Suitable animals for forage based production system: Raising of economically efficient cow

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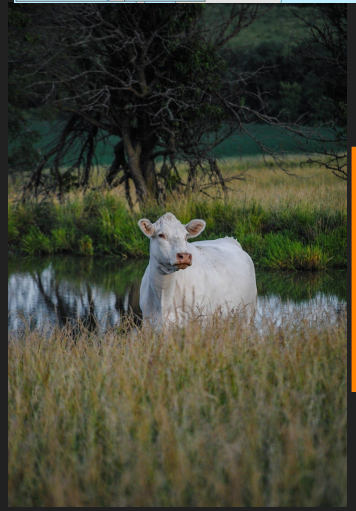
University of Tennessee - Animal Science
Estonian Cattle Breeders Training
November 27, 2023

About Me:

- Raised on a Charolais Farm in Iowa
- Ph.D. at the University of Missouri
- Assistant Professor – University of Tennessee



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My Research Group

Ultimate Goal: Connect animal genotypes to phenotypes

- Better predict animal's performance using genetics and genomics
- Deliver more effective selection tools to producers

Basic research

- Understanding heterosis
- Genotyping strategies (optimize resources)
- Develop new genotyping approaches

Applied research

- Novel phenotype development
- Genotyping strategies (i.e., low-pass sequencing)
- Deliver resources to producers
- Direct industry application

My “Extension” and Outreach Program

Local: Tennessee Master Beef Producer Program

- Educational program trains > 2,500 produces per year
- Cross-industry training (Genetics, nutrition, reproduction, health, welfare)
- Tied to obtaining state agricultural subsidies
    - Genetics, working facilities, equipment, animal health products

National: Beef Improvement Federation

- Sets phenotype and genetic evaluation guidelines for breed associations
- Joint effort between academics, industry, breed associations, and producers

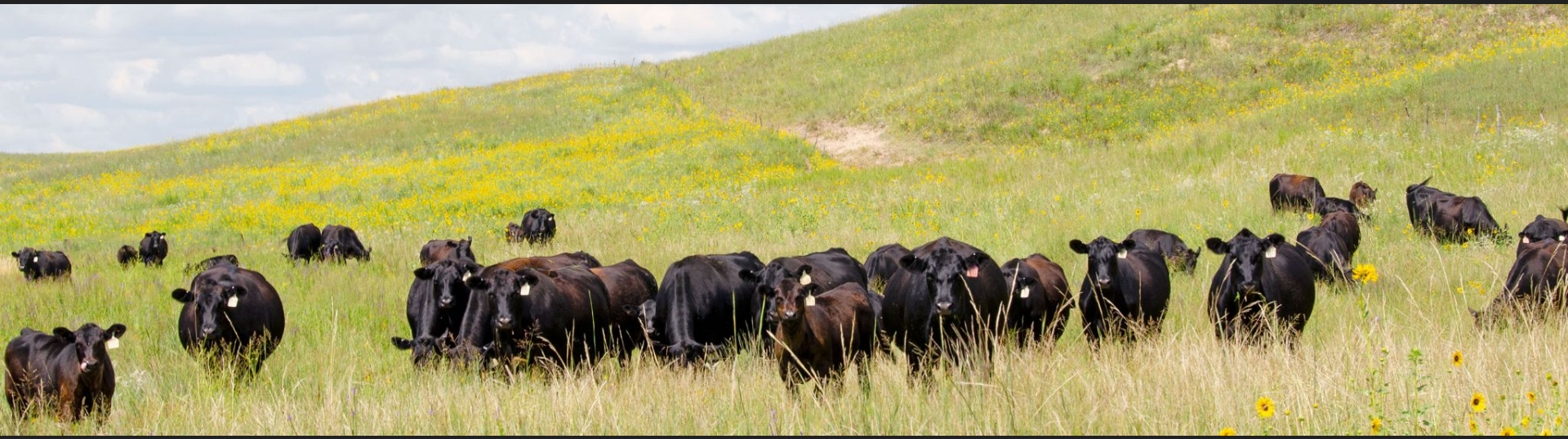
Programming focus

- Cow efficiency
- Crossbreeding & heterosis
- Genomics for the commercial herd
- Bull selection
- Selection Indexes

Tennessee's Beef Industry

- Plentiful rain, temperate climate
  - 127 cm rain annually
  - Average high 37˚C in July
  - Average low in January is -1˚C
- Tall fescue is predominant forage
- Small herds (Average size < 30)
- Mainly cow-calf production
- "High-risk" backgrounding operations
- No feedlots, few remaining dairies

Sustainable Beef Production




Efficiency
Profitability
Sustainability
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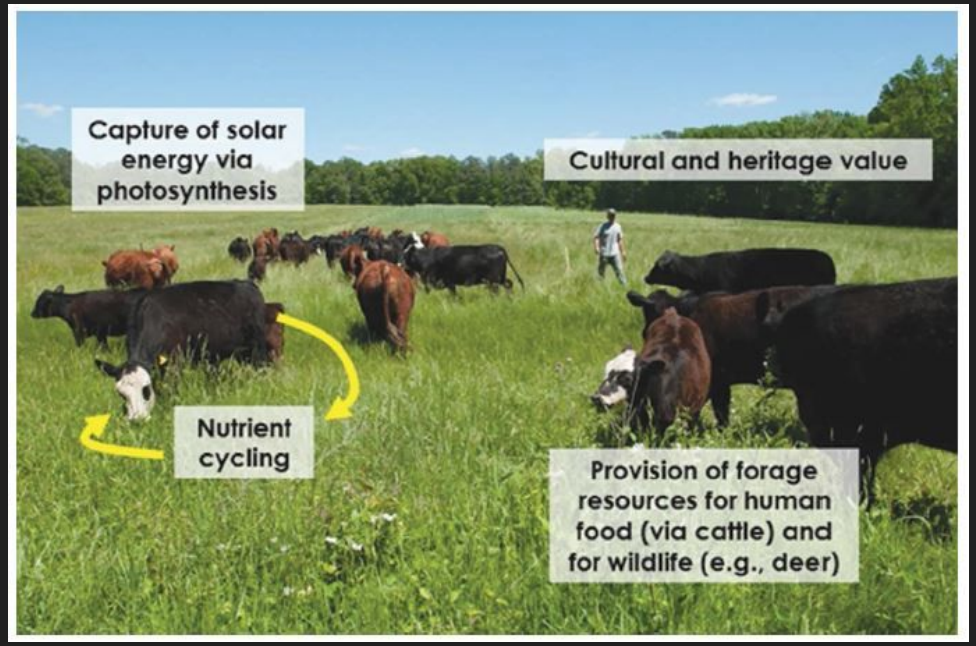
Cattle “upcycle” human-inedible forage

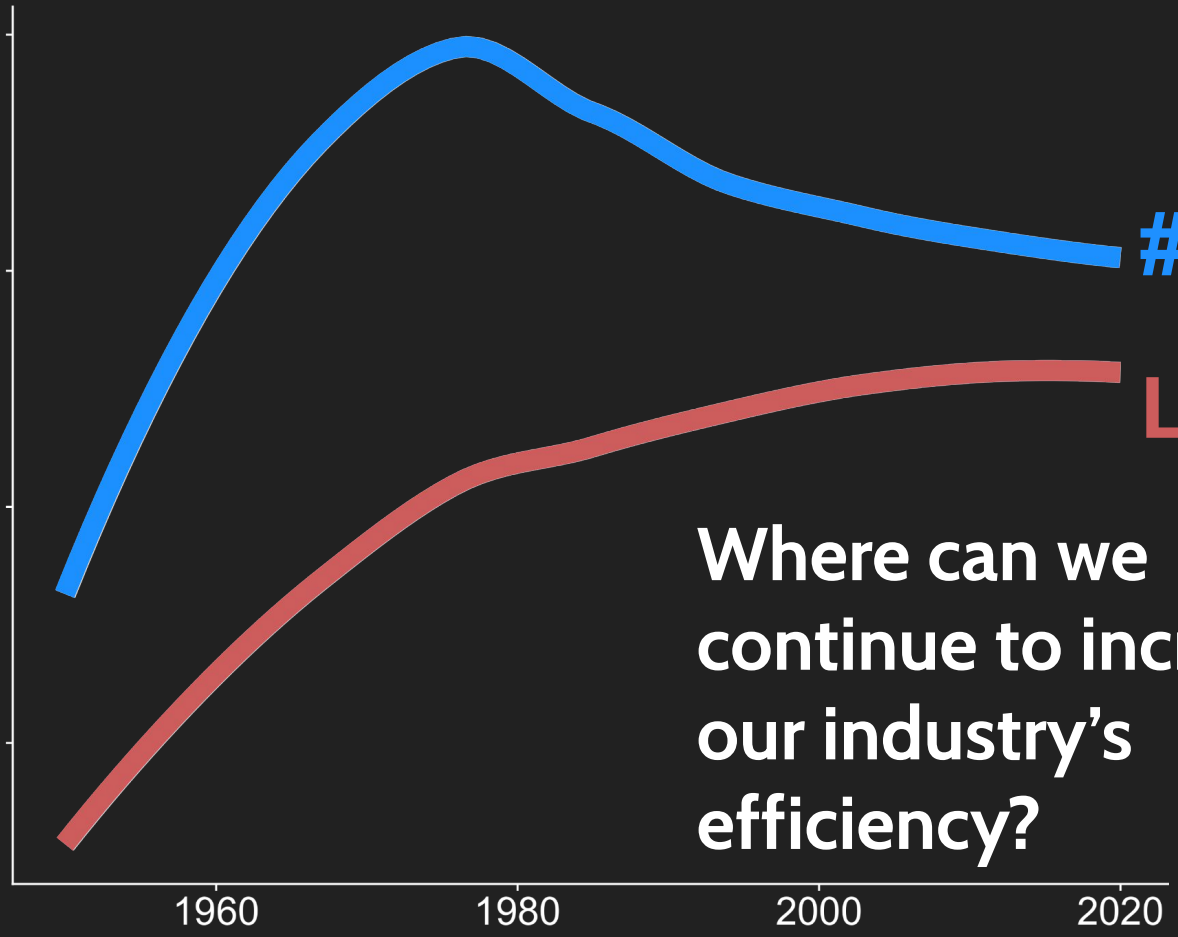
Grasslands are an essential ecosystem

Cattle are the last truly “extensive” livestock

Cattle producers are incredible environmental stewards



90% of a beef animal’s lifetime consumption is forage



Where can we continue to increase our industry's efficiency?

The traits that drive efficiency and sustainability are (almost all of) the same traits that drive profitability

Selecting for more efficient cows

=

More profitable herds!

Efficiency: How can we make more beef with fewer resources?

1) Cows are the most important pieces of a forage-based system
2) Cows are the cornerstone of a *profitable* commercial herd
3) Cow traits have the most opportunity for genetic improvement
4) We can make genetic progress on cow-focused traits
5) Bull selection drives genetic improvement on maternal traits

Measuring Efficiency: Grass units vs. Cow units

Number of cows

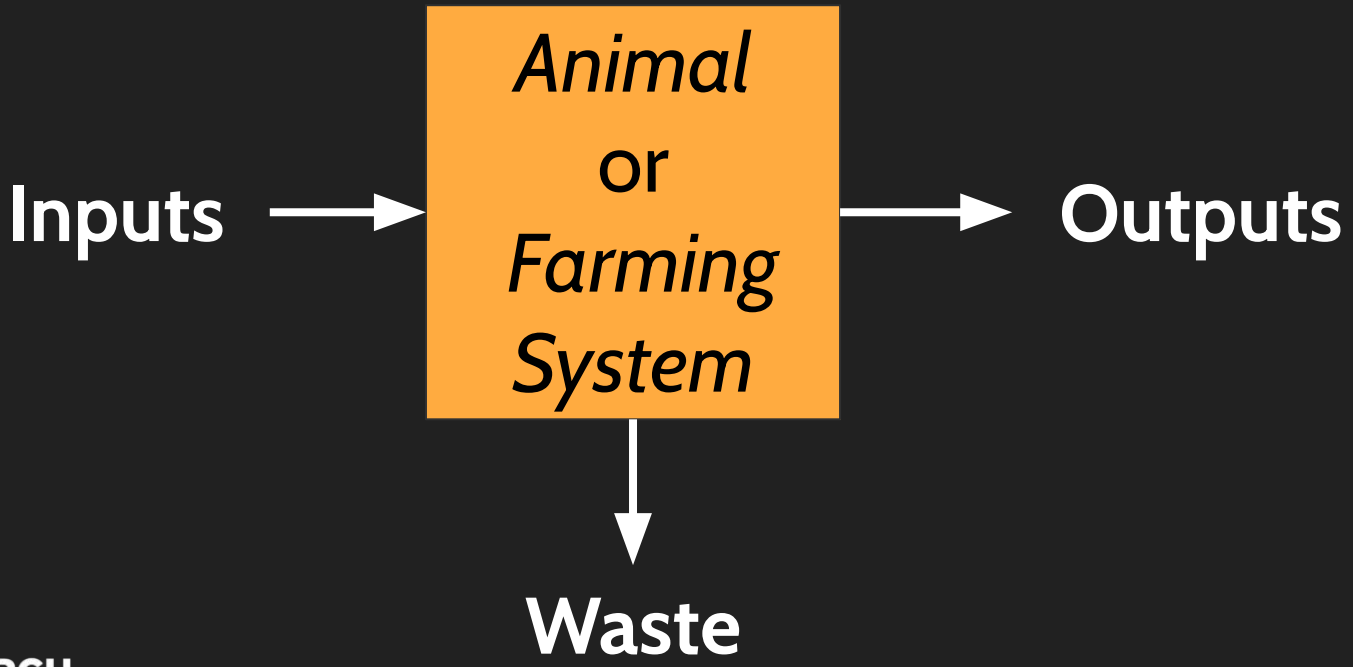
Weaned calf weight or
Feedlot/carcass performance

Measuring Efficiency: Grass units vs. Cow units

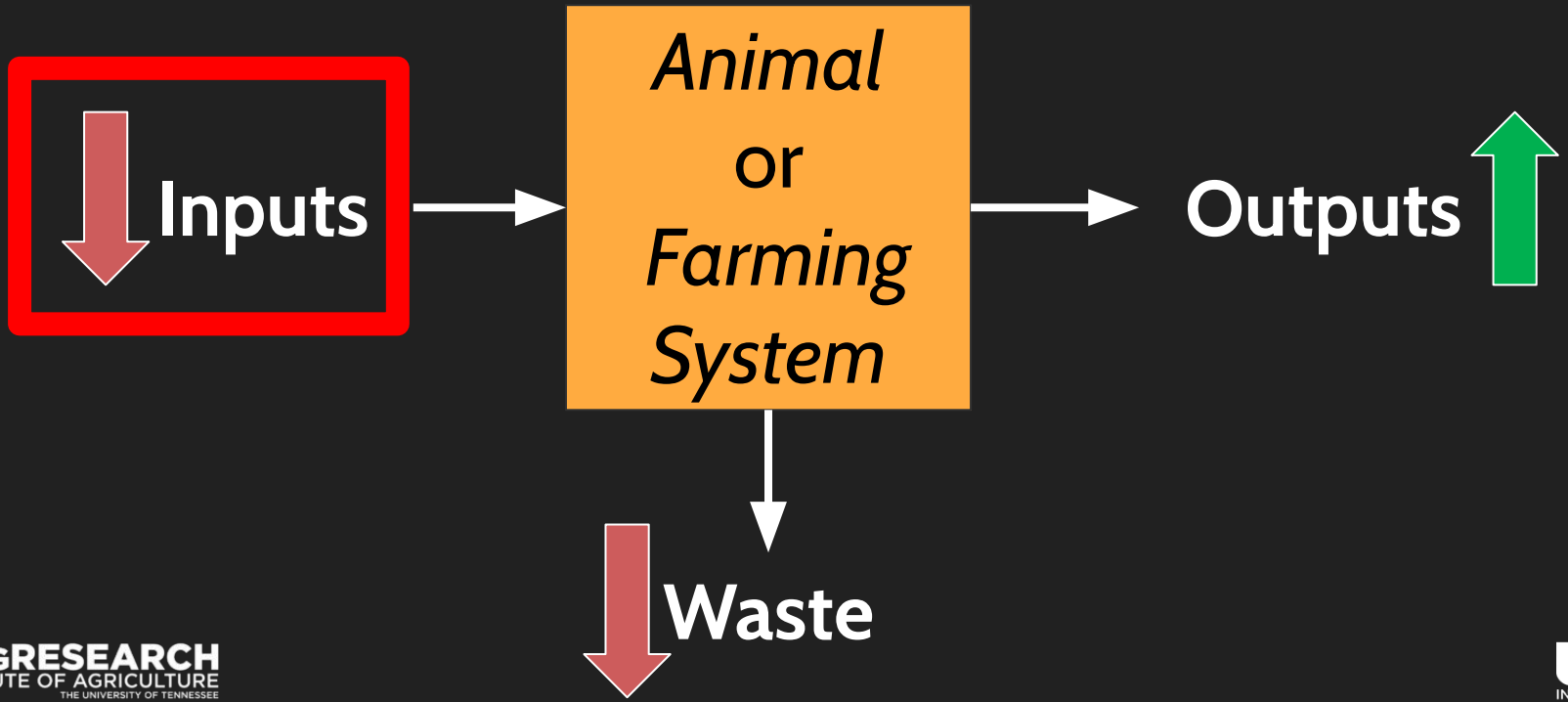
Forage resources

Weaned calf weight or
Feedlot/carcass performance

Defining Efficiency

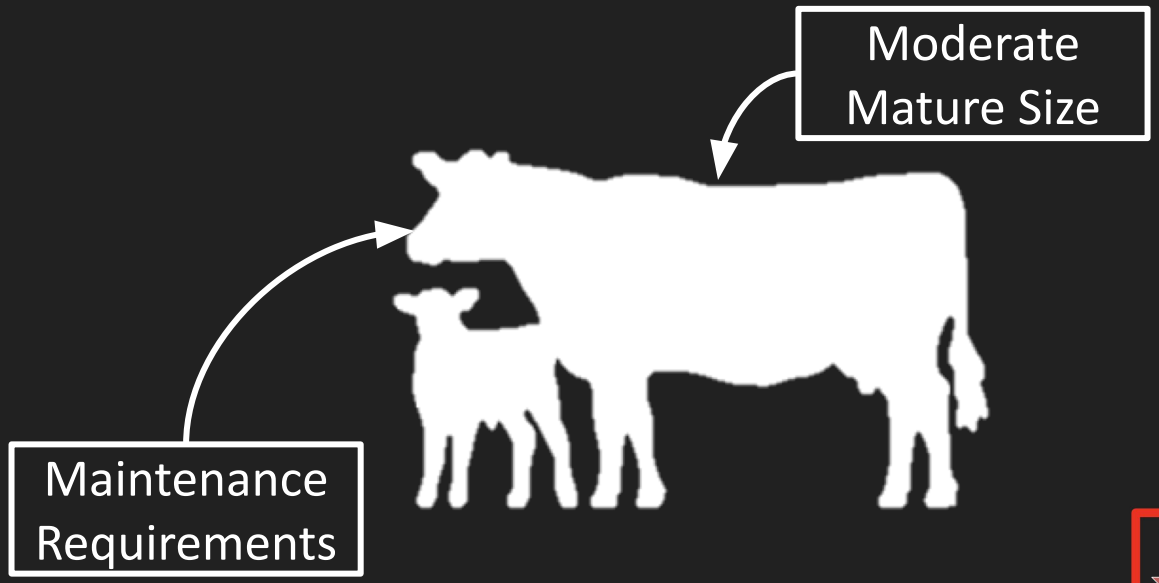


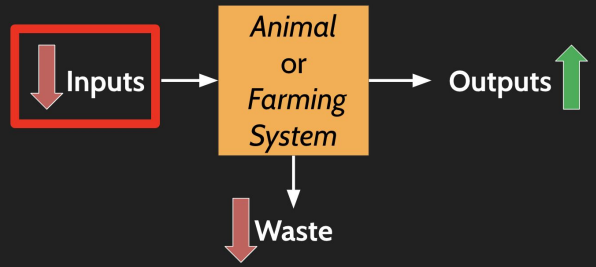
Increasing Efficiency



What does a profitable cow look like?

An EFFICIENT Cow!





Decreasing Inputs

- How much do my cows eat? (Forage or supplements)
- How many heifers do I need to develop? And how much does it cost me to develop my heifers?
- What other resources do I need to do to maintain my cows' health & welfare?
- How much labor do I put into production?

Correlated Traits: Push and Pull

We select 5 generations for calf weaning weight...

What will happen to our mature cow size?

What does that big mature cow like to do?

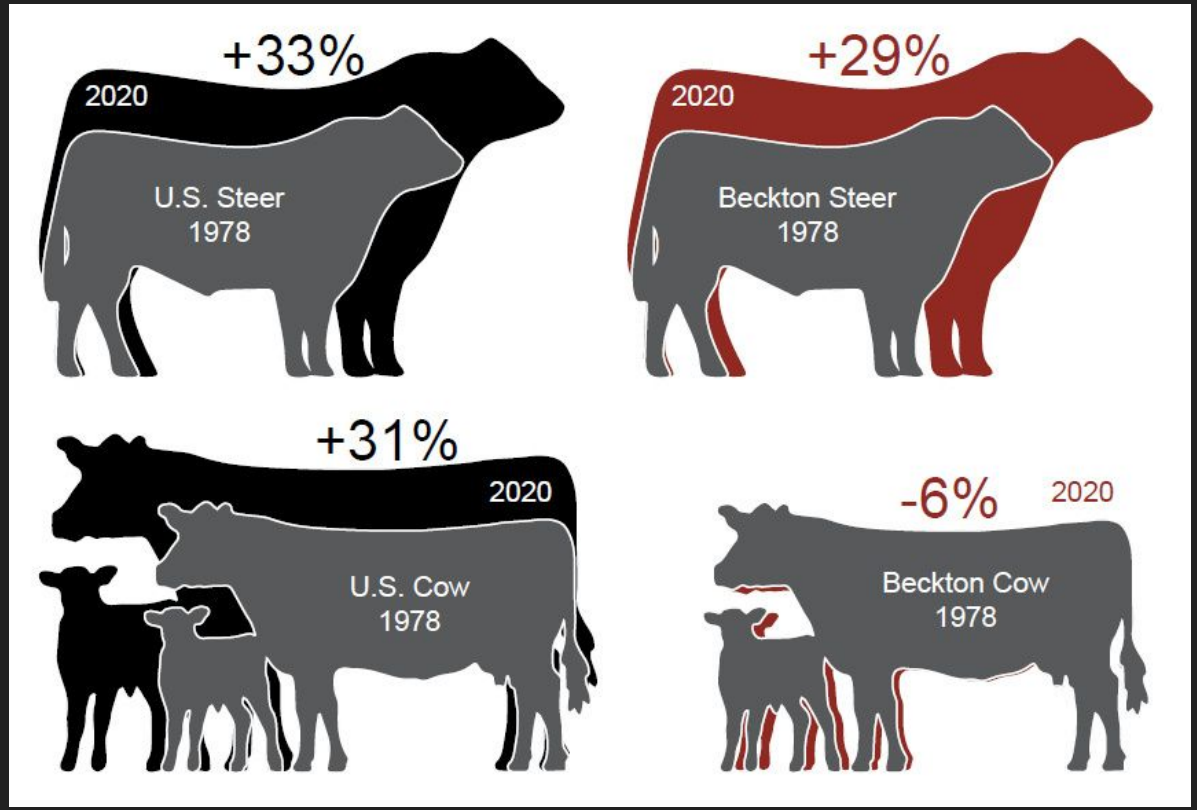
Mature Cow Size: Same forage, more cows

Table 1. Grazing costs and excretion values with varying mature cow size.

Cow Weight, lbs	*1,000*		*1,250*		*1,500*	
	Individual	*Total Herd*	*Individual*	*Total Herd*	*Individual*	*Total Herd*
Daily DMI, lb	22.34	3,017	26.41	3,037	30.29	3,029
Annual DMI, lb	8,154	1,100,790	9,640	1,108,600	11,056	1,105,600
Relative cow #'s	1	135	1	115	1	100
Forage cost, $/cow	$220.16	$29,721.60	$260.28	$29,932.20	$298.51	$29,851.20
Manure Output, lb/yr	3,419	461,565	4,082	469,430	4,713	471,300
Nitrogen excretion, lb/yr	88.2	11,907	104.4	12,006	119.6	11,960
Methane Emissions, lb/yr	167.2	22,572	198.7	22,851	230.8	23,080

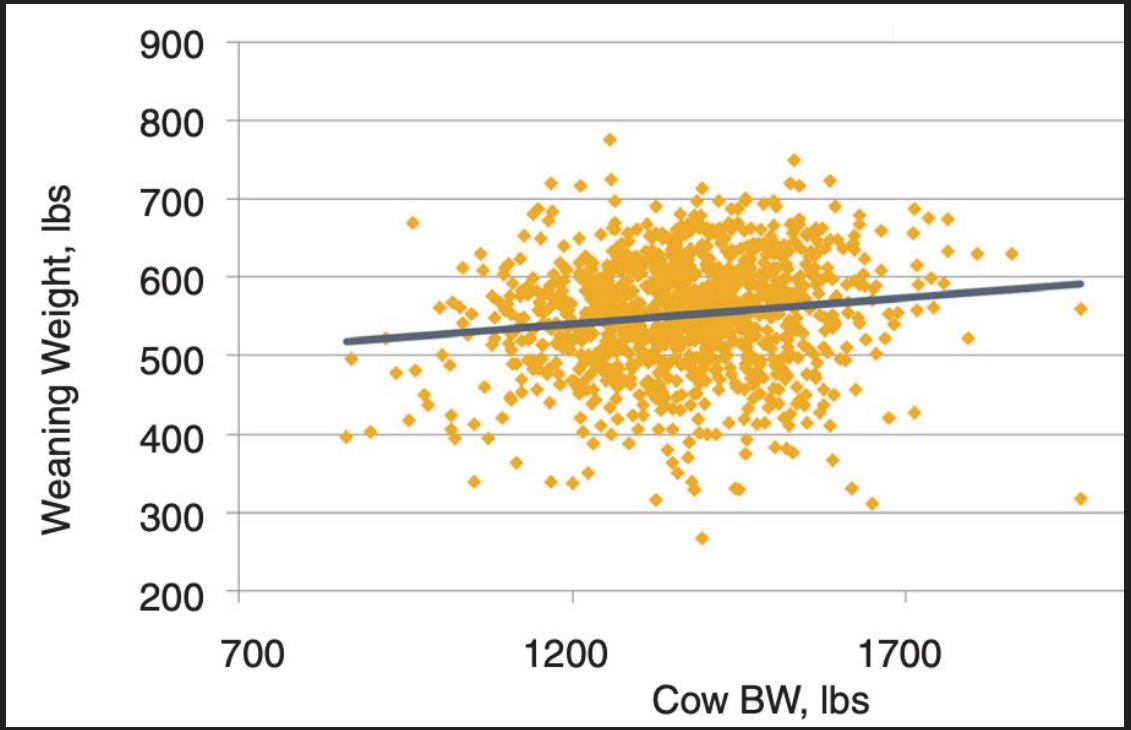
Lalman et al. 2018

In a perfect world… same weaned calf weight, smaller cow



via Beckton Red Angus, USA

Mature Cow Size



Lalman et al. 2018

100 pound heavier cow = $6-$30 additional revenue from calves weaning weight

100 pound heavier cow = $42 additional costs for maintenance

THESE NUMBERS ARE INDEPENDENT OF STOCKING RATE!

Mature Cow Weight vs. Thriftiness

- Forage intake to pounds of weaned calf
  - Difficult to directly measure
  - Some cows can be heavy and eav fairly little
- Measuring forage-intake is very difficult
- Environment and management level?
- Is cow able to reach its genetic potential?

Body Condition Scoring

BCS 1
Emaciated

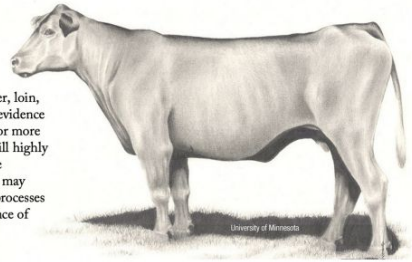
The cow is severely emaciated and physically weak. Bone structure of shoulder, ribs, back, hooks, and pins are sharp to the touch and easily visible. No evidence of fat deposits or muscling. This body condition score is rarely observed in the field.

BCS 2
Very Thin

The cow appears emaciated but not weak. No evidence of fat deposition. Muscle atrophy is significant in the shoulder, over the loin and rump, and through the hindquarters. The spinous and transverse processes, hooks, and pins feel sharp to the touch and are easily seen.

BCS 3
Thin

Very little fat cover over the shoulder, loin, and rump. The foreribs have slight evidence of fat deposition, but the last three or more ribs can be seen. The backbone is still highly visible. Processes of the spine can be identified individually by touch and may still be visible. Spaces between the processes are less pronounced. There is evidence of muscle loss in the hindquarters.

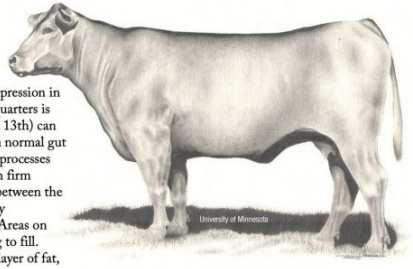


BCS 4
Borderline

Foreribs are slightly noticeable and the 12th and 13th ribs are still easily visible. Muscle atrophy is still noticeable over shoulders, loin, and hindquarters, but is approaching normal. The transverse and spinous processes can be identified only by palpation (with slight pressure) and feel rounded rather than sharp. The hooks and pins are covered in minimal fat and easily identified.

BCS 5
Moderate

There is slight evidence of fat deposition in the brisket. Muscle expression in the shoulder, loin, rump, and hindquarters is normal. The last two ribs (12th and 13th) can only be seen if the cow has less than normal gut fill. Individual spine and transverse processes cannot be seen, can only be felt with firm pressure, and feel rounded. Spaces between the processes are not visible and are only distinguishable with firm pressure. Areas on each side of the tailhead are starting to fill. Hooks and pins are covered with a layer of fat, but still distinguishable.



BCS 6
Good

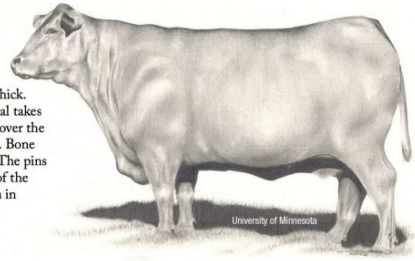
The cow exhibits a smooth appearance throughout. Ribs are fully covered and are not noticeable to the eye. Hindquarters are plump and full. Noticeable springiness over the foreribs and on each side of the tailhead. Firm pressure is now required to feel the transverse processes. Fat deposition in the brisket is evident.

BCS 7
Fleshy

The brisket is full, but not distended. Spinous and transverse processes are embedded in fat and can only be felt with very firm pressure. The topline is beginning to take on a square appearance. Spaces between processes can barely be distinguished. Abundant fat cover on either side of the tailhead with evident patchiness.

BCS 8
Obese

The cow's neck appears short and thick. Brisket is distended with fat. Animal takes on a square and blocky appearance over the topline and smooth along the sides. Bone structure cannot be seen anymore. The pins are embedded in fat on both sides of the tailhead. Evidence of fat deposition in udder.



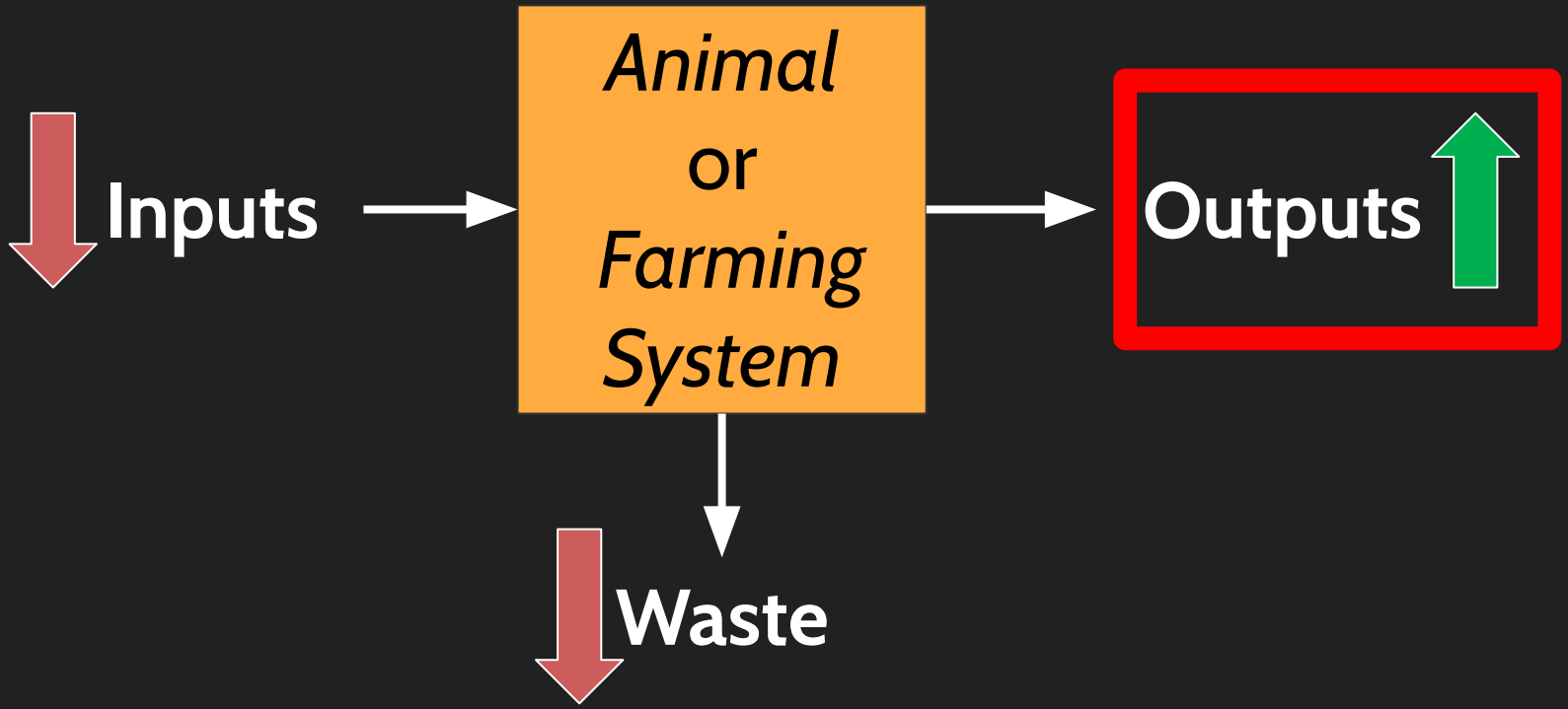
BCS 9
Very Obese

Rarely seen. Bone structures are not easy to identify. The tailhead is buried in fat. The cow appears short-necked with a full, and distended, brisket. Significant fat deposition in the udder. The animal's mobility may be impaired by excessive fat.

A good “rule of thumb”

A Cow should wean ~ ½ her body weight in calf

Increasing Efficiency



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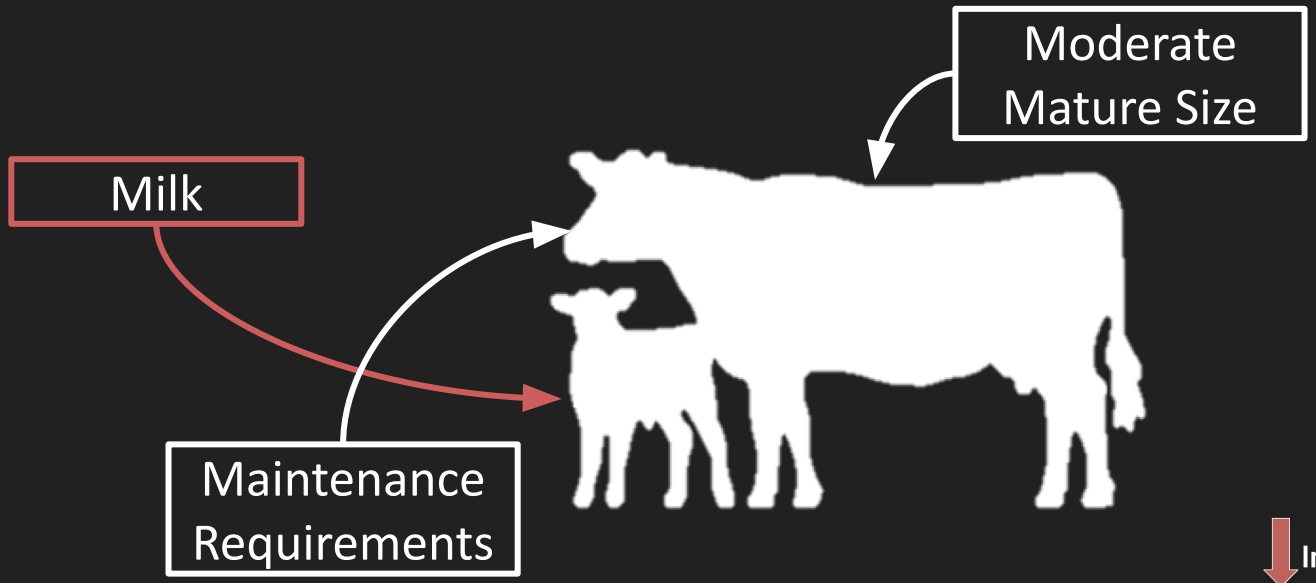

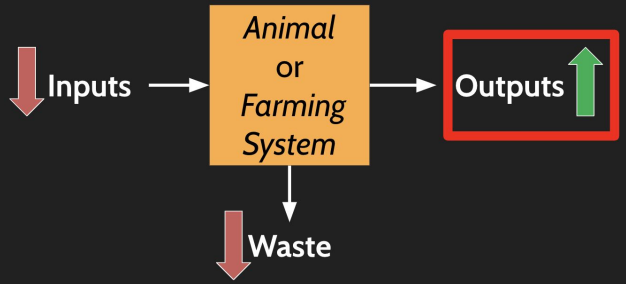

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Two drivers of calf weaning weight

Genetics tradeoffs between these

Direct Weaning Weight

Calf's genetic potential to grow

Maternal Weaning Weight

Milk production + other maternal ability that affects calf weight gain

Milk is good… but expensive to make

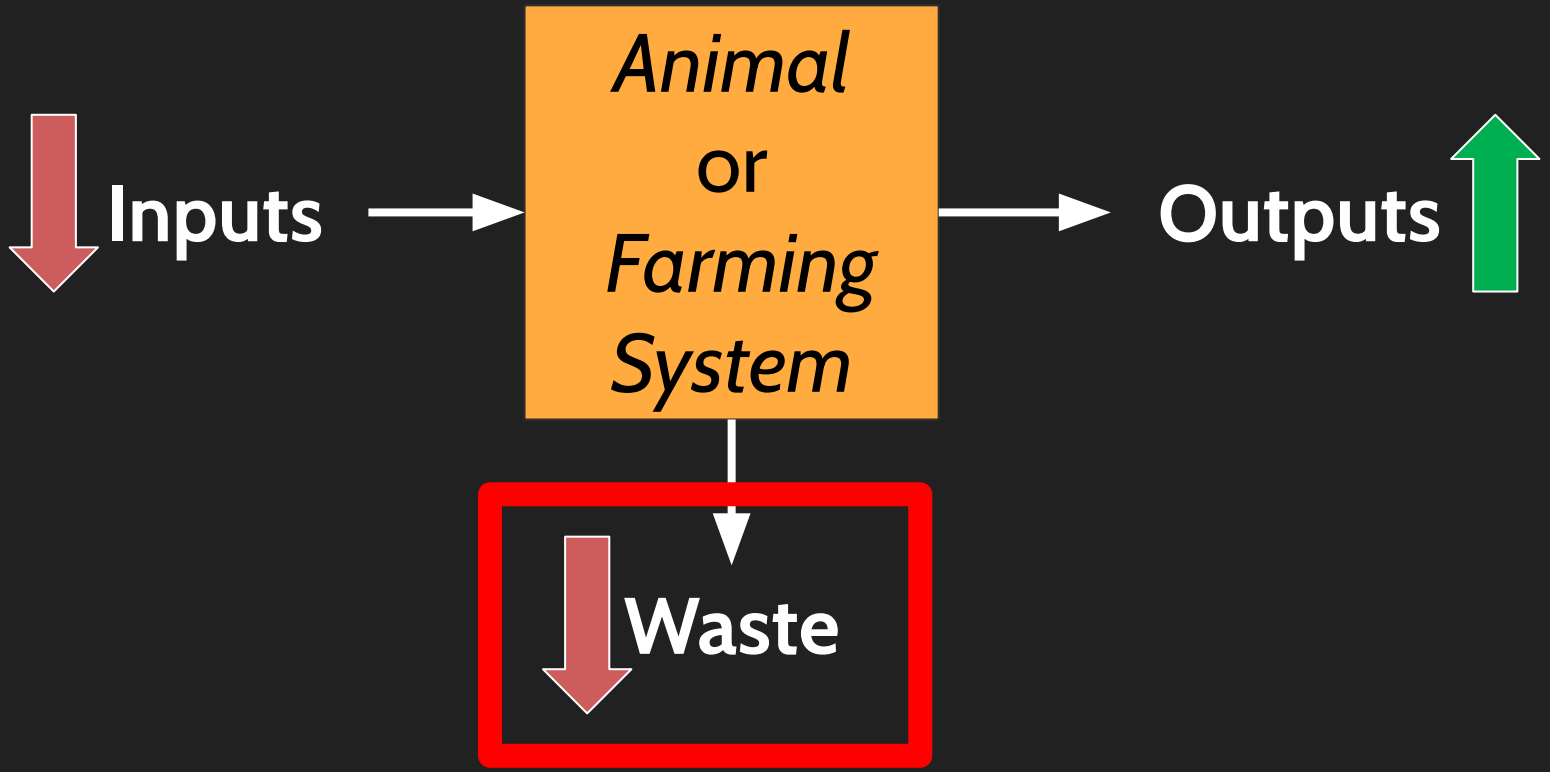
Milk Production is Energetically Expensive

Best in moderate amounts

More milk
=
Bigger calf

More milk
=
Higher feed needs

Increasing Efficiency

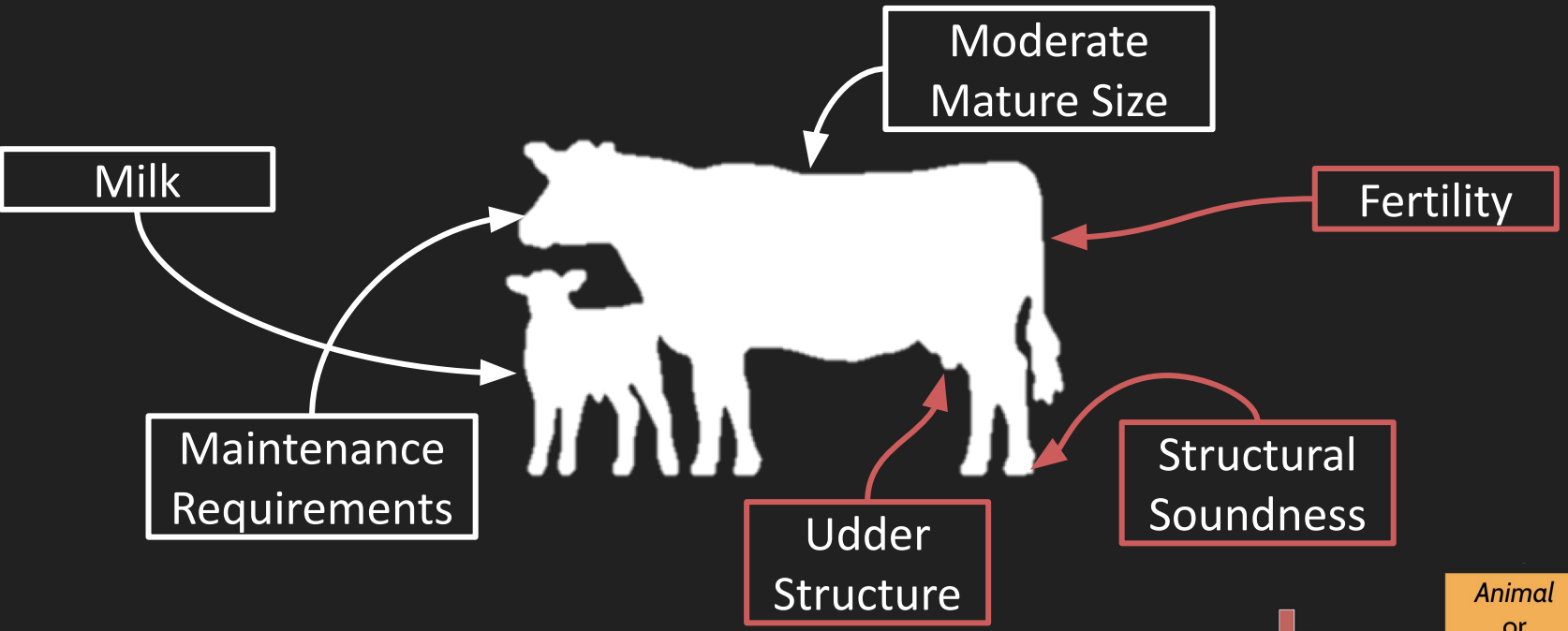


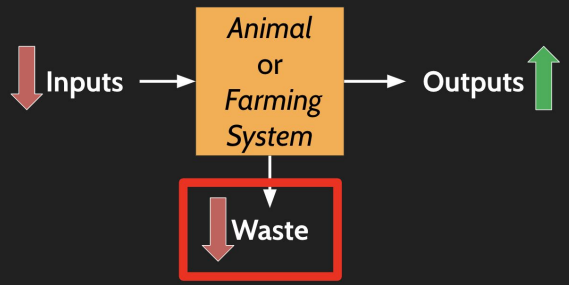
What does a “wasteful” cow look like?

We give her resources and she gives us nothing!

What does a profitable cow look like?

An EFFICIENT Cow!





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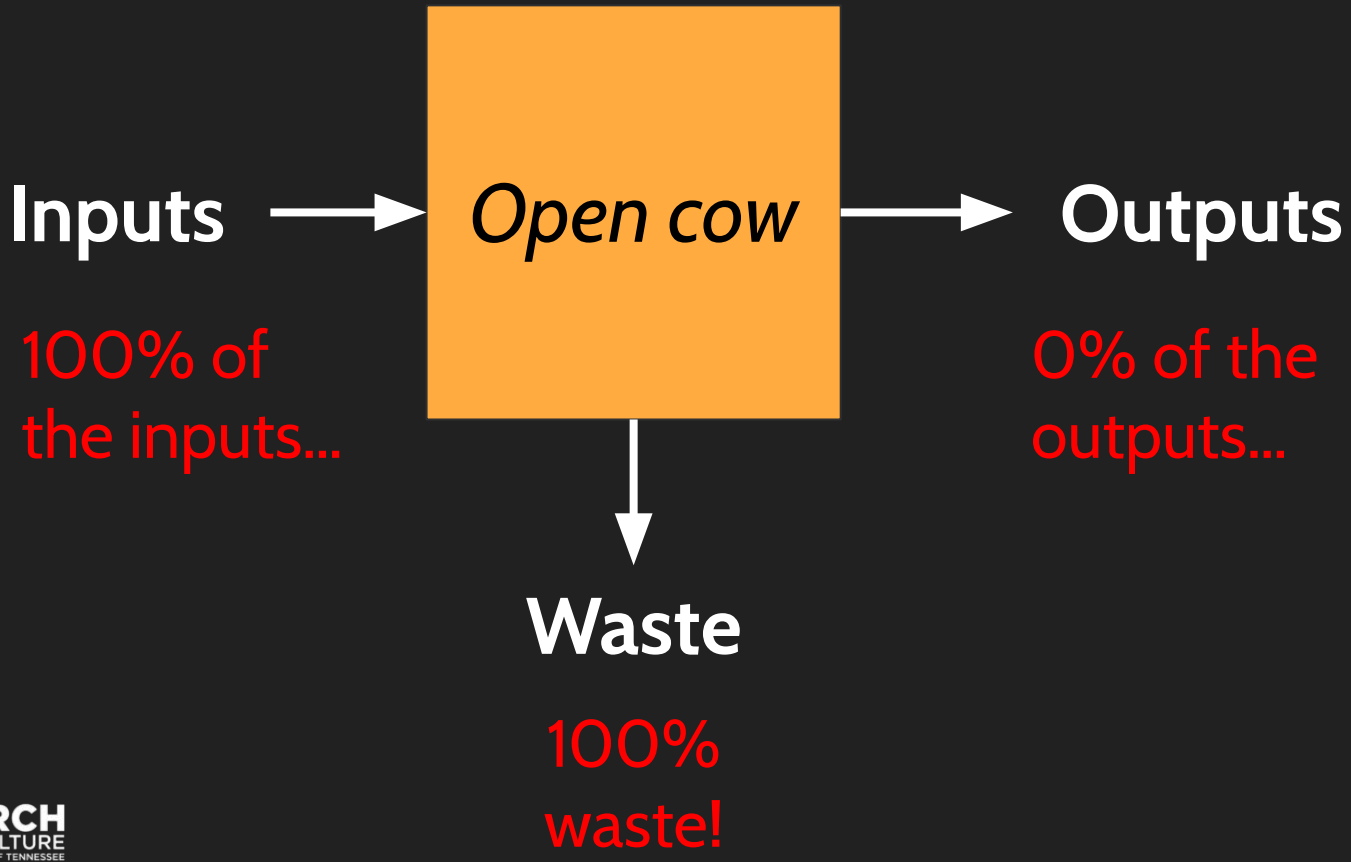
Fertility: Our #1 Efficiency Trait!

- 365-day calving interval is ideal
- Cow without calf generates no return on investment in her maintenance… Feeding cows is not cheap!
- Extended calving seasons can also decrease a herd's overall profitability

An open cow is the world's most inefficient cow!

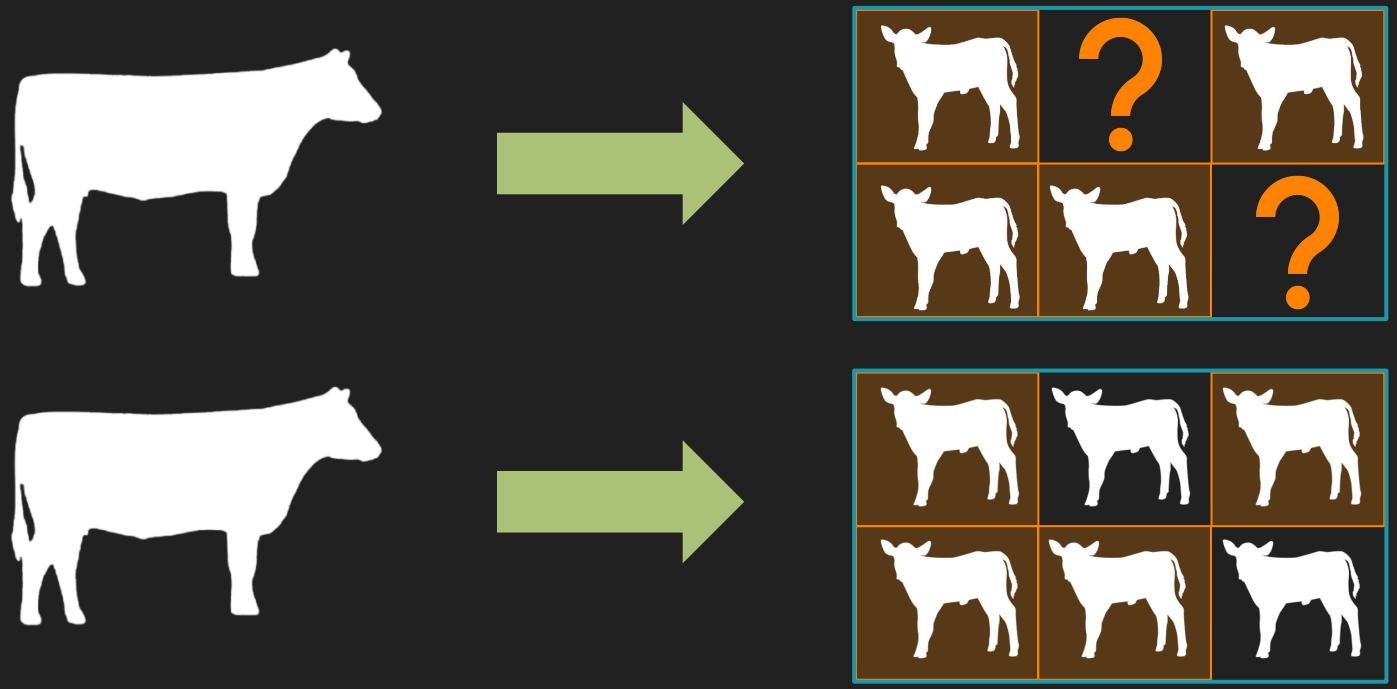


Fertility & Cow Rebreeding

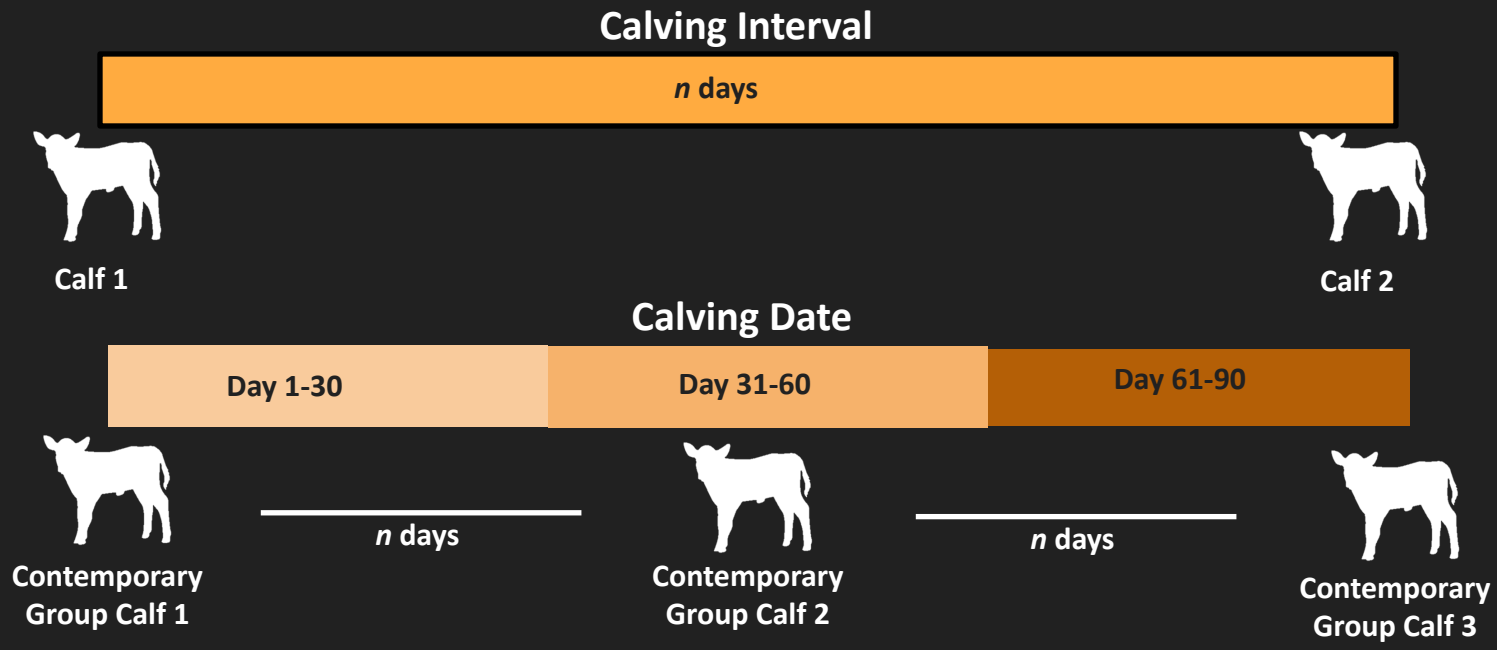
Cow Rebreeding Phenotypes: Genetic control of postpartum interval

Rebreeding after the first calf is most challenging, and largely different from heifer pregnancy.

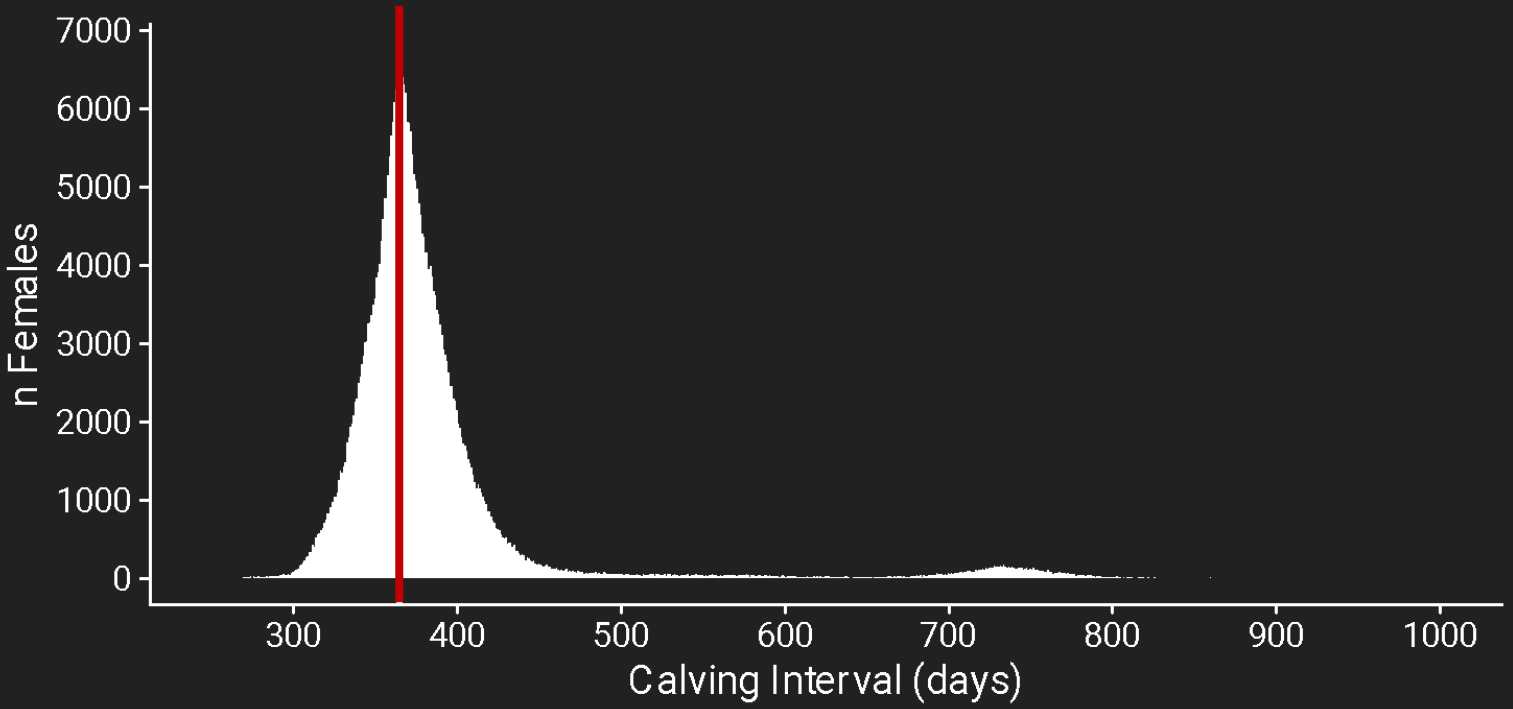
Whole Herd Reporting vs. Traditional Registration



Novel rebreeding phenotypes

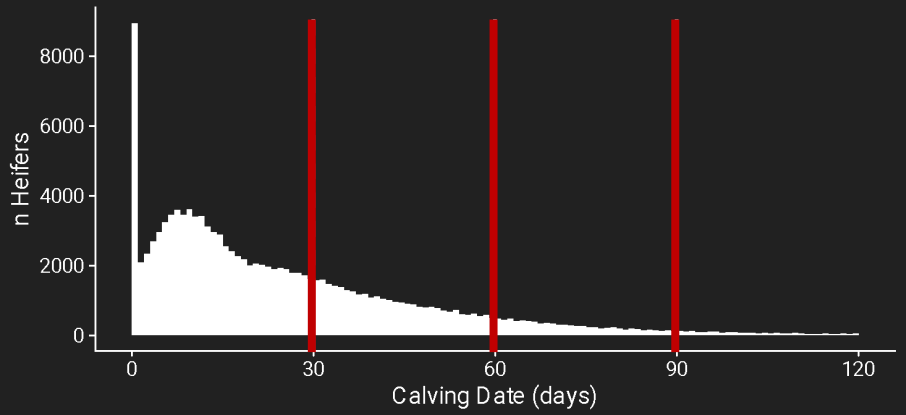


Calving Interval

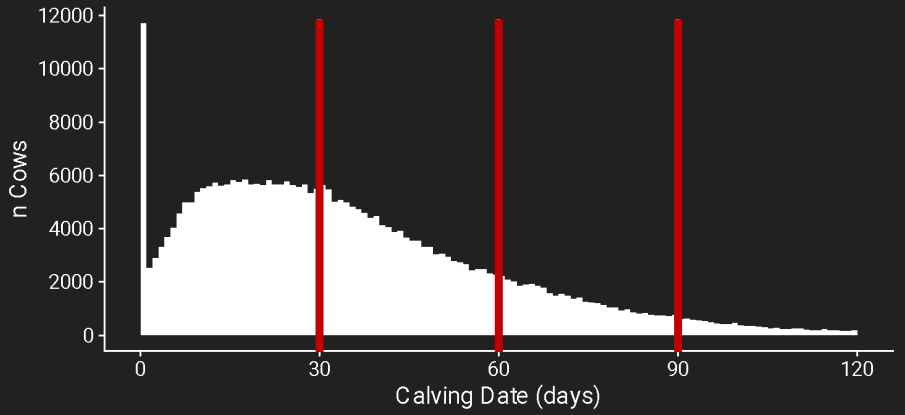


Calving Date (when did cow/heifer calve relative to others?)

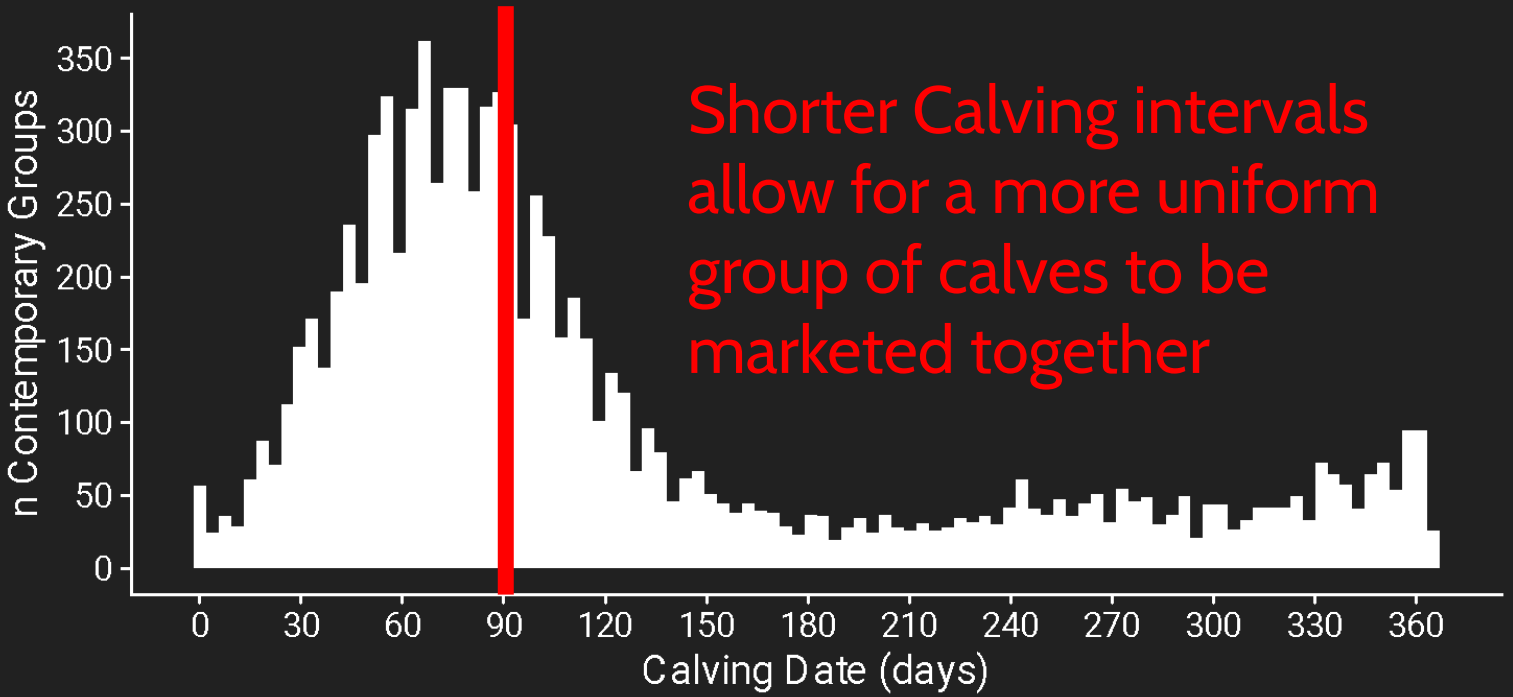
Heifers



Cows

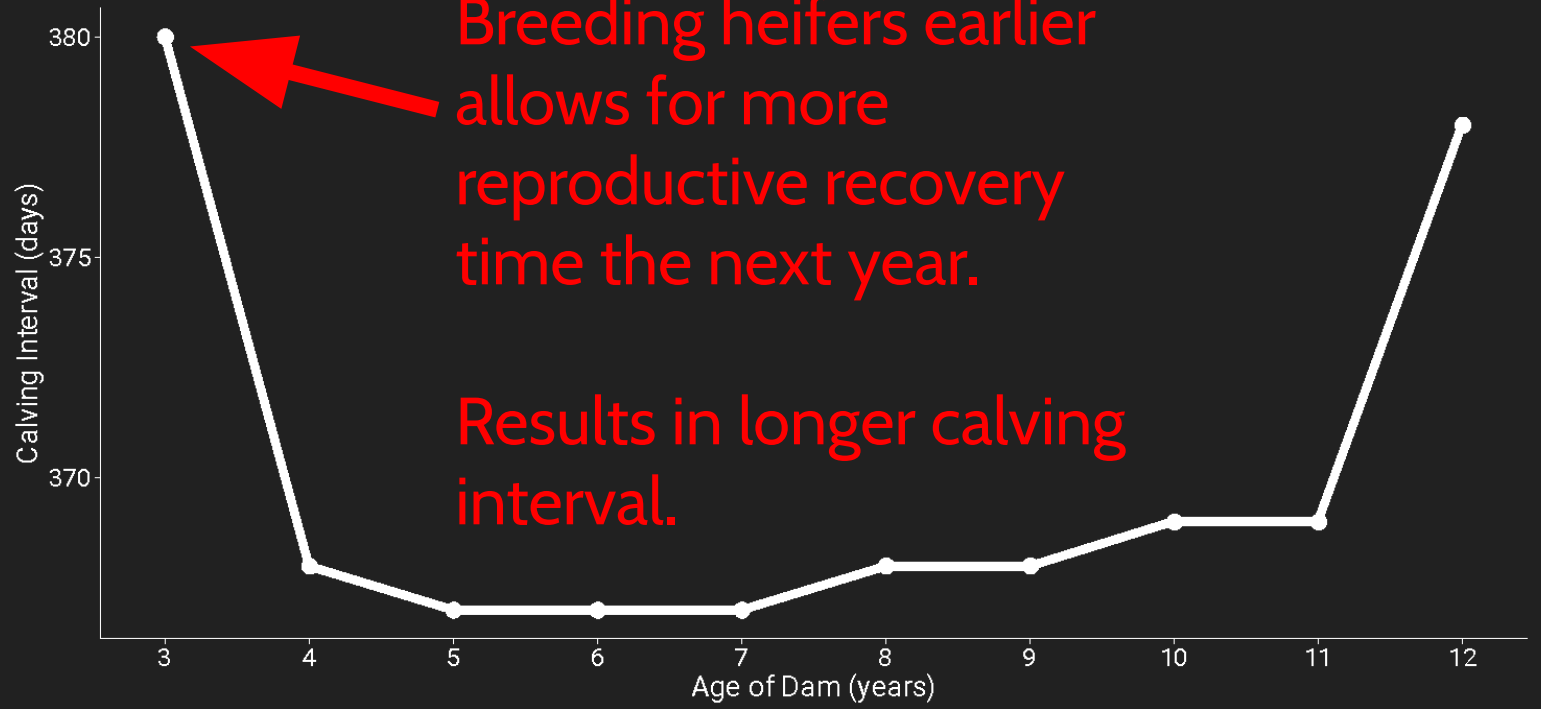


Calving season lengths in ASA THE database

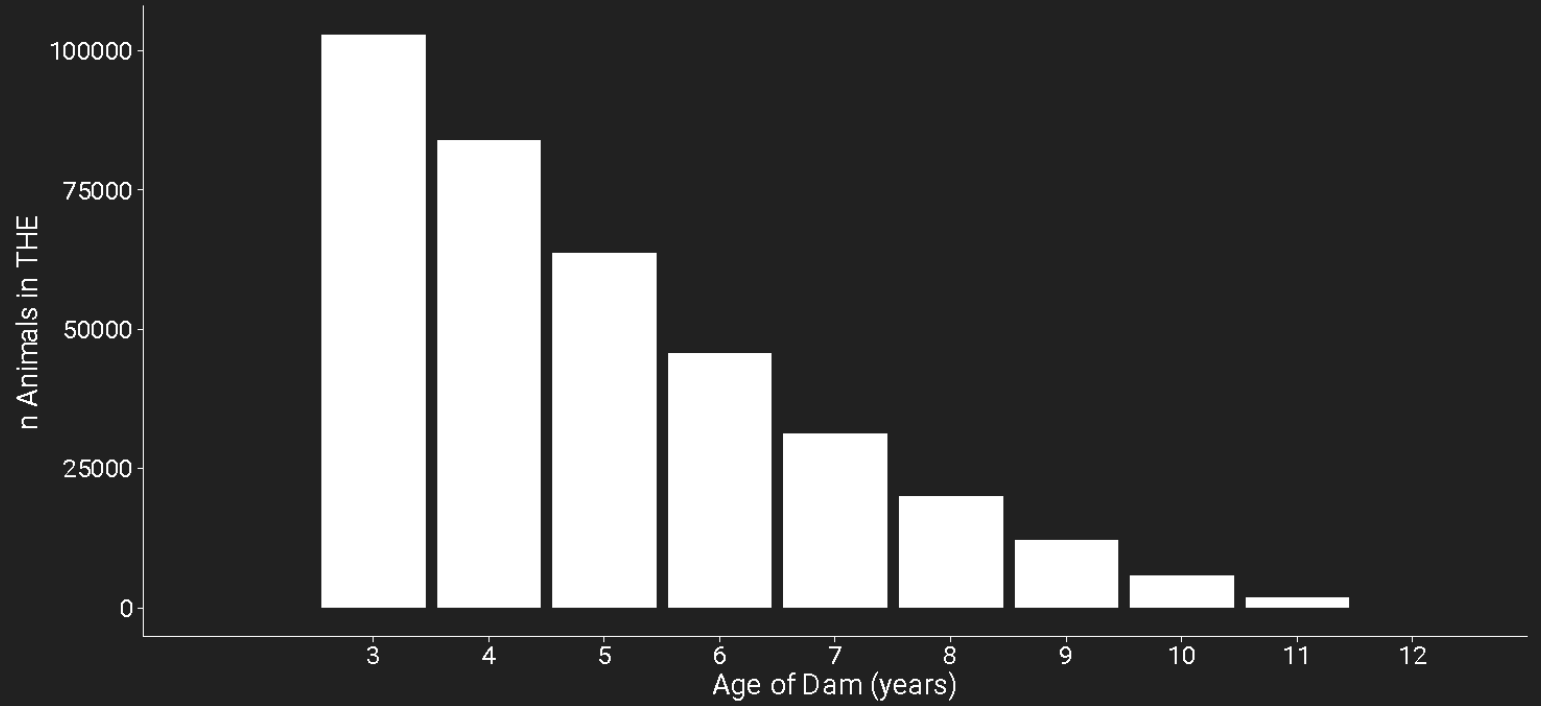


Shorter Calving intervals allow for a more uniform group of calves to be marketed together

Changes in Calving Interval Due to Age



Visualizing Longevity



Heritability Estimates (h^2) for fertility traits

Phenotype	h^2
Calving Date	0.03
Calving Interval	0.07
Discrete Early Calving	0.05
Heifer Pregnancy	0.20

Genetic Correlations (r_g)

Phenotypes	r_g
Calving Date and Calving Interval	0.11
Calving Date and Discrete Early Calving	0.96
Calving Date and Heifer Pregnancy	0.39
Calving Interval and Discrete Early Calving	0.19
Calving Interval and Heifer Pregnancy	0.11
Discrete Early Calving and Heifer Pregnancy	0.27

Developing Heifers for Improved Fertility

1) Heifers need sufficient time to develop (puberty) so that they are cycling by the first breeding season

2) Don't need to over-feed heifers for development
Aim for ~60% of mature body weight at start of breeding

3) Nutrition: Aim for 12.5% crude protein & 65% total digestible nutrients (TDN)

4) Think of development as an investment in future cow

Developing heifers is EXPENSIVE!

This makes *cow-longevity* the most important component of efficiency and profitability!

Long-lived cows are the cornerstones of a commercial herd!

		Year							
		1	2	3	4	5	6	7	8
Variable Cost per Female	$450	$-1220	-883	-546	-209	128	465	802	1139
	$550	$-1320	-1083	-846	-609	-372	-135	102	339
	$650	$-1420	-1283	-1146	-1009	-872	-735	-598	-461

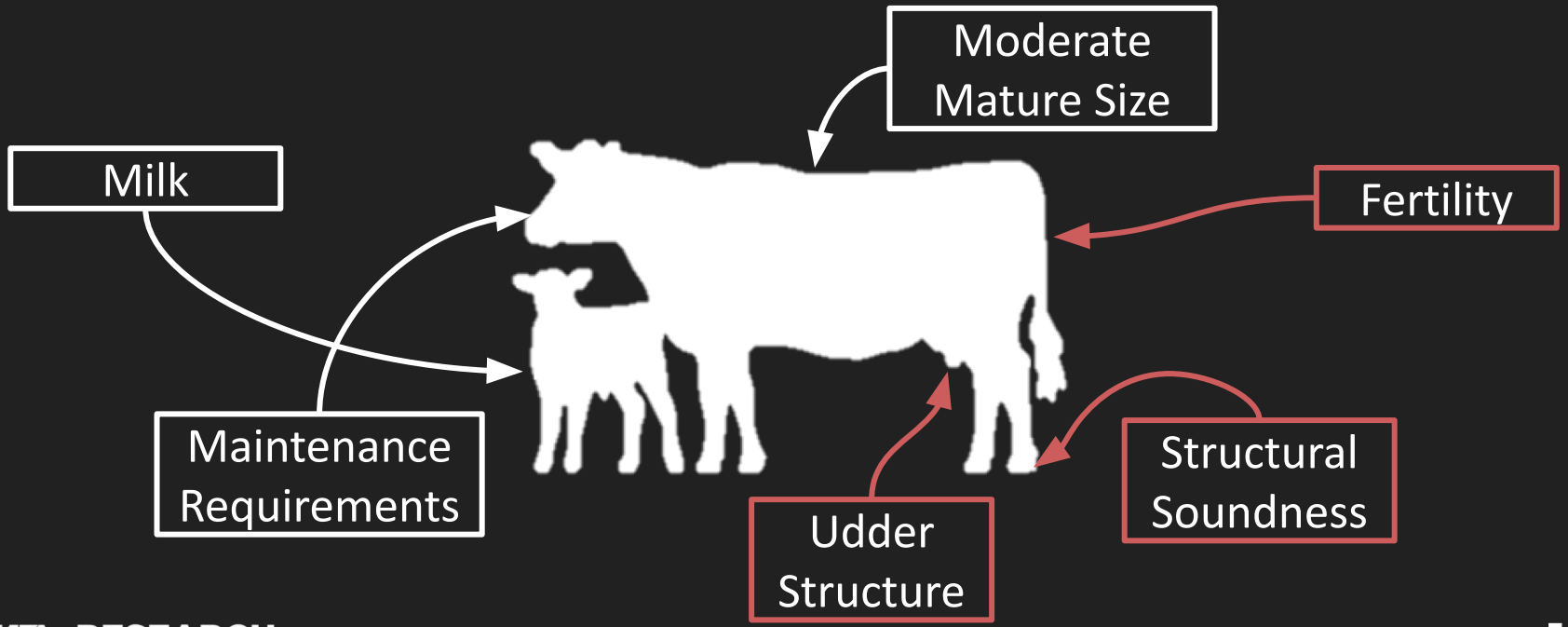
It takes a cow at least five calves to pay off her development costs

Any reason for leaving early will cost $$

Boyer et al. 2020

What does a profitable cow look like?

An EFFICIENT Cow!



Low-maintenance

- Minimizing additional cow upkeep
- Structural soundness
- Udder quality
- Disposition
- Easy calving

Our time as farmers is worth something!

Foot and Udder Structure

Udder Suspension			Teat Size		
Score	Description	Example	Score	Description	
9	Very Tight		9	Very small	
7	Tight		7	Small	
5	Intermediate/moderate		5	Intermediate/moderate	
3	Pendulous		3	Large	
1	Very pendulous, broken floor		1	Very large, balloon-shaped	

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Can we make breeding decisions that increase forage-based cow efficiency?

The easiest way to improve cow efficiency traits:

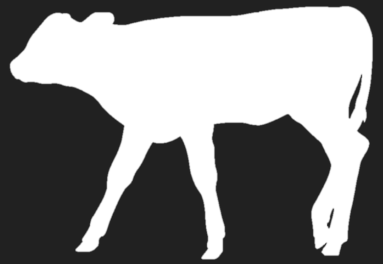
CROSSBREED!

(More on this later)

Which traits matter for efficiency and profitability?

How does this influence our selection decisions?

"Revenue-generating" traits

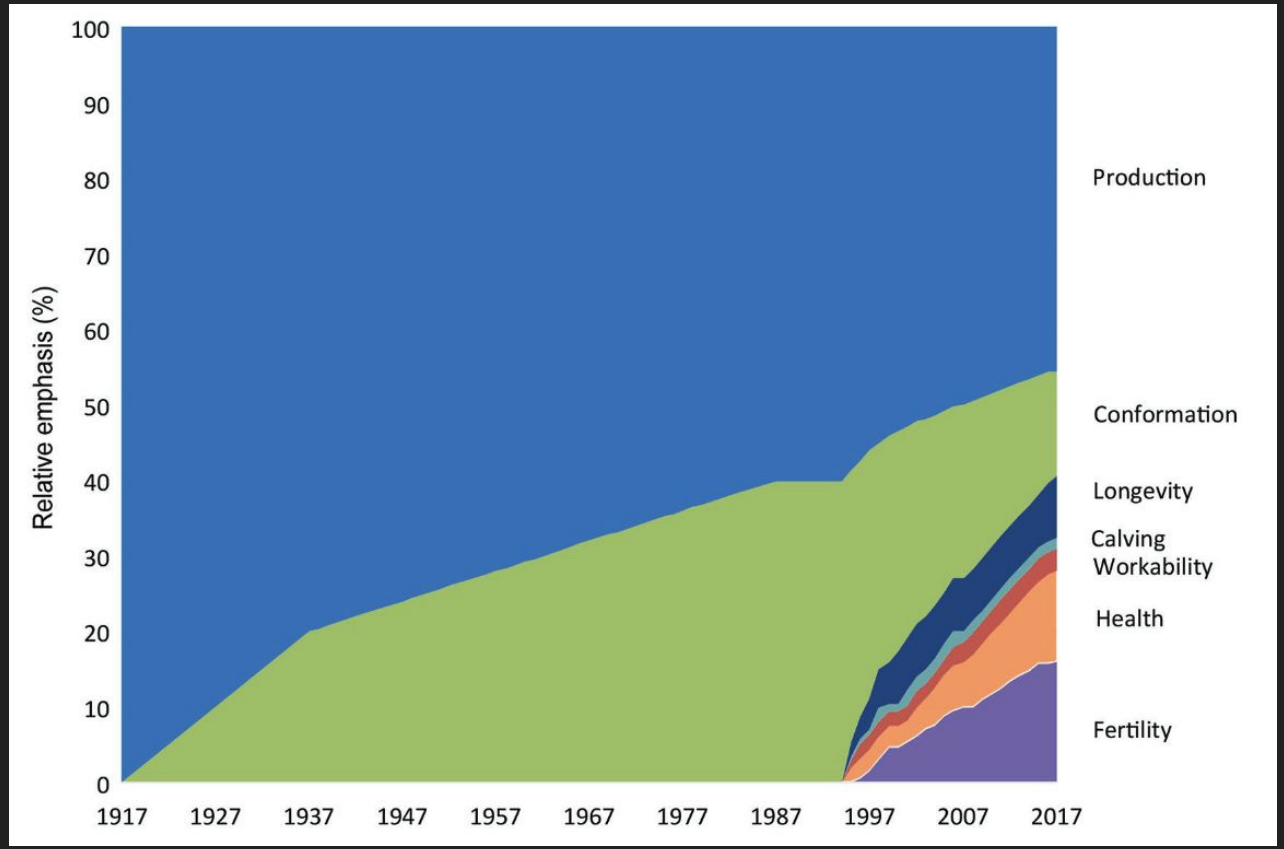


Live calf

Weaned pounds

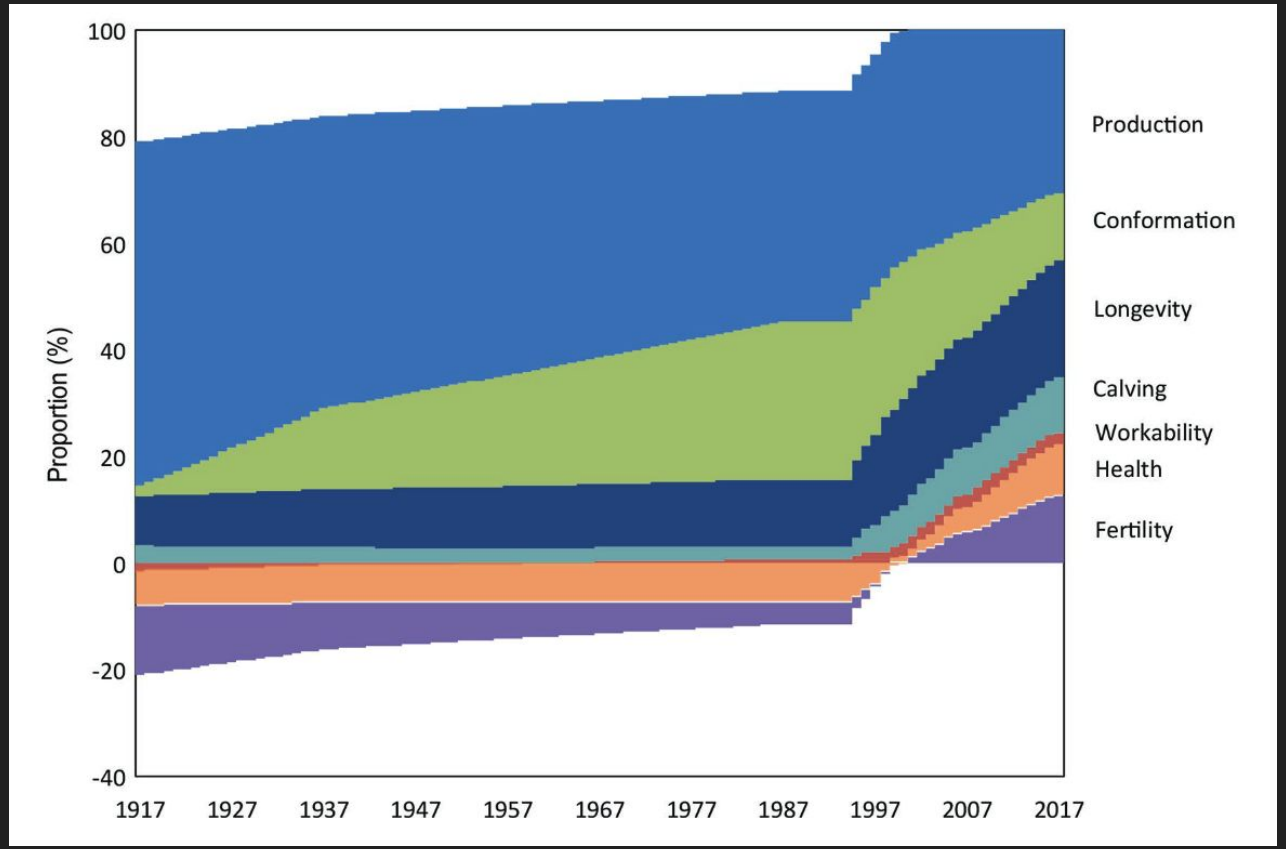
"Cost" (aka replacement female) traits

The US dairy industry has shifted selection emphasis



Miglior et al. 2017

If we measure it... we can select for it!



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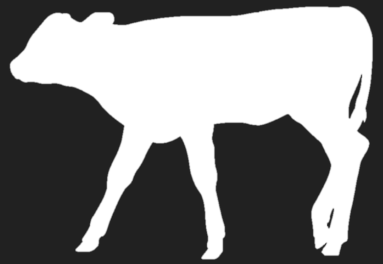

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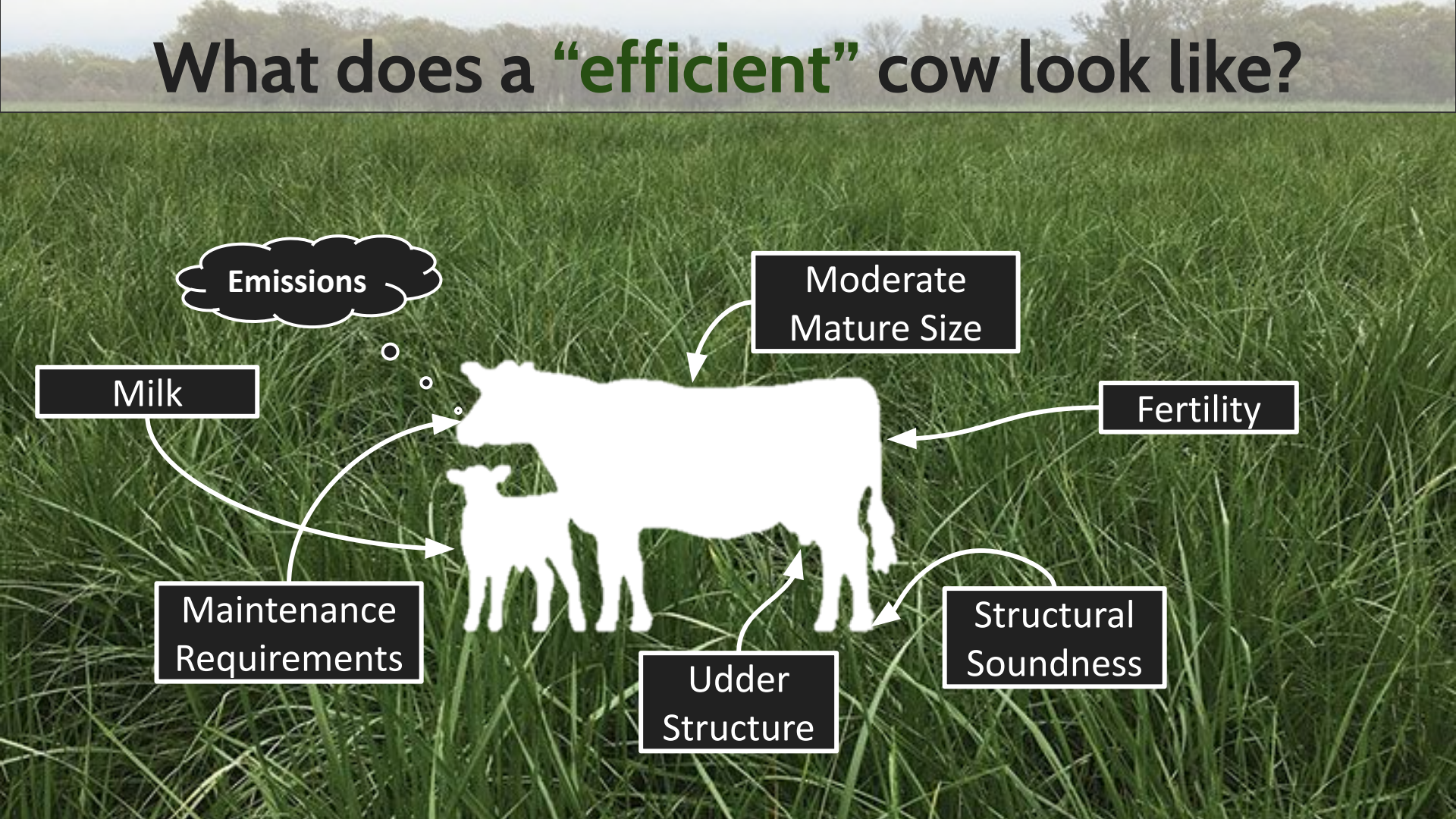
Bull selection tools for cow efficiency and fertility can help us achieve a more genetically efficient cow

What does a "efficient" cow look like?



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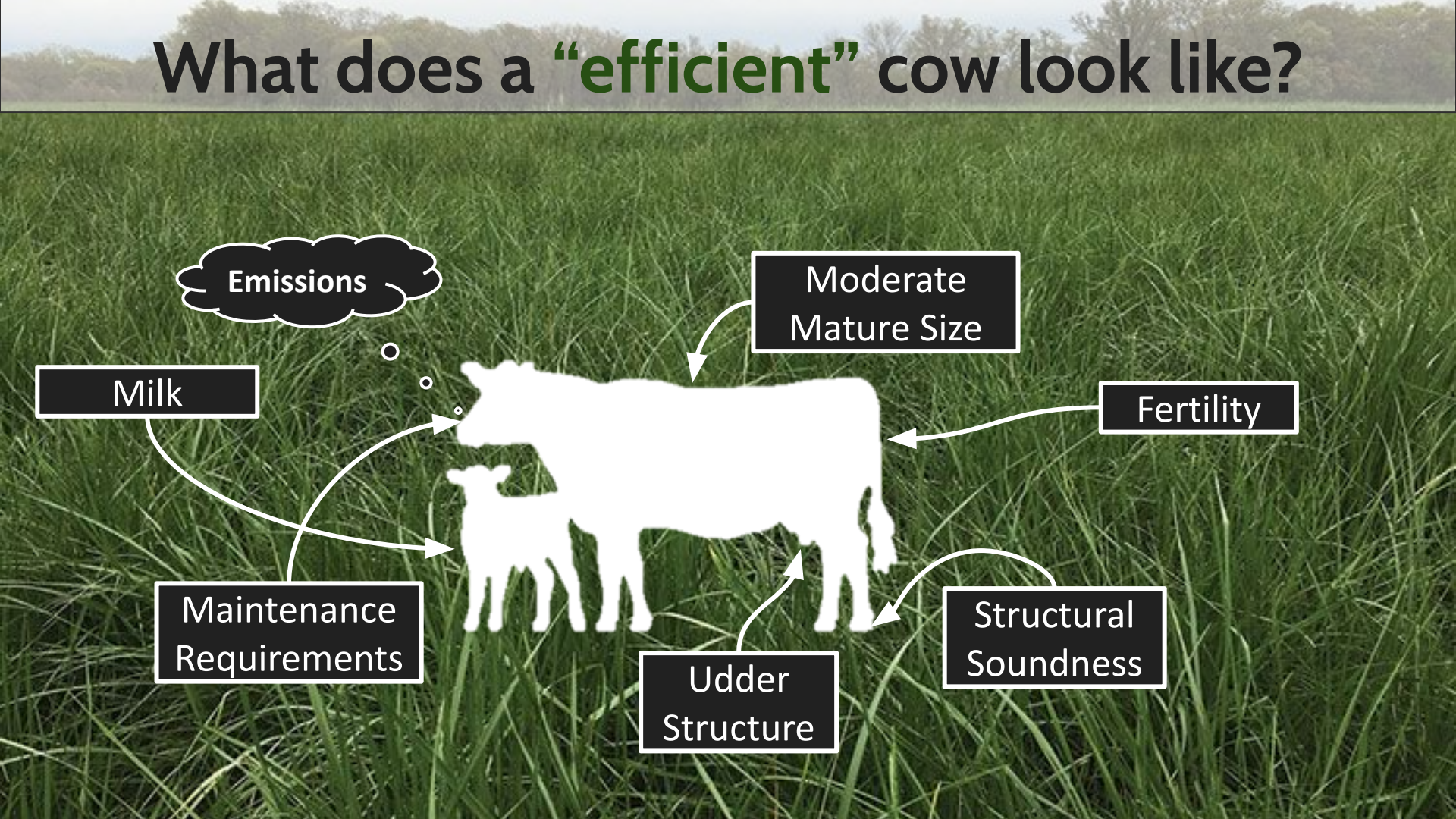
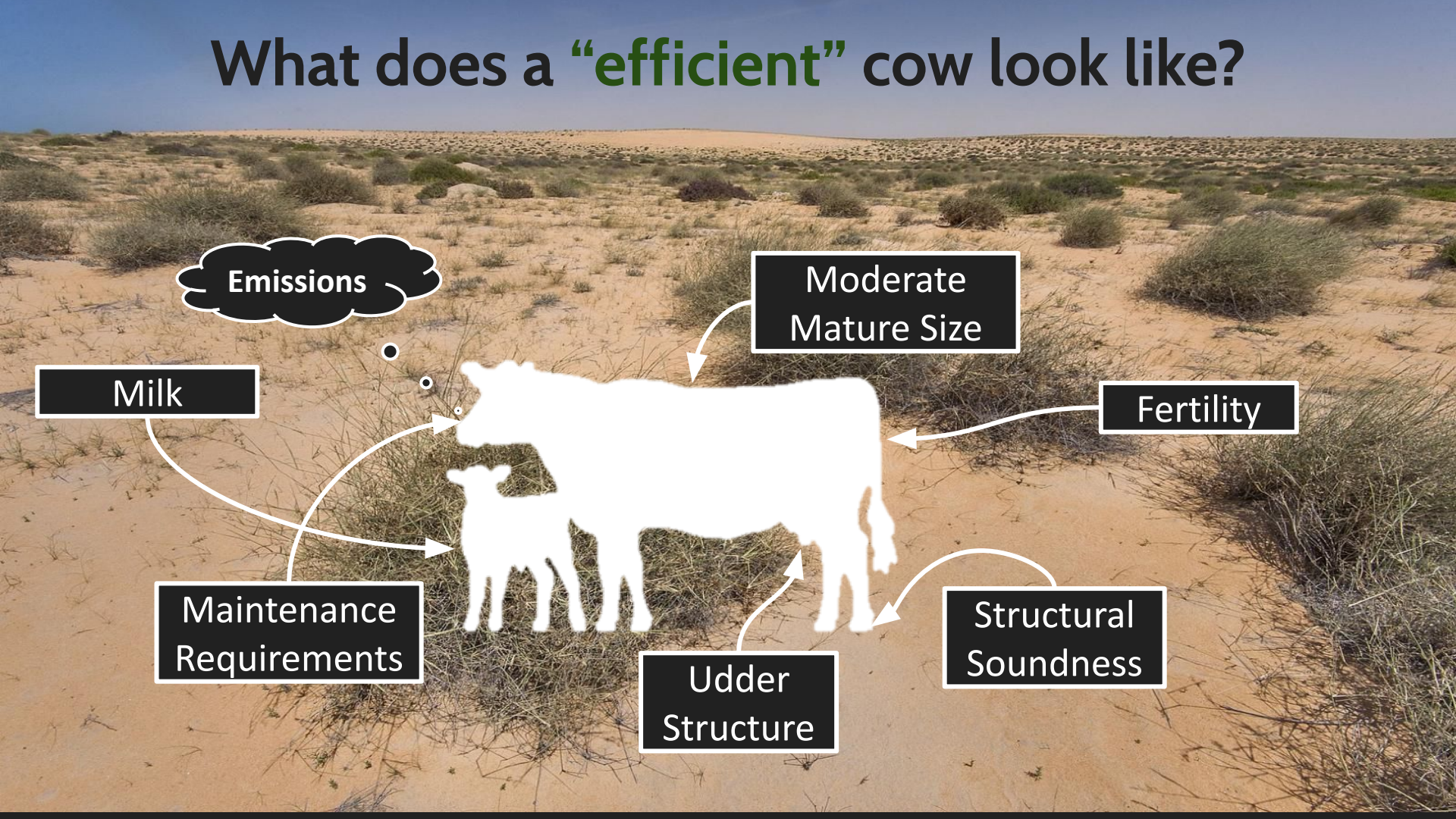


What does a "efficient" cow look like?



Genetic Potential

Resource Needs

Cows need resources to reach their genetic potential

We need the type of cattle that fit our environment/ management

Efficient and profitable cattle breeding require that we take into account both revenue AND costs

Crossbreeding is the easiest way to improve efficiency traits across the board

Cow fertility traits are lowly heritable and highly dependent on good management

Maternal milk production is best in moderation.

Reach out with questions!

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