Corn Silage Evaluation: MILK2000 Challenges & Opportunities With MILK2006

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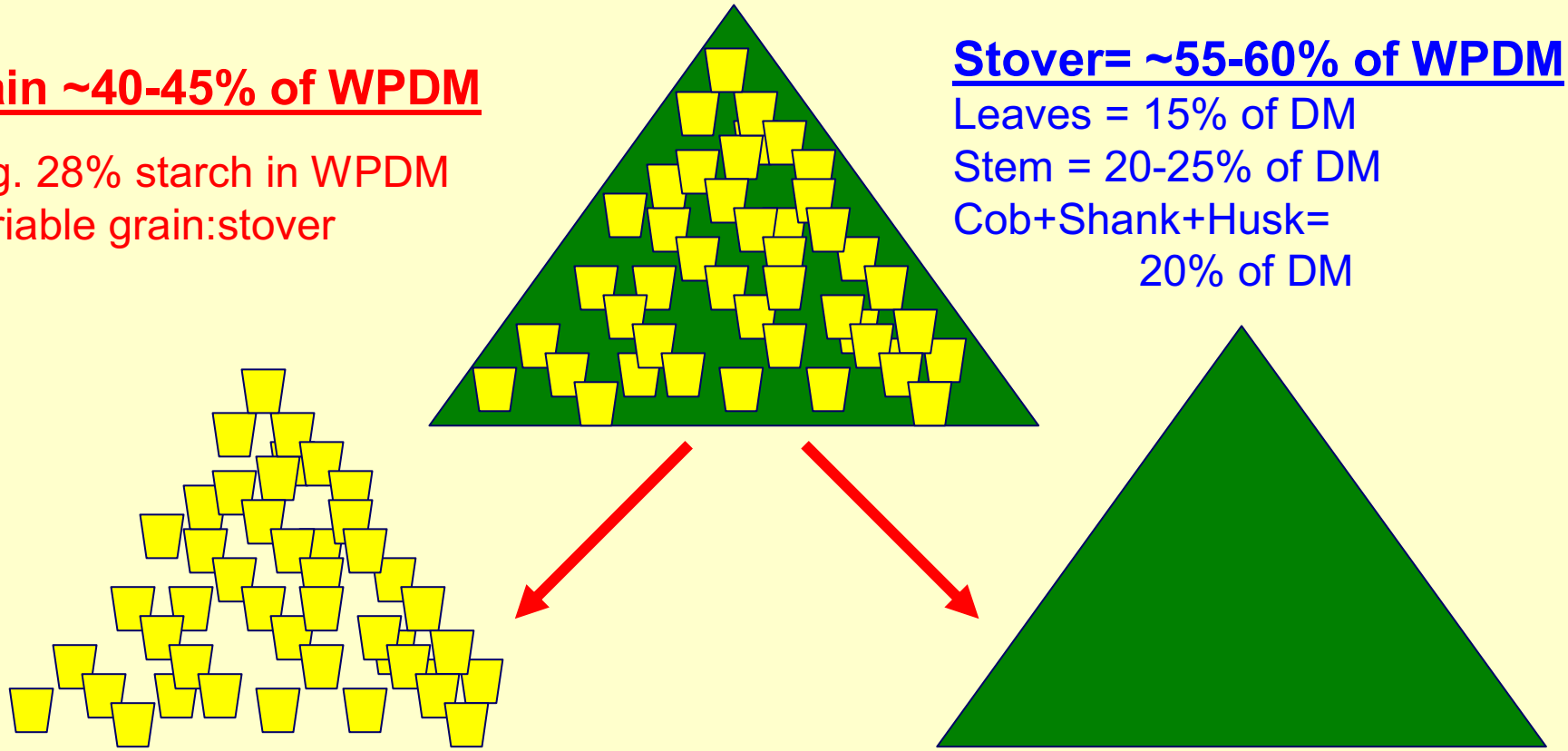
Whole-Plant Corn Silage

Grain ~40-45% of WPDM

- Avg. 28% starch in WPDM
- Variable grain:stover



Stover= ~55-60% of WPDM

Leaves = 15% of DM
Stem = 20-25% of DM
Cob+Shank+Husk=
20% of DM

80 to 98% starch digestibility

- Kernel maturity
- Kernel particle size
- Endosperm properties

40 to 70% NDFD

- lignin/NDF

Adapted from Joe Lauer, UW Agronomy

NRC (2001) Dairy TDN

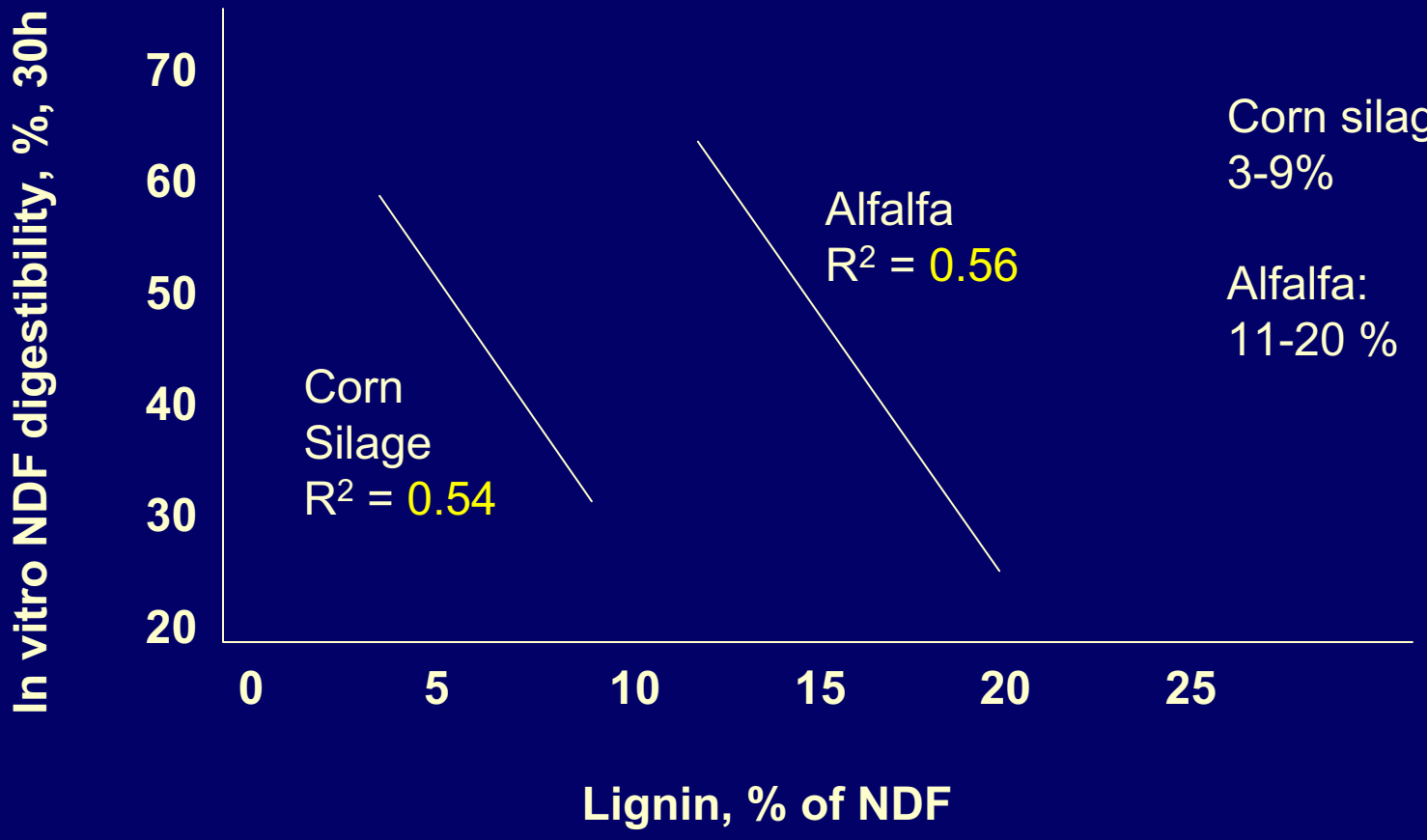
TDN 1-X =

tdCP + (tdFA x 2.25) + tdNDF + tdNFC -7

Why measure NDFD *in vitro* vs. calculating via lignin?

- Lignin wet chem assay difficult & its calibration with NIRS has been poor
- Lignin to NDFD equation is theoretically based
- Lignin explains only about half of the *in vitro* NDFD variation
  - Stover NDF & lignin contents ↑ & NDFD ↓ with maturity, while WP NDF & lignin contents are constant or ↓ as grain% increases

Relationship between lignified NDF and *in vitro* NDFD for corn & alfalfa forages



Corn silage:
3-9%

Alfalfa:
11-20 %

Allen, 2003

30-h NDFD (adapted from Allen, 2003) vs. NDF digestibility calculated using NRC-01 lignin equation

Whole-Plant Lignin, % DM	Calculated NDFD	30-h NDFD
2.1	62	60
3.1	57	45
4.2	53	30

Measured NDFD or Estimated from Lignin?

NDF, %	Lignin, %	Calc. NDFD	30-h NDFD
45.0	3.52	56	46.0
45.0	3.26	57	48.4
45.0	3.32	57	54.4
45.1	3.18	57	55.0
45.0	3.43	56	67.3

- Corn silage data set from Van Amburgh (2004)
- Similar relationships from 36.5 to 51.8% NDF

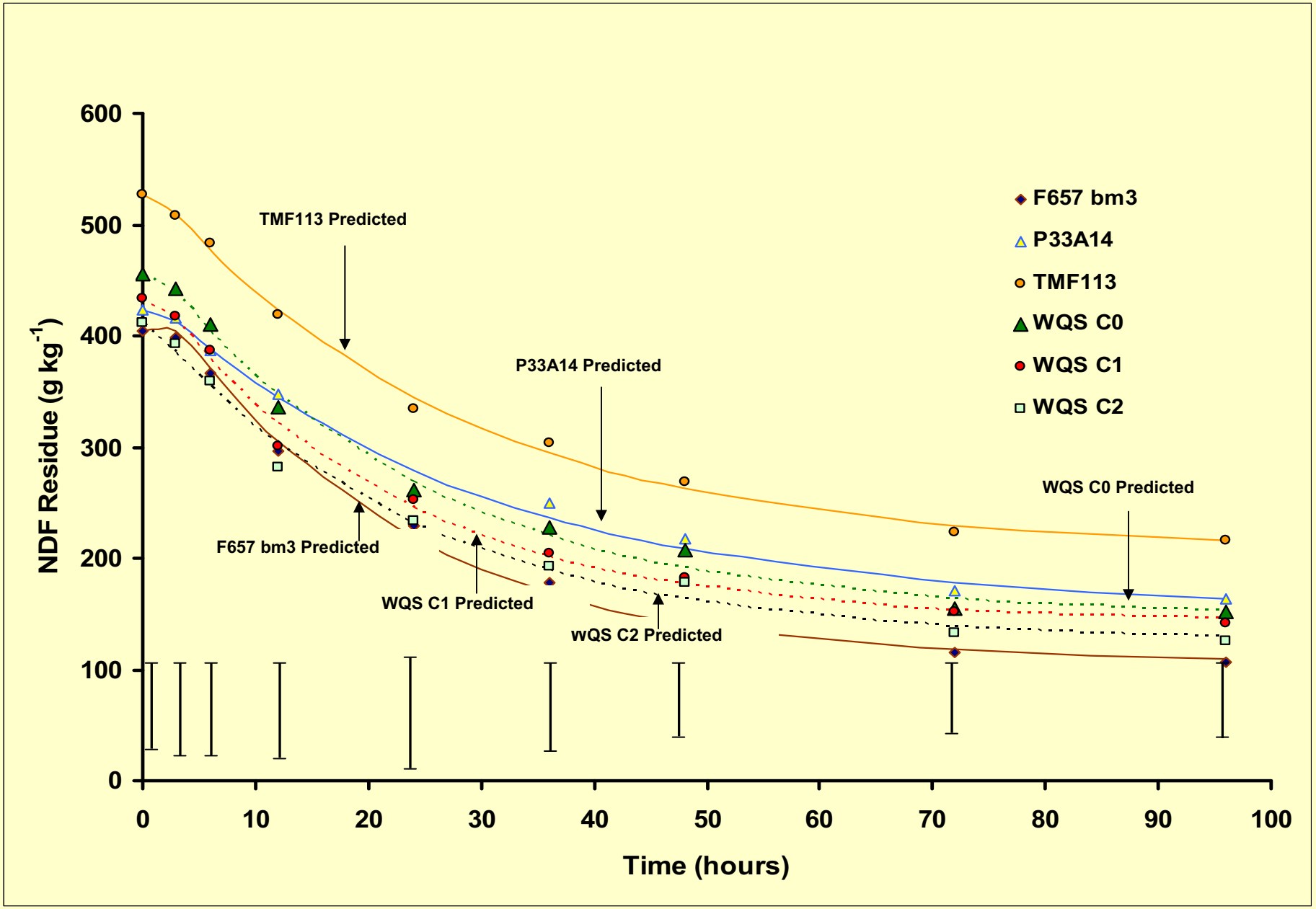
Adapted from: Rick Grant, NRAES Silage Conf., 2006

The incubation time-point debate

- 48-hr.
  - Reflects maintenance intake for use in NRC summative equation
  - Less influenced by lag & rate, so possibly lower COV
- 30- or 24-hr.
  - 30-h more closely related to ruminal retention time
  - 30-h was used in most cow trials
  - Faster lab turn-around
  - Better lab efficiency at 24-h?

The incubation time-point debate

- MILK2000
  - 48-h
- MILK2006
  - 48-h default, with 30-h or 24-h User Defined Option
  - Lab average NDFD required
    - NDFD DMIadjustment = (avg. NDFD – NDFD) * 0.26
    - NDFD adjustment for summative TDN_{1x} equation



Adapted from Coors (data from Justen, 2004).

Variation in “normal “ corn silage NDF digestibility calculated using NRC-01 lignin equation and table data

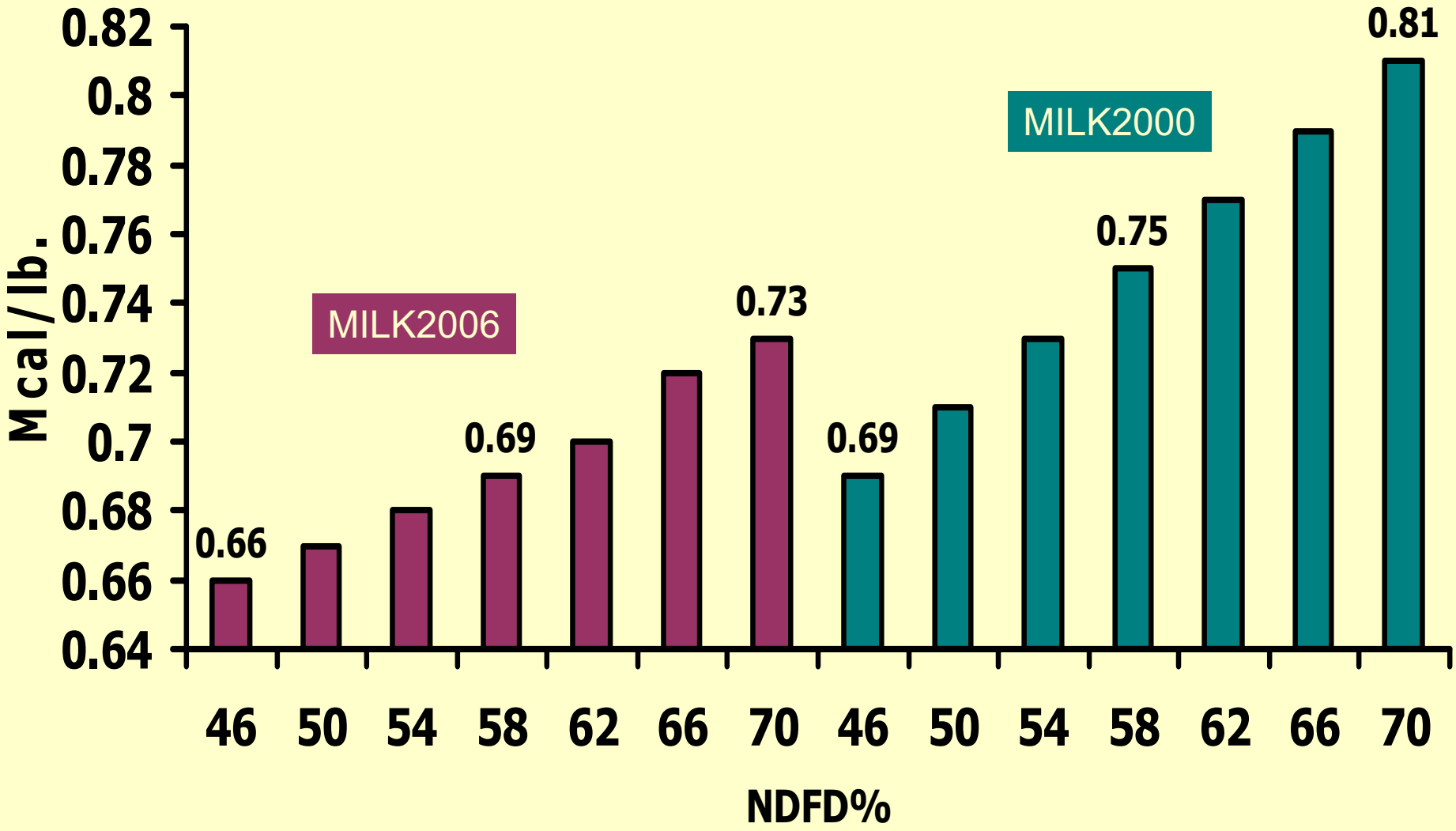
Whole-Plant Lignin, % DM	Calculated NDFD
1.0 (2stdev)	65
1.8 (1stdev)	61
2.6 (avg.)	59
3.4 (1 stdev)	56
4.2 (2stdev)	56

NDFD -- MILK2000 vs. MILK2006

- MILK2000
  - A 1%-unit change in NDFD from lab average NDFD changes DMI 0.37 lb (Oba and Allen, 1999, JDS)
  - Double counting of TDN & DMI changes related to changes in NDFD
    - Tine et al. (2001, JDS) and Oba and Allen (1999, JDS)
      - At production levels of intake, NDFD has minimal impact on NE_L content but does impact NE_L intake primarily thru its impact on DMI
  - Calculation of $NE_{L\text{-}3x}$ from TDN_{1x} as per NRC (1989)
- MILK2006
  - A 1%-unit change in NDFD from lab average NDFD changes DMI 0.26 lb (Jung, 2004, MN Nutr. Conf.; Oba and Allen, 2005, Tri-State Nutr. Conf.)
  - NDFD used for calculating $NE_{L\text{-}3x}$ adjusted for impact of NDFD on DMI (Oba and Allen, JDS, 1999)
  - Calculation of $NE_{L\text{-}3x}$ from TDN_{1x} via DE and ME as per NRC (2001)

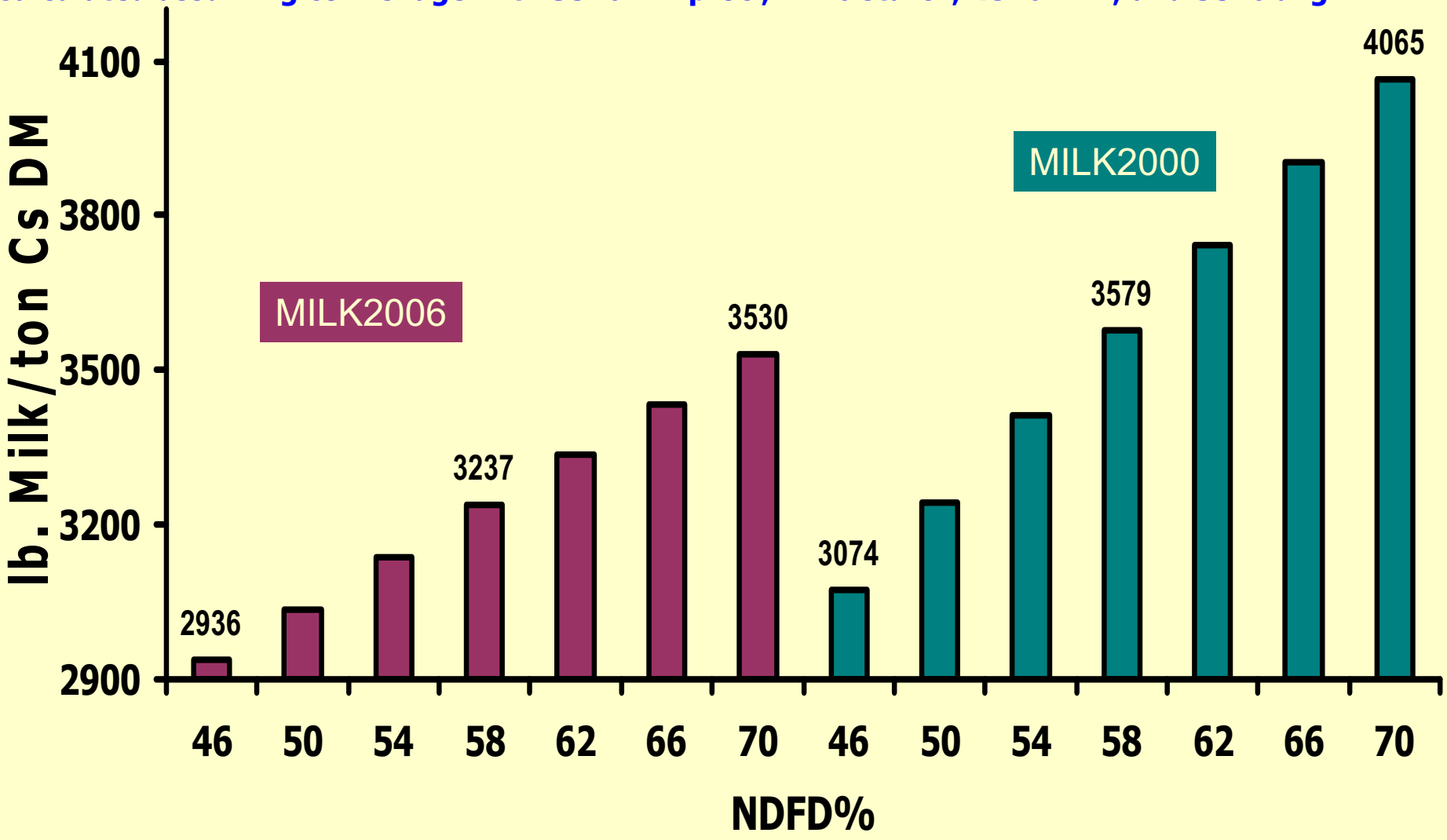
Corn Silage NDFD% vs. NE_{L3x}

Calculated assuming corn silage with 35% DM proc., 27% starch, 45% NDF, and 58% avg. NDFD



Corn Silage NDFD% vs. Milk per Ton

Calculated assuming corn silage with 35% DM proc., 27% starch, 45% NDF, and 58% avg. NDFD



NRC (2001) Dairy TDN

TDN 1-X =

tdCP + (tdFA x 2.25) + tdNDF + tdNFC -7

NRC (2001) Dairy TDN

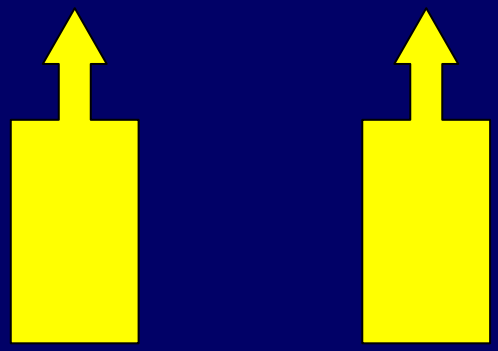
tdNFC* = *NFC% x 0.98 x PAF

	PAF
Corn grain, ground dry	1.00
Corn grain, ground high moisture	1.04
Corn silage, normal	0.94
Corn silage, mature	0.87

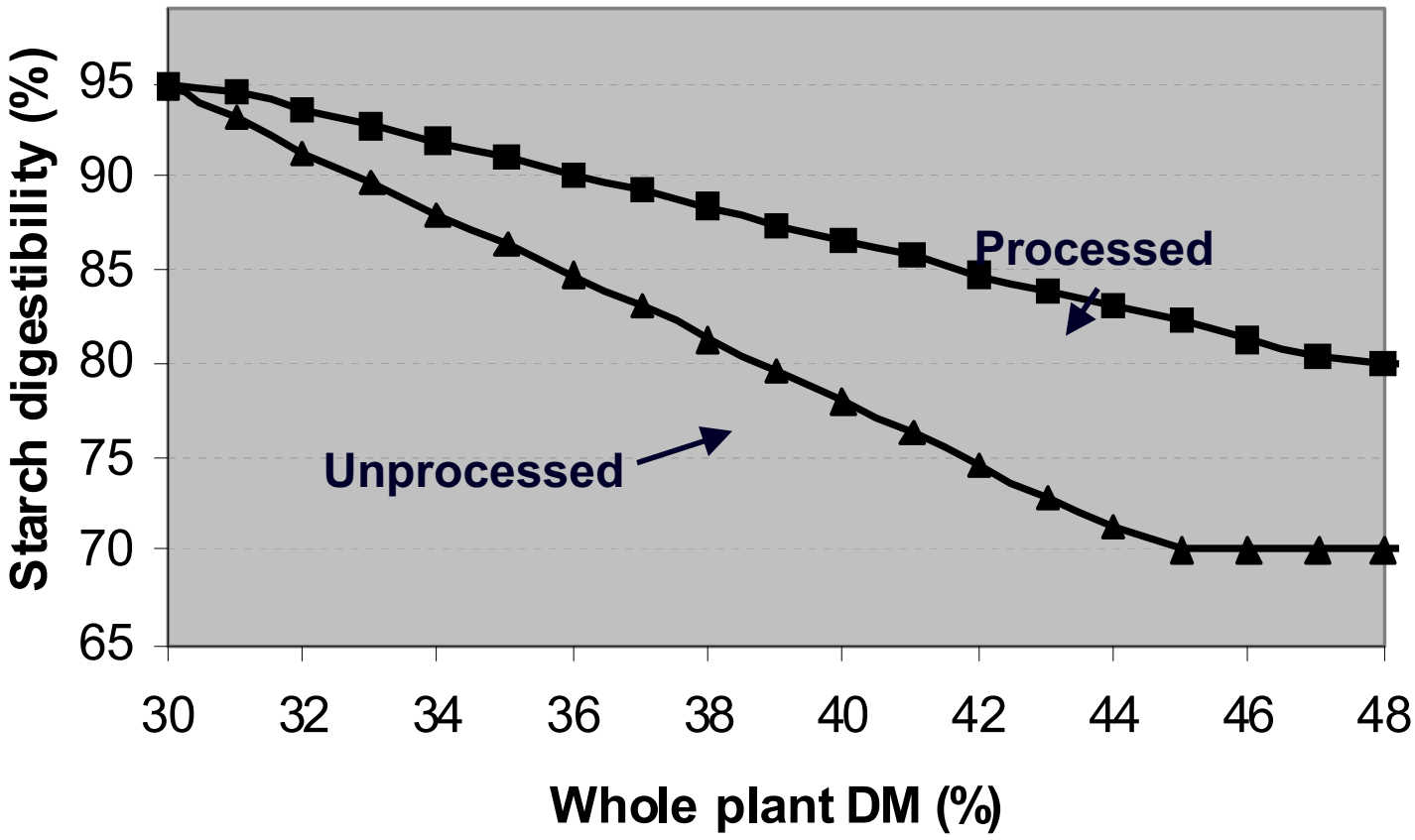
Schwab-Shaver Energy Equation

$$TDN_{1\text{-}x} =$$

$$DIG_{CP} + DIG_{FA} + DIG_{Starch} + DIG_{NSTNFC} + DIG_{NDF} - 7$$



Predicted Starch Digestibility



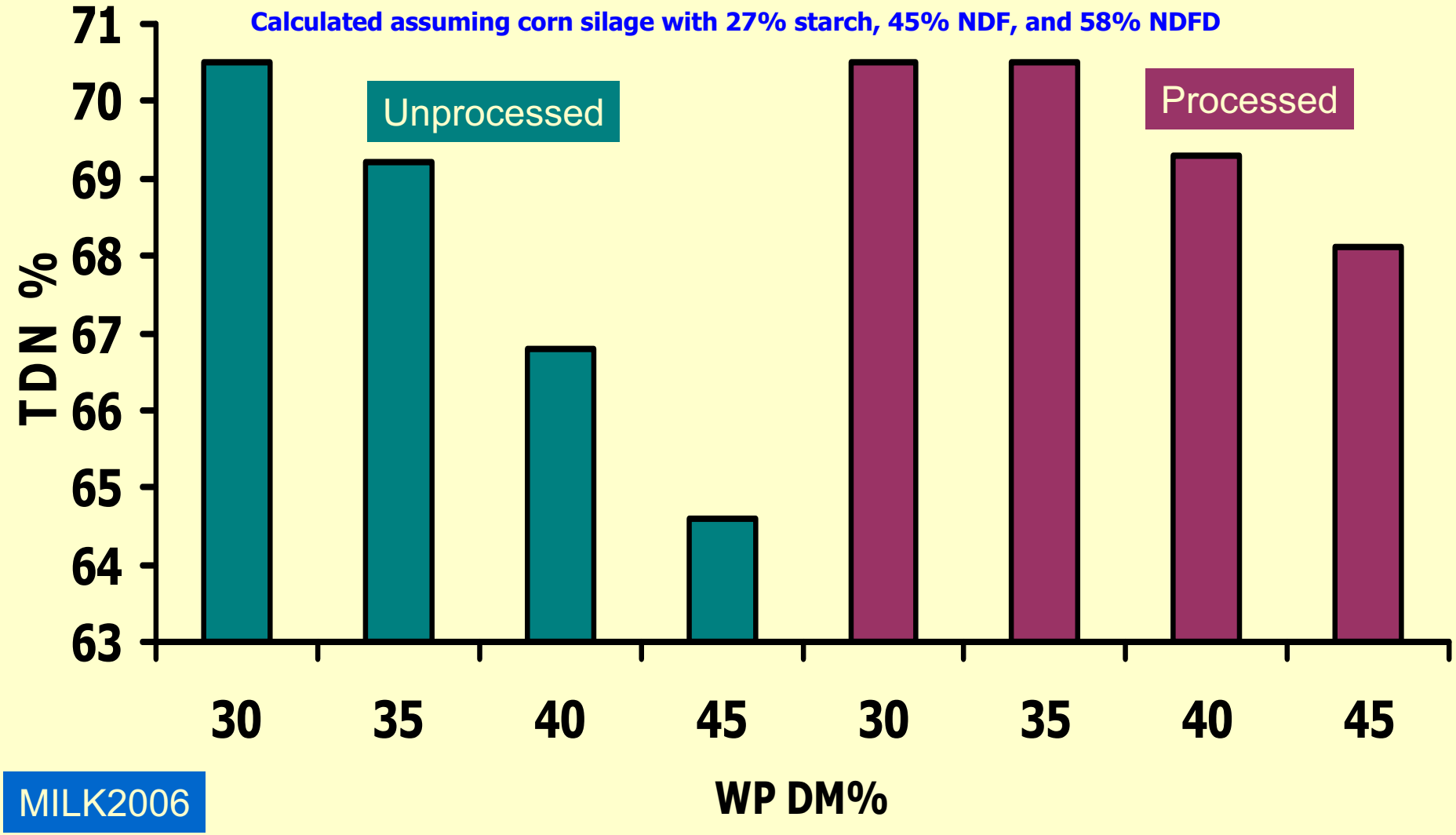
Adapted from Schwab et al., 2003.

Differences in calculation of *tdNFC*

Based on corn silage with 41% NFC & 28% starch

WP DM %	NRC-01 *tdNFC%*	Schwab et al., 2003 *tdStarch&NSTNFC%*	
		Unprocessed	Processed
30	40	40	40
35	38	39	40
40	35	36	39
45	35	34	38

Corn Silage WP DM% vs. TDN_{1x}



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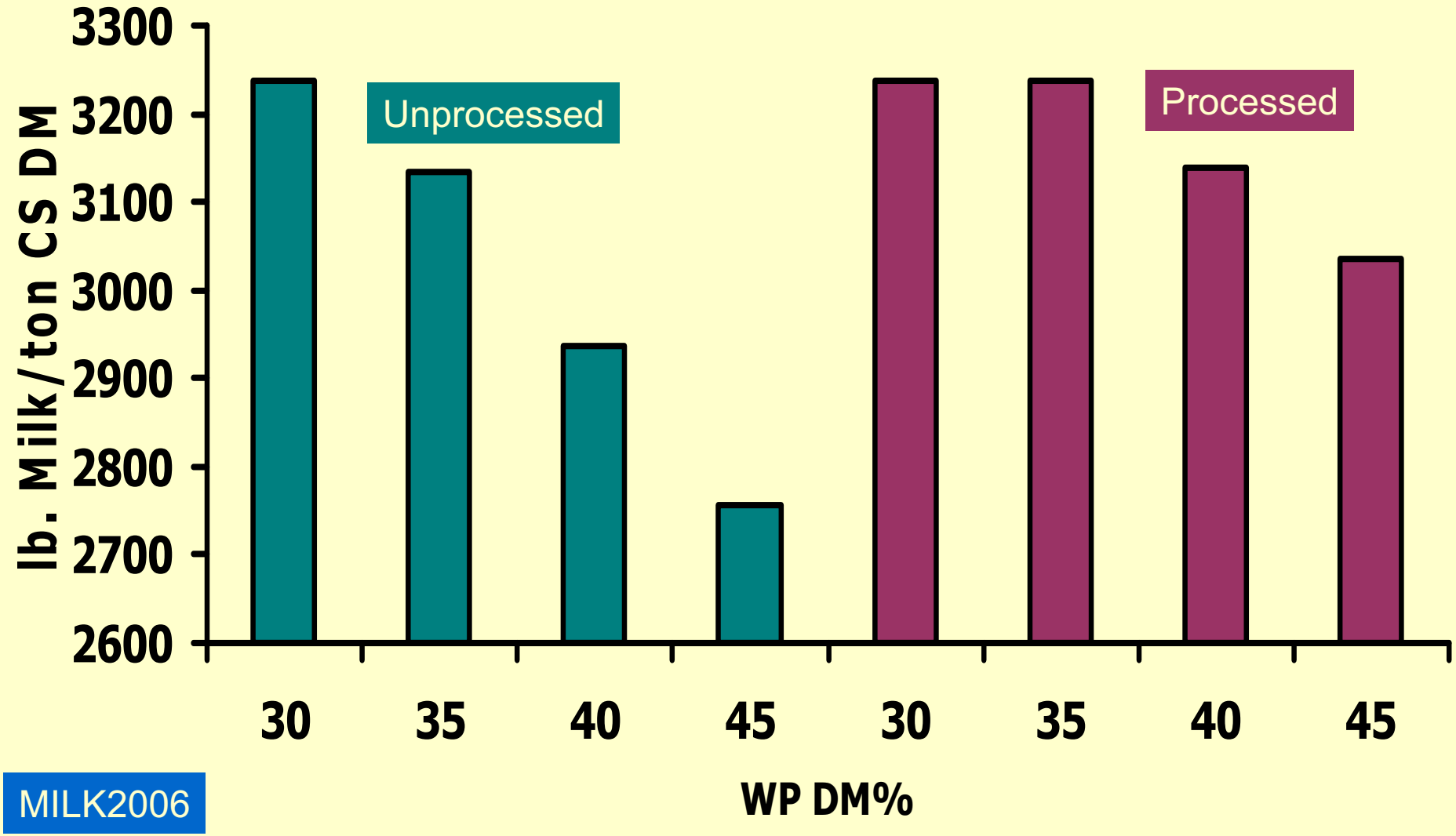
Corn Silage WP DM% vs. Milk per Ton

Calculated assuming corn silage with 27% starch, 45% NDF, and 58% NDFD



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Evaluating Starch Digestion in Ruminants……

In Vivo…… Total Tract Collections & Digesta Markers
Cannulae (Rumen, Duodenum, Ileum)

Macro In Situ…. Rumen cannulae
Incubation time?
Starch-Feeds cannot be fine ground
Post-Ruminal Enzymatic?

In Vitro…. Rumen fluid
Incubation time ?
Starch-Feeds cannot be fine ground
Post-Ruminal Enzymatic?

Corn Silage Processing Score

Mertens, USDFRC & Dairyland Labs, Arcadia, WI

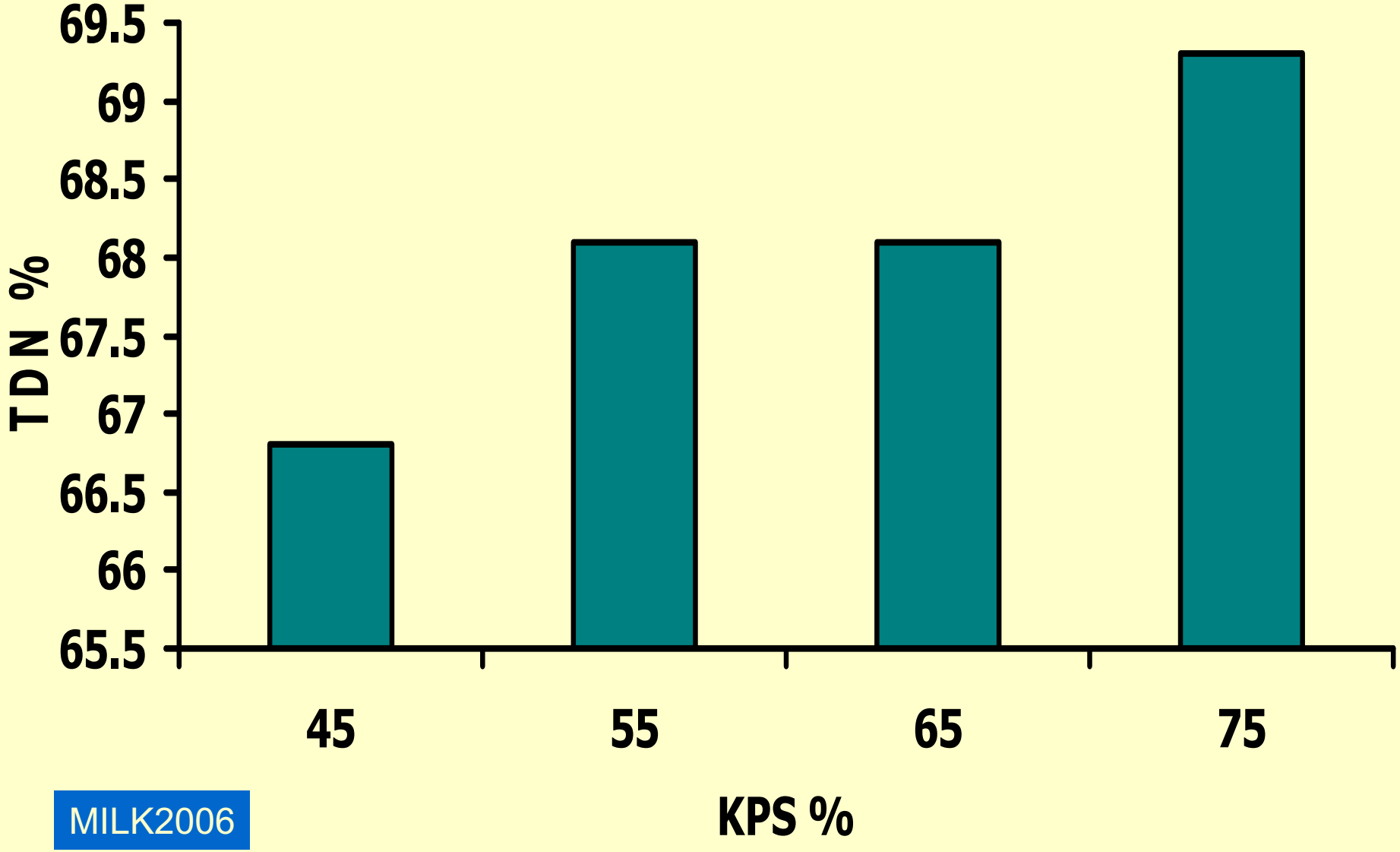
- Ro-Tap Shaker
  - 9 sieves (0.6 thru 19 mm) and pan
  - Analyze for starch on 4.75 mm & greater sieves

% of starch passing 4.75 mm sieve	CSPS
>70%	Optimum
70% to 50%	Average
< 50%	Poor

Kernels and Large Fragments Were Retained on > 4.75-mm Sieves

Corn Silage KPS vs. TDN_{1x}

Calculated assuming corn silage with 40% DM 27% starch, 45% NDF, and 58% NDFD



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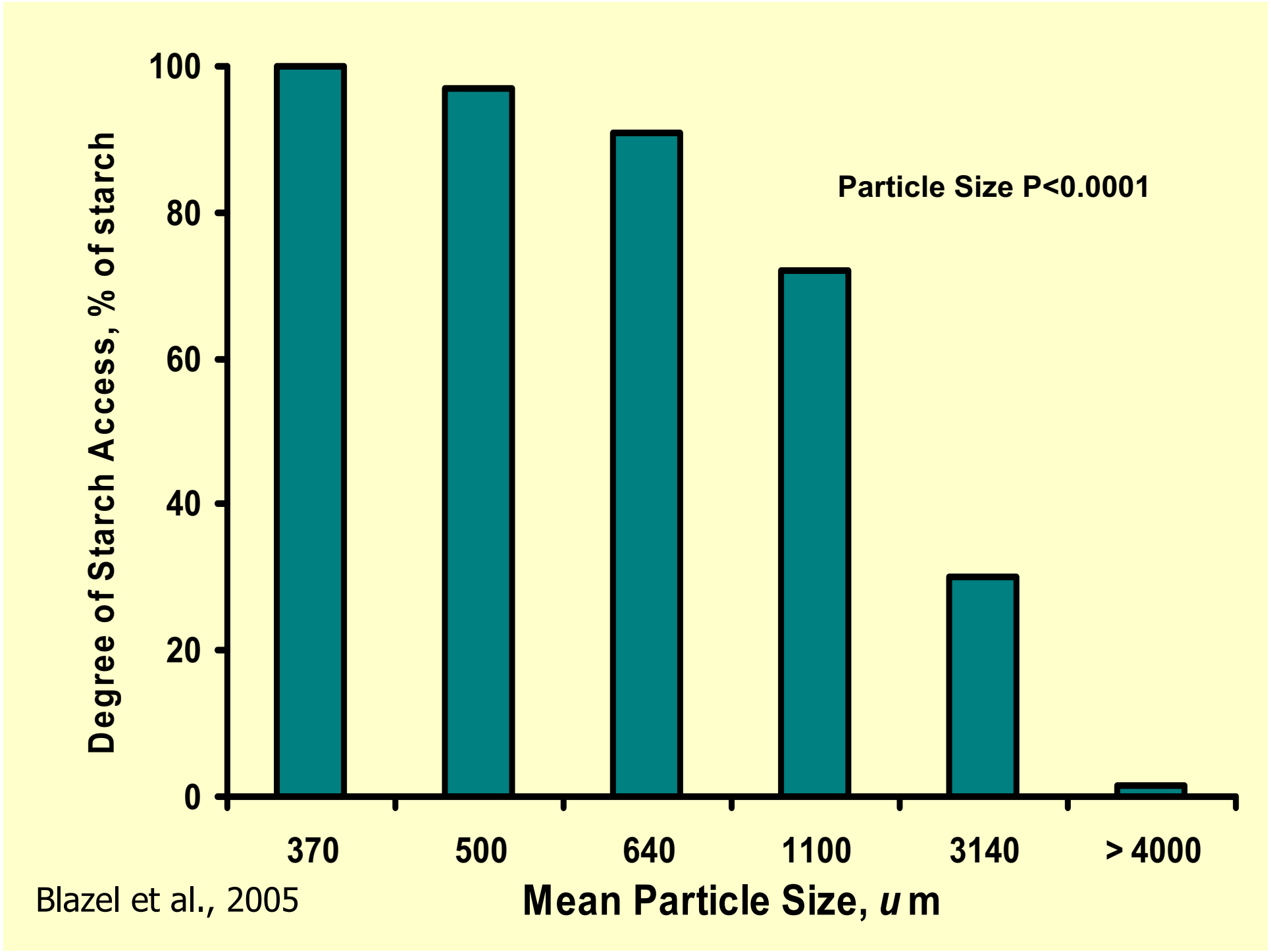
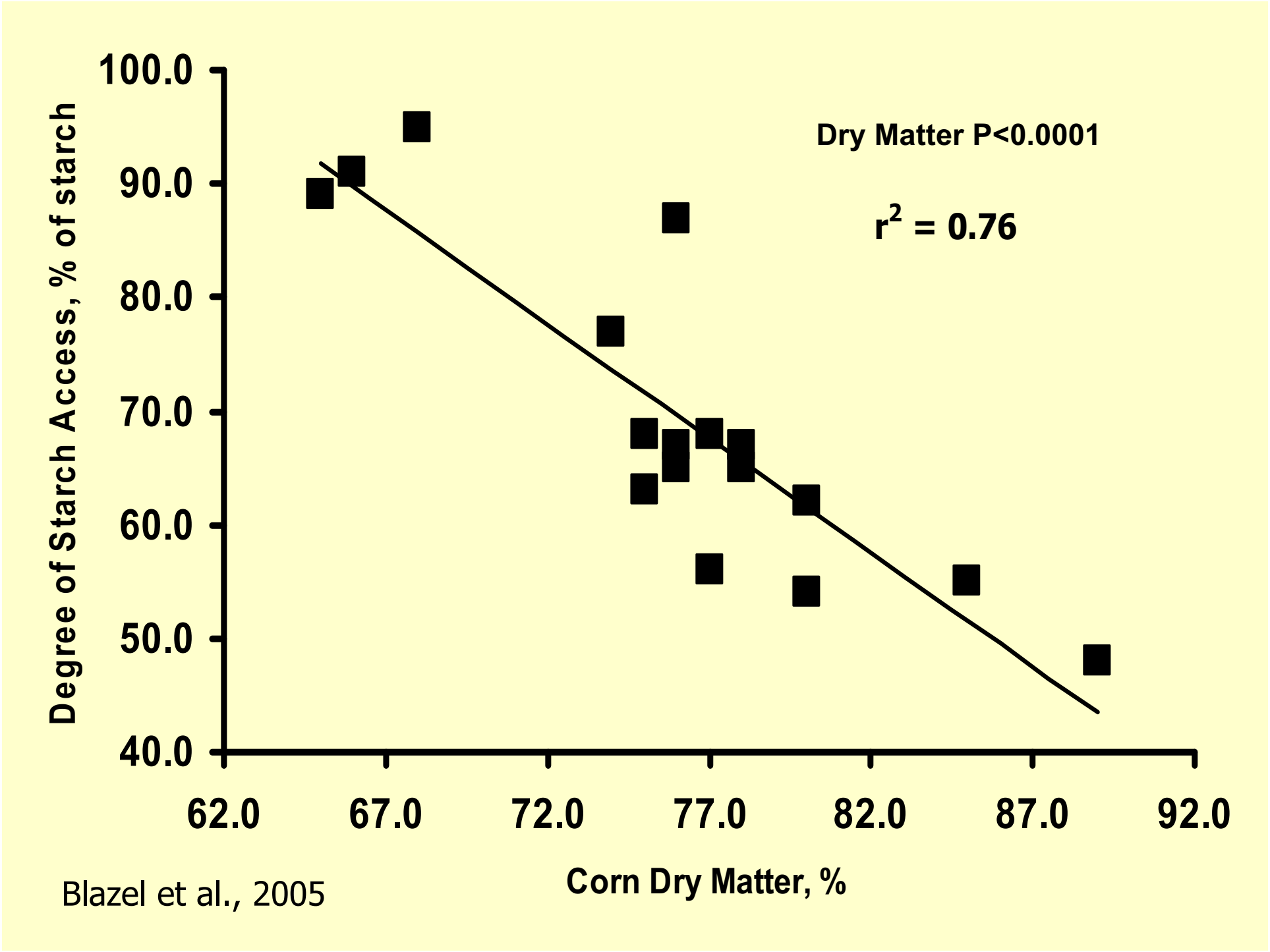
Degree of Starch Access (DSA)
Blasel, Hoffman and Shaver, JAFST, 2006

- Adaptation of food industry assay "Degree of Starch Gelatinization"
- Detects particle size, moisture, and vitreousness differences in corn samples
- Appears to offer better characterization of processed corn silage samples than KPS
- DSA can be related to total tract starch digestion
  - More animal validation data needed
- Pilot study of assay across labs in progress



Blazel et al., 2005



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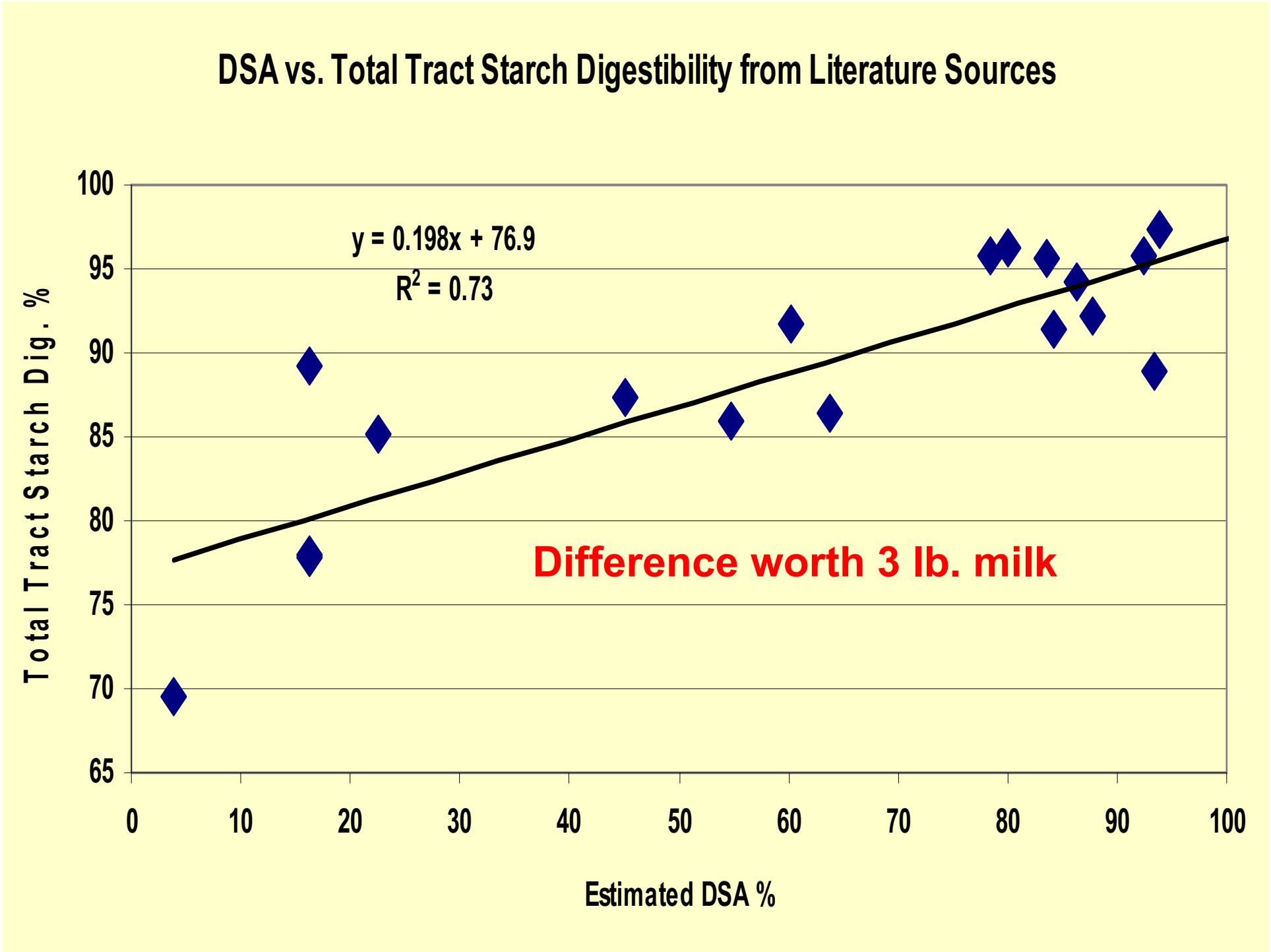
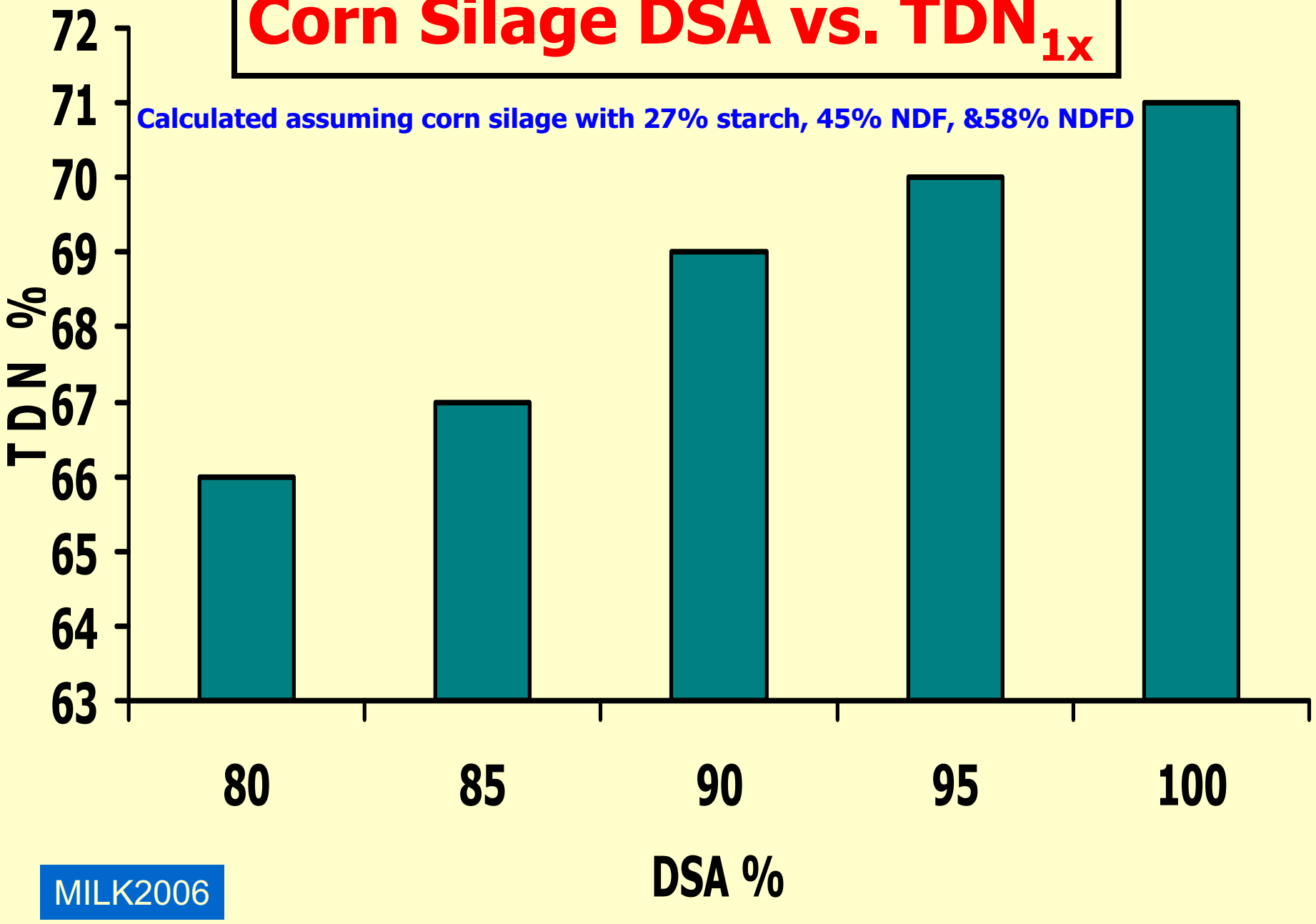

DSA vs. Total Tract Starch Digestibility from Literature Sources
y = 0.198x + 76.9
R2 = 0.73
Difference worth 3 lb. milk
Total Tract Starch Dig. %
Estimated DSA %
100
95
90
85
80
75
70
65
0
10
20
30
40
50
60
70
80
90
100

Corn Silage DSA vs. TDN_{1x}

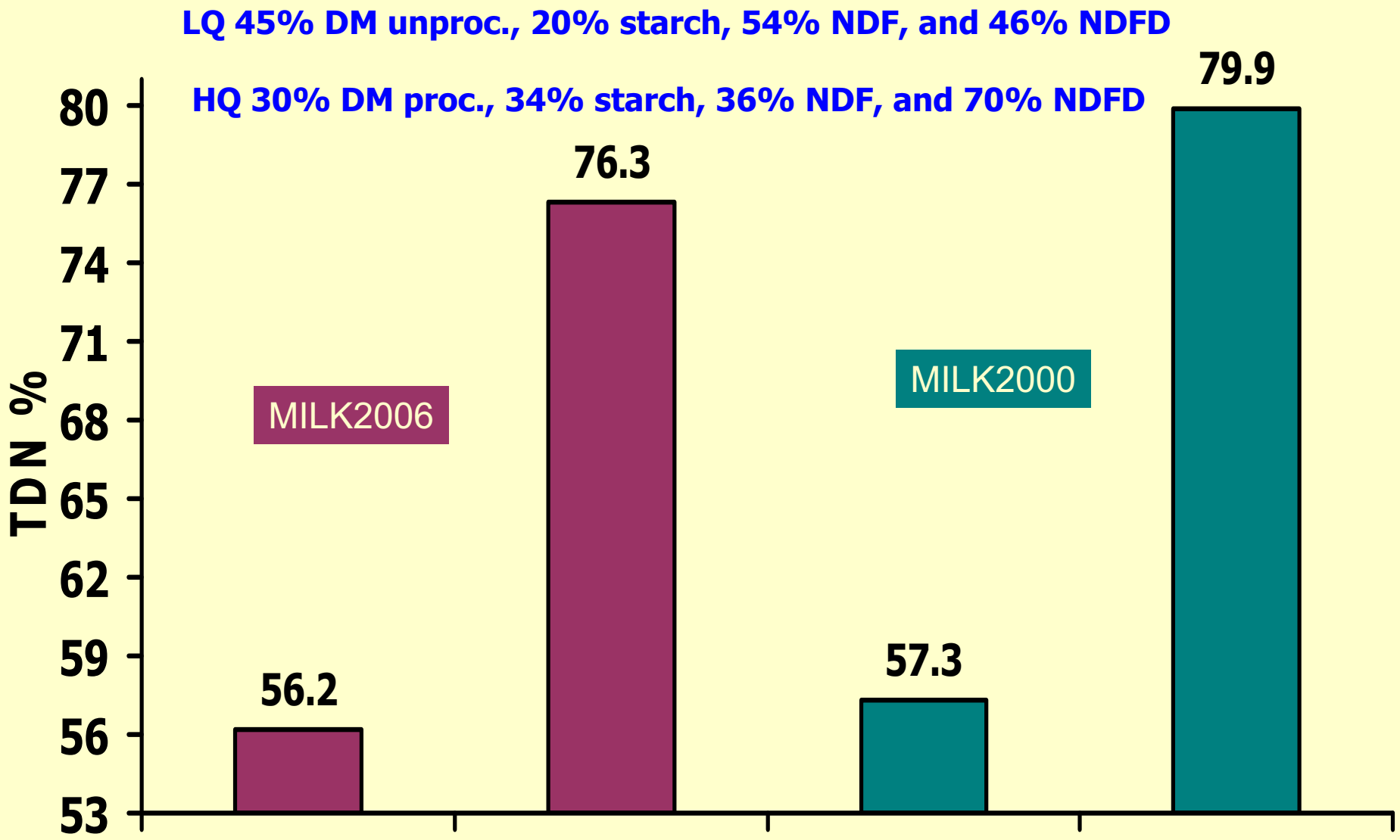


MILK2006

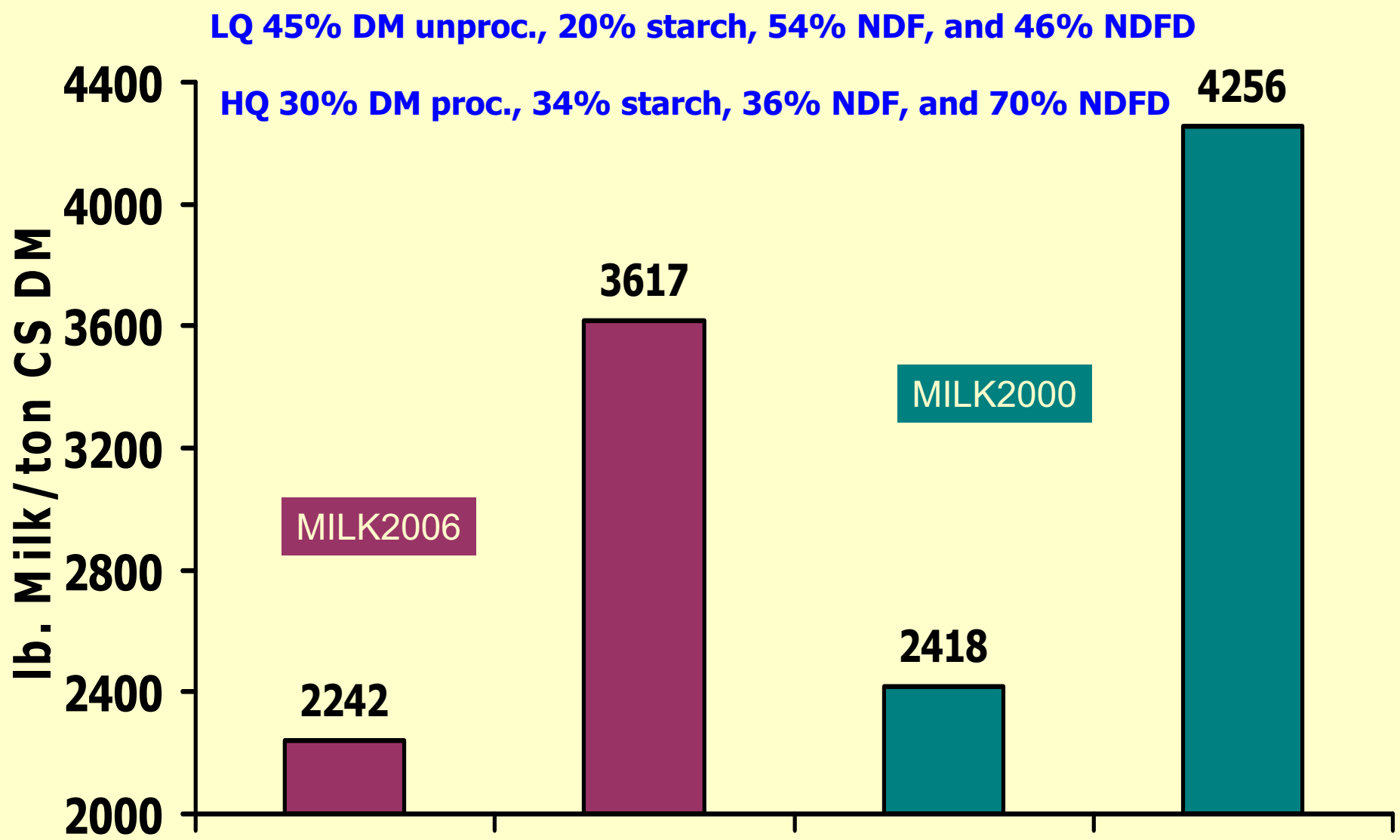
MILK2006: Starch Digestion User Defined Options

- Default
  - WP DM & Kernel Processing Regressions
- KPS
- DSA
- Ruminal in situ plus post-ruminal in vitro

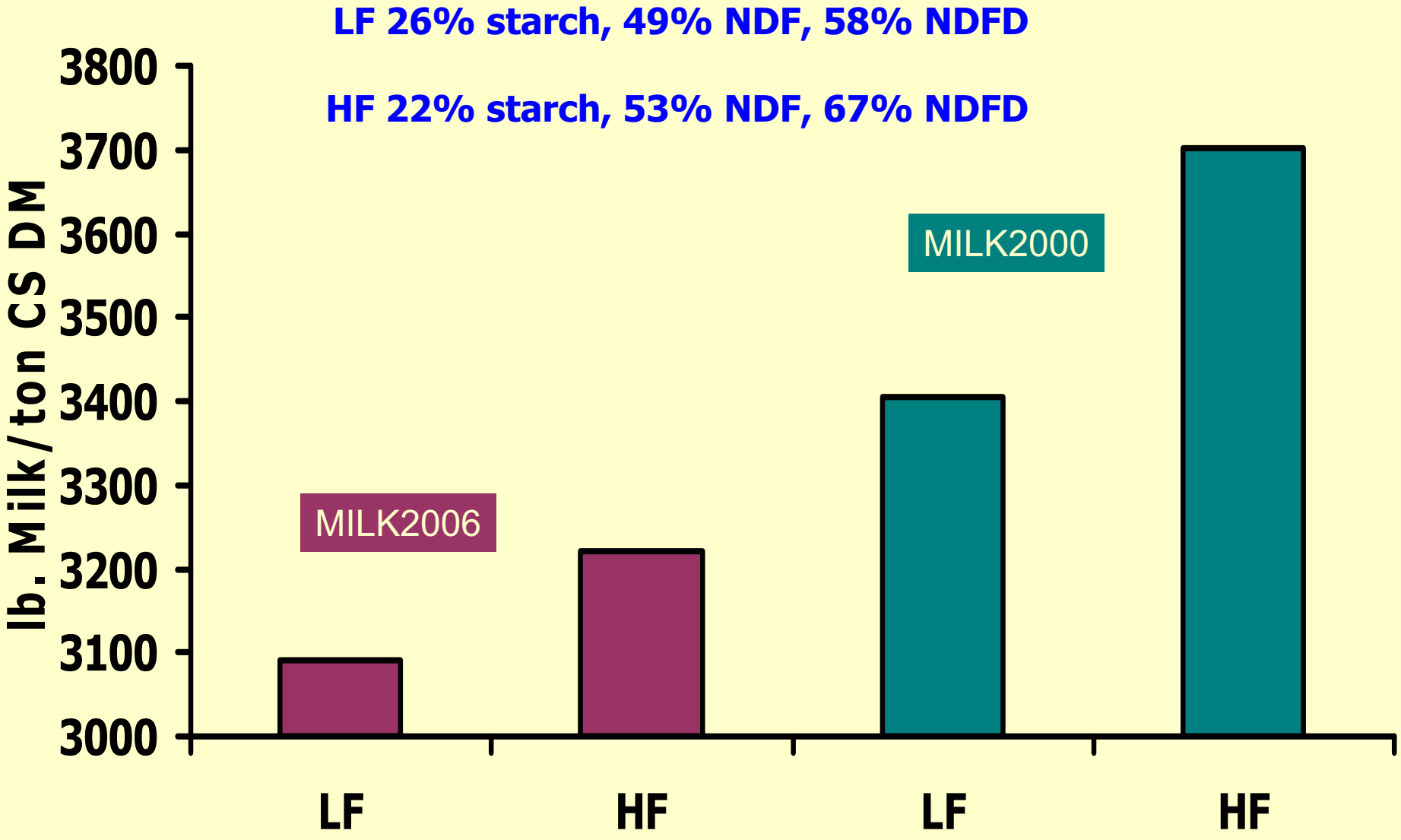
TDN_{1x} Simulation -- Input Extremes



Milk per Ton Simulation -- Input Extremes



Milk per Ton -- High NDF, NDFD vs. Low NDF, NDFD
Ivan et al., JDS, 2005



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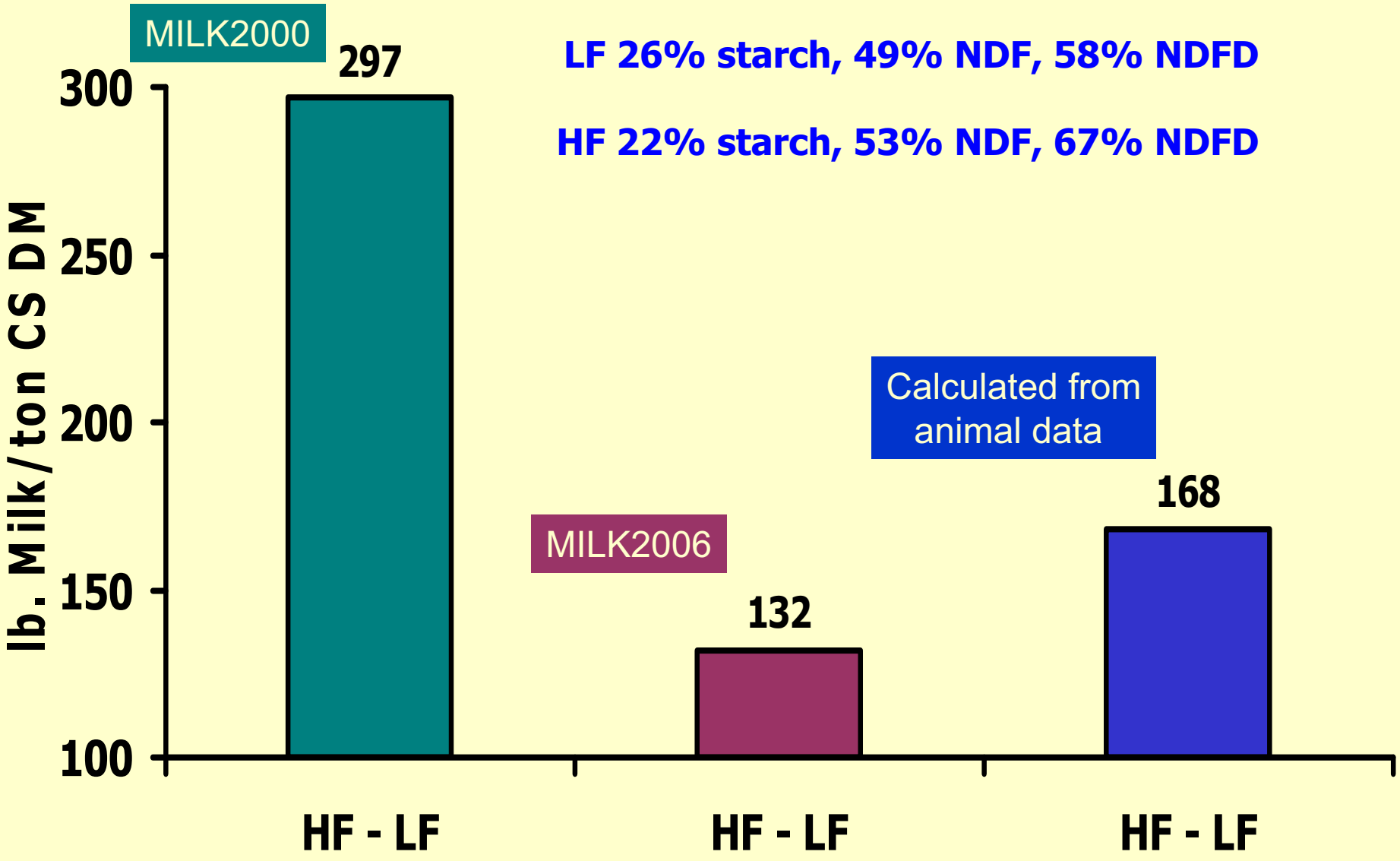
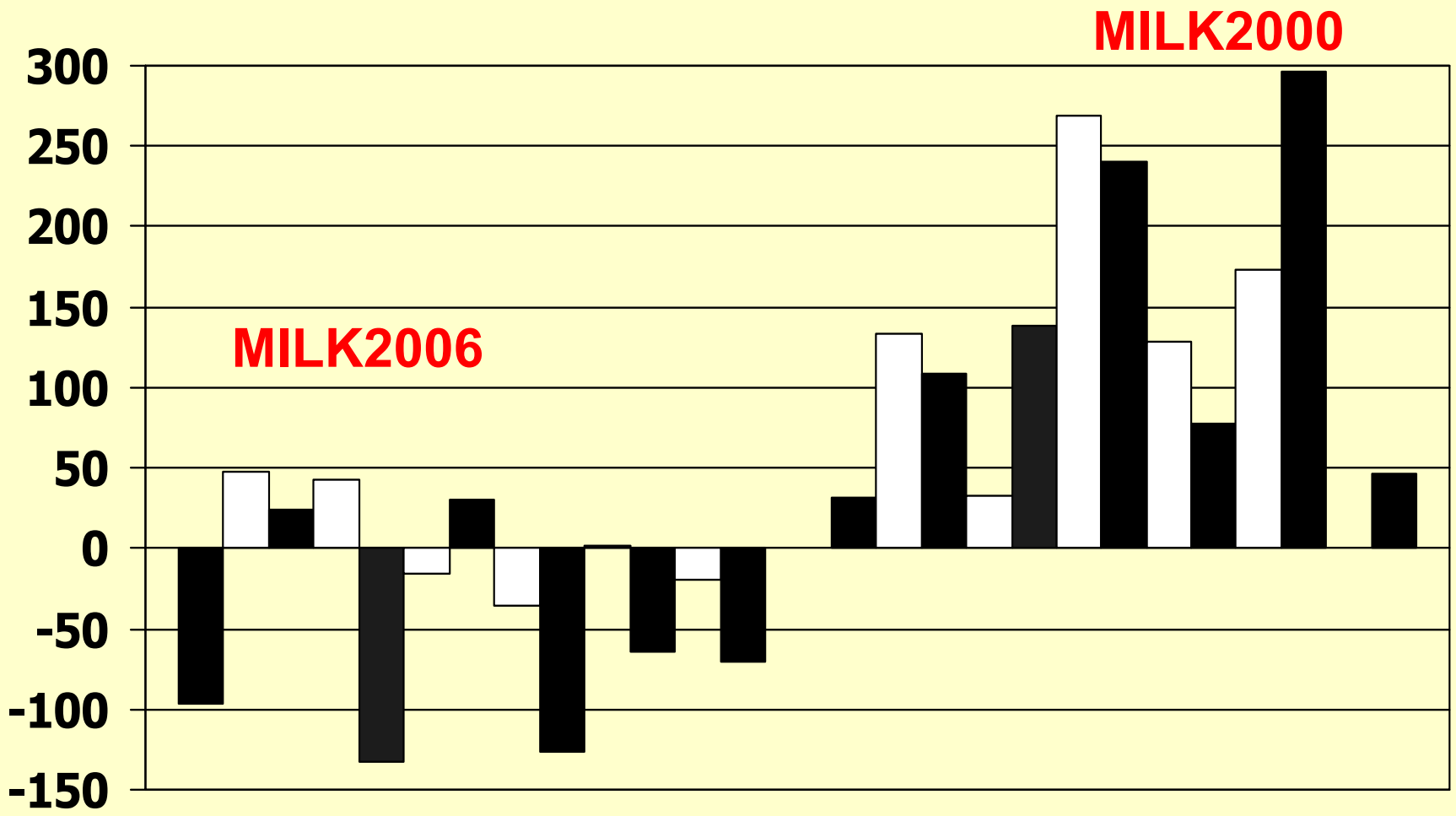
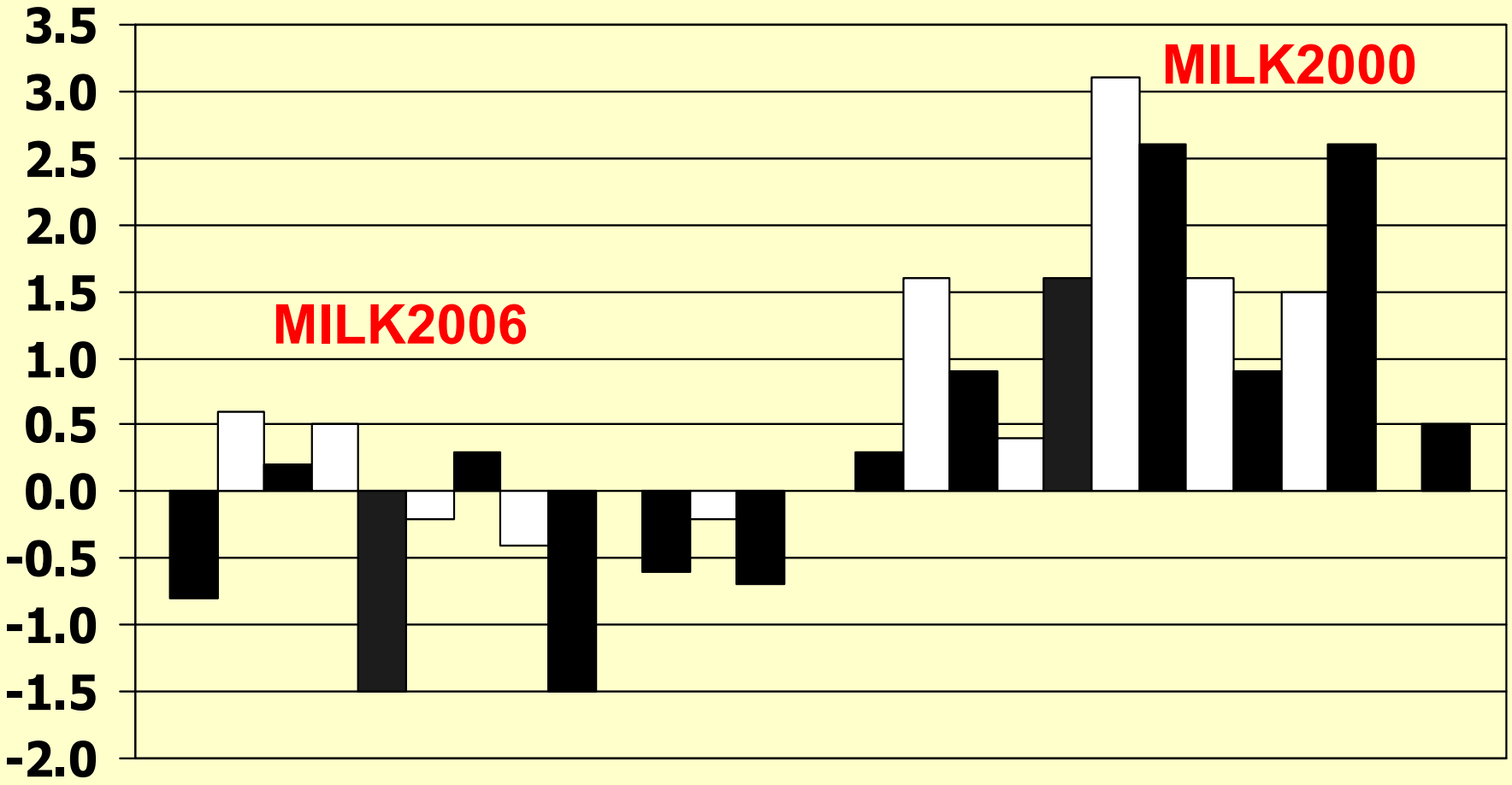


Treatment differences for model-predicted milk per ton versus milk per ton from in vivo data



Calculated from 10 JDS papers with 13 comparisons

Treatment differences for model-predicted milk per day versus milk per day in vivo data



Calculated from 10 JDS papers with 13 comparisons

UW Correlations

n = 3727 treatment means

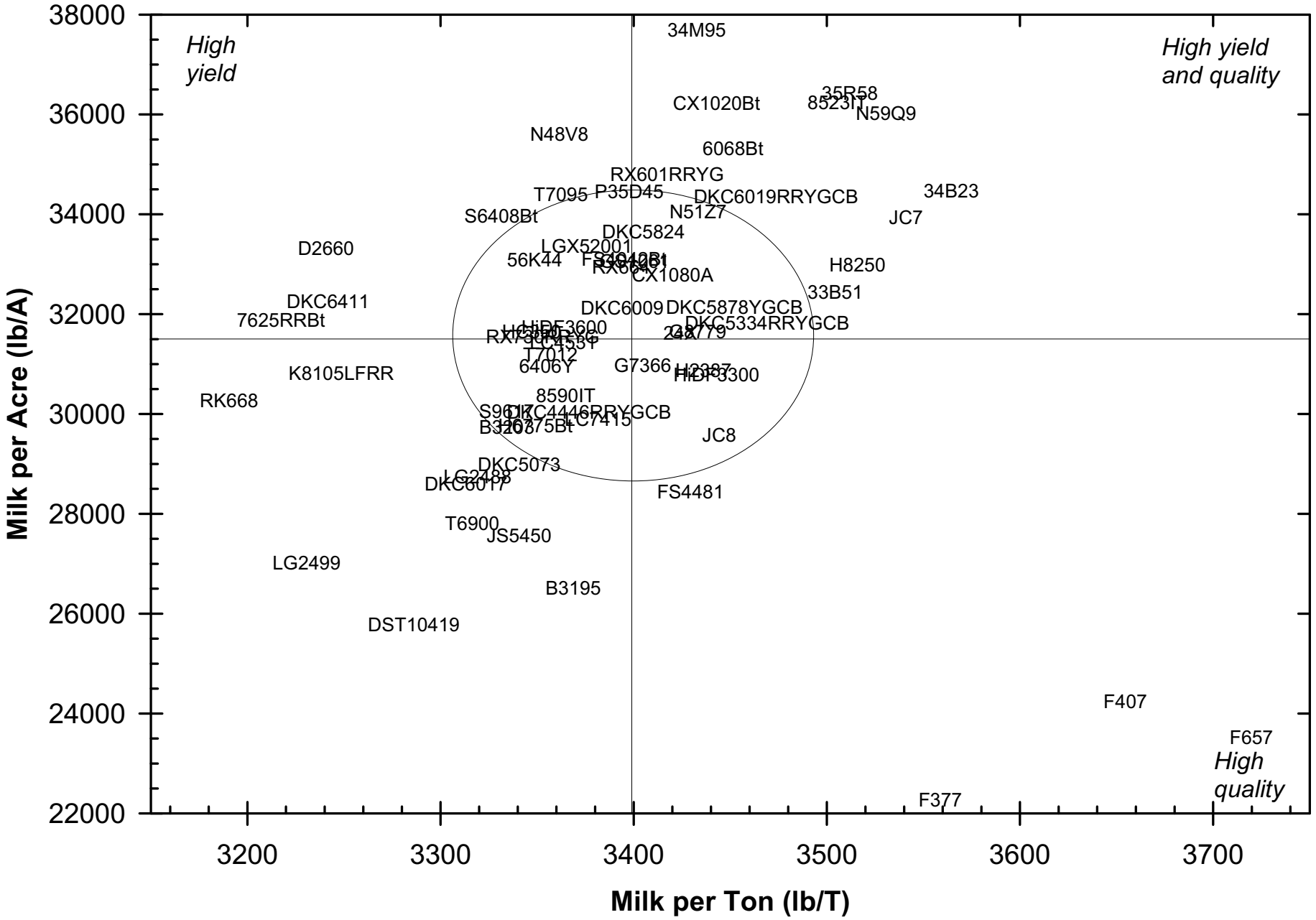
r-values	Milk per Ton DM 2006	Milk per Ton DM 2000	Milk per Ton DM 1995	Milk per Ton DM 1991
NDF	-0.46	-0.40	-0.94	-0.99
Starch	0.48	0.44	0.75	0.74
NDFD	0.49	0.70	0.16	-0.10
StarchD	0.30	0.21	-0.25	-0.27

UW Correlations

n = 3727 treatment means

r-values	Milk per Acre 2006	Milk per Acre 2000	Milk per Acre 1995	Milk per Acre 1991
DM Yield tons/acre	0.97	0.97	0.88	0.85
Milk per Ton DM	0.23	0.20	0.52	0.61

Relationship between milk per acre and milk per ton of corn hybrids in South Central WI during 2002.



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