Cow Efficiency/Productivity: The MARC Perspective

USDA

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Cow efficiency

- Everybody wants it
  - But what is it?
  - Could be defined in multiple ways
    - Generally at focused on biological at USMARC:
      - Calves weaned/cow exposed
      - Calves weaned/(unit energy * cow exposed)
      - Total weaning weight/(unit energy * cow exposed)
    - Most of these measures are 'population based'
      - Traits on individuals affect expression

Components of cow efficiency

- Fertility
- Cow intake/energy requirements
  - Maintenance, lactation, gestation, immunity
- Calf survival
- Calf growth
- Calf intake
- Longevity

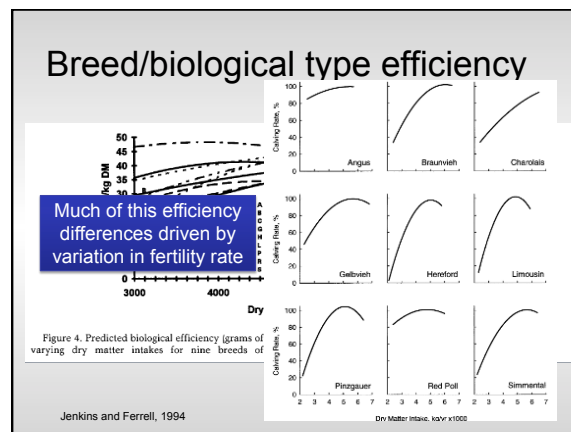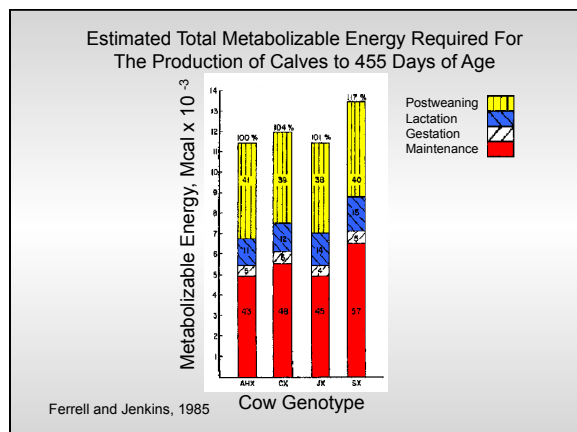Most predicted by other indirect measures

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Goals

- Review of some efficiency/lifetime productivity research at USMARC

- Current results relative to adult cow weight in the germplasm evaluation program (GPE)

- Future plans relative to GPE and cow intake

USMARC efficiency studies

USMARC cow efficiency research

- Impossible to discuss without referencing Ferrell and/or Jenkins
  - Evaluation of energy utilization in various systems and across various breed types

  - Optimal efficiency depends on breed type and available resources

  - Used cows from GPE and GPU programs

Estimated Total Metabolizable Energy Required For The Production of Calves to 455 Days of Age

Ferrell and Jenkins, 1985

Breed/biological type efficiency

Much of this efficiency differences driven by variation in fertility rate

Figure 4. Predicted biological efficiency (grams of varying dry matter intakes for nine breeds of

Jenkins and Ferrell, 1994

OUTPUT/INPUT DIFFERENCES AMONG BOS TAURUS X BOS TAURUS F₁ COWS (JENKINS ET AL., 1991)

Item	Overall mean	Breed group[a] (ratio)					
		HAx	RPx	BVx	GVx	MAx	Clx
Progeny (138.5 days)							
Weight gain, lb	346	97	99	103	100	103	98
Energy consumed, Mcal ME	744	106	102	99	96	98	99
Dams (138.5 days)							
Milk production, lb/day	8.8	85	101	118	111	104	82
Cow weight, lb	1,138	98	91	97	100	107	107
Fat probe, in	.25	124	101	91	93	90	101
Energy consumed, Mcal ME	3,787	91	96	105	105	100	104
Efficiency (138.5 days)							
Progeny gain, lb/Mcal ME calf + dam	.077	103	103	99	97	103	95

[a]HAx = Hereford or Angus, RPx = Red Poll, BVx = Brown Swiss, GVx = Gelbvieh, MAx = Maine Anjou, and Clx = Chianina sired F₁ crosses.

OUTPUT/INPUT DIFFERENCES AMONG BOS INDICUS X BOS TAURUS AND BOS TAURUS X BOS TAURUS F₁ COWS (GREEN ET AL., 1991)

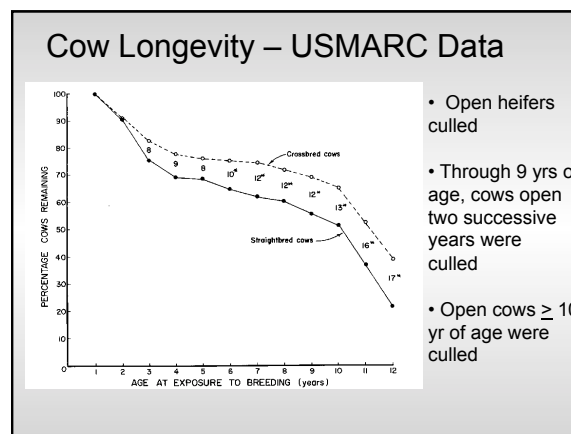| Item	Overall mean	Breed group[a] (ratio, %)			
		HAX	PzX	BmX	SwX
Progeny (126 days)					
Weight gain, lb	284.3	92	99	108	103
Energy consumed, Mcal ME	592.2	112	102	92	94
Dams (126 days)					
Milk production, lb/day	15.5	90	103	105	101
Cow weight, lb	1,236	98	100	105	97
Fat probe, in	.31	91	95	102	112
Energy consumed, Mcal ME	3,292	93	104	106	97
Efficiency (138.5 days)					
Progeny gain, lb/Mcal ME calf + dam	.073	95	95	104	106

[a]HAX = Hereford -Angus, PzX = Pinzgauer, BmX = Brahman, and SwX = Sahiwal crosses.

Synchronizing Genetic Resources with Feed Resources (Cundiff, 1981)[a]

Feed resources[b]		General purpose breeds		Maternal breeds		Terminal Sire breeds
Finishing progeny	Cow herd	Growth rate, mature size and leanness	Milk prod	Growth rate, mature size and leanness	Milk prod	Growth rate mature size and leanness
Low	Low	XX	XXX	X	XXX	XXX
Low	Mod.	XXX	XXXX	XX	XXXX	XXX
Low	High	XXX	XXXXX	XXX	XXXXX	XXXX
Mod.	Low	XX	XX	XX	XX	XXXX
Mod.	Mod.	XXX	XXX	XXX	XXX	XXXXX
Mod.	High	XXXX	XXXX	XXX	XXXX	XXXXX
High	Low	XXX	XX	XX	XX	XXXX
High	Mod.	XXXX	XXX	XXX	XXX	XXXXX
High	High	XXXXX	XXXX	XXXX	XXXX	XXXXXX

[a] Increasing X's reflect higher performance levels for growth rate, mature size and leanness or milk production.
[b] Low, moderate and high levels of energy for the cow herd or for growing and finishing progeny for slaughter.

Cow Longevity – USMARC Data

- Open heifers culled
- Through 9 yrs of age, cows open two successive years were culled
- Open cows ≥ 10 yr of age were culled

Effects of heterosis were greatest for
- Lifetime production (30%)
- Longevity or herd-life (15%)
- Annual income (23%)

LONGEVITY AND LIFETIME PRODUCTION TO 12 YRS OF AGE OF CROSSBRED AND STRAIGHTBRED COWS AMONG ANGUS, HEREFORD AND SHORTHORN (Nunez et al. and Cundiff et al.)

| Trait	Crossbred cows	Straightbred cows	Heterosis units	pct
Longevity (herd life, years)	9.7	8.4	1.3	15
Breeding seasons, no.	8.2	7.1	1.2	16
Pregnancies, no.	7.7	6.0	1.2	20
Calves born, no.	6.6	6.0	1.0	10
Calves weaned, no	6.2	5.2	1.0	20
Cumulative 200 d wt weaned, lb	2,798	2,156	642	30
Annual income (100 cow herd)	$16,524	$13,468	$3,056	23

Matching potential to resources

- Legitimate question as to whether these same genetic resources exist (at least in the same breed types)

- Certainly growth has changed energy inputs

- More time needed to evaluate longevity, survival, fertility

Differences in Cow Weights

Are we changing efficiency through selection for growth?

BREED GROUP MEANS (DEVIATIONS FROM HA & AH) FOR MATURE WEIGHT (ADJUSTED TO CONDITION SCORE OF 5.5) OF F1 CROSS COWS IN CYCLES I AND II (BIRTH YEARS: 1970-74) COMPARED TO CYCLE VII (BIRTH YEARS 1999-2000), LB
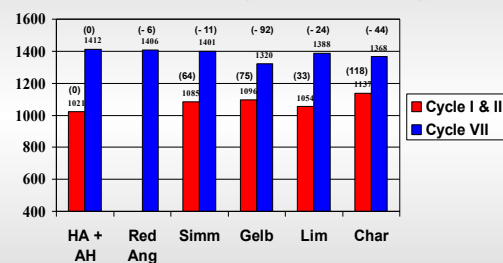
Genetic Trends for Yearling Weight, lb
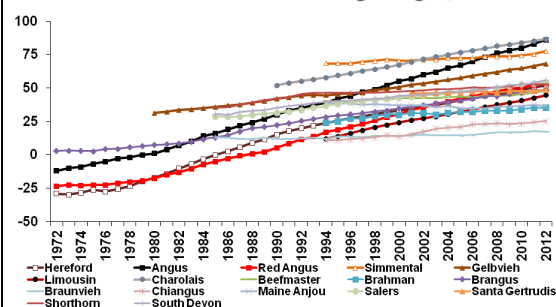
Adapted from Spring 2014 Genetic Trends from Breed Associations and 2014 AB-EPD factors

Cow weight differences same?

- Compare continuous GPE breeds
  - ~8 years since cycle VII sampling
  - Mature weight limited
    - Earlier weights are a proxy (highly correlated)
    - Weights at ~550, 920, 1280 d (1.5, 2.5, 3.5 yr)
    - Data not precise yet but give an indication
    - Weight are adjusted to constant body condition

Palpation weight (~1.5 yr)

Breed	GPE weight	Angus – Breed
Angus	950	0
Hereford	905	45*
Red Angus	920	30
Charolais	959	-9
Gelbvieh	968	-18
Limousin	912	39
Simmental	941	10
Brahman	941	9
Braunvieh	820	130***
Chiangus	887	63**
Maine Anjou	877	73**
Santa Gertrudis	942	8
Salers	884	66**
Shorthorn	907	43*

Palpation weight (~2.5yr)

Breed	GPE weight	Angus – Breed
Angus	1150	0
Hereford	1104	46
Red Angus	1094	56
Charolais	1186	-36
Gelbvieh	1128	22
Limousin	1083	67*
Simmental	1123	27
Brahman	1134	16
Braunvieh	950	200***
Chiangus	1079	71*
Maine Anjou	1086	64
Santa Gertrudis	1104	46
Salers	1079	71*
Shorthorn	1057	93**

Palpation weight (~3.5yr)

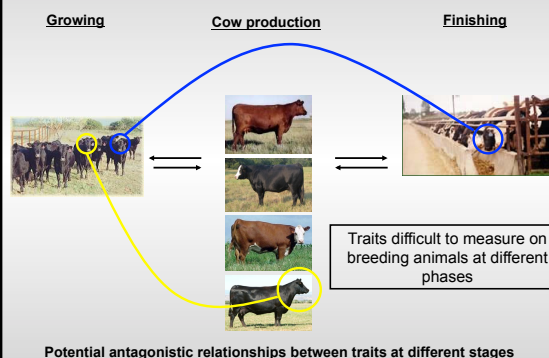| Breed	GPE weight	Angus – Breed
Angus	1250	0
Hereford	1238	12
Red Angus	1246	4
Charolais	1303	-53
Gelbvieh	1238	12
Limousin	1206	44
Simmental	1225	25
Brahman	1214	36
Braunvieh	1033	217***
Chiangus	1154	96*
Maine Anjou	1210	40
Santa Gertrudis	1207	43
Salers	1201	49
Shorthorn	1168	82

Cow Weights

- Some breeds have moderated while others are larger than at Cycle VII

- Seems to be a real opportunity for breed complementarity

- These results are preliminary
  - Would like a few more years of data.

Cow intake plans

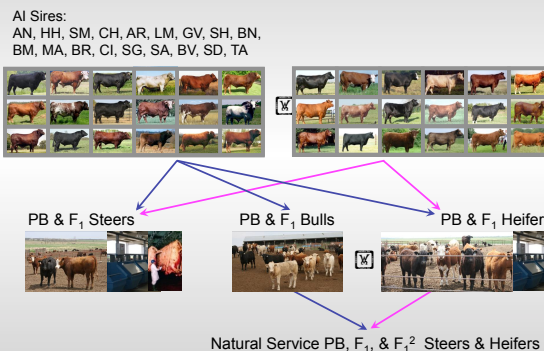Evaluating individual cow intakes and variation in efficiency beyond weights

Cattle lifecycle

<u>Growing</u>   <u>Cow production</u>   <u>Finishing</u>

Traits difficult to measure on breeding animals at different phases

Potential antagonistic relationships between traits at different stages

Feed efficiency

- We've been highly focused on steer efficiency

- Greatest/most variable input is cow cost

- Need to determine relationships between intake/feed efficiency of steer, heifer, and cow

GPE Target Population Structure

AI Sires:
AN, HH, SM, CH, AR, LM, GV, SH, BN, BM, MA, BR, CI, SG, SA, BV, SD, TA

PB & F_1 Steers   PB & F_1 Bulls   PB & F_1 Heifers

Natural Service PB, F_1, & F_1^2 Steers & Heifers

GPE feed intake

- Have been sampling new heifers in GPE (330-400/yr) since 2009

- We will be reevaluating these same animals (unculled) as 5-yr old cows starting this year
  - Calen gates
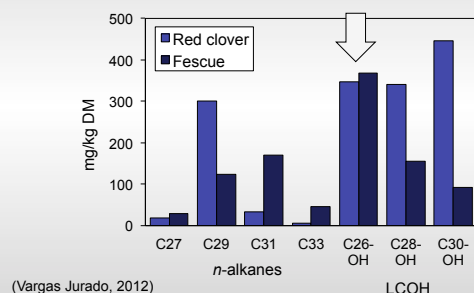 - Approximating hay diet
  - Reflect grass consumption?

Fed vs. grass intake in cows

- Eating behavior of cows on drylot likely different than on pasture
  - No selection
    - Energy and protein content less variable
    - Diet preference likely varies from animal to animal

  - Change in time spent eating
    - May be less opportunity on grass to overeat

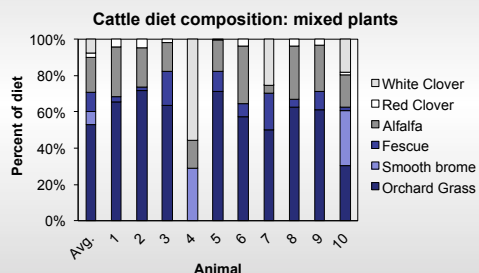 - Real need to validate similarities

Possible solution

- Markers of intake on pasture
  - Waxy markers on plant
    - Long hydrocarbons (*n*-alkanes)
    - Odd number of Carbon molecules
    - Dose with even-chain *n*-alkanes.
    - Can predict intake and differentiate plant materials

  - Collaborations with University of Nebraska
    - Ron Lewis
    - Requires 'dosing' cows while on pasture

Characterize plants (simple mixture)

(Vargas Jurado, 2012)

Prediction (complex mixture)

Cattle diet composition: mixed plants

Legend:
- White Clover
- Red Clover
- Alfalfa
- Fescue
- Smooth brome
- Orchard Grass

Y-axis: Percent of diet (0% – 100%)
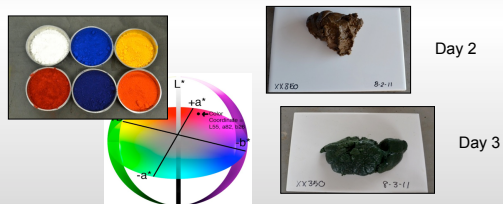X-axis: Animal (Avg., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10)

Extension to pasture: dosing

Extension to pasture: sampling

- Need to link fecal sample to an animal

Day 2

Day 3

Extension to pasture: sampling

Plan

- Have characterized the forage composition on several pasture paddocks at USMARC
- Limited on ability to measure large numbers of cows simultaneously
- Will take a portion of cows from planned feed intake (Calen gates) to validate energy and protein intake

Future possibilities

- Fecal sampling without supplementation
  - DNA identification of animal from fecal sample
  - Prediction of intake without fed marker?
    - Noisier – passage rate, digestion variable
- Larger monitoring of feed disappearance in pasture paddocks
  - Design of animals in paddock group critical
    - Evaluate sire? Haplotypes?

Closing

- Cow herd efficiency remains important at USMARC
  - Much of focus is on cost of maintaining cow herd to increase chance of producing calves each year
  - Measures of income potential continue to be monitored as part of GPE
    - Weight, survival, fertility, longevity, etc.

Acknowledgements

Questions

- Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the USDA and does not imply approval to the exclusion of other products that may be suitable.