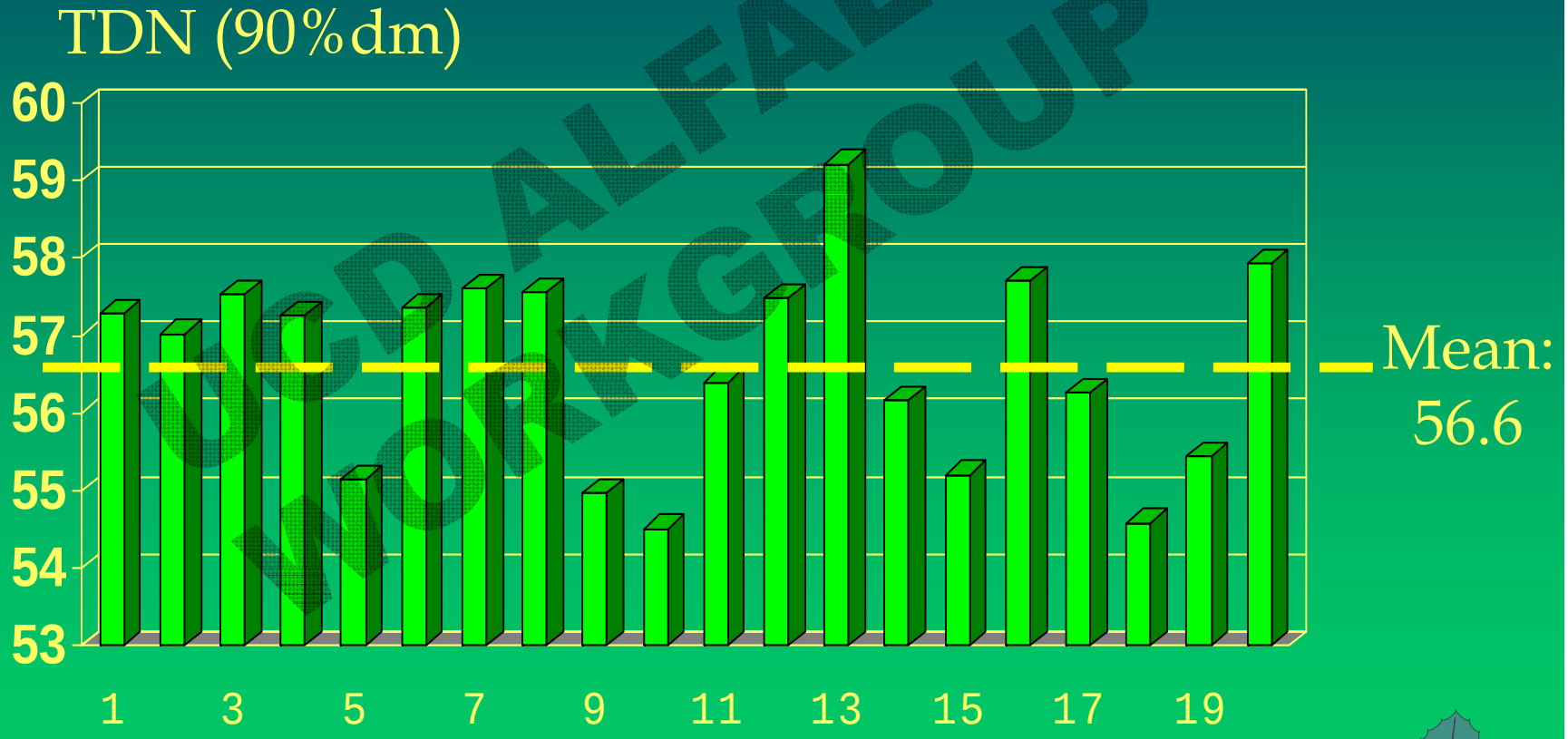


Variation Between cores in a stack



Pure alfalfa hay from a single 'uniform' stack, 20 separate cores from separate bales

The lab results are only as good as the sample.

Abuses of Current System

- Use of a Single Number
  - Overemphasis on (e.g.) TDN or RFV ignores protein, digestibilty, ash, or other attributes
  - Important to incorporate visual judgement

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Visual Evaluation

- Species (alfalfa)
- Leaf/Stem Ratio (subjective)
- Maturity (presence of bloom)
- Stem Thickness (feel them – are they fibrous?)
- Weeds
  - Poisonous, noxious, irritants
- Molds/Dustiness
- Anti-palatability Factors
  - Poor texture
    - hard stems, coarseness
  - Evidence of heating (blackened color)
  - Evidence of excessive pests (black mold)
  - Unpleasant odors

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Relative Reliability of Visual Vs. Lab Analysis

QUALITY FACTOR	VISUAL	LAB
Stage of Maturity	Poor	Excellent
Leafiness	Fair	Excellent
Fiber	Poor	Excellent
Protein	Poor	Excellent
Minerals	Poor	Excellent
Noxious Weeds	Excellent	Poor
Texture/Odor	Excellent	Poor

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Recommended: Use Visual Evaluation Plus Lab Analysis

Abuses of Current System

- Encouraging Lab Bias
  - Double Check Lab Bias
  - Split Sample tests
  - Reduce demand-driven bias

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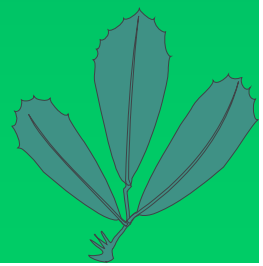
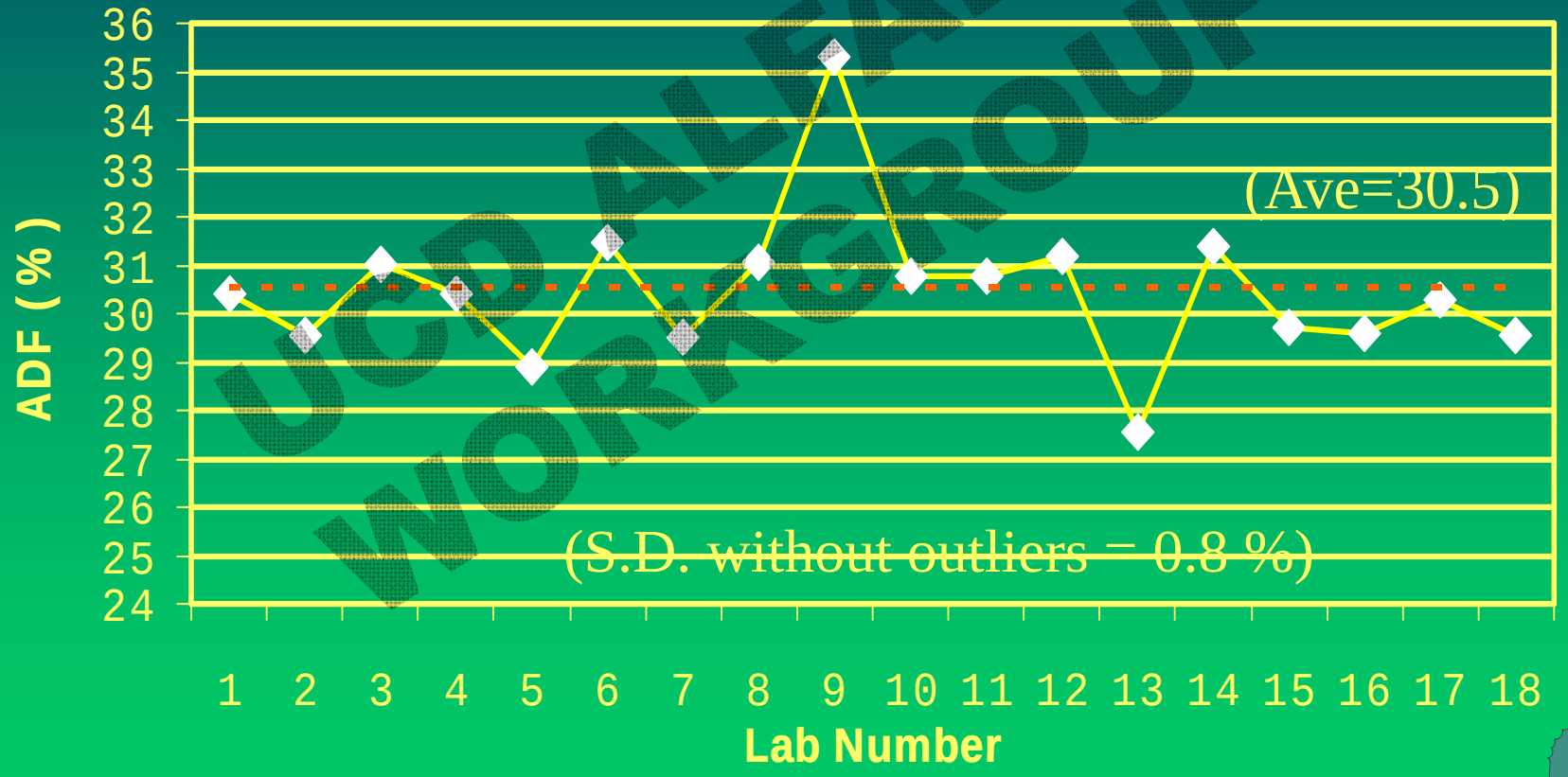


Variation Between Labs—Split Sample Trial



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Abuses of Current System

- Misinterpreting Calculated Values
  - Remember, RFV, TDN, RFQ, NEL, ME are all calculated values
  - Know the origins of these calculations, since it can be confusing
  - If confusion persists, refer to actual analyzed values.

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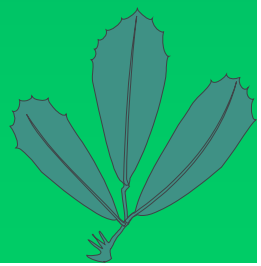

Abuses of Current System

- **Misinterpreting DM Data**
  - DM data should be used to market for YIELD, not for quality
  - ALL forage analyses should be based upon 100% DM data for NDF, ADF, CP, NDFd, etc.
  - High moisture – look for mold or other difficulties

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Abuses of Current System

- Failure to Consider Additional Analyses which may be more predictive

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Intake:

- Very Important to High Producing Dairy Cows
- Less important to beef/non-lactating cows
- Prediction difficult

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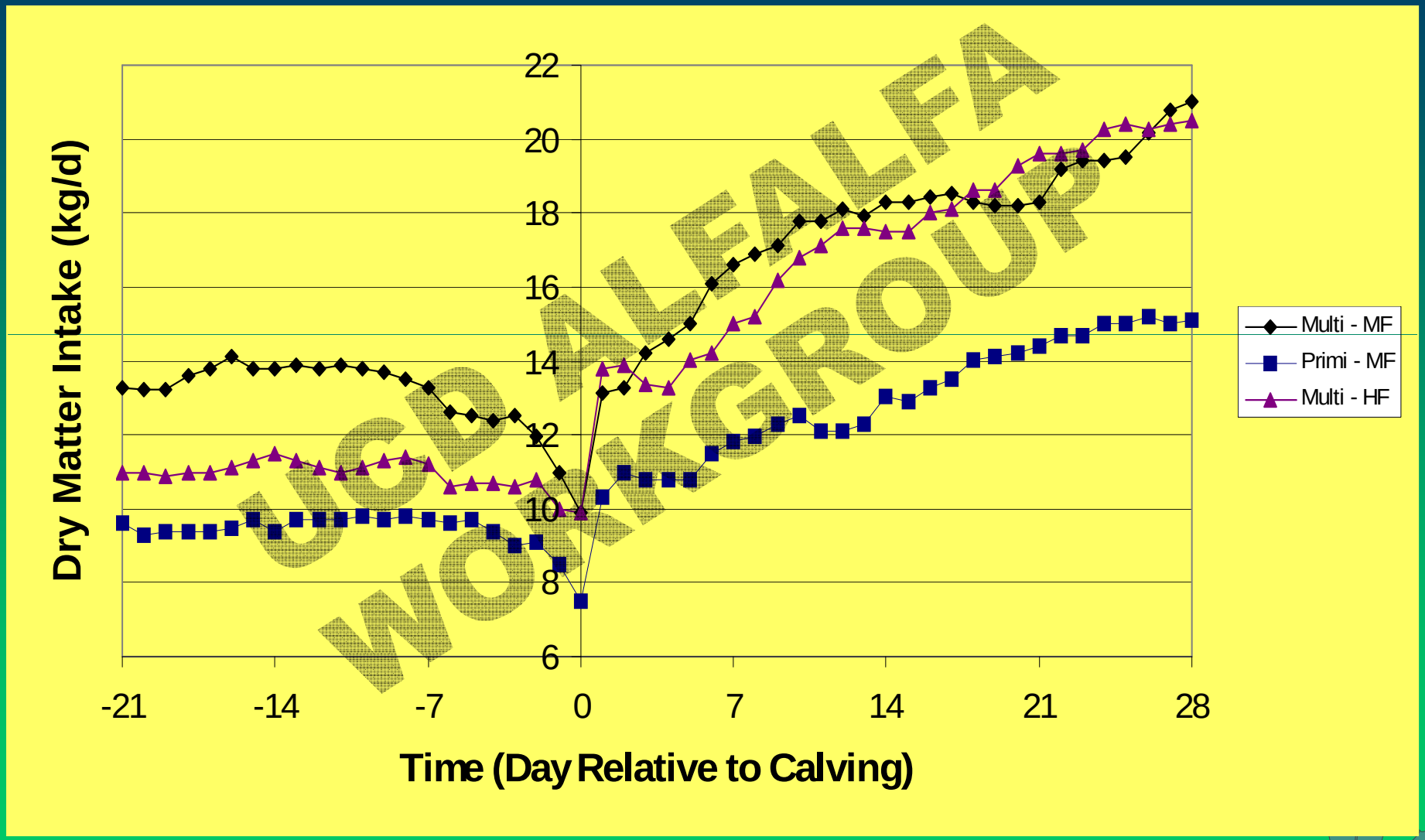
What about Intake??



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)

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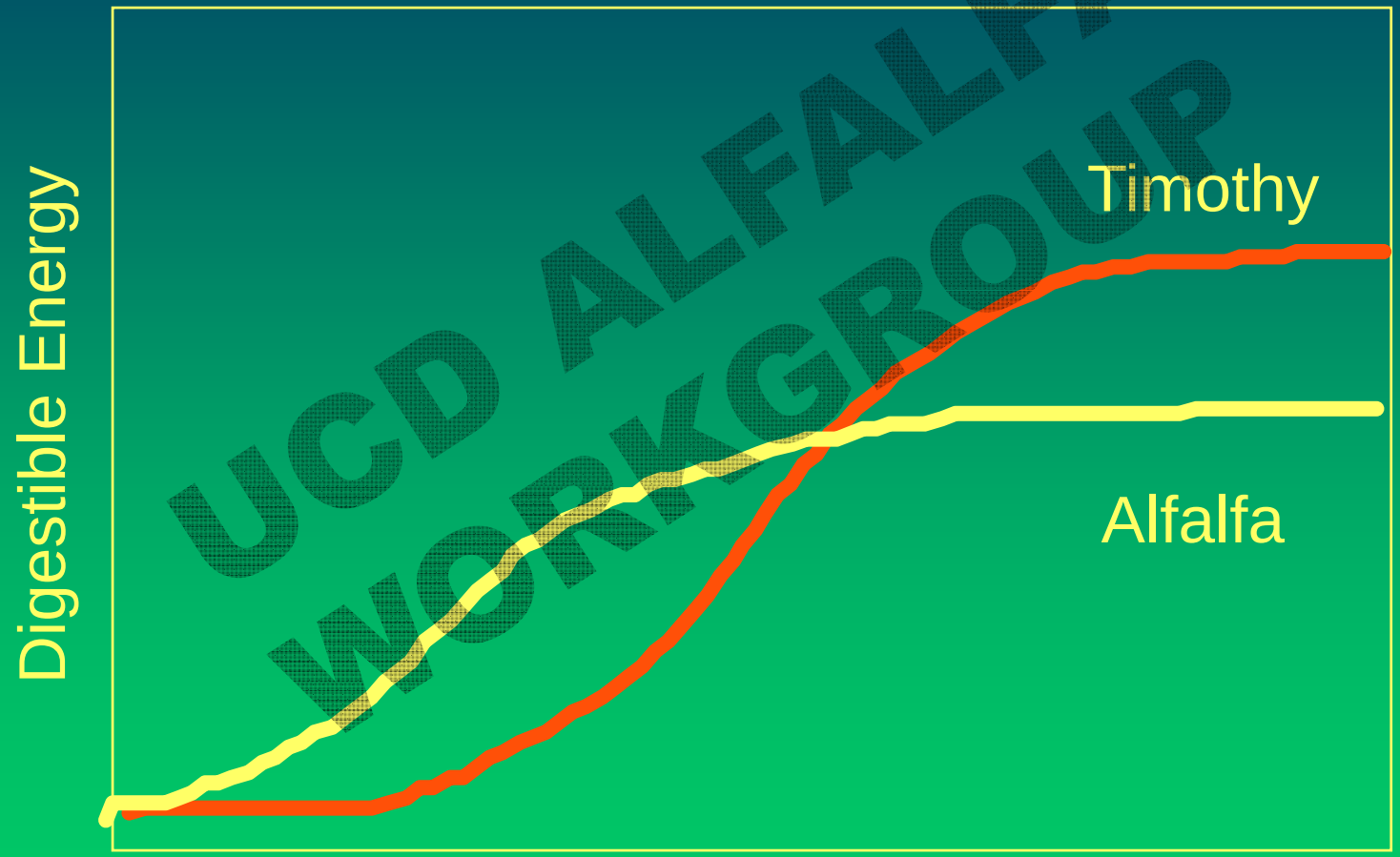
The importance of time in estimating energy yield



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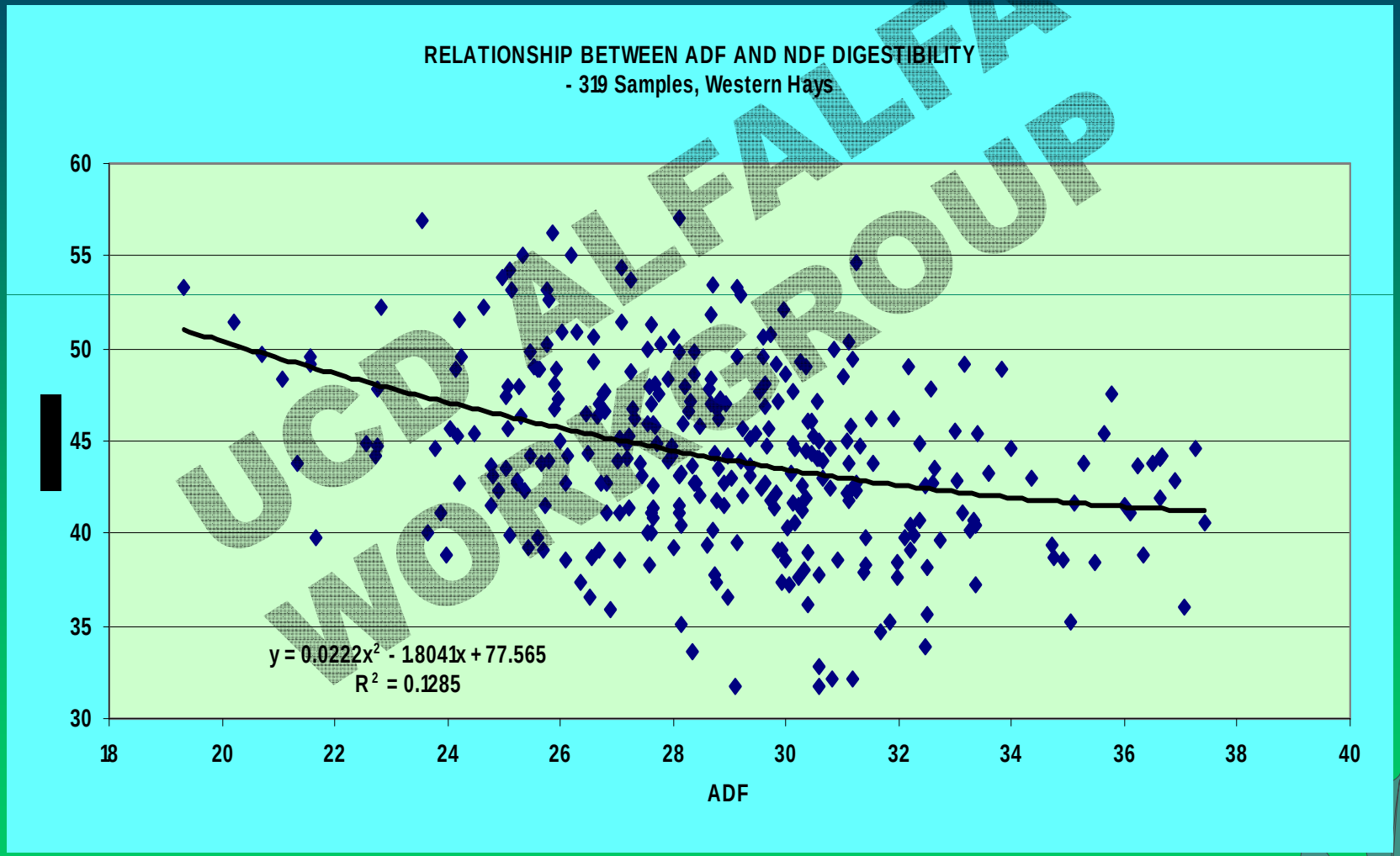
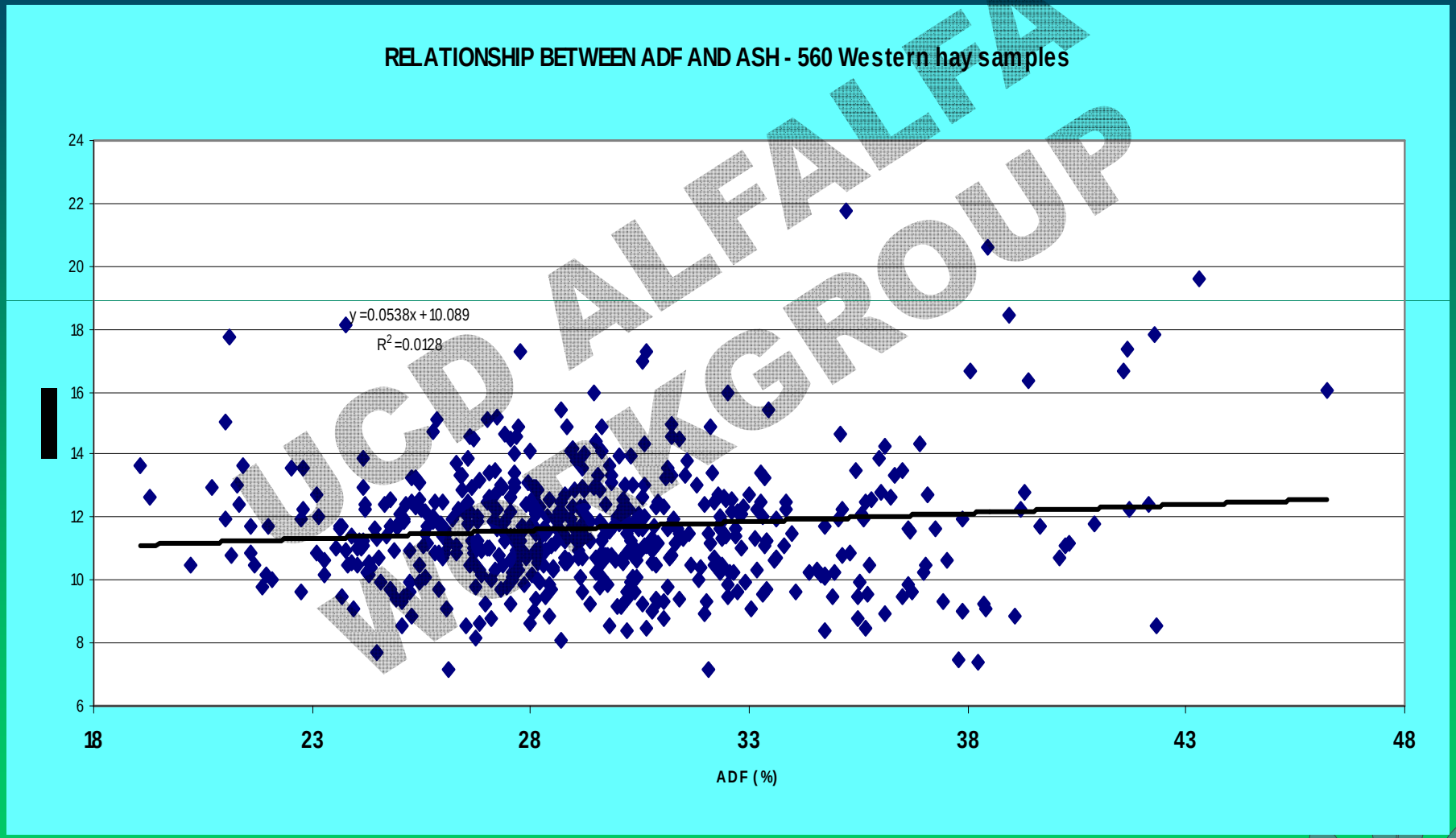
(Adapted from Van Soest, 1995)

NDF Digestibility

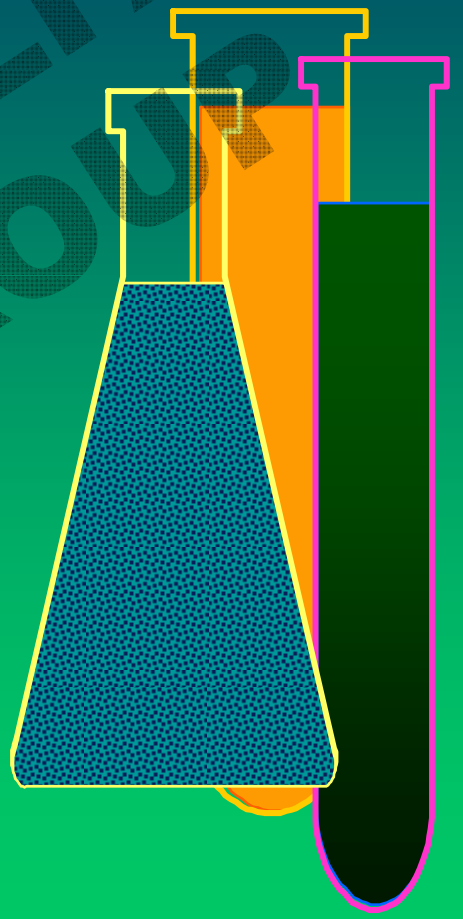


Ash Content of Alfalfa



PURPOSES OF HAY TESTING:

1) Formulate Rations
2) Determine Economic Worth



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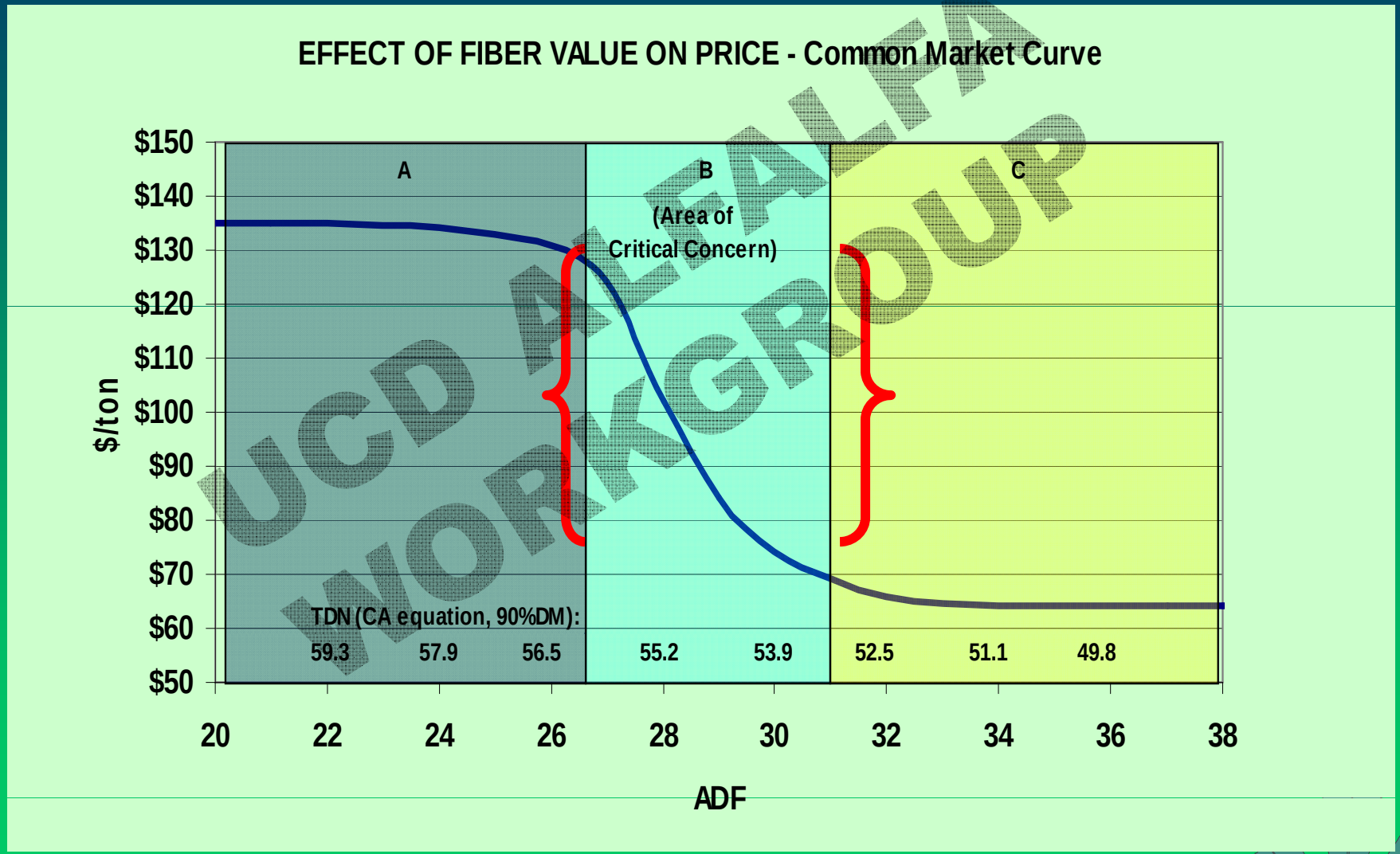
A fiber-based Market System:



Hay Quality Concepts:

(evolution of predictive tools)

Visual

↓

Proximate

↓

RFV for marketing (Midwest)

↓

ADF - TDN (Nutritionists / Marketers)

Summat analyses

Major Question: Can Summative Equations be used for Marketing? RFQ?

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STANDARD HAY TEST REPORT:

Lab Analysis Results[1]: As Rc'd		Dry Matter Basis 90% dm	100% dm
Dry Matter (dm)	87%	90%	100%
ADF	26.1	28	31.0
NDF	33.5	34.7	38.5
CP	17.4	18.0	20.0
Calculated Values[2]:			
TDN	52.1	55.2	59.8
NEL	0.53	0.55	0.61
DDM	57.0	59.0	65.5
RFV			150

CATEGORY:

Supreme (<27 ADF)
Premium (27-30 ADF)
Good (29-32 ADF)
Fair (32-35 ADF)

1. A minimum of .5 percentage point variation is expected in lab results

RFV = NFTA Equation TDN = CA Equation

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New Standard Hay Test:

Core Hay Analysis:

- DM – Not for quality – but for yield
- NDF - Neutral Detergent Fiber
- CP - Crude Protein
- NDFd – NDF digestibility
- Ash

Additional Analyses:

- Lignin – Many nutritionists value lignin
- DCAD – Close up animals

Calculate:

- TDN, RFV, RFQ, Summative Energy Values, NEL, RFV, RFQ, etc.

Emphasize: What is actually measured!

Remember: Only as good as the sampling procedure

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What's in a Forage Plant?

Contribution to Energy (TDN)

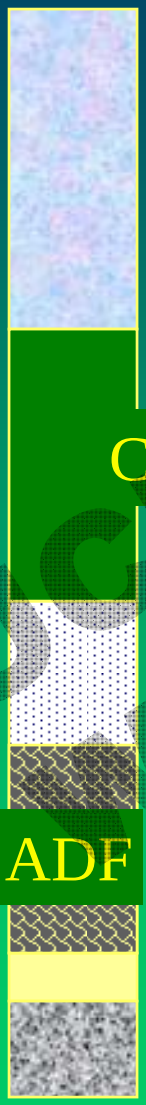
100%

large

Some

100%

None



100% Dry Matter

Non Fiber Carbohydrates (NSC)
Sugars, Starches, Pectin 20-35%

Crude
Protein (soluble, bound) 15-24%

Structural Carbol
NDF (soluble,

Fat 1-3%

Ash 5-12%

When ADF or NDF go up, Forage Quality goes down!
NFC – Non Fiber Carbohydrates need several analyses

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Marketing:

- Use of NDF as the first approximation of quality
- Additional interpretation of NDFd, CP, and ash

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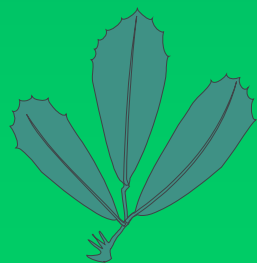

Summary:

- Quality is a complex trait, not conducive to a single number
- Fiber based marketing systems, while simple and effective, are prone to several abuses
- Shifting Largely to:
  - Emphasis on NDF, Drop ADF
  - Use 100% DM values
  - Incorporate NDFd, Ash
- Use calculated values (TDN, RFV, RFQ) but know where they come from.
- Visual Evaluation still important.

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Larry Teuber, photo