Bringing Feed Efficiency Technology to the Beef Industry in Texas

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Global meat production by type (1961 to 2025)

Thomas E. Elam (*Feedstuffs*, Jan. 26, 2004)

Projected world demand for meat will increase 55% by 2025

What will it take to meet a 55% increase in global meat demand?

- ✓ **30-35% increases in grain and oilseed yields**
- ✓ **Reductions in harvest and post-harvest losses of grains and oilseeds**
- ✓ **15-20% improvements in feed efficiencies of beef, pork and poultry**
- ✓ **Implementation of cost-effective strategies to mitigate environmental impacts**

Thomas E. Elam (*Feedstuffs,* Jan. 26, 2004)

Targets for the U.S. to maintain its share of increased global meat production

Item	Current	2025 Target	% Change
Corn yield, bu/ac	135	180	33%
Soybean yield, bu/ac	35	47	34%
Fed cattle conversion, feed/gain	6.5	5.0	23%
Beef production, billion lb	26	34	31%

Thomas E. Elam (*Feedstuffs,* Jan. 26, 2004)

Meeting global meat demands

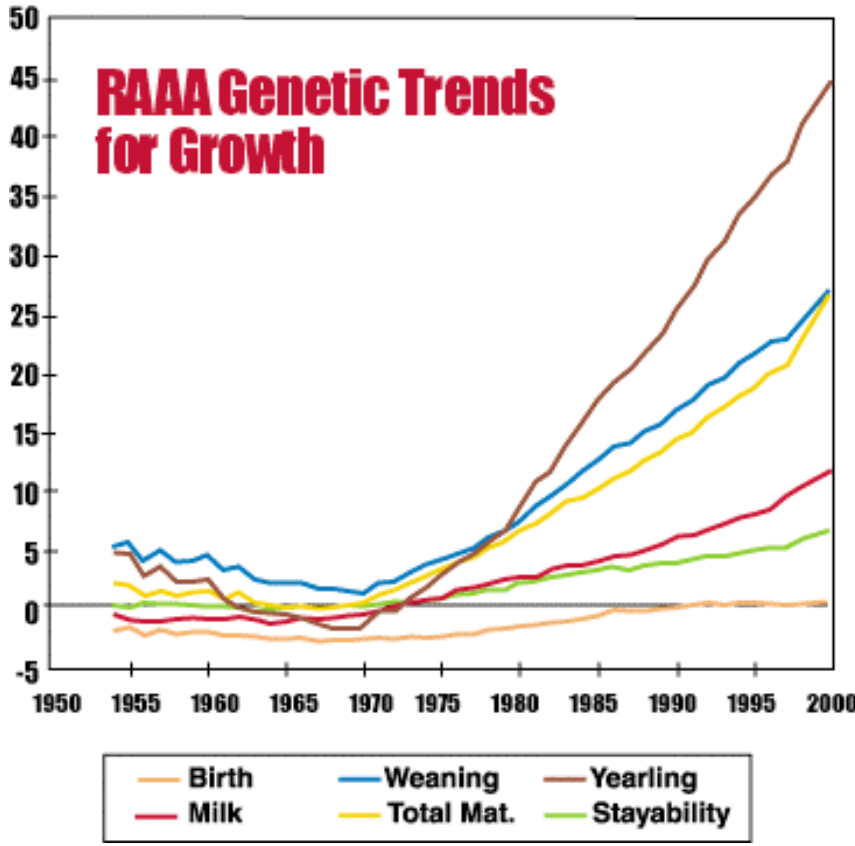
"Both crop yields and feed conversions will need to increase significantly over the next 25 years to meet global meat demands in an economical and environmentally sustainable manner"

"We will need to continue to develop tools and technologies our producers need to increase production through increased efficiency of resource use"

Thomas E. Elam (*Feedstuffs,* Jan. 26, 2004)

Beef production efficiency

- ✓ **Since 1955, beef production per unit cow has increased 80%**
- ✓ **As a result, beef production has about doubled even though the cow herd size is about the same as it was in 1955**
- ✓ **Substantial improvements have been realized through selection for growth traits which are easy to measure and moderately heritable**
- ✓ **Feed:gain ratio is also moderately heritable ($h^2 = 0.32$)**



Why has the beef industry not selected for feed efficiency?

- ✓ **Measuring feed efficiency in cattle is expensive**
- ✓ **Although moderately heritable, feed:gain ratio is negatively correlated genetically with:**
  - **Postweaning ADG**
  - **Yearling BW**
  - **Cow mature size**
- ✓ **Selection for improved FCR will indirectly:**
  - **Increase genetic merit for growth**
  - **Increase cow mature size**
  - **Feed costs for the cow herd**

New technologies available to facilitate selection for improved feed efficiency

- **Net feed intake--new measure of feed efficiency that facilitates selection for improved efficiency independent of growth traits**
- **Innovative technology to cost-effectively measure feed intake, growth, feeding behavior and provide early detection of sickness in cattle (GrowSafe systems)**
- **Genomics--discovery of QTL linked to NFI will facilitate gene marker-assisted selection**

What is net feed intake (NFI)?

- ✓ **NFI is a trait that measures the variation in feed intake beyond that needed to support maintenance and growth requirements**
- ✓ **NFI has been shown to moderately heritable ($h^2 \approx 0.30$ to 0.40)**
- ✓ **NFI is genetically independent of BW and ADG**

How is net feed intake (NFI) measured?

- **NFI is measured as the difference between an animal's actual feed intake and the amount of feed an animal is expected to eat based on its size and growth rate**

- **Calves that eat less than expected for their weight and ADG will have negative NFI**

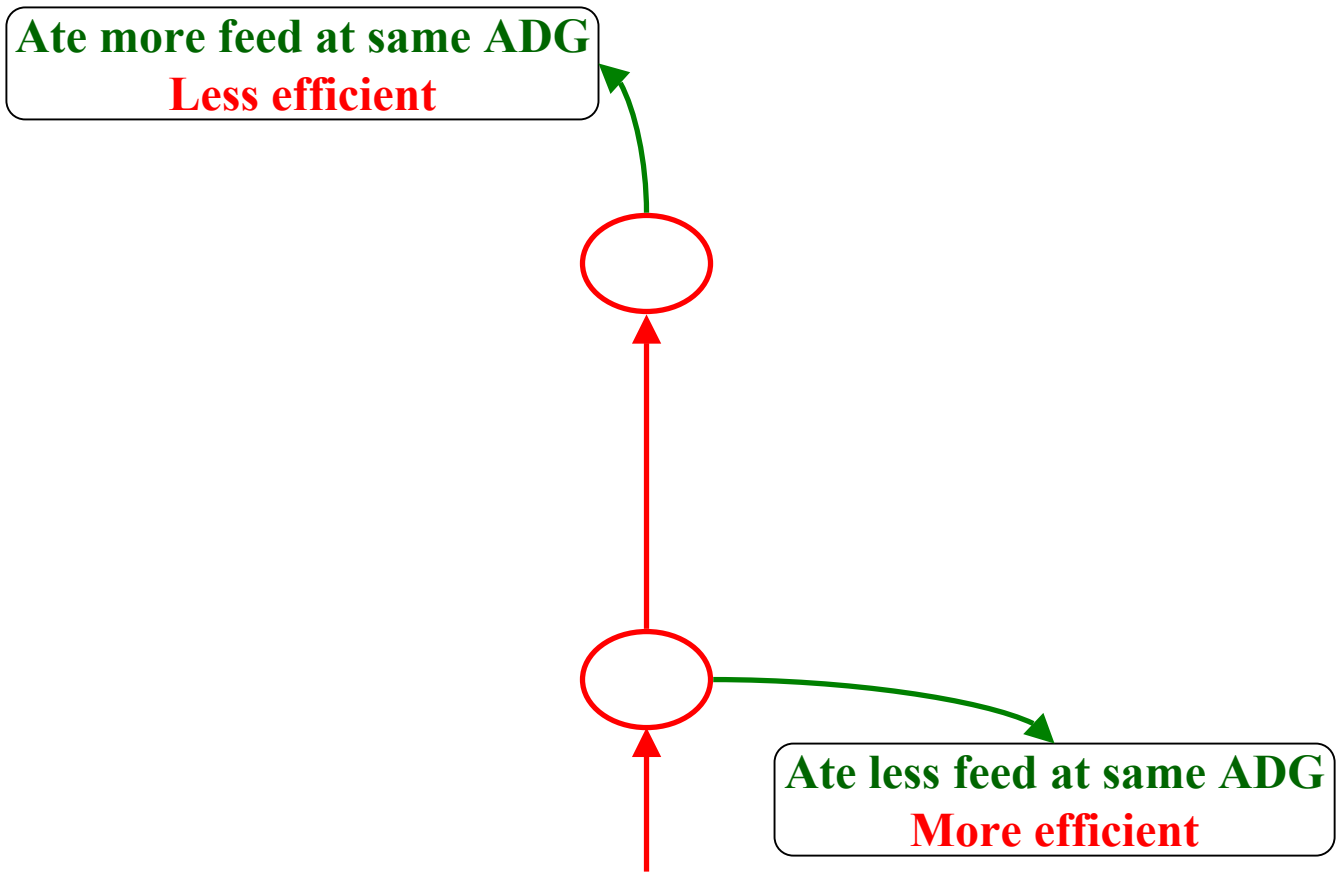
  Negative NFI = superior net feed efficiency

- **Calves that eat more than expected for their weight and ADG will have positive NFI**

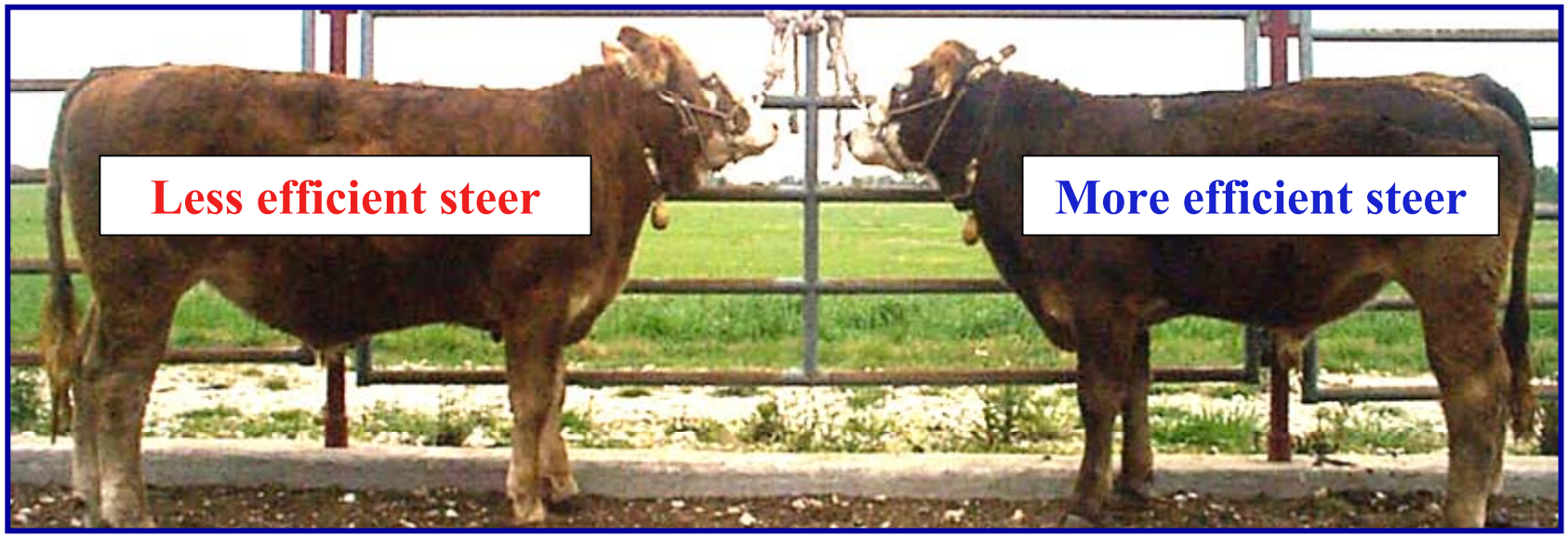
  Positive NFI = inferior net feed efficiency

Relationship between feed intake and growth in steers

Relationship between feed intake and growth in steers



Comparison of steers with divergent NFI



Performance data during an 77-day growing trial:

538 lbs	Initial body weight	535 lbs
2.11 lbs/day	ADG	2.16 lbs/day
1502 lbs	Expected feed intake	1509 lbs
1717 lbs	Actual feed intake	1232 lbs
+215 lbs	Net feed intake	-277 lbs

The more efficient steer (negative NFI) gained the same, but ate 485 lbs less feed than the less efficient steer (positive NFI)

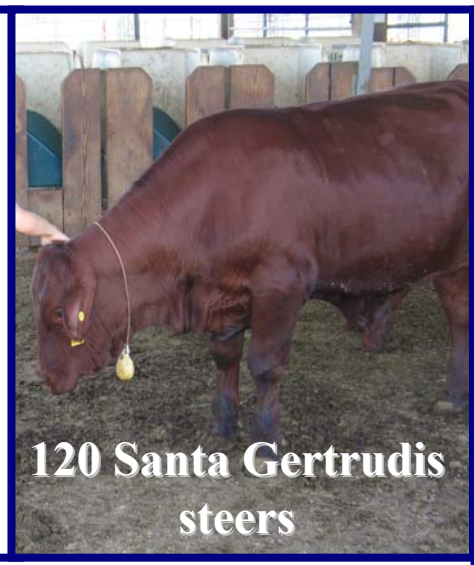
TAMU net feed intake studies

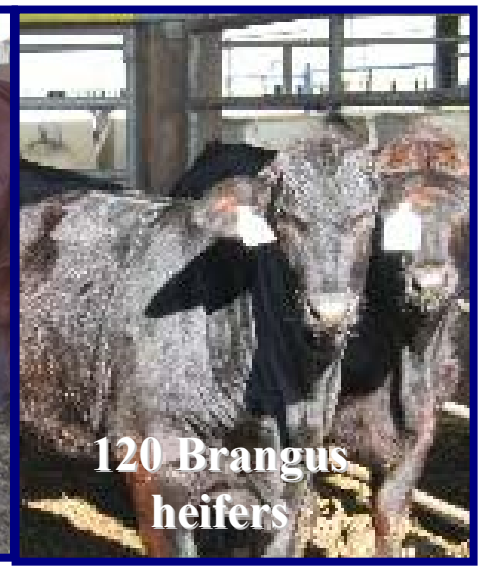
Experimental Designs:

- Growing calves adapted to diet for 28 d
- Roughage-based diets fed for 70 or 77 d
- Individual feed intakes measured via Calan gate feeders
- BW weighed at 7- or 14-d intervals
- DMI = $ß_0 + ß_1$ mid-test $BW^{.75} + ß_2$ ADG + error

QuickTime™ and a Photo - JPEG decompressor are needed to see this picture.

65 Bonsmara bulls





Average net feed intake (kg/day) for growing calves with low (efficient) and high (inefficient) NFI

Study	Low NFI	High NFI calves
Braunvieh steers	-0.98	0.88
Bonsmara bulls	-1.32	1.11
Santa Gertrudis steers	-1.02	1.07
Brangus heifers	-1.04	1.02

†Low and high NFI calves were < 0.5 and > 0.5 SD from the average NFI

Average daily gains (lb/day) of calves with low and high NFI

Study	Low NFI calves	High NFI calves	High/Low Difference
Braunvieh steers	1.02	1.02	0%
Bonsmara bulls	1.75	1.76	0.5%
Santa Gertrudis steers	1.28	1.27	-0.4%
Brangus heifers	0.92	0.90	-2.0%

†Low and high NFI calves were < 0.5 and > 0.5 SD from the average NFI

Dry matter intakes (lb/day) of calves with low and high NFI

Study	Low NFI calves	High NFI calves	High/Low Difference
Braunvieh steers	7.9	9.6	20.6%
Bonsmara bulls	9.6	12.0	25.1%
Santa Gertrudis steers	9.0	11.2	24.2%
Brangus heifers	8.3	10.2	22.4%

†Low and high NFI calves were < 0.5 and > 0.5 SD from the average NFI

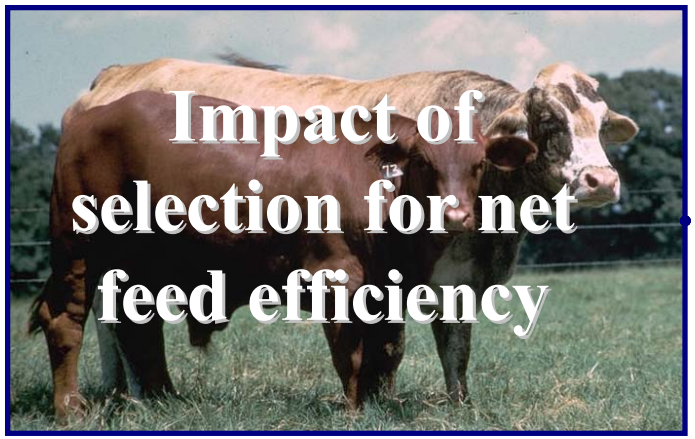
Phenotypic correlations between NFI and ultrasound carcass measurements

Study	Ribeye area	Backfat thickness	IM fat content
Braunvieh steers	0.03	0.22*	0.10
Bonsmara bulls	-0.01	0.20†	0.23†
Santa Gertrudis steers	0.10	0.13	0.10
Brangus heifers	0.05	0.10	0.09

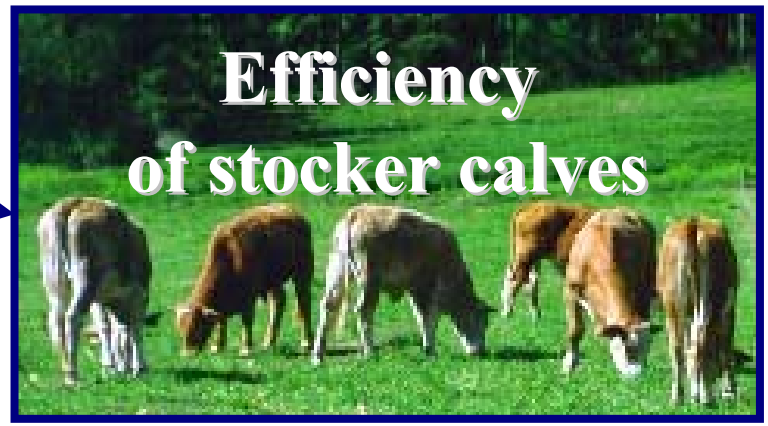
**P < 0.05; †P < 0.10*

Summary of studies with growing calves fed roughage-based diets

- **Calves with high NFI ate 20-25% less feed and had 21-26% higher feed:gain ratios compared to calves with low NFI even though growth performance was similar**
- **In two of the studies, the low NFI calves were slightly leaner than the high NFI cattle, but ribeye areas were similar in all studies**
- **NFI is a trait that has the potential to facilitate selection of cattle that require fewer feed inputs without compromising growth performance**


Impact of
selection for net
feed efficiency


Efficiency
of beef cows


Efficiency
of stocker calves


Beef quality &
composition


Efficiency
of feedlot cattle

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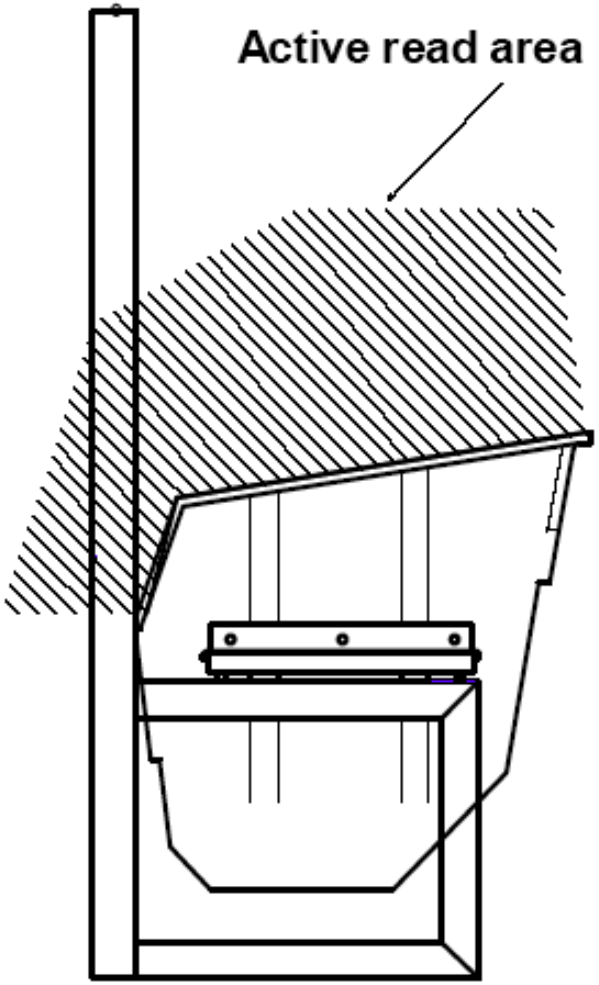
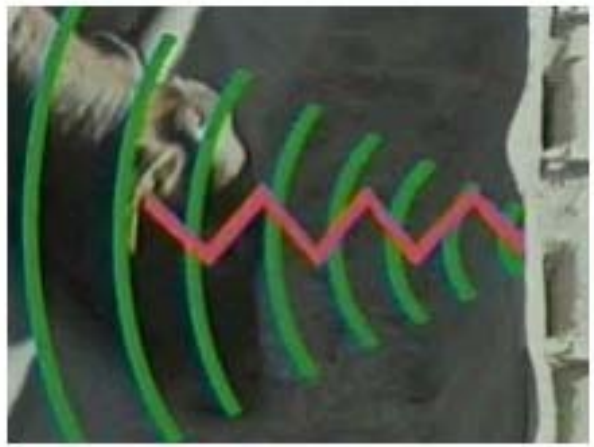


Antenna in each feed bunk emits an electromagnetic field which activates the transponder tag

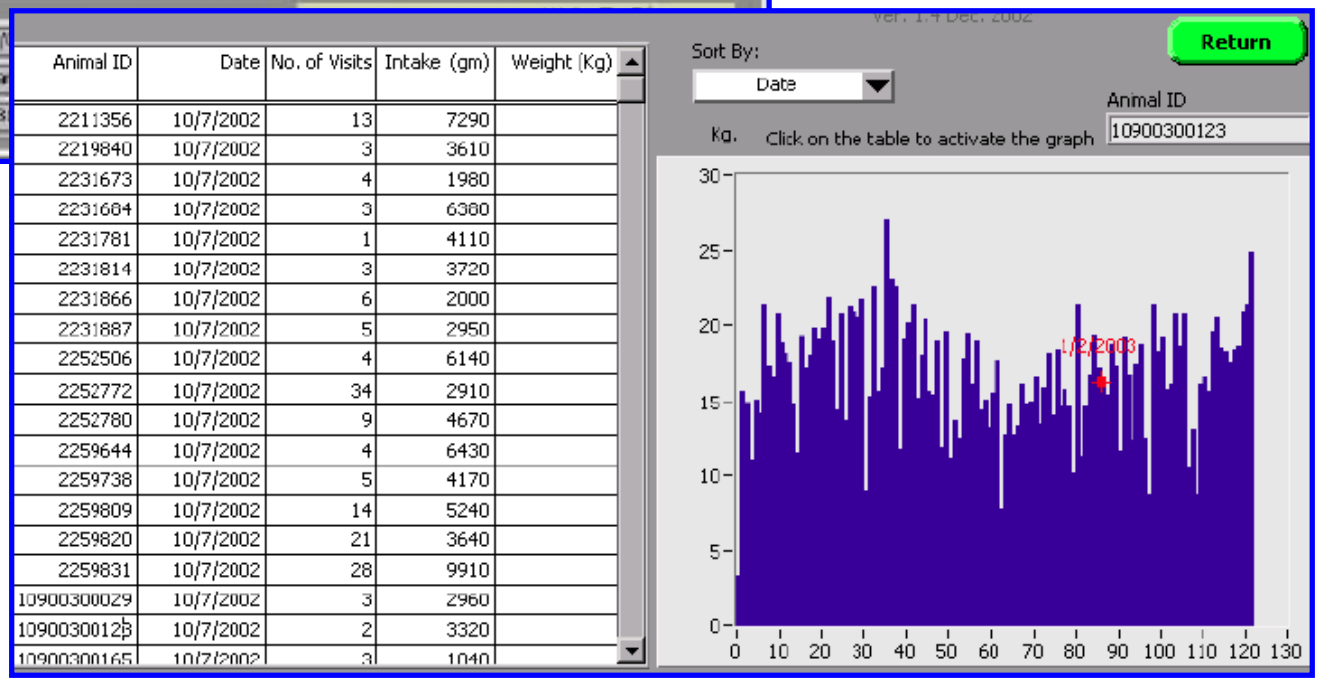
GrowSafe SYSTEMS



Upon activation, transponder tag emits a signal to the antenna to identify the animal

Load cells record feed disappearance

GrowSafe Data Acquisition System



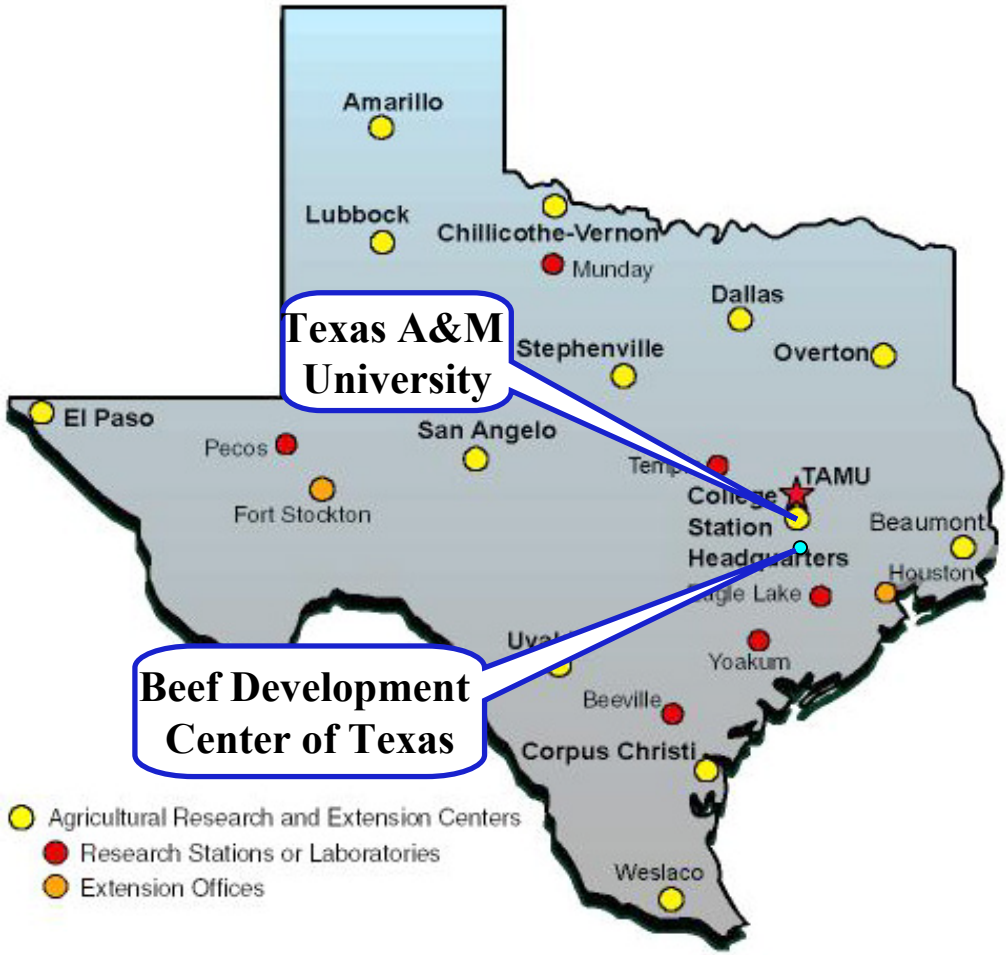
Animal ID	Date	No. of Visits	Intake (gm)	Weight (Kg)
2211356	10/7/2002	13	7290	
2219840	10/7/2002	3	3610	
2231673	10/7/2002	4	1980	
2231684	10/7/2002	3	6360	
2231781	10/7/2002	1	4110	
2231814	10/7/2002	3	3720	
2231866	10/7/2002	6	2000	
2231887	10/7/2002	5	2950	
2252506	10/7/2002	4	6140	
2252772	10/7/2002	34	2910	
2252780	10/7/2002	9	4670	
2259644	10/7/2002	4	6430	
2259738	10/7/2002	5	4170	
2259809	10/7/2002	14	5240	
2259820	10/7/2002	21	3640	
2259831	10/7/2002	28	9910	
10900300029	10/7/2002	3	2960	
10900300123	10/7/2002	2	3320	
10900300165	10/7/2002	3	1040	

Feed intake data

Benefits of GrowSafe technology

- **Most cost-effective method to measure feed intake in cattle**
- **Less disruption in typical feeding behaviors compared with standards methods (Pen pointer and Calan gate feeder systems)**
- **Generates feeding behavior data (feeding frequency & duration) that can potentially predict sickness prior to visual signs of clinical symptoms**
- **In the future: more accurate measurements of growth rate using in-pen load cells to weigh calves**

Cooperative project with Beef Development Center of Texas to measure feed efficiency traits in commercial bulls



18 GrowSafe feedbunks

120-130 hd capacity

Objectives of cooperative research & development project at Beef Development Center

- ✓ **Validate use of GrowSafe technology for use in commercial bull-test facilities**
- ✓ **Develop standardized test-protocols and computational-methods for measuring NFI**
- ✓ **Develop methodology to reduce length of test required to measure NFI**
- ✓ **Examine relationships between NFI and bull fertility**
- ✓ **Collect data for eventual calculation of NFI EPD**
- ✓ **Develop selection indexes that incorporate NFI**
- ✓ **Facilitate early adoption of the technology**

First test completed: Nov. 3, 2004	
Breed	**Number**
Angus	99
Brangus	16
Sim Angus	5
Total	120
Second test started: Dec. 8, 2004	
Angus	114
Brangus	12
Limousin	6
Santa Gertrudis	5
Total	137

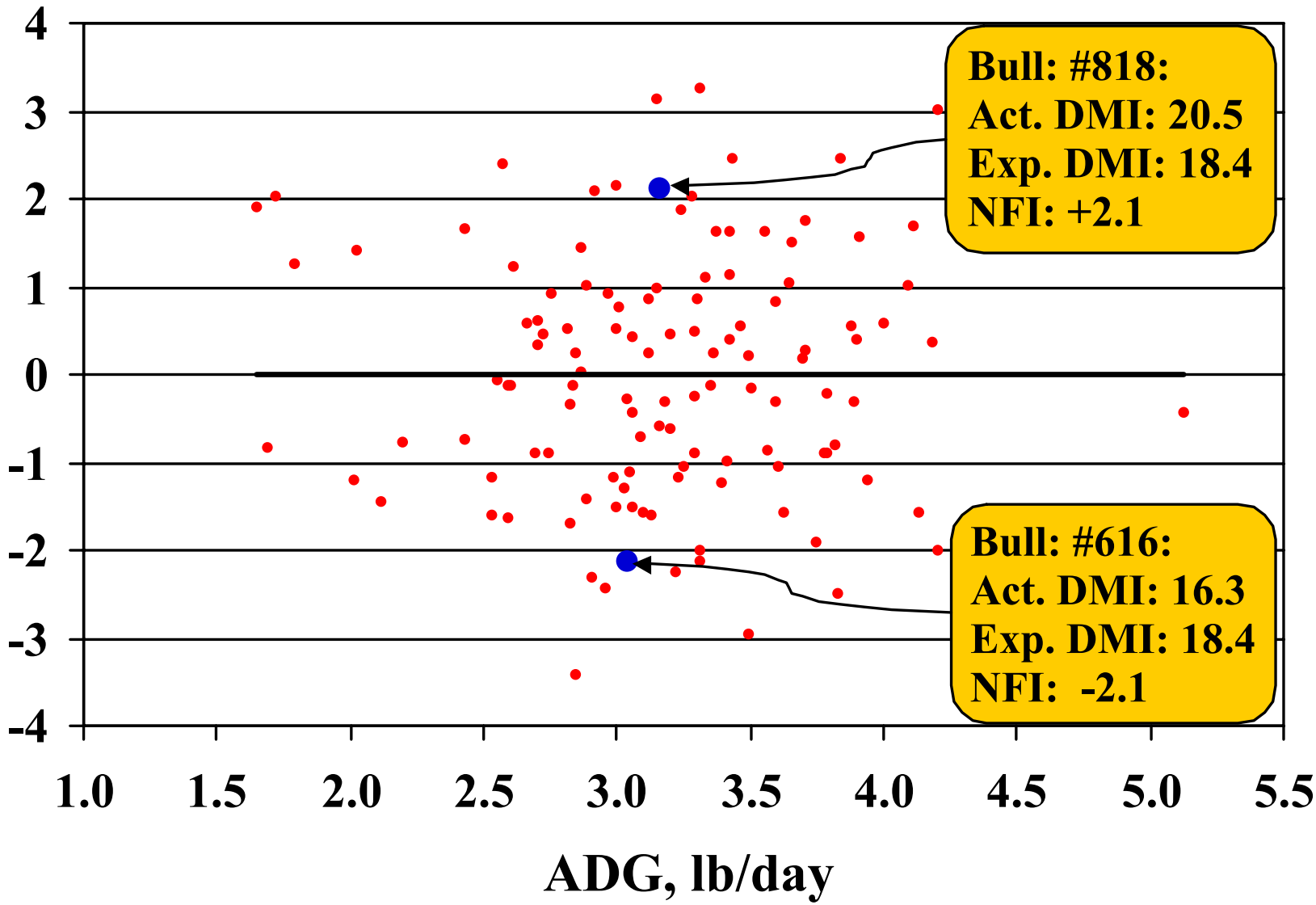
On test date: 7/14/04
Off test date: 11/3/04
Sr Ultrasound, HH, SC: 9/8/04
Jr Ultrasound, HH, SC: 11/3/04

GrowSafe Systems
Off Test Report

11/23/04

						Data collected on day 56 (Jr bulls) or 112 (Sr bulls)							112 day data				84 day data		
Owner	Breed	Reg #	Tattoo	BDC tag	DOB	Age Group	SC, cm	Hip Ht, in	Act REA, in^2	365-Adj REA, in^2	Rib Fat, in	% IMF	On Test BW, lb	Off Test BW, lb	365-Adj YW, lb	Test ADG, lb/d	DMI, lb/d	FCR, DMI/ADG	NFI, lb/d
Melvin Theriot	Angus	14683257	1223	659	10/28/03	Jr	40.00	48.50	11.70	11.80	0.21	2.63	710	992	975	2.52	13.45	4.73	-3.43
Wade Wallis	Angus	14698555	W21	802	9/29/03	Sr	38.00	48.00	9.10	9.30	0.20	1.65	720	1100	1010	3.39	16.10	4.61	-2.94
Alford Echols	Angus	14730504	679	849	10/12/03	Jr	39.00	50.25	12.40	12.10	0.22	2.24	828	1180	1110	3.14	18.61	4.86	-2.50
Melvin Theriot	Angus	14683241	1523	652	10/8/03	Jr	35.00	47.50	12.10	11.70	0.28	3.24	758	1055	988	2.65	15.63	5.29	-2.42
Melvin Theriot	Angus	14683268	1483	658	9/24/03	Sr	36.50	49.00	9.50	9.80	0.30	3.98	852	1130	1023	2.48	16.35	5.62	-2.31
Robert Ott	Brangus	R9669719	18N	735	11/03/03	Jr	31.00	52.00	10.54	10.52	0.39	3.44	746	1050	1047	2.71	16.24	5.05	-2.25
Jack Linder	Brangus	R9667179	419N16	742	11/02/03	Jr	37.50	52.50	13.42	13.37	0.21	2.16	848	1200	1194	3.14	18.68	5.65	-2.12
Robert Berger	Angus	14476436	3190	616	9/20/03	Sr	32.50	48.50	10.20	10.30	0.23	2.61	776	1090	977	2.80	16.30	5.37	-2.11
Robert Towns	Brangus	R9670487	7/N2	695	11/20/03	Jr	34.50	52.00	10.86	11.15	0.17	2.13	588	984	1025	3.54	16.88	4.02	-2.01

Results from first feed efficiency test at the Beef Development Center of Texas



Results from first feed efficiency test at the Beef Development Center of Texas

Trait	Most efficient bulls (low NFI)†	Least efficient bulls (high NFI)
Number of bulls	42	37
ADG, lb/d	3.35	3.26
Final BW, lb	1085	1078
Actual DMI, lb/d	17.4	20.3
Expected DMI, lb/d	18.8	18.6
NFI, lb/d	-1.4	+1.7
Feed:gain ratio	5.28	6.34

†Most and least efficient bulls were less or greater than 0.5 SD from the average

Challenges to adoption of NFI technology

- ✓ **Large overhead costs associated with centralized bull test**
- ✓ **Animal health concerns with centralized bull tests**
- ✓ **Reluctance by seedstock breeders to turn over management of high-value bulls to central test operators**
- ✓ **Additional costs of measuring NFI**

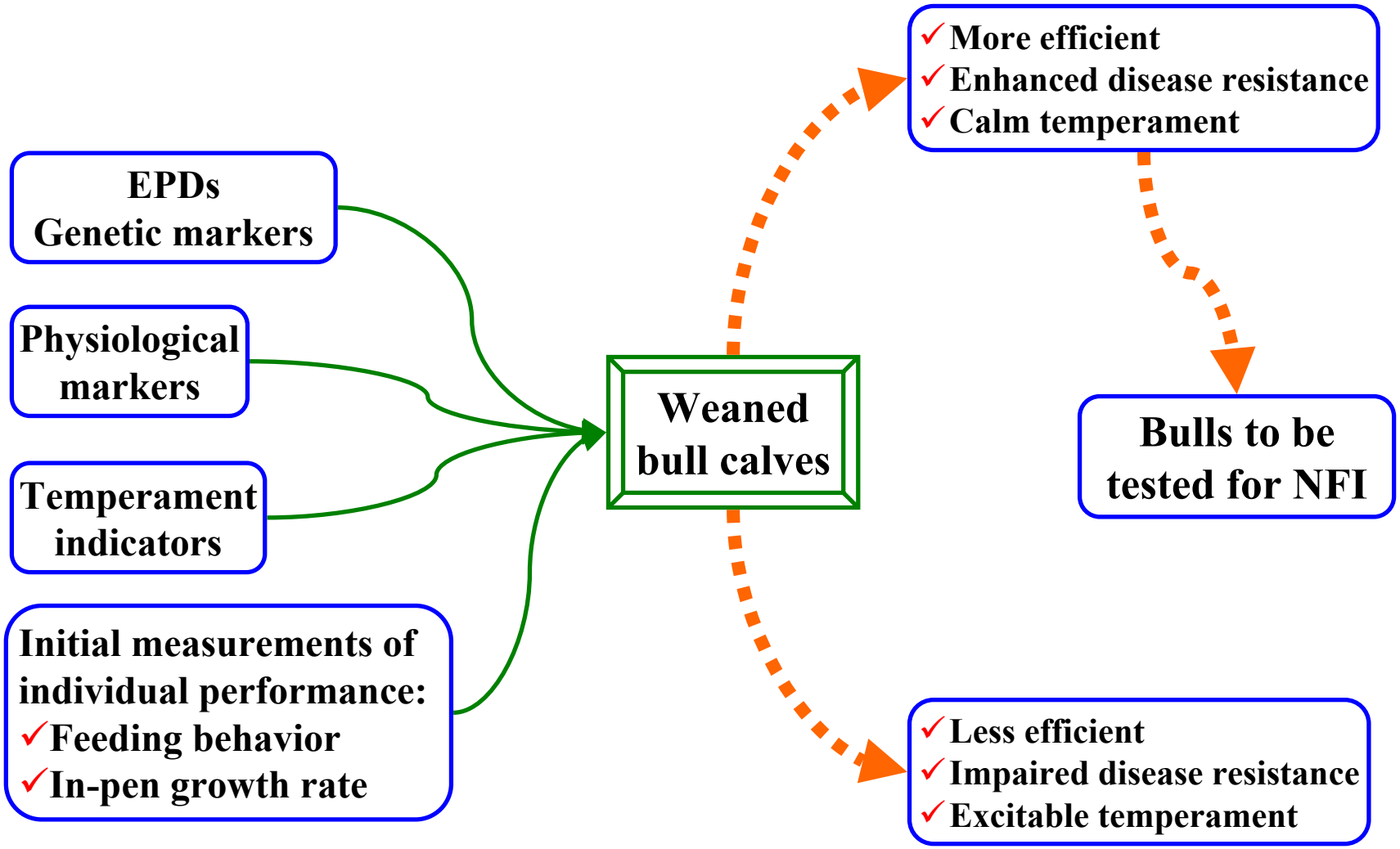
Reducing the cost of identifying bulls with superior genetic merit for NFI

- ✓ **Reduce length of time required to measure NFI:**
  - **Minimum length of 70 day test needed if bulls are weighed at 14-day interval to accurately measure ADG**
  - **Only 56 days required to accurately weigh feed intake**
  - **In-pen weighing system to collect more frequent weights could reduce length of test**

Reducing the cost of identifying bulls with superior genetic merit for NFI

- ✓ **Reduce number of bulls that need to be tested:**
  - **Seedstock breeders will not measure NFI of all their bulls**
  - **Modeling results from Australia have estimated that profit was generally maximized when only 10-20% of bulls were selected for NFI testing**
  - **Need other traits that are correlated with NFI and cheaper and easier to measure to "prescreen" bulls to be submitted for NFI testing**

Two-stage approach to identifying bulls with superior genetic merit for NFI



Correlations between serum IGF-I levels and performance traits in calves

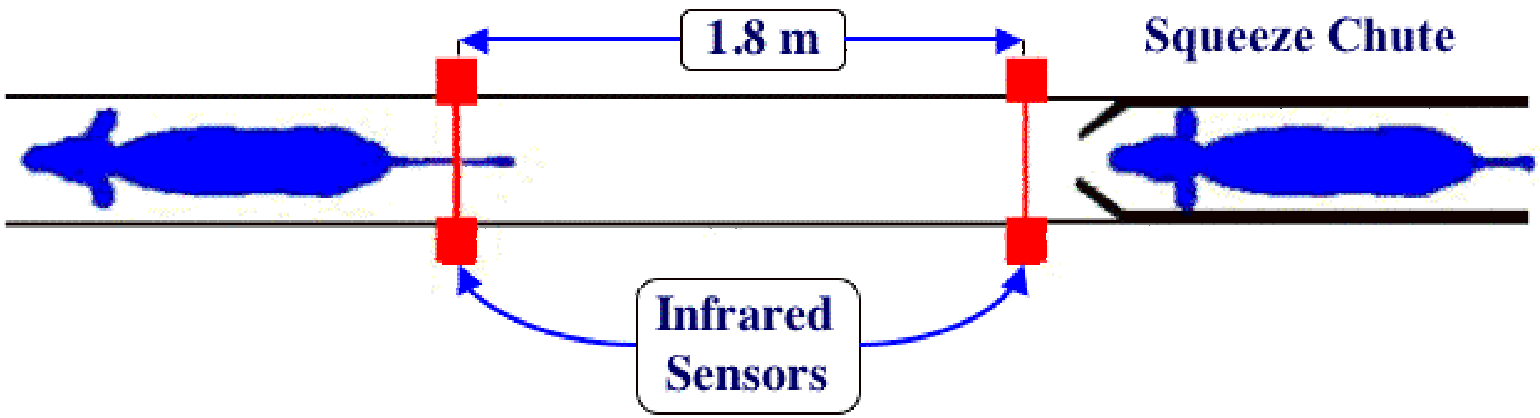
Trait	Johnston et al. 2002 IGF-I (r_g)	Braunvieh-sired steers IGF-I	Bonsmara bulls IGF-I
ADG	-0.20	-0.04	0.03
DMI	0.27	0.17†	0.29†
Feed:gain ratio	0.55	0.19*	0.36*
RFI	0.39	0.22*	0.38*
% reduction in low RFI	--	-29%	-25%

**P < 0.05; †P < 0.10*

Impact of temperament on production efficiency of growing calves

Exit velocity:

- ✓ **Objective measure of temperament**
- ✓ **Moderately heritable**
- ✓ **Moderately correlated to performance and carcass tenderness**

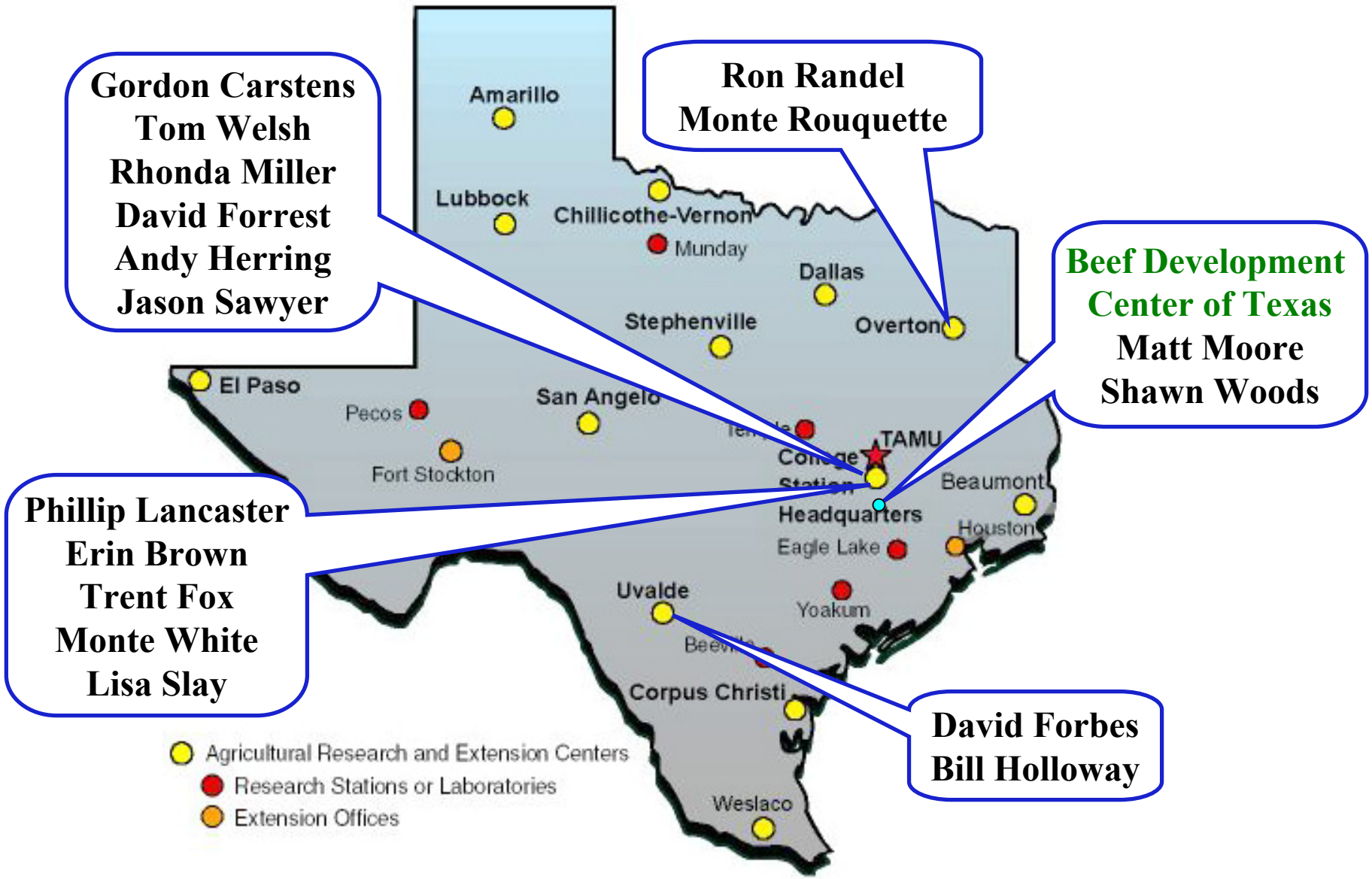


Correlations between exit velocity (EV) and efficiency traits in growing calves

Trait	Bonsmara bulls EV	Santa Gertrudis steers EV	Brangus heifers EV
Final BW	-0.32*	-0.28*	-0.24*
ADG	-0.25*	-0.25*	-0.11
DMI	-0.34*	-0.17†	-0.22*
Feed:gain ratio	-0.17	0.12	-0.07
RFI	-0.15	0.07	-0.09

**P < 0.05; †P < 0.10*

Current TAES researchers involved in the net feed efficiency research program



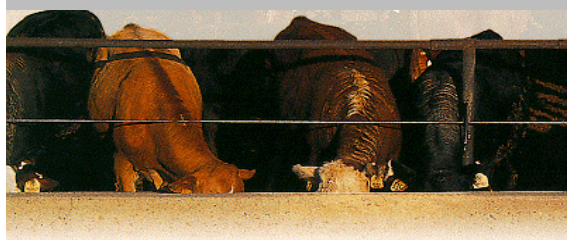
U.S. Bull Tests

Wisconsin BEEF Improvement Association

Northeast Colorado Bull Test Association

MIDLAND BULL TEST

Kansas Bull Test



BCIA
Productivity and Quality

Iowa Cattlemen's Association
PERFORMANCE TESTED

PROFIT MAKER Bulls

BULL TEST

Cal Poly