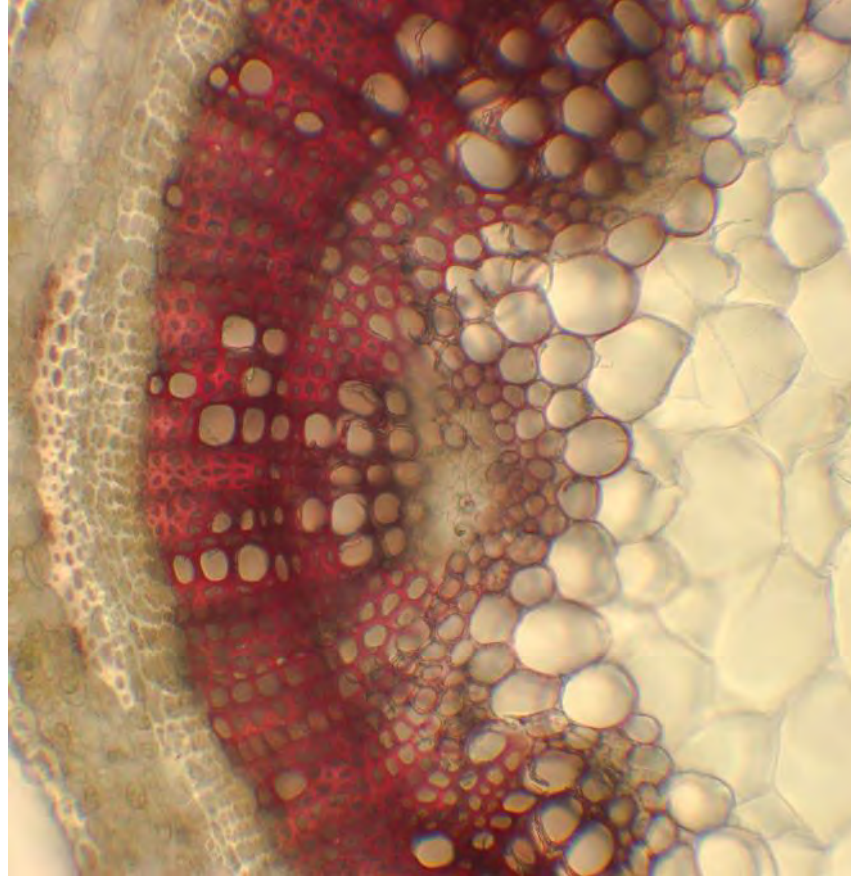




Extended Digestibility Windows Enable a Three-Cut Harvest System in Improved Alfalfa Germplasm

Zhanyou Xu, Cesar A. Medina, Jiahao Fan, Richard Yu, Deborah J. Heuschele, Zhou Zhang, Deborah A. Samac





Project to improve alfalfa stem fiber digestibility through selective breeding



Why improve fiber digestibility?

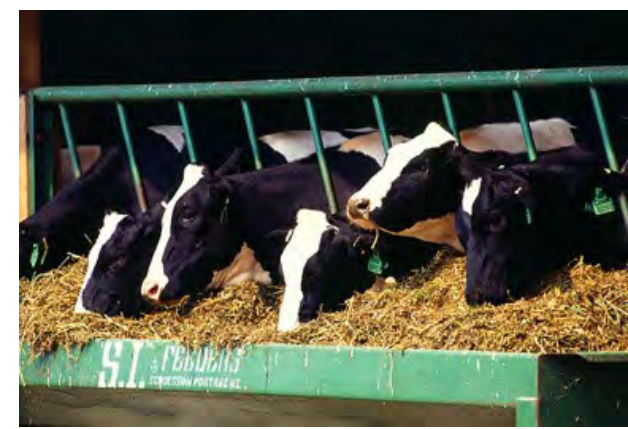
- Increase growth and milk production
- In vitro neutral detergent fiber digestibility (IVNDFD) is a predictor of animal performance

Accomplishments and Impact from Breeding for Increased Forage Nutritional Value

M. D. Casler* and K. P. Vogel

Crop Science 39:12-20, 1999

- 1% increase in IVDMD results in an increase of 3.2% daily gain in beef cattle



Selection scheme

- Selecting for total herbage fiber digestibility or reduced lignin
 - Increases the leaf to stem ratio
- Selection for stem fiber digestibility
 - Is there diversity for stem fiber digestibility in alfalfa germplasm?
 - Is the trait stable over harvests and environments?
 - Is the trait heritable?
 - What gain from selection?
 - Is the trait stable with forage maturity?
 - Is the trait stable in swards vs spaced plants?
 - What traits changed/remain unchanged with selection?
 - Can we use genomic selection to accelerate breeding?



Selection nursery

- Mixture of seeds from six commercial varieties established in 1997
 - 2,000 plants
 - Leaf-stem separation
 - NIRS prediction with wet lab calibration



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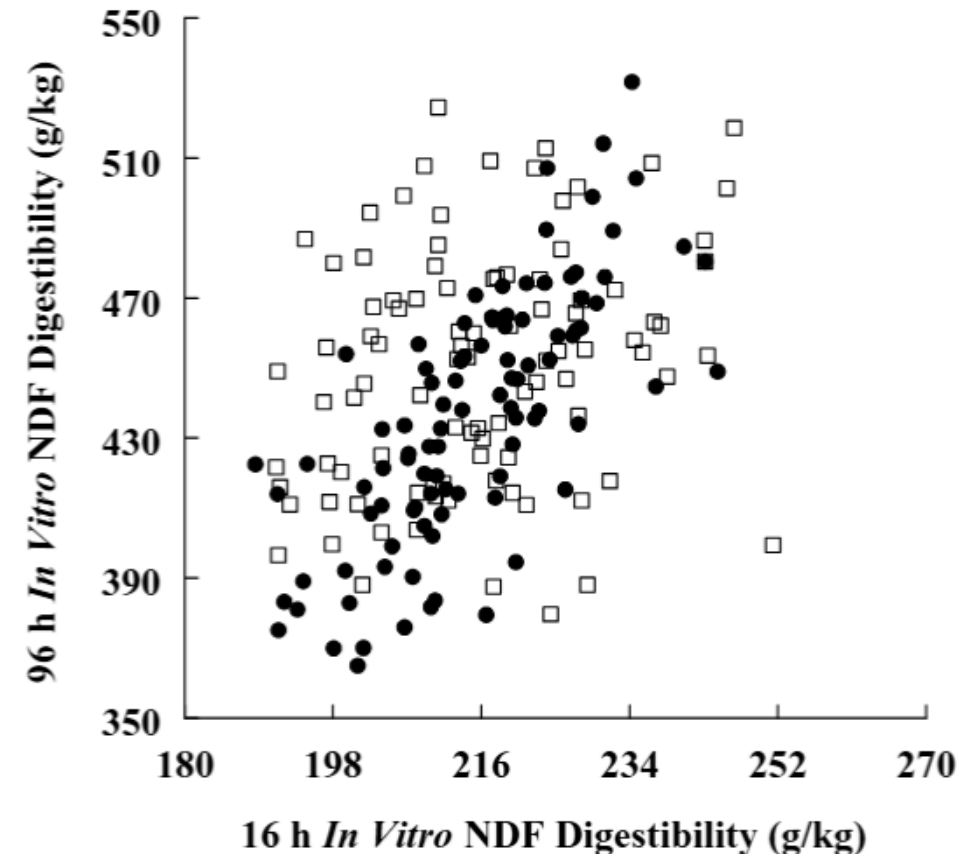
Animal Feed Science and Technology
110 (2003) 17–29

www.elsevier.com/locate/anifeedsci

ANIMAL FEED
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TECHNOLOGY

Identification of lucerne stem cell wall traits related
to in vitro neutral detergent fibre digestibility

Hans-Joachim G. Jung*, JoAnn F.S. Lamb



Traits associated with divergent IVNDFD

- High vs low 16-h IVNDFD (rapid NDF digestion)
 - Lower cell wall concentration
 - Higher pectin
 - Shorter internodes
- High vs low 96-h IVNDFD (potential extent NDF digestion)
 - Lower Klason lignin
 - Longer internodes
- IVNDFD is not a specific biochemical component
 - There are no plant genes for IVNDFD
 - Identify markers and associated genes with biochemical/morphological traits

Two cycles of divergent selection for stem fiber IVNDFD

Cycle 0: 2,000 plants, FD4

H16-h

H96-h

L16-h

L96-h

Cycle 1: 2 production years, 2 locations

H16-h x H 96-h (HxH)

H 16-h x L 96-h (HxL)

L 16-h x H 96-h (LxH)

L 16-h x L 96-h (LxL)

Cycle 2: 2 production years, 2 locations

H16-h

H96-h

L16-h

L96-h

H16-h x H 96-h (HxH)

H 16-h x L 96-h (HxL)

L 16-h x H 96-h (LxH)

L 16-h x L 96-h (LxL)

16 plants/plot

Harvested at early bud, late flower, green pod

Leaf:stem separated

NIRS for forage quality traits



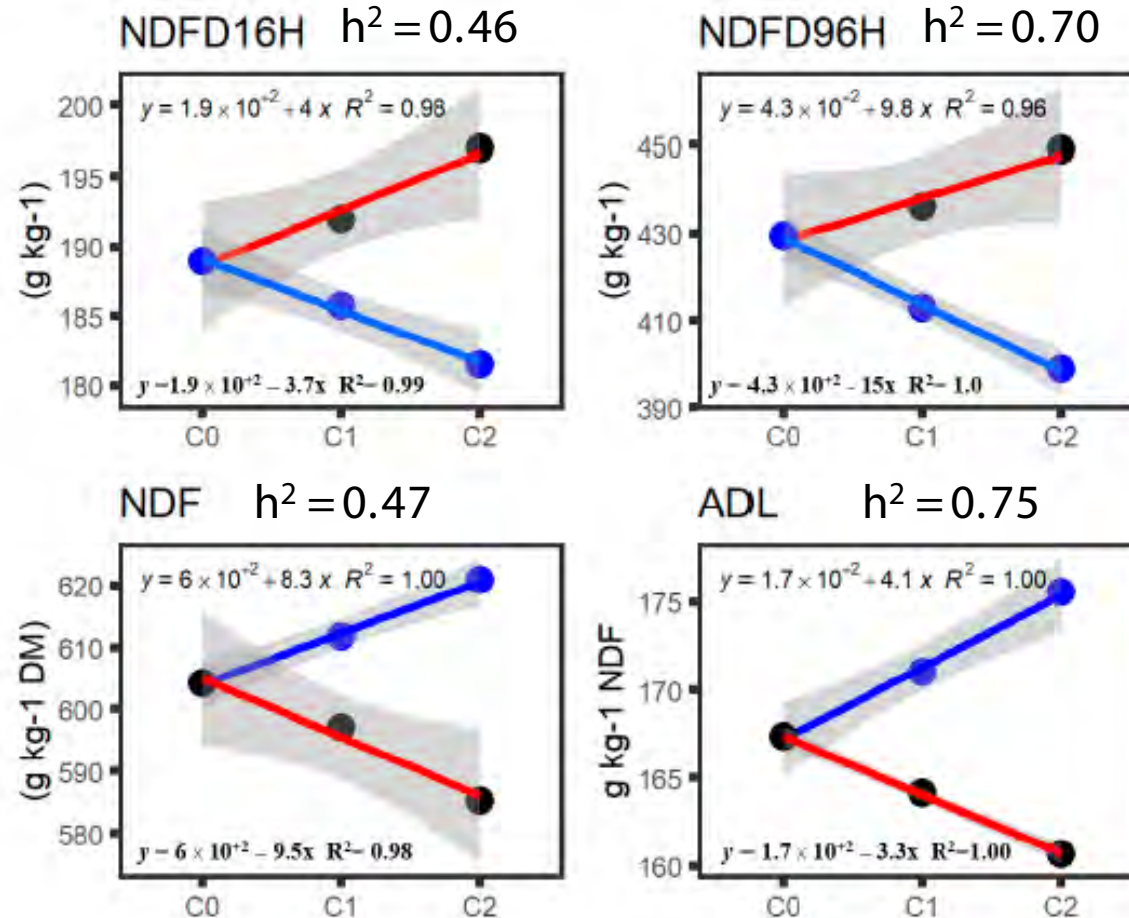
Gain from divergent selection



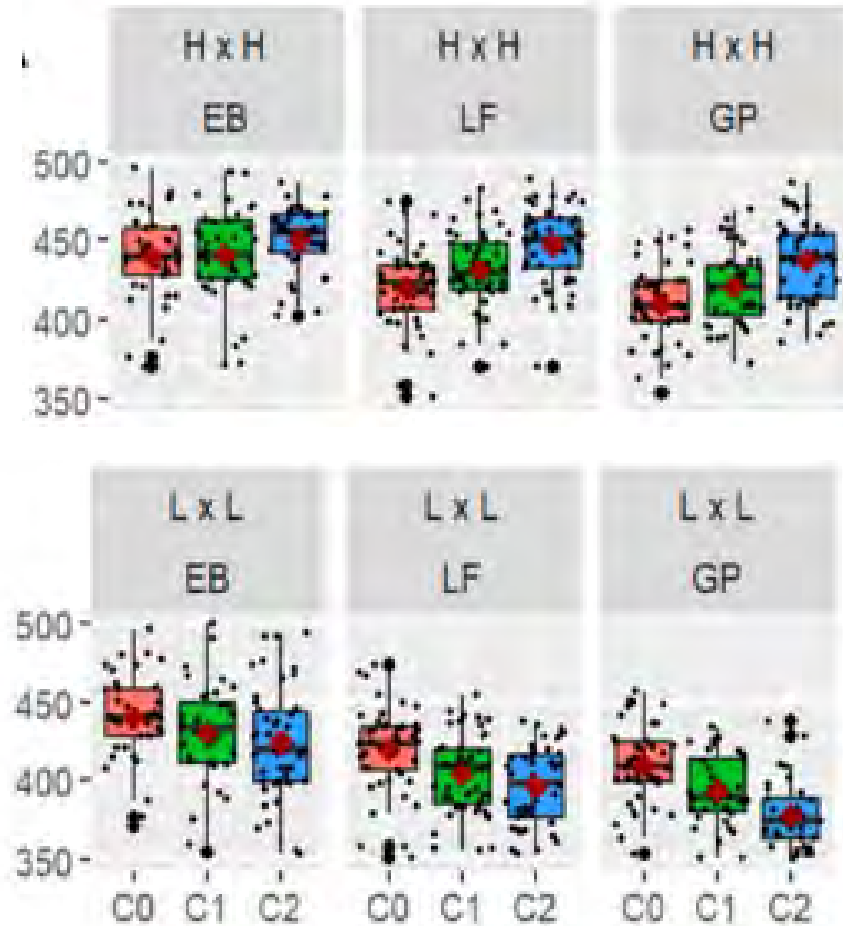
Article

Improved Forage Quality in Alfalfa (*Medicago sativa* L.) via Selection for Increased Stem Fiber Digestibility

Zhanyou Xu ^{*,†} , Deborah J. Heuschele [†], JoAnn E. S. Lamb, Hans-Joachim G. Jung and Deborah A. Samac



Genetic gain at all maturities



Conclusions of selection study

- Selection had no effect on the leaf:stem ratio
- Selection for high IVNDFD reduced NDF and ADL/NDF in plant stems at the late flowering and green pod maturity stages
- Selection reduced seasonal variability in stem digestibility



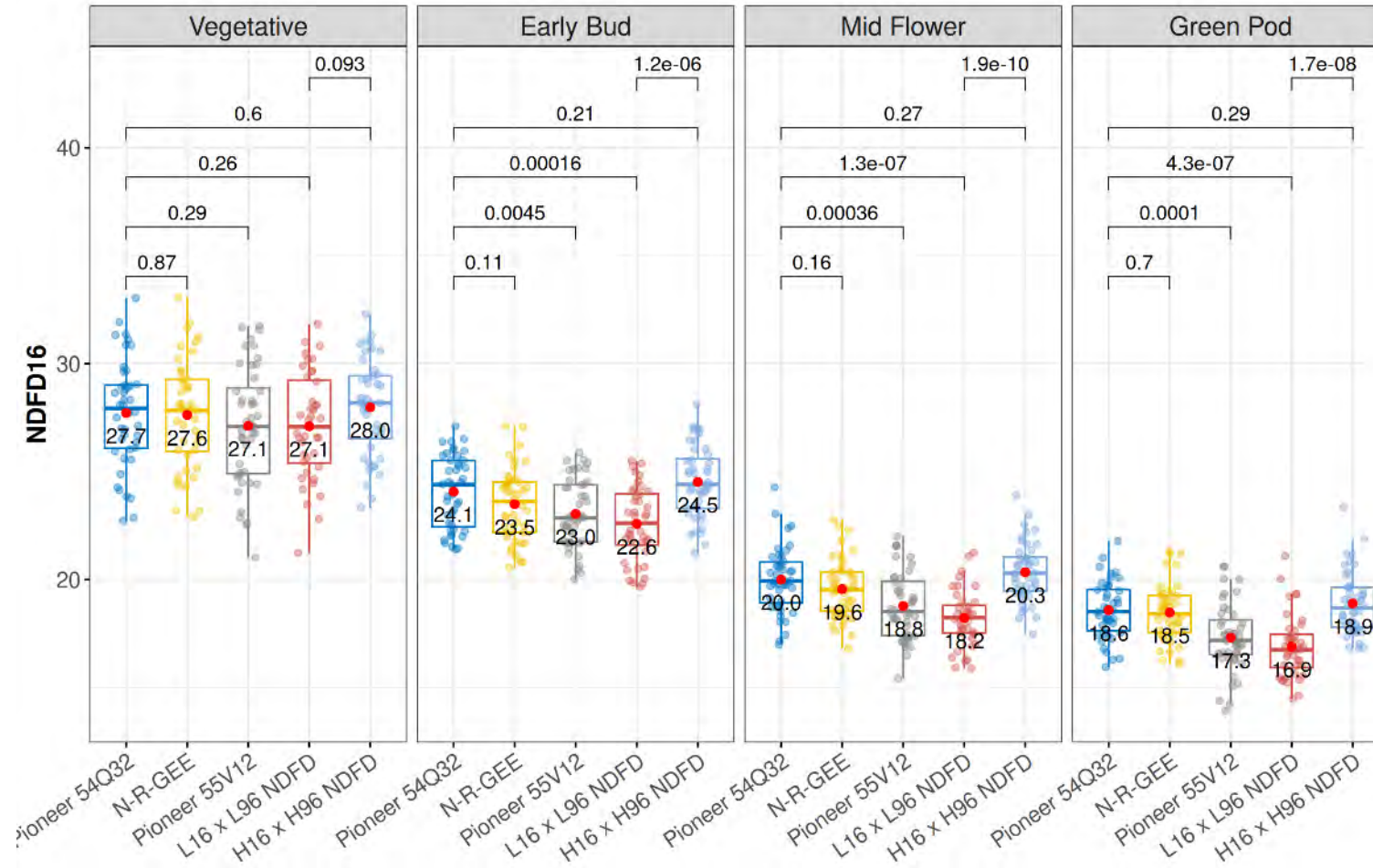
Larger plot trials

Entries	Trait	StP2012	StP2013	WI 2012
UMN 4405 (H16 x H96)-cycle 2	High digestibility	64	48	64
UMN 4406 (L16 x L96)-cycle 2	Low digestibility	64	48	64
Pioneer 54Q32	High quality	64	48	64
Pioneer 55V12	High standability	64	48	64
Cornell N-R-GEE	High soluble fiber	64	48	64

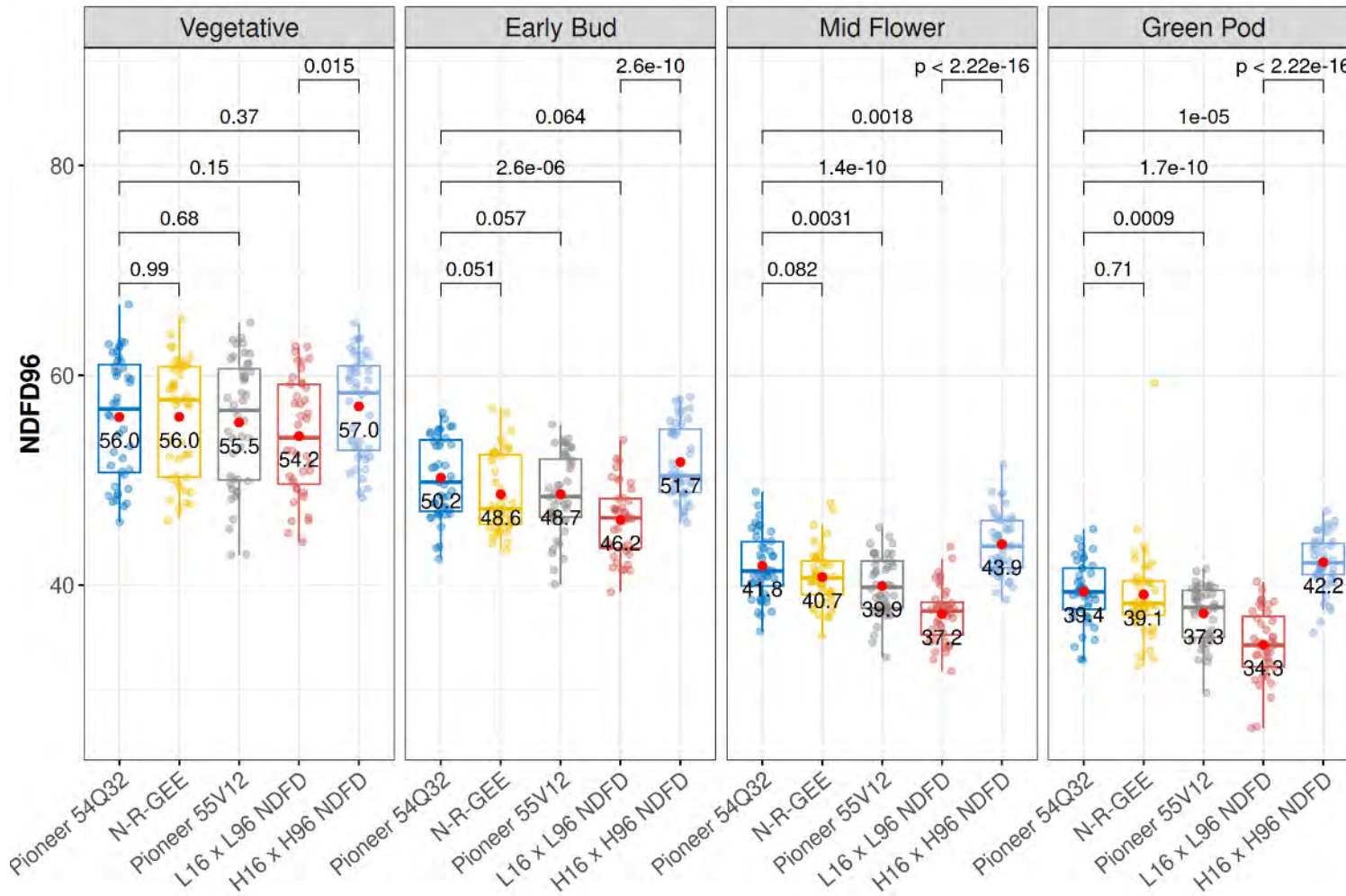


- Six-row plots, 15 feet long, 100 seeds/ft²
- Two locations (MN, WI), two production years
- Vegetative, early bud, mid-flower, green pod
- Leaf:stem separation
- NIRS for forage quality traits

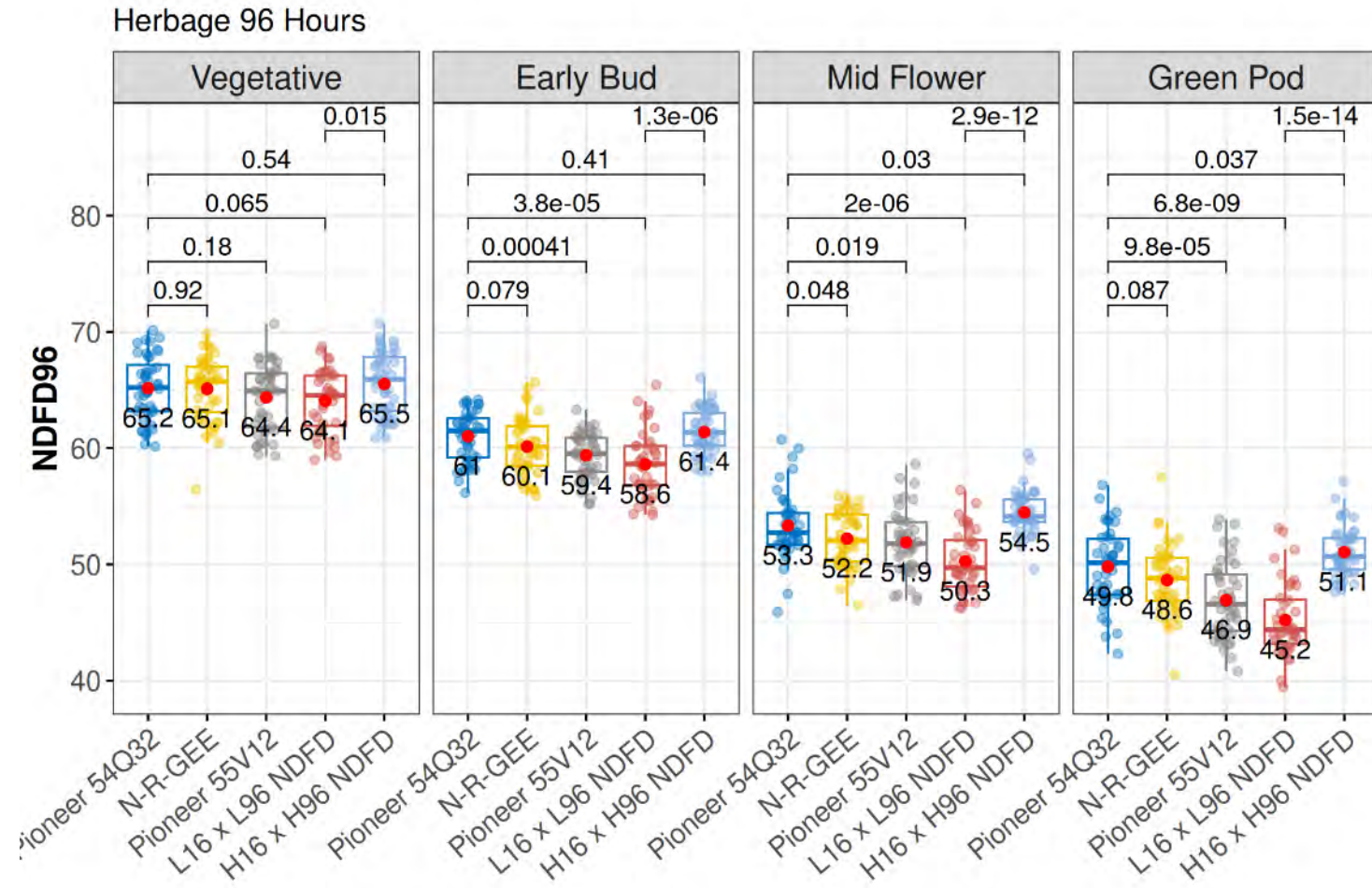
Stem 16-h IVNDFD



Stem 96-h IVNDFD



Total herbage 96-h NDFD



Extended harvest window (days) for 96-h IVNDFD

Entry	Leaf	Herbage	Stem
UMN 4405 (H16 x H96)	+8.65	+6.65	+8.87
UMN 4406 (L16 x L96)	+2.32	-7.58	-10.20
Pioneer 54Q32	0	0	0
Pioneer 55V12	-2.22	-5.57	-4.40
Cornell N-R-GEE	+2.05	-1.28	-1.72



Harvest window for RFV

Entry	Leaf	Herbage	Stem
UMN 4405 (H16 x H96)	-2.68	-2.18	+4.94
UMN 4406 (L16 x L96)	-6.83	-21.84	-10.62
Pioneer 54Q32	0	0	0
Pioneer 55V12	-1.43	-14.03	-13.92
Cornell N-R-GEE	+6.87	-4.63	-17.62



Conclusions and current research

- Recurrent selection for alfalfa stem IVNDFD was a successful strategy for improving
 - fiber digestibility
 - reducing lignin in stems
 - No change in leaves:stems
 - Increased digestibility in later maturity stages
- Identified SNP markers associated with fiber digestibility and lignin concentration
 - Two cycles of genomic selection completed
- Investigating lignin distribution in stems



Thank you!



Keith Henjum



Ted Jeo

