Practical methods for predicting performance of growing and finishing beef cattle

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Predicting feedlot performance

- **Critical to financial and logistical decisions**
- **Current NE equations seem reasonably effective when outcomes are known**
  - ✓ ***Modifications can improve predictions (Zinn et al., 2008)***
- **Challenge for feedlot managers – Predict outcomes based on limited data available when cattle start on feed**

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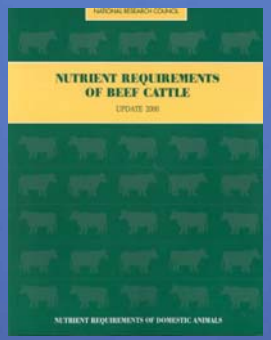
Predicting feedlot performance

- **What factors are readily available and have predictive value for feeding periods varying from 100 to >250 d across a variety of geographic and environmental conditions with cattle of diverse biological types from varying backgrounds, etc.?**
  - ✓ ***Initial shrunk BW (ISBW) and sex are consistently available in virtually all feedlots***
  - ✓ ***BCS, health history, frame scores, etc. (Reinhardt et al., 2009) may be useful, but are less consistently available***
    - **How does one apply such information at a pen level?**

Predicting feedlot performance

- **If dietary NE concentrations are known, performance can be estimated by NRC (1996) equations if:**
  - ✓ ***DMI and final shrunk BW (FSBW) at target endpoint are known***



- **Thus, predicting DMI and FSBW is pivotal to estimating feedlot cattle performance**

Predicting feedlot performance

- **Our previous results indicated that ISBW and sex have considerable predictive value for estimating DMI (NRC, 1996; McMeniman et al., 2009) and FSBW (McMeniman et al., 2010)**
  - ✓ ***Equations developed by McMeniman et al. (2009; 2010) have not been evaluated for accuracy and precision with independent databases***
  - ✓ ***Evaluation with independent dataset(s) represents the true test of the predictive value***

Objectives

- Validate published DMI prediction equations based on ISBW and sex
- Assess the utility of ISBW and sex to predict other important outcome variables (ADG, G:F, and HCW) and validate the results with independent data

Equation development

- **Development database described in detail in McMeniman et al. (2009; 2010)**
- **3,363 pen records collected over a 4-yr period (2003 to 2006) from 3 Texas Panhandle feedlots**
  - ✓ ***1,986 pens of steers and 1,377 pens of heifers***
- **Cattle remained together from arrival (or shortly thereafter) to slaughter**
- **Primarily British and Continental breeding (no Holstein cattle)**

Equation development

Measurements

- **Measurements of relevance for this evaluation:**
  - ✓ *DOF, ISBW, sex, FSBW, G:F, DMI, average DMI from d 8 to 28 ($DMI_{8\text{-}28d}$)*
- **Season cattle started on feed defined as:**
  - ✓ *F = Sept, Oct, Nov; W = Dec, Jan, Feb; Sp = Mar, Apr, May; S = June, July, Aug*
- **Performance outcomes of interest:**
  - ✓ *DMI and FSBW using equations developed by McMeniman et al. (2010)*
  - ✓ *ADG, G:F, and HCW using equations generated from the database of McMeniman et al. (2010)*

Equation development

Statistical Methods

- **PROC MIXED of SAS used to develop ADG, G:F, and HCW equations from McMeniman et al. (2010) database**
- **Data fitted to a random coefficients, generalized least squares regression model *(Littell et al., 2006)***
- **Subject for random statement was entry year x entry season x feedlot**
  - ✓ ***Variance-(co) variance matrix of random factors modeled using PROC MIXED***
- **Consistent with McMeniman et al. (2010), only ISBW and sex were considered as independent variables**

Equations developed

Equation	Dependent variable	Equation components[1]	r^2	RMSE
1	DMI, kg/d			
	Steers	3.830 + 0.0143 ISBW	*0.76*	*0.46*
	Heifers	3.184 + 0.01536 ISBW		
2	DMI, kg/d			
	Steers	2.550 + 0.470 $DMI_{8\text{-}28d}$ + 0.00692 ISBW	*0.83*	*0.38*
	Heifers	2.367 + 0.470 $DMI_{8\text{-}28d}$ + 0.00692 ISBW		
3	FSBW, kg			
	Steers	484.0 + 0.286 ISBW	*0.84*	*17.5*
	Heifers	371.6 + 0.448 ISBW		

[1]All variables included in equations are significant, $P < 0.10$.

Equations developed

Equation	Dependent variable	Equation components[1]	r^2	RMSE
4	ADG[2], kg			
	Steers	0.9276 + 0.001382 ISBW	*0.46*	*0.11*
	Heifers	0.7182 + 0.00166 ISBW		
5	G:F			
	Steers	0.1949 - 0.0001 ISBW	*0.22*	*0.009*
	Heifers	0.18162 - 0.000084 ISBW		
6	HCW, kg			
	Steers	333.81 + 0.1213 ISBW	*0.81*	*11.75*
	Heifers	250.6375 + 0.2492 ISBW		

[1]All variables included in equations are significant, $P < 0.10$.
[2]Shrunk ADG was calculated with dead animals removed.

Validation dataset

- **573 lots of steers and 208 lots of heifers**
  - ✓ *184 steers/lot and 187 heifers/lot*
- **Lots might be comprised of multiple pens**
- **Primarily British and British x Continental (no Holsteins)**
- **Data from 2 Texas Panhandle feedlots**
  - ✓ *Close-outs from August 2009 through April 2010*
  - ✓ *1 of the 2 feedlots included in the development database*
- **Diets and management were similar at the 2 locations and consistent with development database**

Validation of equations

Statistical Methods

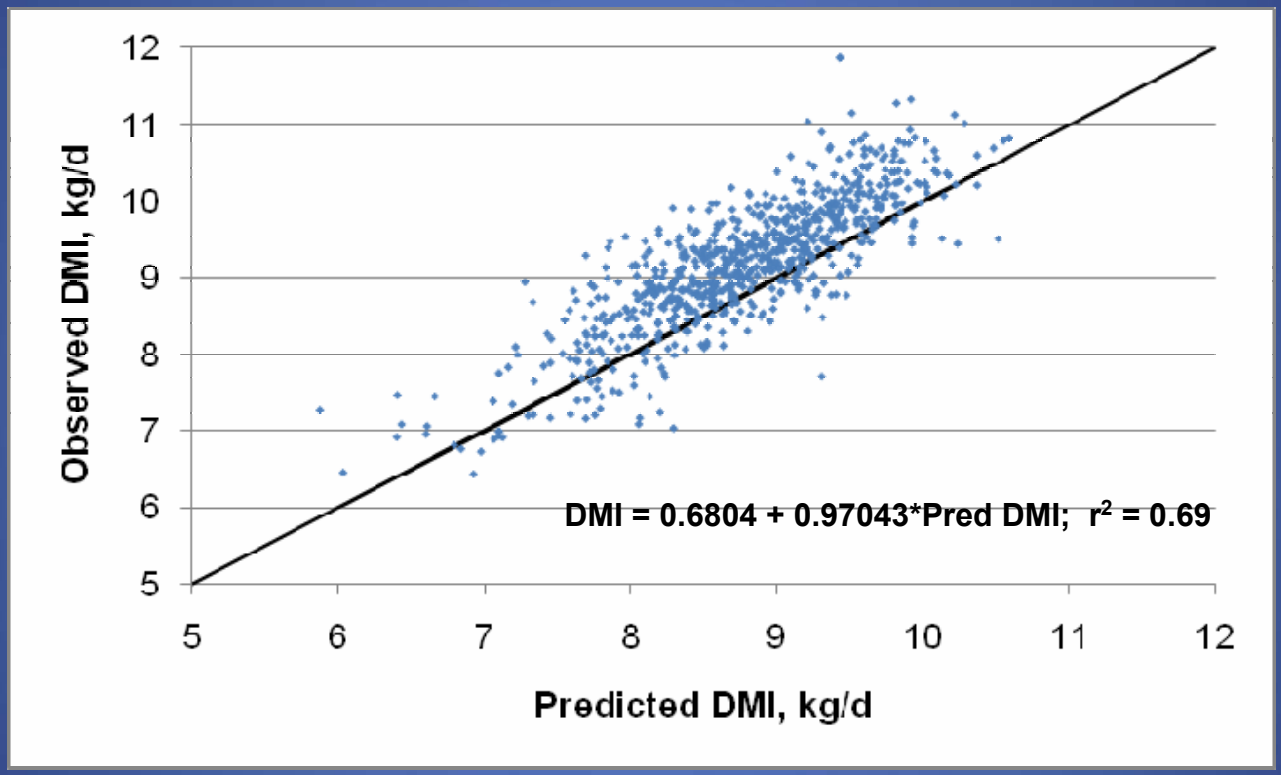
- **DMI, FSBW, ADG, G:F, and HCW predicted in the validation dataset from the equations derived from the development database**
  - ✓ ***Observed performance regressed on predicted performance to evaluate r^2 and root mean square error of prediction (RMSE)***
  - ✓ ***Residuals (observed minus predicted) regressed on mean-centered predicted values to determine mean and linear biases***

Validation of equations

Regression of observed on predicted performance

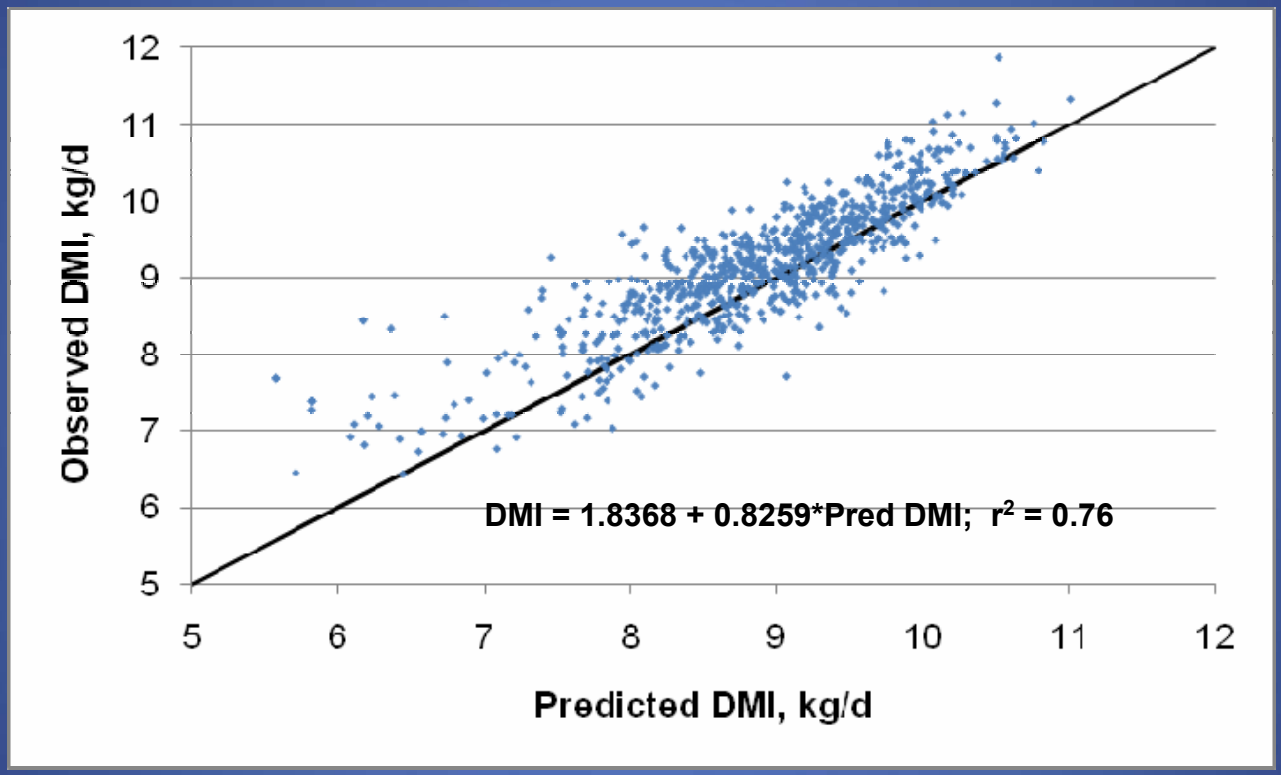
Equation	Variable	r^2	RMSE	Mean bias	*P*-value	Linear bias	*P*-value
1	DMI, kg/d	0.692	0.474	0.421	0.001	-0.0296	0.203
2	DMI, kg/d	0.755	0.423	0.290	0.001	-0.1741	0.001
3	FSBW, kg	0.737	20.56	24.28	0.001	-0.0052	0.808
4	ADG, kg	0.370	0.139	0.125	0.001	0.0799	0.114
5	G:F	0.076	0.011	0.006	0.001	-0.2971	0.001
6	HCW, kg	0.733	14.36	17.88	0.001	0.1187	0.001

Validation of DMI prediction equations



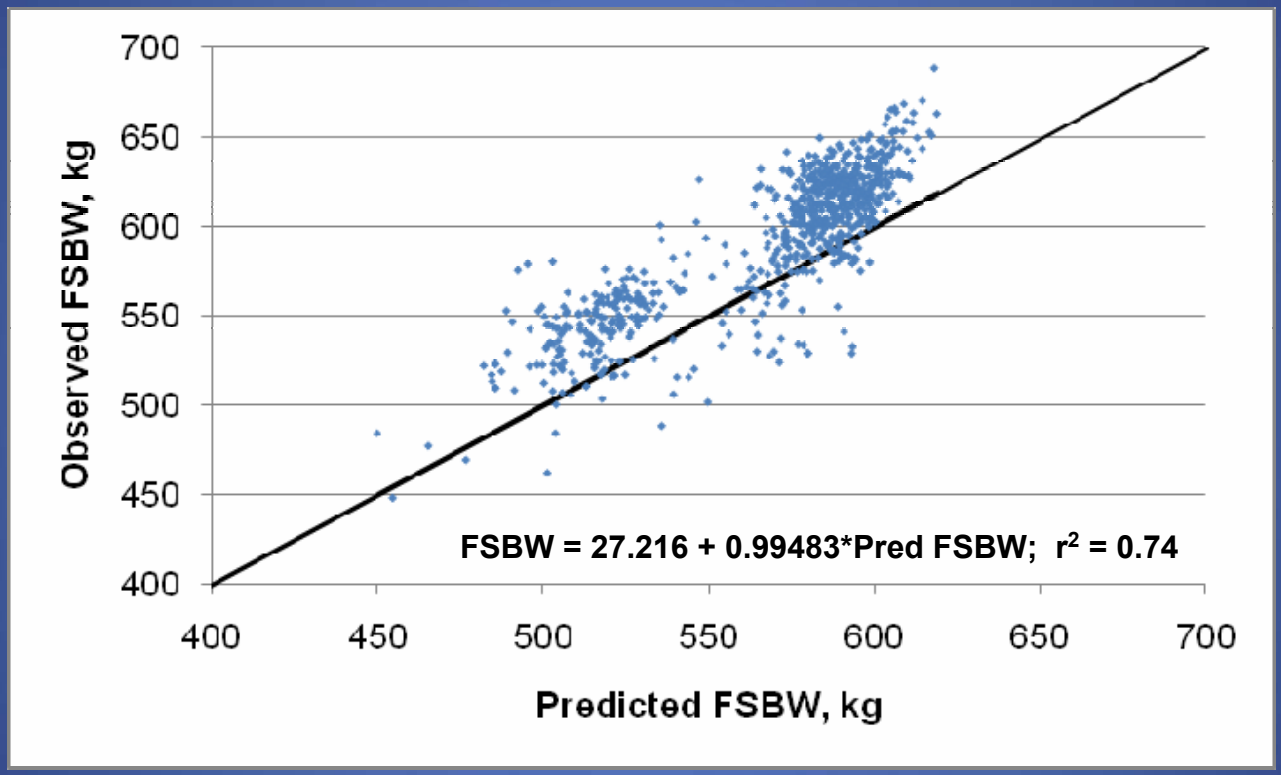
Equation 1: DMI predicted from sex and ISBW

Validation of DMI prediction equations



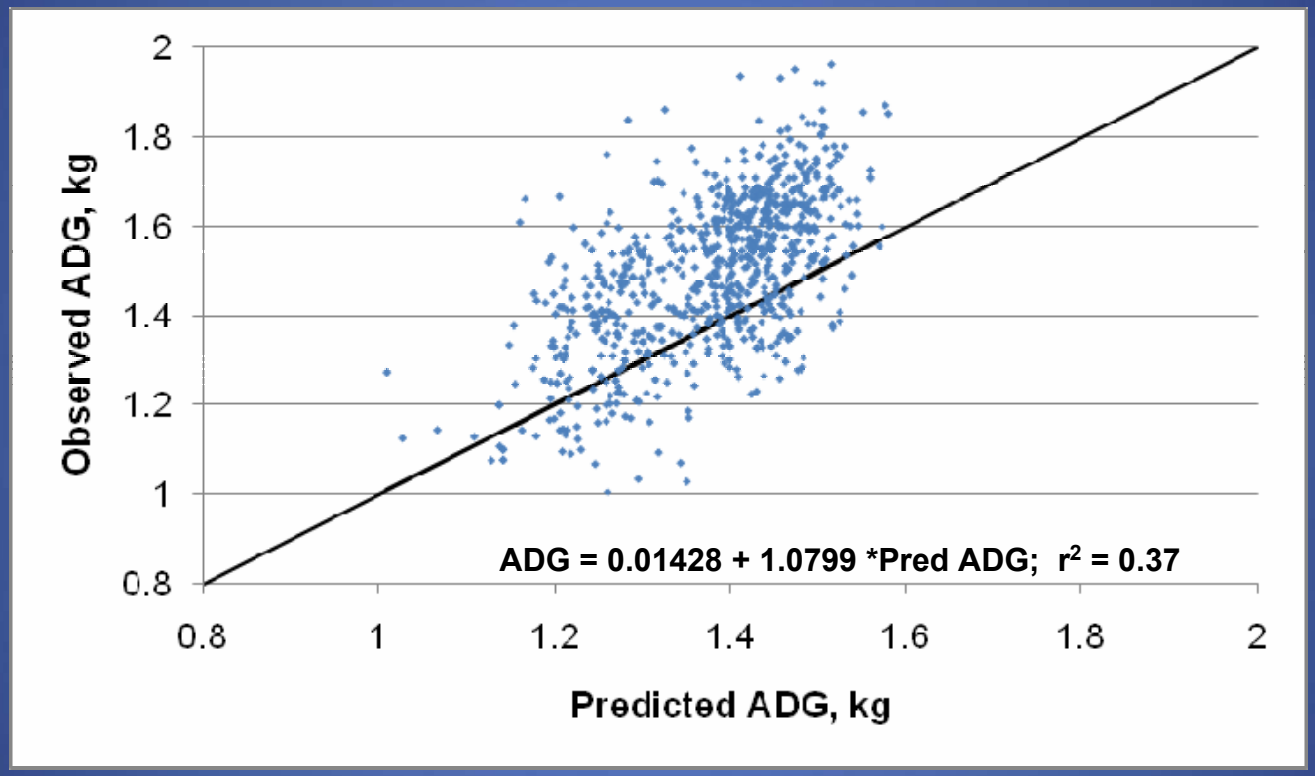
Equation 2: DMI predicted from sex, ISBW, and average DMI from d 8 to 28

Validation of FSBW prediction equation



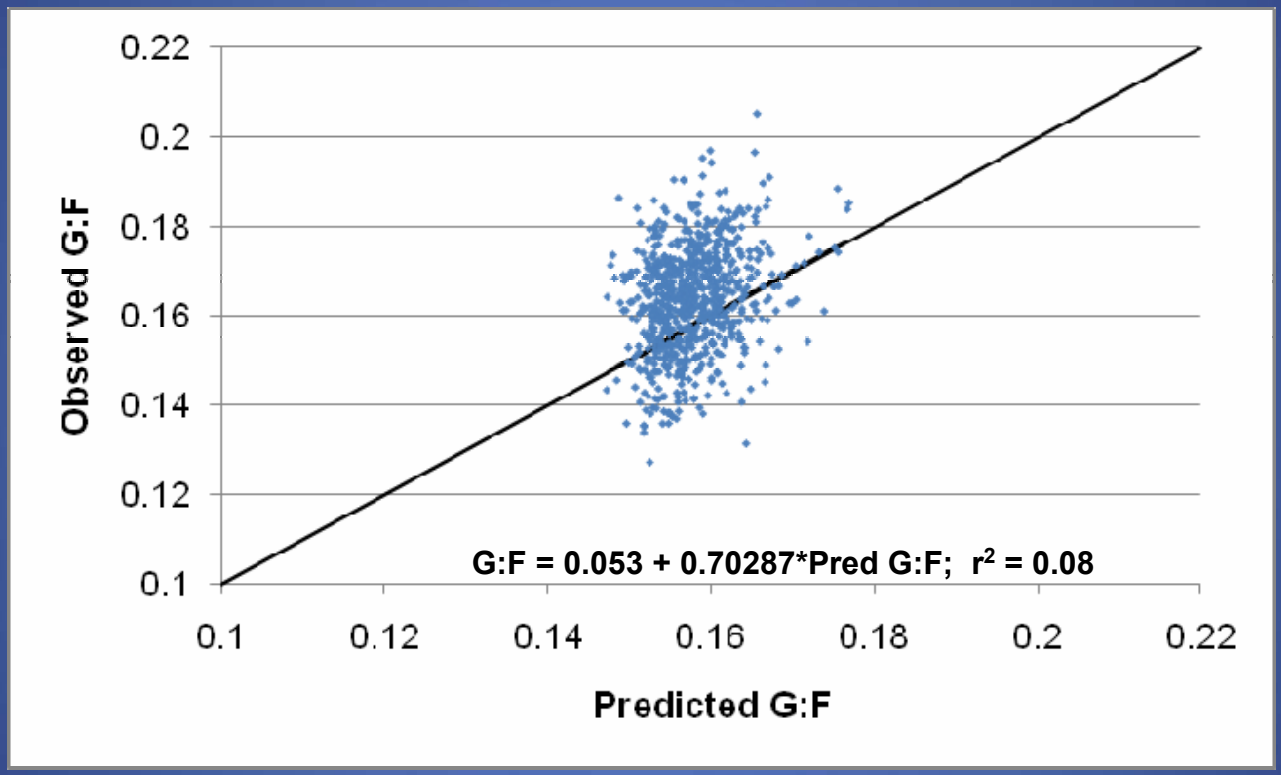
Equation 3: FSBW predicted from sex and ISBW

Validation of ADG prediction equation



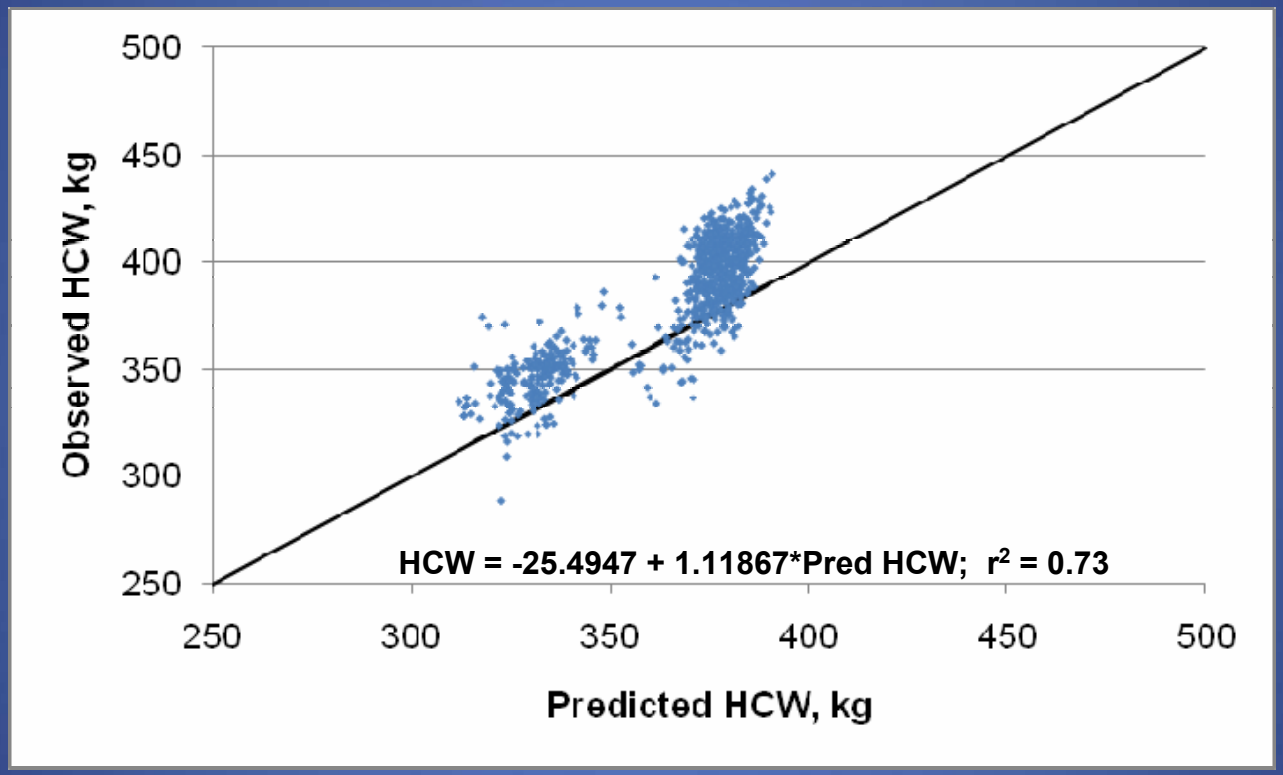
Equation 4: ADG predicted from sex and ISBW

Validation of G:F prediction equation



Equation 5: G:F predicted from sex and ISBW

Validation of HCW prediction equation



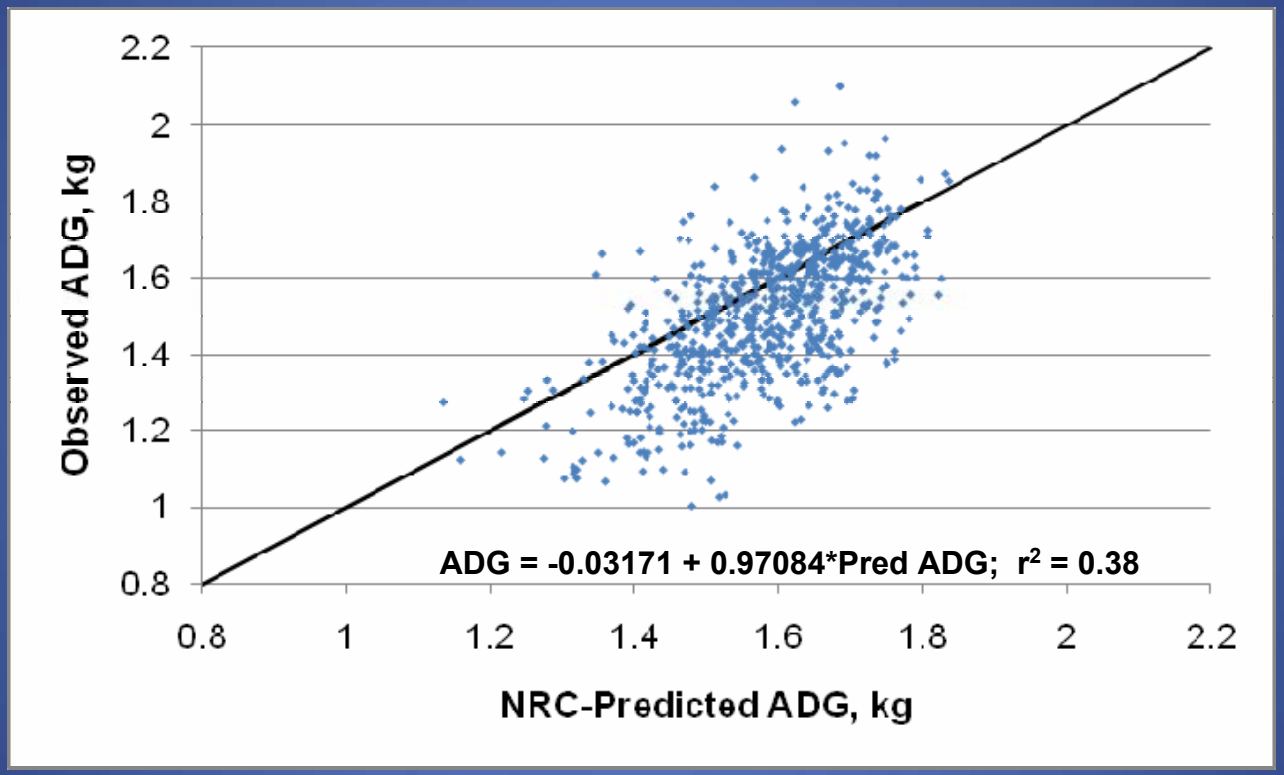
Equation 6: HCW predicted from sex and ISBW

Predicting performance using intake and retained energy equations (NRC, 1996)

- NRC (1996) equations can be used to calculate expected performance if NE concentrations are known and DMI and FSBW are known or predicted
- To investigate this approach, dietary NEm and NEg concentrations assumed to be 2.2 and 1.52 Mcal/kg of DM, respectively
  - ✓ *Similar to values determined by McMeniman et al. (2010)*
- FSBW predicted from Equation 3 and DMI predicted from Equations 1 and 2 used to calculate shrunk ADG from NRC (1996) equations

Validation of ADG prediction equation

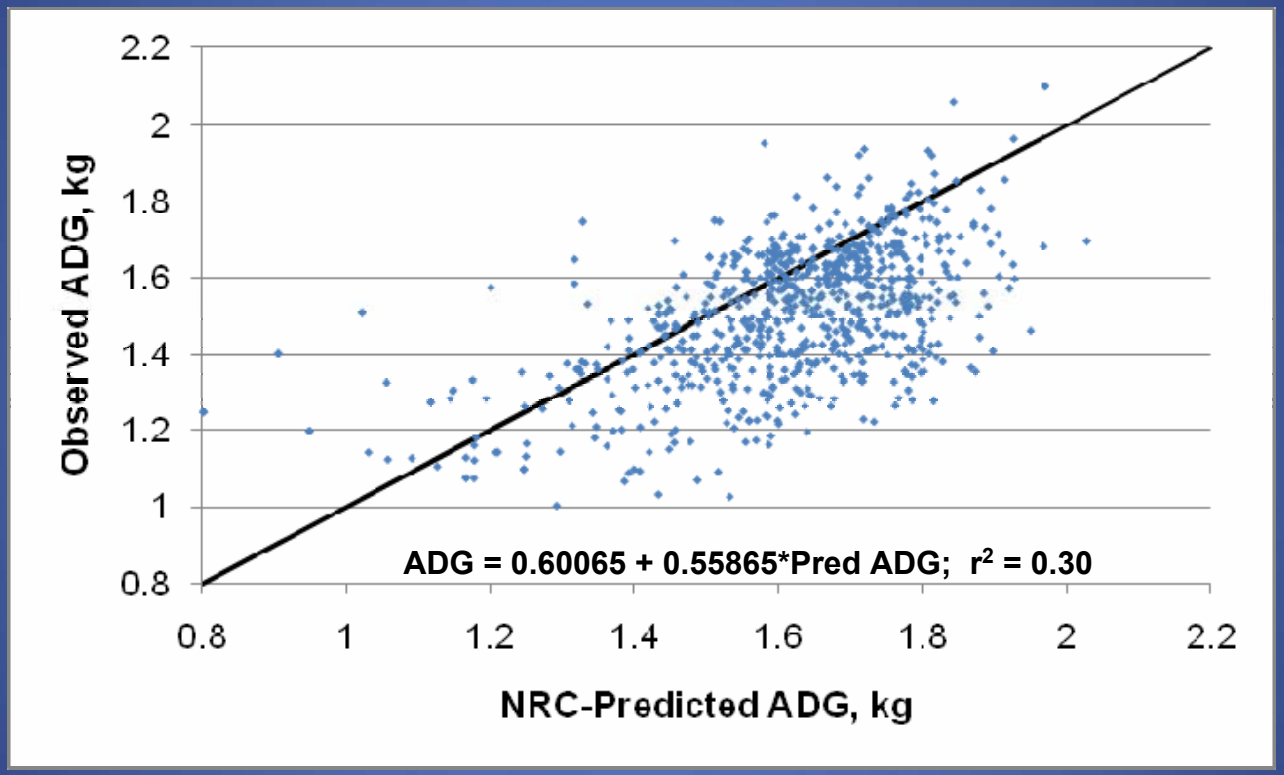
NRC-Predicted ADG



ADG predicted from RE equations (NRC, 1996) using predicted DMI and FSBW from Equations 1 (without $DMI_{8\text{-}28d}$) and 3, respectively

Validation of ADG prediction equation

NRC-Predicted ADG



ADG predicted from RE equations (NRC, 1996) using predicted DMI and FSBW from Equations 2 (including $DMI_{8\text{-}28d}$) and 3, respectively

Statistics from regression of observed shrunk ADG on shrunk ADG calculated from predicted DMI and FSBW on the validation dataset

Variable	r^2	RMSE	Mean bias	*P*-value	Linear bias	*P*-value
ADG_1, kg	0.376	0.138	-0.078	0.001	-0.029	0.515
ADG_2, kg	0.301	0.147	-0.113	0.001	-0.441	0.001

Shrunk ADG (dead animals removed) was calculated from NRC (1996) equations using FSBW predicted from Equation 3 and DMI predicted from Equations 1 (ADG_1 = without $DMI_{8\text{-}28d}$) and 2 (ADG_2 = with $DMI_{8\text{-}28d}$), respectively.

Options for evaluating performance data (i.e., reviewing close-outs)

- NRC (1996) equations with modifications (e.g., Zinn et al., 2008)
- Possible alternative: Apply the residual feed intake (RFI) concept to close-out data
  - Pen-based RFI calculated from:
    - ✓ *Developed DMI equations and close-out data*
    - ✓ *Empirically predicting DMI from observed ADG and average $BW^{0.75}$ for each pen (Cruz et al., 2010)*
- Pens classified into high and low RFI based on pens>0.5 or <0.5 SD from the mean RFI
- RFI groups examined to assess factors that contributed to either exceptional or subpar performance

Pen-based RFI

- **In the development database, DMI predicted from ADG and average $BW^{0.75}$ accounted for approximately 83% of the variation in observed DMI**
  - ✓ ***Thus, compared with predictions from Equation 1, DMI predicted from ADG and average $BW^{0.75}$ would yield more precise estimates of RFI***
- **RFI classification evaluated for various performance outcomes**

Pen-based RFI for steers

Variable	High RFI	Low RFI	"Middle RFI"
Count	553	574	859
No. of animals/pen	205	173	198
Dead, %	1.16	1.23	1.16
DMI, kg/d	9.1	8.2	8.6
ADG, kg	1.40	1.39	1.39
G:F	0.153	0.169	0.161
DOF	167	181	175
Initial BW, kg	347	338	339
HCW	372	382	376
Choice and Prime, %	45.3	41.8	44.3
Yield grade 1 and 2, %	63.1	61.0	61.5

Pen-based RFI for heifers

Variable	High RFI	Low RFI	"Middle RFI"
Count	425	430	522
No. of animals/pen	198	157	187
Dead, %	1.37	1.12	1.37
DMI, kg/d	8.5	7.5	7.9
ADG, kg	1.24	1.23	1.23
G:F	0.146	0.163	0.155
DOF	159	163	165
Initial BW, kg	317	313	310
HCW	327	331	329
Choice and Prime, %	53.2	52.0	53.6
Yield grade 1 and 2, %	61.0	59.2	59.4

Further evaluation of pen-based RFI

- Comparisons of NE- vs. RFI-based methods needed
- Comparison to other measures of efficiency (e.g., G:F) needed
- Evaluation with additional datasets required

Summary and conclusions

- **ISBW as an independent variable combined with slope and intercept adjustments for steers vs. heifers provides a practical means of predicting performance**
- **r^2 values for predictions of DMI and FSBW were approximately 0.7 or greater with prediction errors of 3 to 5% of mean values**
- **Further adjustment factors should be considered:**
  - ✓ ***Cattle type***
  - ✓ ***Weather (heat or cold stress)***
  - ✓ ***Health (morbidity)***

Summary and conclusions

- **Equations developed might not have universal application**
  - ✓ ***Other geographical regions than those in the development database should be considered***
  - ✓ ***As commercial feedlots increase cattle sorting on arrival, equations should be evaluated in different sorting groups***
- **Equations developed to predict performance might be useful in developing standardized approaches to evaluate factors affecting feedlot cattle performance**

Thank you

Questions?