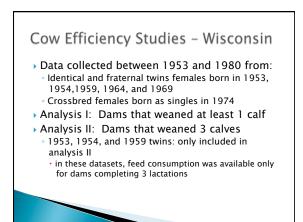


### The Search for the Elusive Optimum Cow

"The optimum beef cow is indeed an elusive beast. I have searched for her for more than 20 years, and have come up empty handed. But I believe I'm getting close".

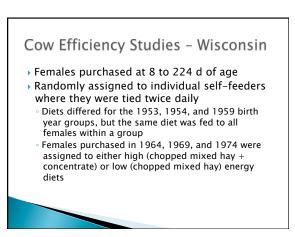






ear of Birth	Analysis I	Analysis II
953		6
954		8
959		8
964	37	22
969	45	33
974	56	33

Year 1953	Breed Composition of Dams
1953	Breed composition of Ballis
	Hereford
1954	Hereford
1959	Hereford
1964	Hereford (except one twin set each of Hereford x Guernsey, Hereford x Shorthorn, Hereford x Holstein, and Hereford x Brown Swiss)
1969	17 Herefords, 2 Hereford x Shorthorn, 2 Hereford x Charolais, and 24 Holsteins
1974	14 Hereford x Holstein, 14 Angus x Holstein, 15 Simmental x Holstein, 13 Chianina x Holstein



### Cow Efficiency Studies – Wisconsin

- Individual feed consumption measured at 28d intervals from the time females were placed on the experiments until 3 calves were weaned or the dams reached 5 yr of age
- Calves received creep feed starting at 60 d of age in 1953, 1954, and 1959, and at 28 d of age in the other experiments
  - Ad libitum individual pre- and postweaning feed consumption of progeny was measured

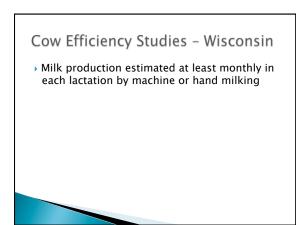
Cow Efficiency Studies – Wisconsin
Weaning weights of calves adjusted to a 240d of age basis
Previous research (Carpenter et al., 1972; Marshall et al., 1976; Wagner, 1978) has shown cows weaning male calves tend to be more efficient than those with female progeny
Therefore, progeny weights and feed consumptions were adjusted for sex using additive adjustment factors

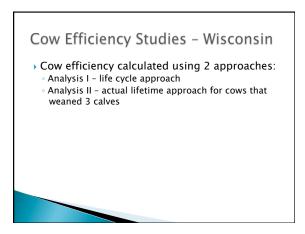
### Cow Efficiency Studies – Wisconsin

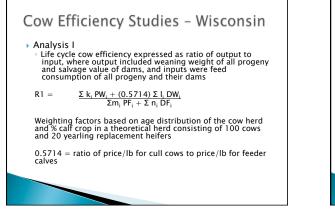
- Twin females bred at 1<sup>st</sup> observed estrus after 15 mo of age and at each succeeding estrus
   Crossbred females purchased in 1974 were
- bred at 1<sup>st</sup> detected estrus (puberty) and at each subsequent estrus
- Following each calving, all dams were bred at 1<sup>st</sup> estrus and at each subsequent estrus
   (i.e., year-round calving)

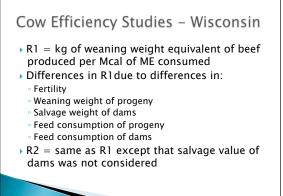
### Cow Efficiency Studies - Wisconsin

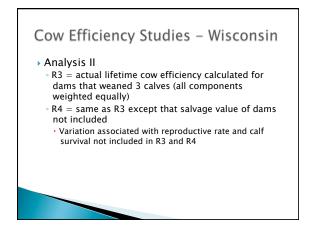
Year	Breed of Sire
1953	Hereford
1954	Hereford
1959	Hereford
1964	Polled Hereford
1969	Hereford cows mated to Holstein bulls; Holstein cows mated to Hereford bulls
1974	Jersey bulls used to produce 1 <sup>st</sup> parity calves and Charolais bulls used to produce 2 <sup>nd</sup> and 3 <sup>rd</sup> parity calves
	calves





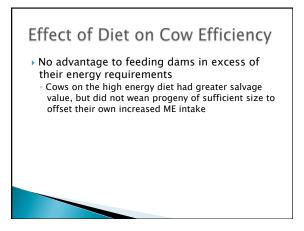


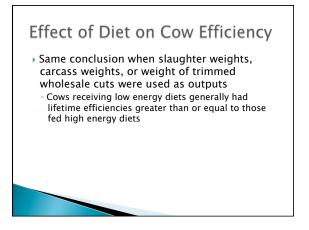


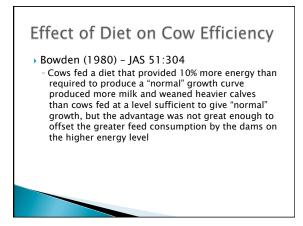


	R1	R2	R3	R4
Year-diet	P= 0.03	P < 0.001	P = 0.56	P < 0.01
1964-high	0.0230	0.0177	0.0299	0.0200
1964-low	0.0261	0.0218	0.0314	0.0232
1969-high	0.0254	0.0211	0.0303	0.0218
1969-low	0.0258	0.0218	0.0308	0.0231

Effect	of Die	t on Co	ow Effic	ciency
	R1	R2	R3	R4
Year-diet	P = 0.14	P = 0.14	P= 0.19	P = 0.43
1974-high	0.0238	0.0196	0.0302	0.0219
1974-low	0.0249	0.0207	0.0291	0.0213







### Effect of Diet on Cow Efficiency

 Holloway et al. (1975) - JAS 41:855
 Level of winter supplement of dam generally did not affect the efficiency of conversion of DE intake by dam or by dam and progeny into weaning weight of progeny

#### Breed Group Effects – 1964, 1969

	R1	R2	R3	R4
Breed Group	P < 0.01	P = 0.01	P < 0.01	P < 0.01
Hereford	0.0257	0.0209	0.0317	0.0227
Hereford x dairy	0.0247	0.0205	0.0304	0.0219
Hereford x beef	0.0273	0.0227	0.0321	0.0234
Holstein	0.0225	0.0184	0.0281	0.0202

### Breed Group Effects - 1964, 1969

- Hereford x beef dams were most efficient, followed in order by Herefords, Hereford x dairy, and Holstein dams
  - Holstein cows least efficient
  - Even though they produced progeny with heavier weaning weights and lower creep feed consumption, and had greater salvage value than the other breed groups
  - Low efficiency ratios of the Holstein dams were associated with their large ME intake
  - Efficiency of Holstein dams likely would improve if they were mated to a larger breed of sire to produce progeny with sufficient growth potential to utilize their milk output
     Were mated to Hereford bulls in this study

## Breed Group Effects – 1964, 1969 Hereford or Hereford x beef dams were also most efficient, followed by Hereford x dairy and Holstein dams when slaughter weights, carcass weights, or trimmed wholesale cut weights were used as output

Breed Effects on Cow Efficiency
<ul> <li>Holloway et al. (1975) - JAS 41:855</li> <li>No significant differences in ability of Hereford, Hereford x Holstein, or Holstein dams mated to Angus and Charolais sires for their first and second calves, respectively, to convert DE of cow or of cow and calf into weaning weight of calf</li> </ul>

Hereford x	P = 0.22	P = 0.15	P = 0.59	
Holstein	0.0256	0.0215	0.0305	P = 0.48 0.0224
Angus x ( Holstein	0.0241	0.0198	0.0294	0.0214
Simmental x Holstein	0.0243	0.0202	0.0297	0.0217
Chianina x ( Holstein	0.0234	0.0191	0.0290	0.0208

### Breed Group Effects - 1974

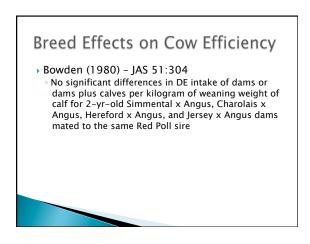
- Breed differences not significant
   Hereford x Holstein dams ranked highest for all 4 measures of efficiency, followed in order by Simmental x Holstein, Angus x Holstein, and Chianina x Holstein dams
  - Progeny of Simmental x Holstein and Chianina x Holstein dams were most efficient in conversion of feed into postweaning gain
  - Very similar life cycle and actual lifetime efficiency ratios for 1974 breed groups when pre- and postweaning periods were combined

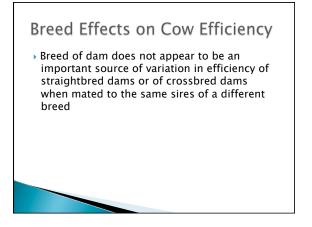
# Breed Effects on Cow Efficiency Carpenter et al. (1972) - Texas Agr. Exp. Sta. Prog. Rep. 3118, pp. 27-30 Charolais cows slightly more efficient than Hereford

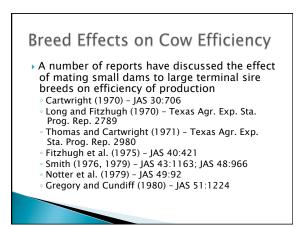
cows when feed efficiency was measured as the ratio of calf weaning weight to feed consumption of the cow and calf during lactation

# Breed Effects on Cow Efficiency

- Marshall et al. (1976) JAS 43:1176
   No significant breed of dam effects for cow efficiency at weaning, although Angus dams tended to have efficiency ratios superior to those of Charolais or crossbred dams
- Wagner (1978) Ph.D. Dissertation
   Breed of dam not an important source of variation for weaning efficiency of Angus, Hereford, Charolais, and reciprocal cross dams





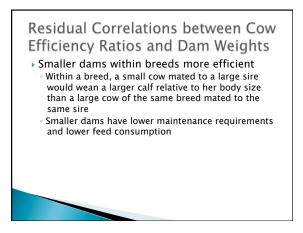


## Breed Effects on Cow Efficiency Wisconsin study - mating Hereford x Holstein dams to small Jersey sires in the first parity to minimize calving difficulty and to large Charolais sires in subsequent parities to exploit complementarity may result in superior biological efficiency Appears to be advantageous to challenge a cow by mating her to as large a bull as possible within the limitations imposed by calving difficulty



- Weaning rate had a highly significant effect on life cycle cow efficiency (R1 and R2)
   As weaning rate increased, R1 and R2 increased
  - Emphasizes the importance of fertility and calf survival
  - Dams weaning less than the maximum number of progeny allowable are unlikely to exhibit superior life cycle efficiencies

	dual Cor ency Ra			een Cow Weights
Trait	R1	R2	R3	R4
DW <sub>1</sub>	-0.36**	-0.41**	-0.24**	-0.46**
DW <sub>2</sub>	-0.31**	-0.36**	-0.27**	-0.47**
DW <sub>3</sub>	-0.42**	-0.47**	-0.24**	-0.50**



# Relationship between Cow Size and Efficiency

- Excellent review by Morris and Wilton (1976) JAS 56:613
- Melton et al. (1967) Texas Agr. Exp. Sta. Prog. Rep. 2485, pp 11-13
   Within both Herefords and Charolais, small cows were more efficient
- Kress et al. (1969) JAS 29:373
   Light and heavy cows about equal in efficiency when salvage weight of cow considered
   Lighter cows more efficient when salvage value ignored

# Relationship between Cow Size and Efficiency Carpenter et al. (1972) - Texas Agr. Exp. Sta. Prog. Rep. 3118, pp 27-30 Measured cow efficiency as the ratio of calf weaning weight to feed consumption of cow and calf during lactation Trend existed within breeds for cows with smaller mature weights to be more efficient

# Relationship between Cow Size and Efficiency

- Klosterman et al. (1974) Ohio Agr. Res. Devel. Center Bull. No. 77, pp 77-80
   Found no significant differences in efficiency to weaning among small, medium, and large cows, although small cows tended to be more efficient
- Marshall et al. (1976) JAS 43:1176
   Found no relationship between cow weight and efficiency

Trait DFo	<b>R1</b> -0.06	R2 -0.07	R3 -0.04	R4 -0.13
DF <sub>1</sub>	-0.29**	-0.29**	-0.63**	-0.64**
DF <sub>2</sub>	-0.19*	-0.17*	-0.51**	-0.43**
DF3	-0.58**	-0.49**	-0.41**	-0.44**

#### Relationship of Cow Efficiency with Feed Intake of Dams

- Kress et al. (1969) JAS 29:373
   Dams that ate less during lactation were more efficient
- Carpenter et al. (1972) Texas Agr. Exp. Sta. Prog. Rep. 3118, pp 27–30
- Reported a correlation of -0.43 between efficiency and feed consumption of dam during lactation
- Marshall et al. (1976) JAS 43:1176
   Reported a small undesirable correlation between efficiency and cow TDN intake from weaning of one calf to weaning of next calf

		R1	R2	R3	R4
$V_3$ 0.16 0.17* 0.15 0.23*	W <sub>1</sub>	0.14	0.13	0.18	0.25**
<b>b</b>	W <sub>2</sub>				
PW, 0.64** 0.70** 0.20* 0.31**	W <sub>3</sub>				
	. PW	0.64**	0.70**	0.20*	0.31**

Relationship of Cow Efficiency with Progeny Weights

- Sum of progeny weights was more highly correlated with R1 (r = 0.64) and R2 (r = 0.70) than the sum of dam weights, dam feed consumption, or progeny feed consumption
- Marshall et al. (1976) reported a large favorable association between weaning weight and efficiency (r = 0.87), as did Carpenter et al. (1972; r = 0.71)

				ncy with
_	-			Imption
Trait	R1	R2	R3	R4
PF <sub>1</sub>	0.03	0.02	0.05	0.03
PF <sub>2</sub>	0.08	0.09	0.21*	0.16
PF <sub>3</sub>	0.04	0.04	0.07	0.11
Σ PF <sub>i</sub>	0.43**	0.47**	0.15	0.15

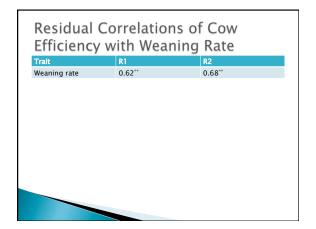
#### Relationship of Cow Efficiency with Progeny Creep Feed Consumption

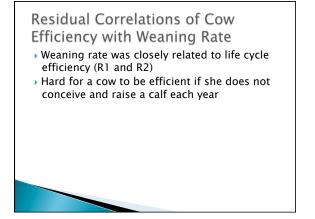
- Within parity correlations of progeny creep feed consumption with efficiency were not significant
- ME intake of progeny summed over all parities had significant positive correlations with life cycle efficiency (R1 and R2)
- Efficiency improved as creep intake of progeny increased
   Carpenter et al. (1972) and Marshall et al. (1976) found small favorable correlations between feed intake of progeny and weaning efficiency

Trait	R1	R2	ge at Ca R3	R4
Age at puberty	-0.13	-0.14	-0.55**	-0.54**
Age at 1 <sup>st</sup> calving	-0.10	-0.11	-0.51**	-0.49**
Age at 2 <sup>nd</sup> calving	-0.09	-0.08	-0.60**	-0.51**
Age at 3 <sup>rd</sup> calving	-0.35**	-0.29**	-0.67**	-0.60**

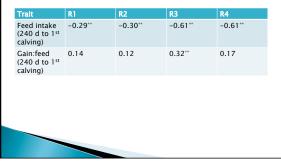
# Relationship of Cow Efficiency with Age at Puberty and Age at Calving

- Only dams born in 1974 were bred at puberty
   Residual correlations of age at puberty with actual lifetime efficiency (R3 and R4) were highly significant
- Decreased age at 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> calving had large favorable relationships with R3 and R4
- Cows that reached puberty at an early age and calved at early ages throughout their lives were most efficient





### Relationship of Cow Efficiency with Feed Consumption and Gain:Feed from 240 Days to First Calving



#### Relationship of Cow Efficiency with Feed Consumption and Gain:Feed from 240 Days to First Calving Feed consumption of heifers from start of test at 240 d of age until 1<sup>st</sup> calving was an important component of lifetime efficiency Heifers that had more efficient weight gains from the start of test until 1<sup>st</sup> calving were more efficient producers of weaned calves Also true when slaughter weights, carcass weights, and trimmed wholesale cut weights used as outputs Kress et al. (1969) reported favorable correlations between feed efficiency from 240 d to 15 mo of age and cow efficiency in each lactation

	Relationship of Cow Efficiency with 240–Day Heifer Traits			
Trait	R1	R2	R3	R4
240-d wt	-0.07	-0.08	-0.06	-0.14
240-d ht	-0.08	-0.08	-0.10	-0.17
240-d wt/ht	-0.06	-0.08	-0.04	-0.12

# Relationship of Cow Efficiency with 240-Day Heifer Traits

- Correlations with 240-d weight, height, and weight:height ratio were small and nonsignificant
  - These traits would not be good indicators of subsequent efficiency as a cow
  - Hawkins et al. (1965) JAS 24:848 (Abstract)
  - Did not find a significant relationship between yearling weight of a heifer and her subsequent calf production

Trait	R1	R2	R3	R4
Wt - 1 <sup>st</sup> calv.	-0.25**	-0.28**	-0.39**	-0.51**
Wt - 2 <sup>nd</sup> calv.	-0.34**	-0.36**	-0.44**	-0.59**
Wt - 3 <sup>rd</sup> calv.	-0.52**	-0.53**	-0.39**	-0.56**
Ht - 1 <sup>st</sup> calv.	-0.22**	-0.24**	-0.15	-0.23*
Ht - 2 <sup>nd</sup> calv.	-0.34**	-0.37**	-0.26**	-0.33**
Ht - 3rd calv.	-0.29**	-0.31**	-0.16	-0.26**



- Residual correlations of efficiency ratios with weight at calving were negative and highly significant in all instances
   Smaller dams were more efficient even when cow
- salvage value was included in the efficiency ratio • Correlations between efficiency estimates and
- height at calving ranged from -0.15 to -0.37 • Kress et al. (1969) found that cow height had only a small association with efficiency

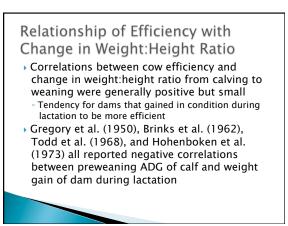
Trait	R1	R2	at Calvir R3	R4
Wt:ht ratio - 1st calving	-0.22**	-0.25**	-0.42**	-0.53**
Wt:ht ratio - 2 <sup>nd</sup> calving	-0.28**	-0.31**	-0.44**	-0.58**
Wt:ht ratio - 3 <sup>rd</sup> calving	-0.52**	-0.53**	-0.40**	-0.58**

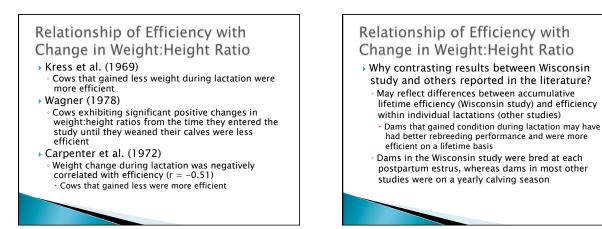
## Relationship of Cow Efficiency with Weight:Height Ratio at Calving Weight:height ratio at calving was negatively and significantly correlated with efficiency Inclusion of salvage weight of cow in the efficiency ratios tended to reduce the degree of association with weight:height ratio Fatter cows were heavier and had greater salvage value

#### Relationship of Cow Efficiency with Weight:Height Ratio • Kress et al. (1969) • Cows with greater weight:height ratios were less

- efficient Marshall et al. (1976) More highly conditioned cows tended to wean lighter calves and were less efficient when cow
- weight and milk production were held constant

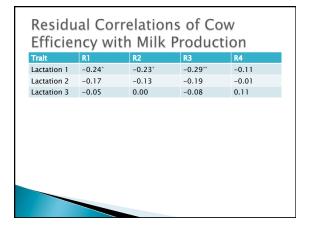
Trait Change in wt:ht, lact. 1	R1 0.00	<b>R2</b> -0.03	R3 0.37**	<b>R4</b> 0.18
Change in wt:ht, lact. 2	0.06	0.00	0.35**	0.24*
Change in wt:ht, lact. 3	0.14	0.08	0.21*	0.05





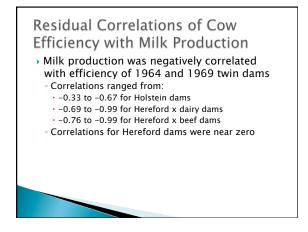
#### Relationship of Efficiency with Change in Weight:Height Ratio

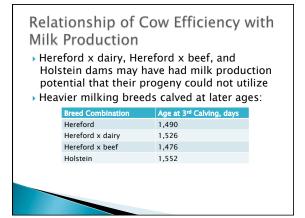
 Change in condition during lactation needed to maximize biological efficiency may also be related to milk production levels of breeds involved in the different studies

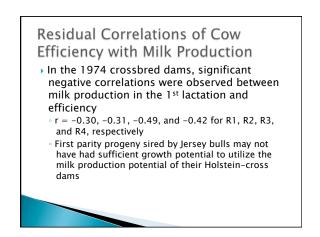


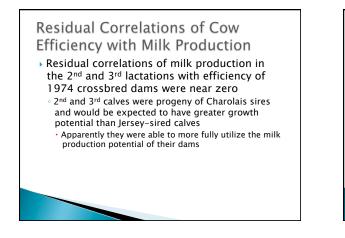
#### Residual Correlations of Cow Efficiency with Milk Production

- Relationship between 4% fat-corrected milk production and efficiency tended to be negative
  - However, correlations of R3 and R4 with milk production tended to be positive for 1950's twin cows
  - Correlations between R4 and milk production in the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> lactations were 0.59, 0.47, and 0.70, respectively









### Relationship of Cow Efficiency with Milk Production

- Kress et al. (1969), Carpenter et al. (1972), Marshall et al. (1976)
   Reported greater efficiency in heavier milking cows
- Holloway et al. (1975)
   No significant differences in efficiency among Hereford, Holstein, and Hereford x Holstein cows
- K. C. Davis et al. (1994) JAS 72:2591
   For northern range production systems, breed groups of moderate mature size and milk production will be more profitable than extreme types for growth and milk production

### Relationship of Cow Efficiency with Milk Production

 Increased milk production only desirable if the extra milk can be consumed and converted into weaning weights of sufficient magnitude to offset the increased energy intake required by the dams to produce the milk

### Relationship of Cow Efficiency with Milk Production

- Willham (1972) JAS 34:864
  - If feed resources are fixed, milk production should not exceed a level that prevents sufficient nutrients for successful rebreeding
- Notter et al. (1979) JAS 49:70
   Increases in milk production that reduced weaning weight per cow exposed by decreasing pregnancy rates reduced economic efficiency
- Increased milk levels improved biological efficiency only if they resulted in improved weaning rates

# Relationship between Weaning and Slaughter Efficiency

- Dams that were efficient in the production of weaning weight were also efficient producers of slaughter weight, carcass weight, and trimmed wholesale cut weight
  - Correlations among efficiency estimates calculated at weaning and slaughter endpoints were 0.88 or above

### Relationship among Efficiency Estimates at Slaughter

 Correlations among efficiency estimates based on slaughter weights, carcass weights, and trimmed wholesale cut weights were large (0.93 or above)

# Relationship between Weaning and Slaughter Efficiency

 No serious antagonisms appear to exist between pre- and postweaning efficiency
 Systems of production that maximize weaning efficiency should be effective in maximizing efficiency to the slaughter endpoint

