

## CDCB 2019 Industry Meeting

# How do we measure feed efficiency?

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# Feed Intake and Feed Efficiency

The simply story. . . .

- Cows eat an amount of feed
- Cows produce a volume of milk

**Feed Efficiency = kg milk / kg dry matter intake**

# Feed Intake and Feed Efficiency

Things are rarely as simply as they seem. . . .

- Cows eat an amount of feed, but they also eat an amount of energy (and nitrogen, nutrients, etc.)
- Cows produce a volume of milk but depending on components, this volume has a different energy amount/content and potentially a different economic value
- We feed cows even when they aren't producing milk
- Given this, there are actually many possible ways to express feed or milk efficiency

**Feed Efficiency =**

**FCM / kg DMI**  
**Mcal milk / kg DMI**  
**Milk N / feed N**  
**\$ Milk / \$ Feed**  
**Feed Saved**

# Milk Energetics

not all milk is created [energetically] equal. . .

	4.0 FCM	3.5 FCM	ECM
1.0 kg milk =	0.75 Mcal	0.70 Mcal	0.69 Mcal
1.0 Mcal Milk =	1.33 kg	1.43 kg	1.45 kg

$$\text{Mcal milk} = (\text{kg fat} * 9.29) + (\text{kg true protein} * 5.63) + (\text{kg lactose} * 3.95)$$

**Remember maintenance?**

for every 1 Mcal NE<sub>L</sub> consumed above maintenance yields 1 Mcal milk

# Do milk energetics make a difference?

- Example: **Milk / DMI vs. FCM / DMI**
- **Milk Yield (lb) / DMI (lb)**
  - 80 lb milk / 50 lb DMI = **1.6**
- **3.5% FCM (lb) / DMI (lb)**
  - 80 lb milk @ 3.7% vs. 3.4% milk fat / 50 lb DMI
    - 82.6 lb FCM / 50 lb DMI = **1.66**
    - 78.7 lb FCM / 50 lb DMI = **1.57**

# How do we measure?

- Feed intake?
- Milk yield?
- Milk composition?

by farm? by pen? by cow?

***We can collect a lot of pen level  
feed efficiency data easily,***

***but that doesn't help us select for feed efficiency or to  
understand sources of individual animal variance. . .***

# How do we measure in research?

it is all about the individual!



**Calan Gates**



**Insentec  
Gates**



**Tie Stalls**

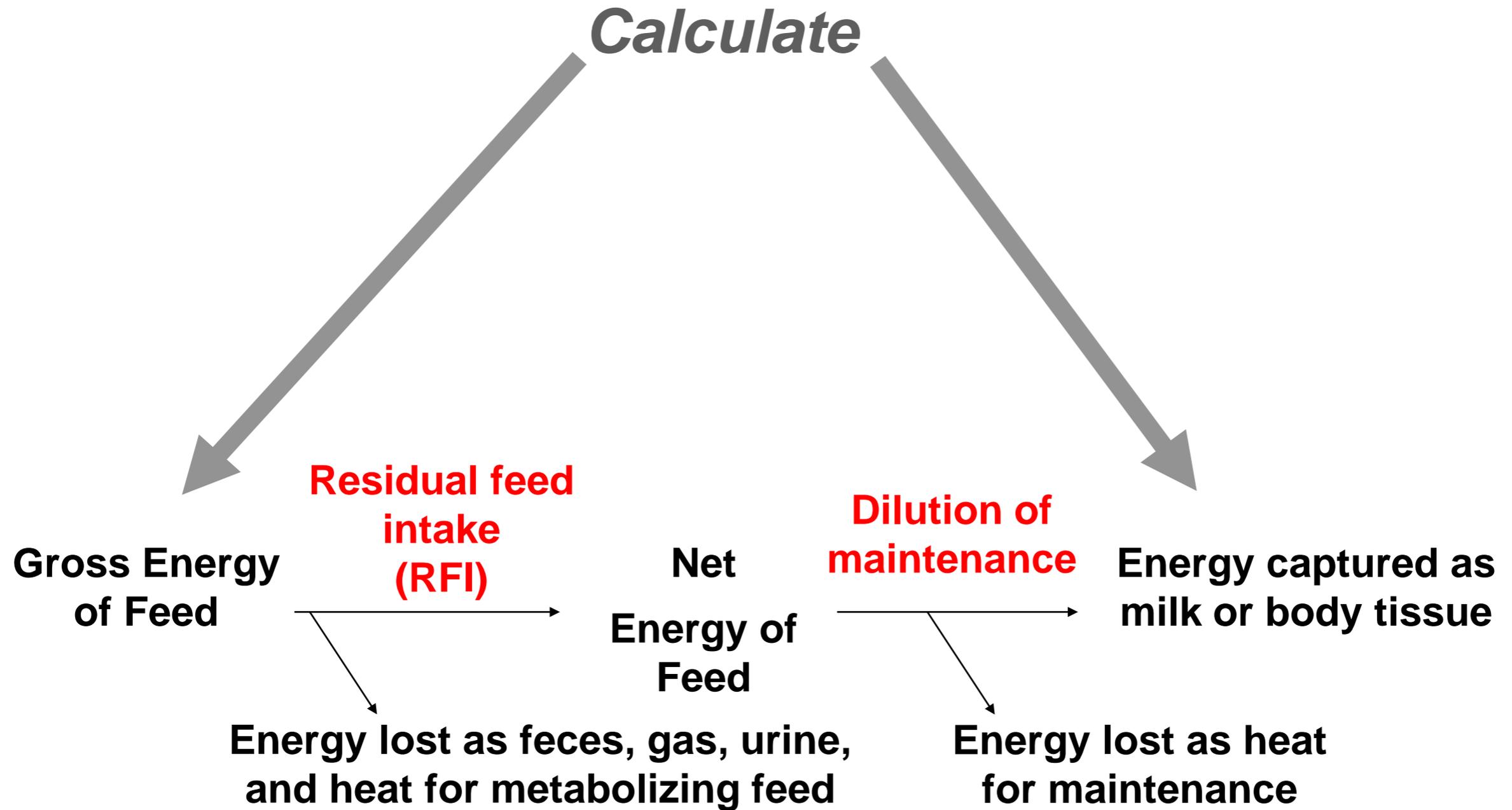


# What could go wrong?

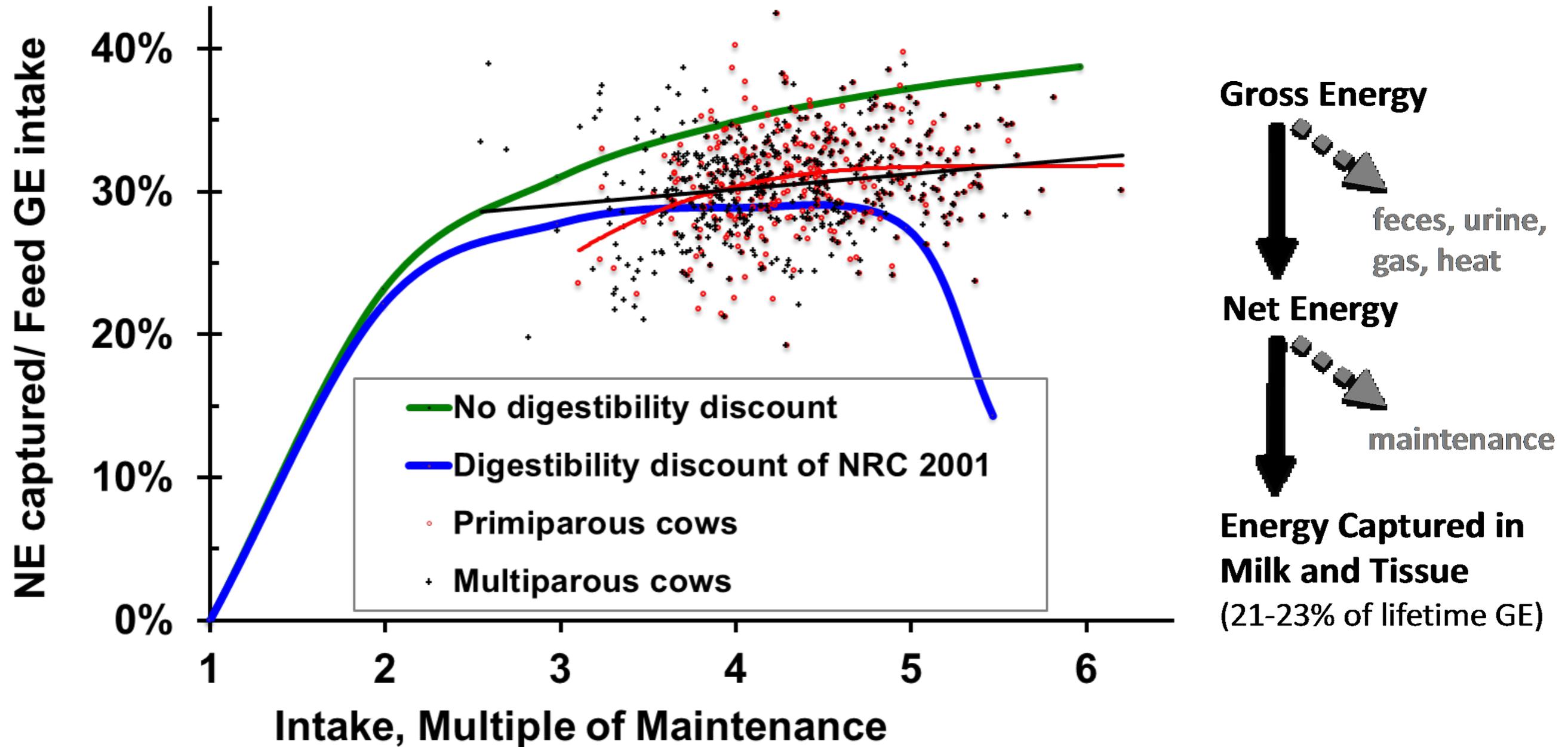
- Cows can appear to be very feed efficient if they steal feed from other cows
  - Result: we select for the most dominant cows
  - Solution: modify facilities to prevent stealing and monitor data closely
- Cows can appear to be very feed efficient if they mobilize body stores to make up energy deficits
  - Result: we select for cows that lose excessive BCS
  - Solution: we measure RFI during mid-lactation and we account body weight change
- Cows can appear less efficient if they spill water into their feed and their feed refusals have more moisture than we account for
  - Result: we select for “neat” cows
  - Solution: modify tie-stalls to prevent



# What do we do with all this individual cow data?

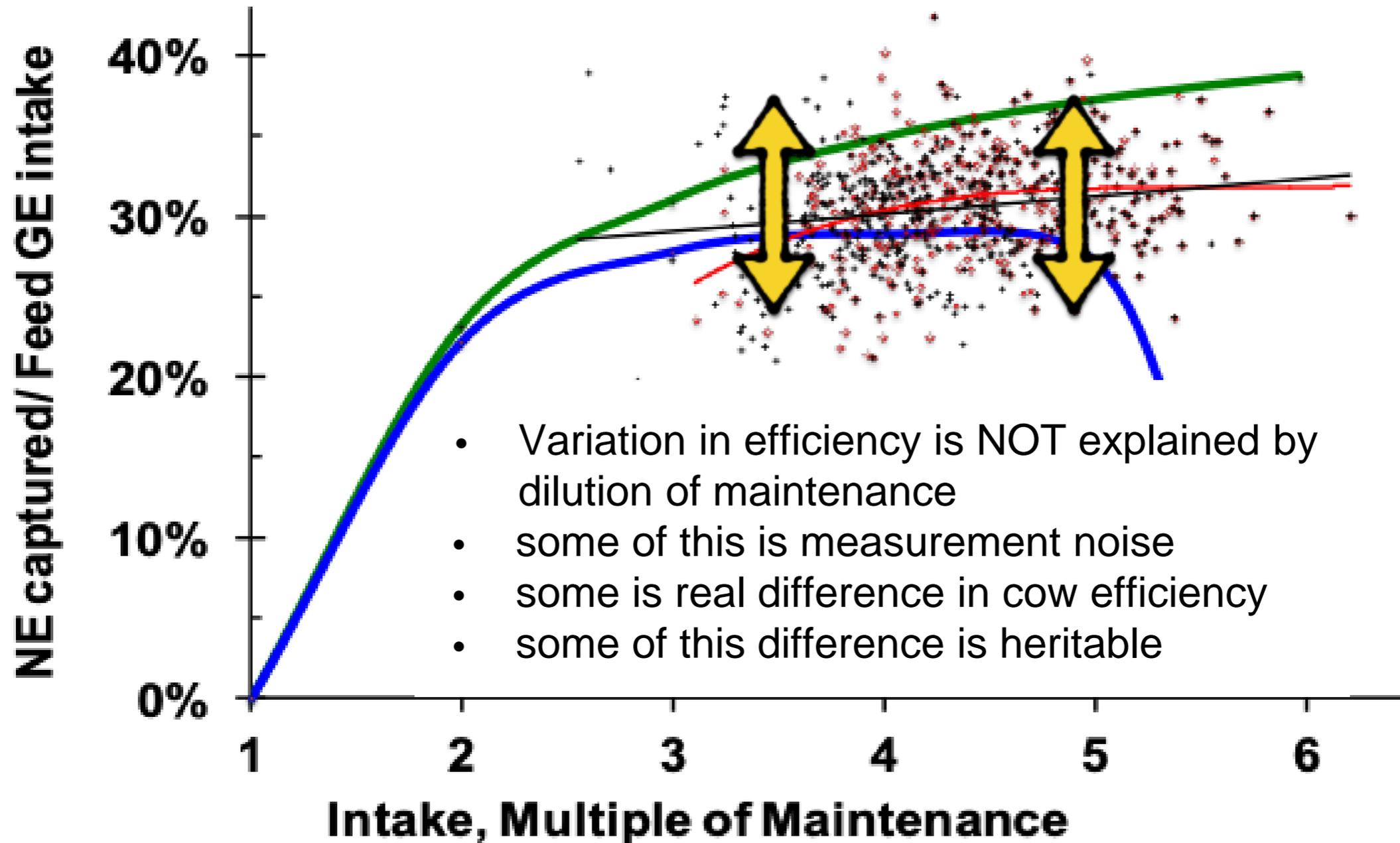


# Gross Feed Efficiency vs. Residual Feed Intake



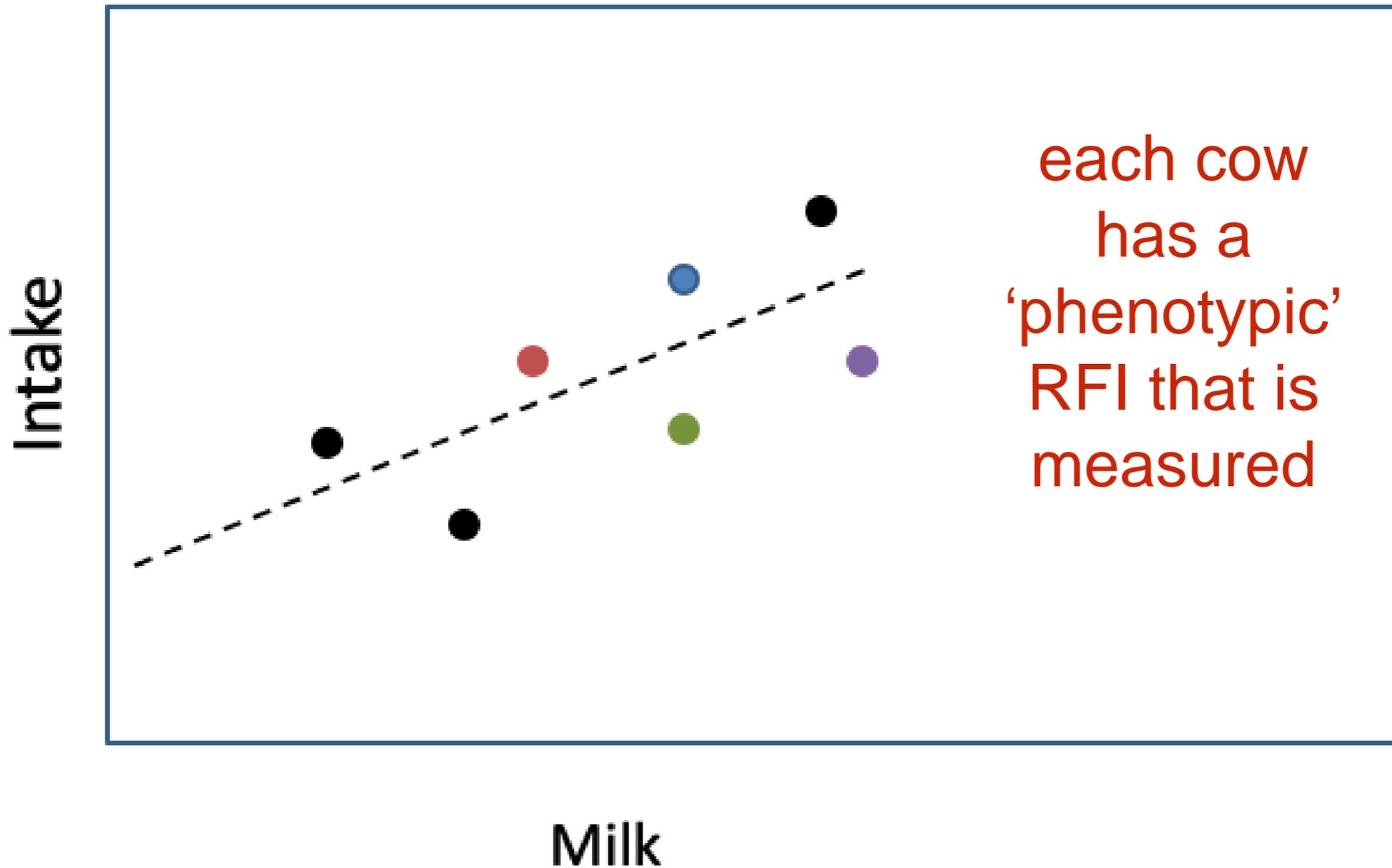
maintenance requirement is about 10 Mcal NE (25 Mcal GE, or 6 kg of feed) and each multiple is about 15 kg of extra milk

# Gross Feed Efficiency vs. Residual Feed Intake



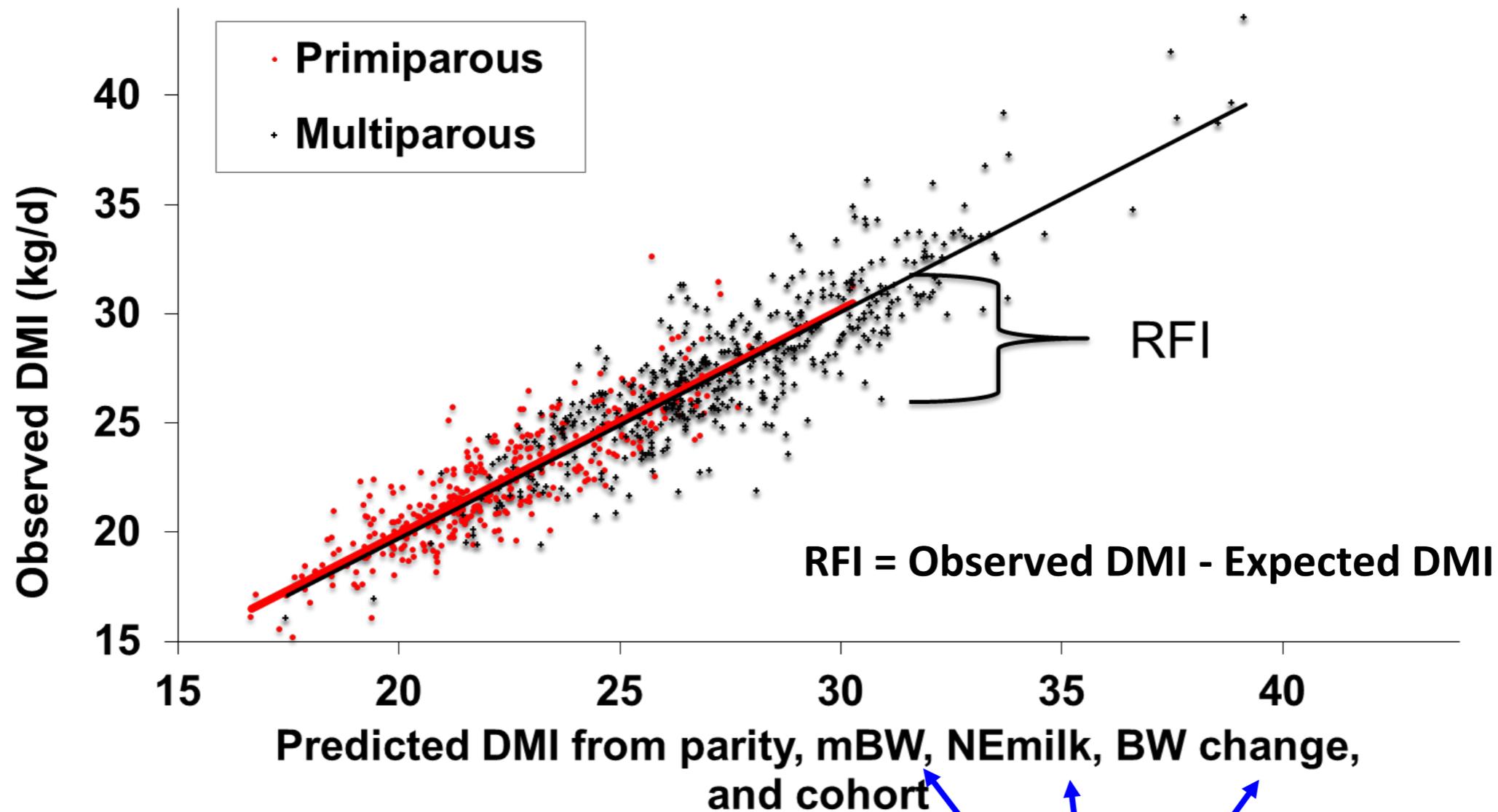
# Residual Feed Intake (RFI): in a simplistic sense

**RFI is the variance that is not explained by dilution of maintenance.  
It is the difference between what she eats and what we predict she should eat.**



*Example shown without digestion depression; constant marginal efficiency*

# Residual Feed Intake (RFI): in a realistic sense



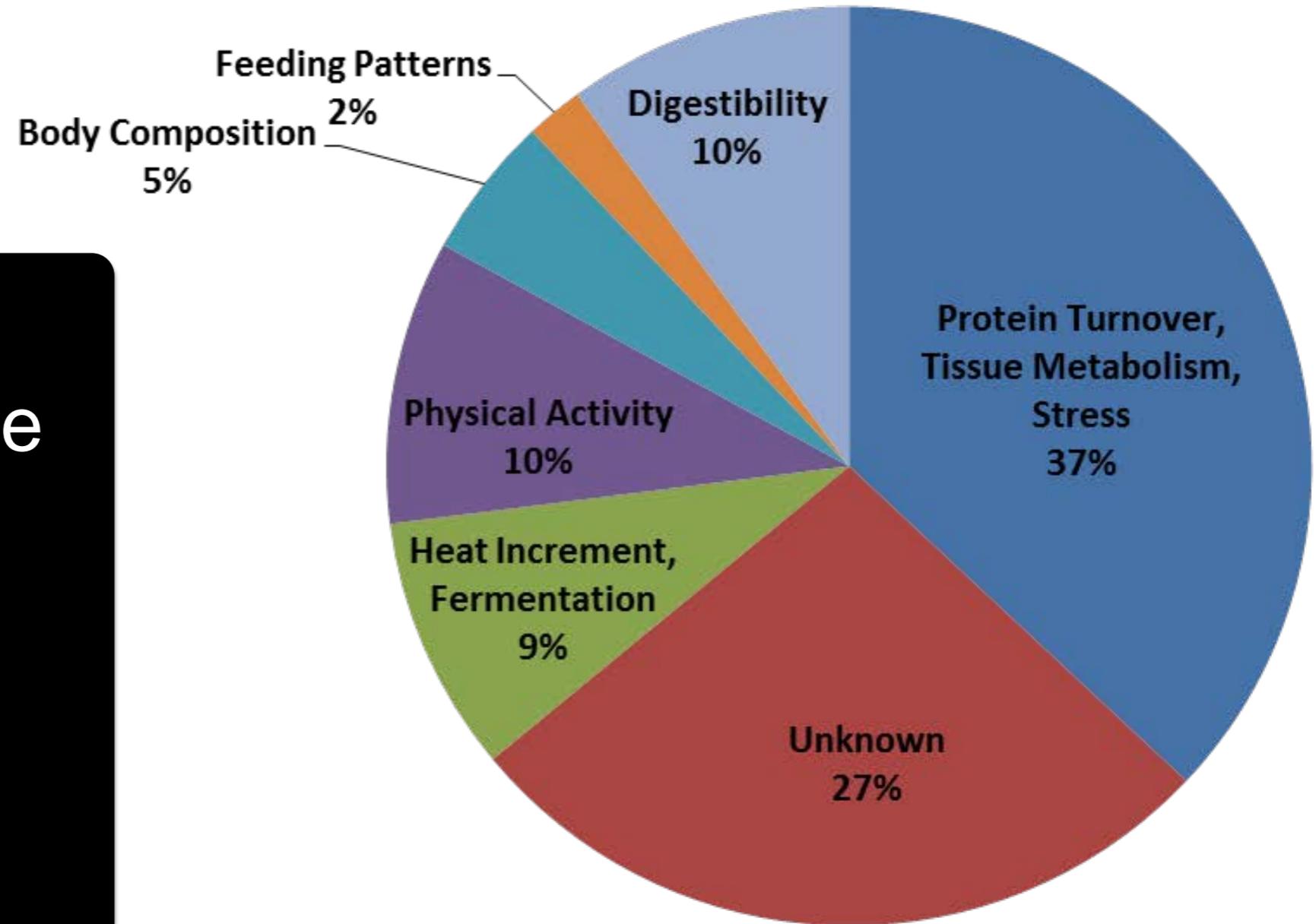
VandeHaar, 2013

**A negative RFI is what we want!**

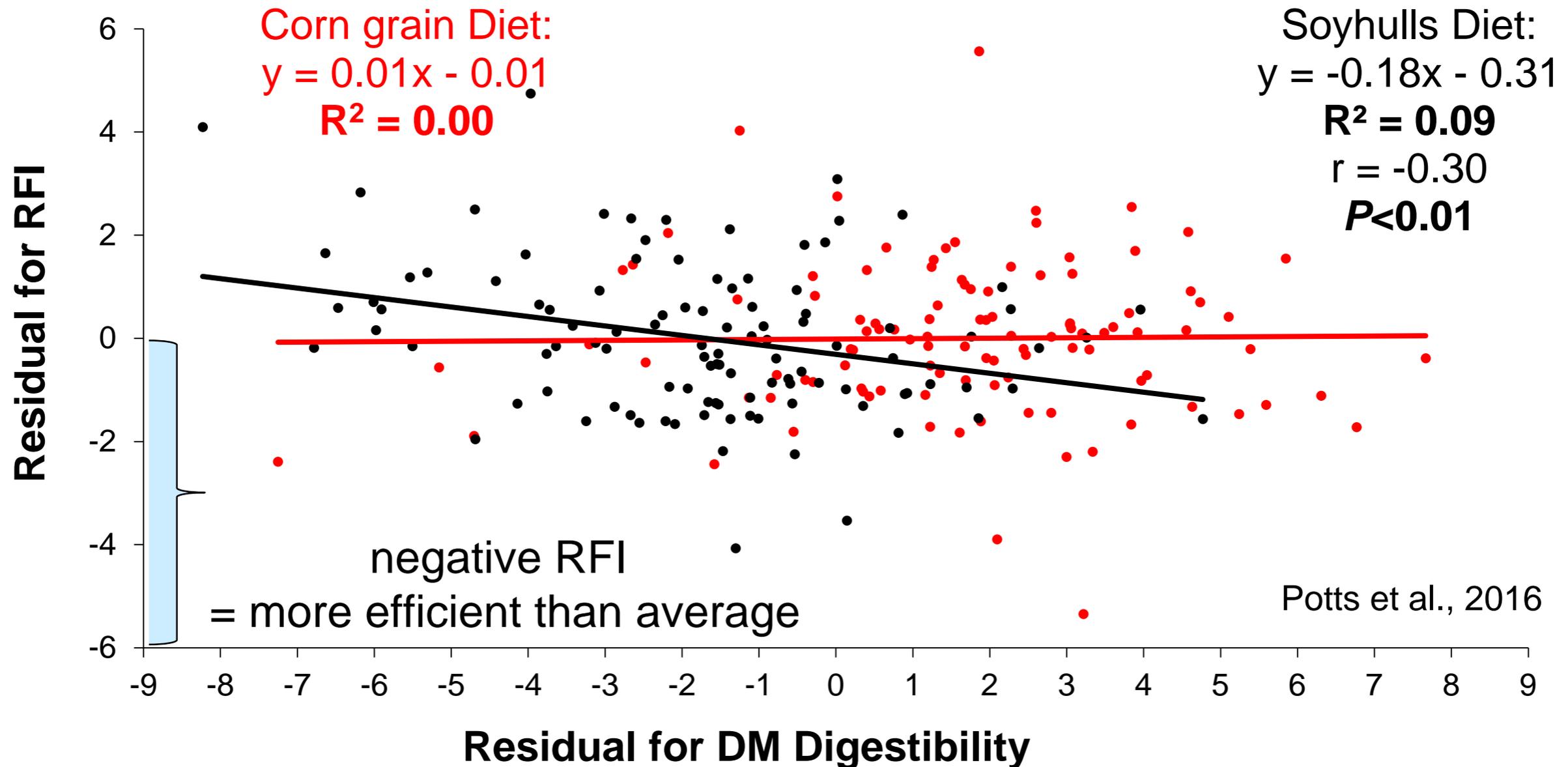
**However, there is more to efficiency than RFI. We also want high production.**

# Sources of Phenotypic RFI

Which of these categories vary by animal? or could be influenced?

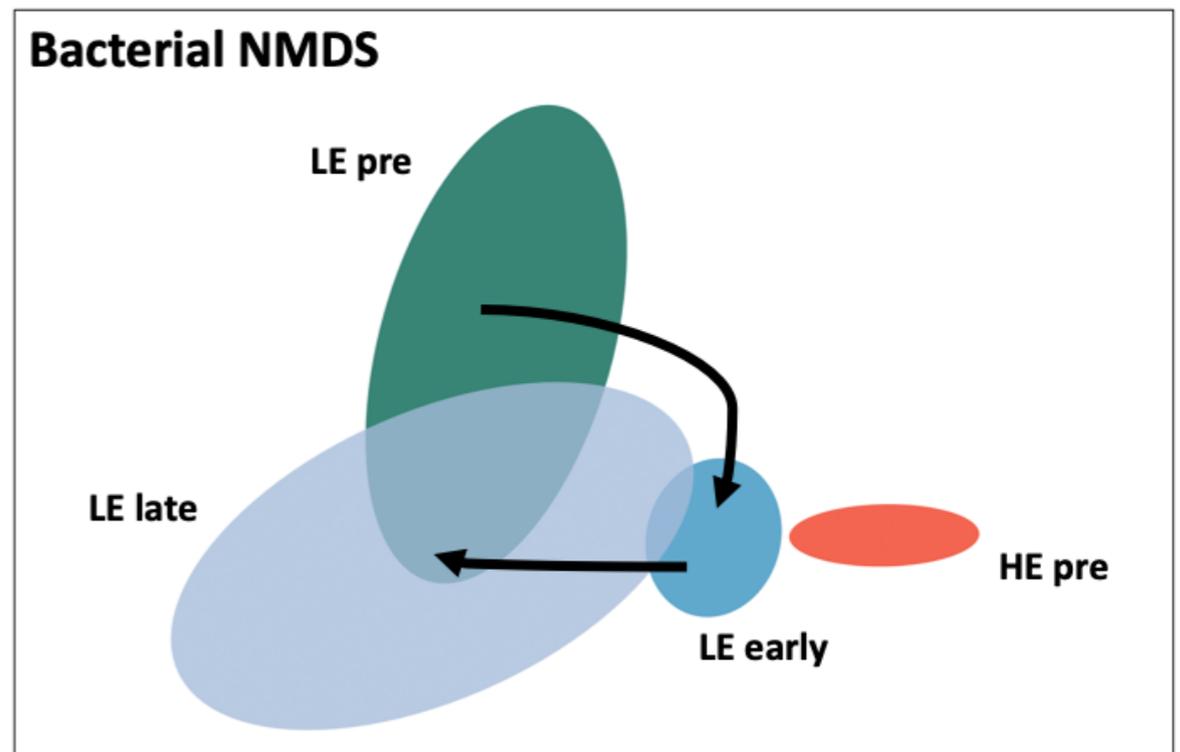
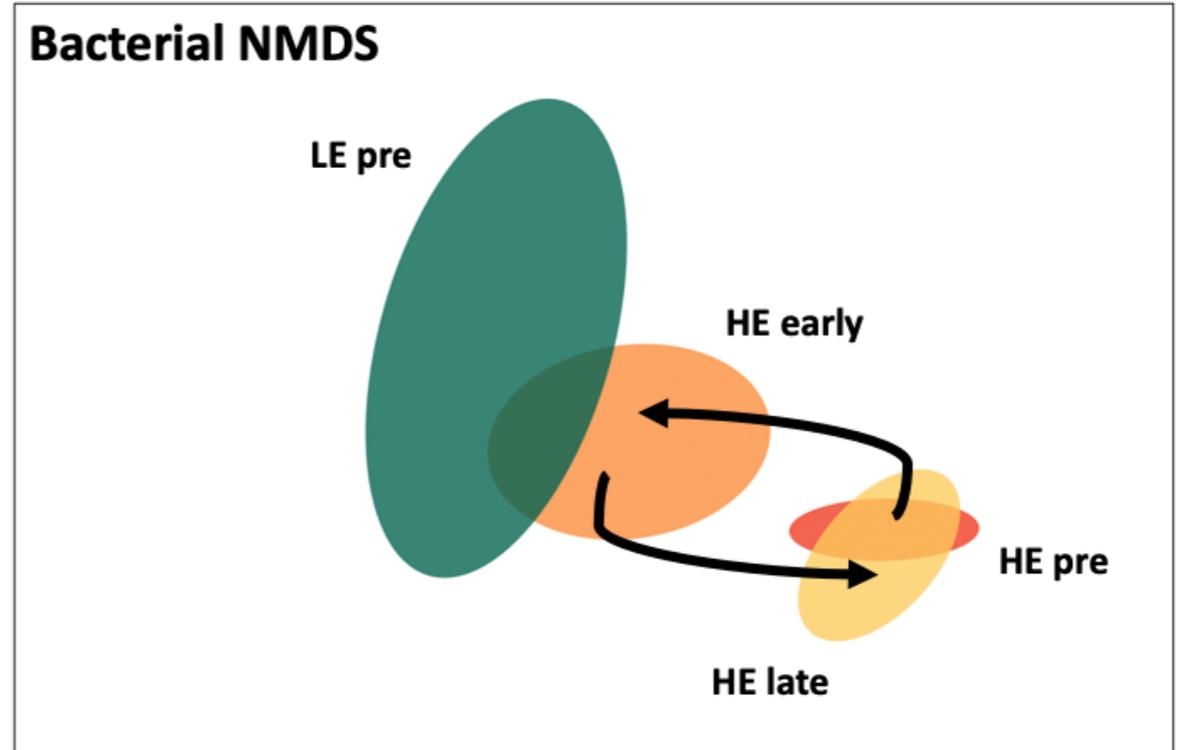
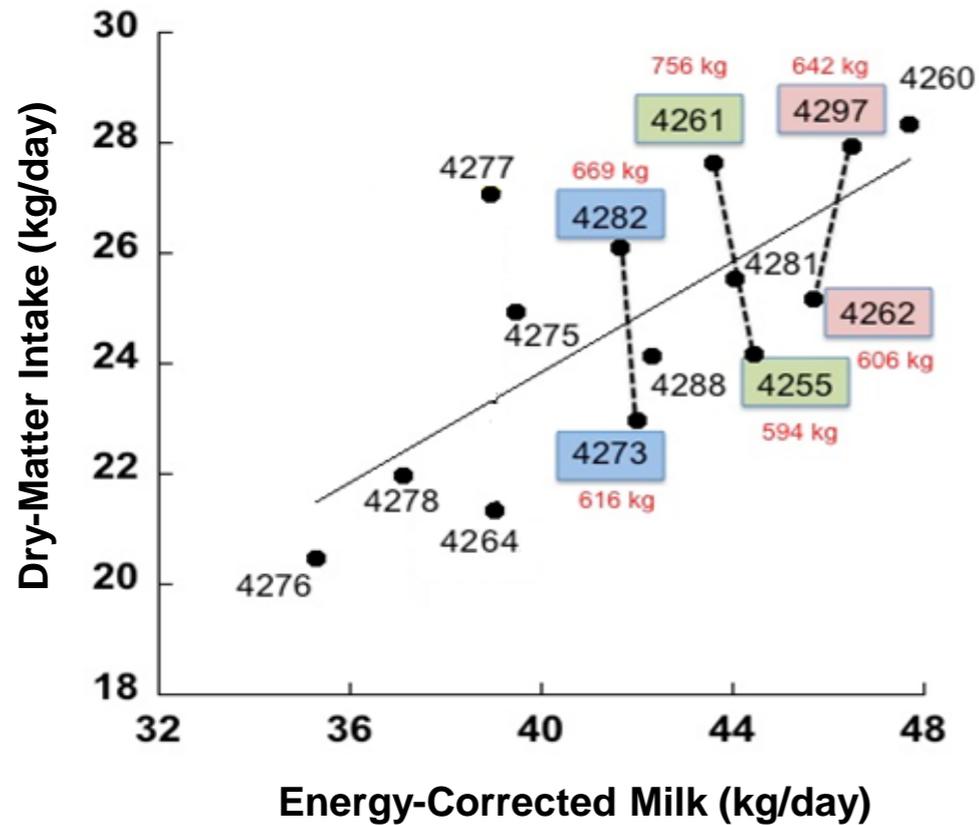


# Does diet digestibility contribute to RFI?



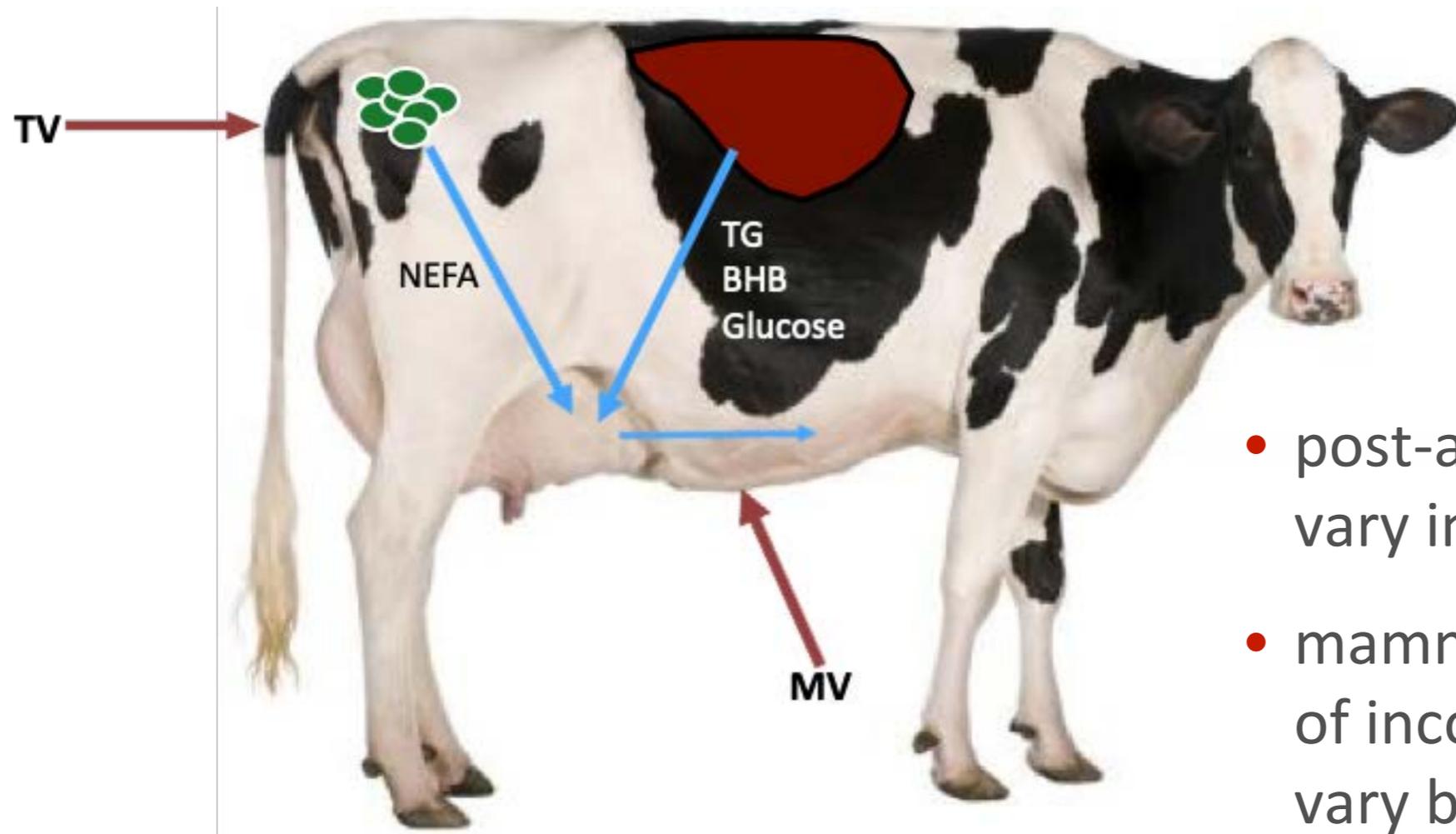
Diet digestibility accounted for 10 to 30% of RFI when cows are fed low starch diets, but not when fed high starch diets

# Do rumen microbial populations influence feed efficiency?



- There are microbial community patterns of high and low efficient animals
- Return of the bacterial community to that of the host by 1 week post-transfer, supports an interaction of host and microbes

# Does post-absorptive nutrient metabolism influence RFI?



- post-absorptive tissue use may vary in efficiency by cow
- mammary uptake and efficiency of incorporation into milk may vary by cow
- may explain some of the variance between primiparous and multiparous cows

# Take-Home Messages

- Precision in measurement is key for determining phenotypic residual feed intake
- RFI represents the difference in feed efficiency not explained by dilution of maintenance
  - it is the difference in what the cow ate vs. what we predict she should have eaten
- There are many biological sources of RFI and understanding their contribution will help further clarify animal to animal differences
  - diet digestibility, rumen fermentation, post-absorptive nutrient utilization, and feed behavior

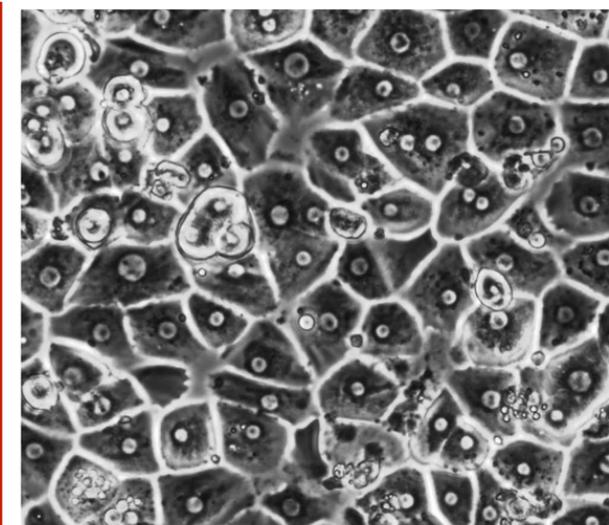
# Acknowledgements



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# Questions?



# Do milk energetics make a difference?

- Example: **Milk / DMI vs. ECM / DMI**
- Holstein: 80 lb milk, 3.7% fat, 3.2% protein, 50 lb DMI
- Jersey: 60 lb milk, 5.2% fat, 3.8% protein, 45 lb DMI
- **Milk / DMI**
  - Holstein: 80 lb / 50 lb = **1.60**
  - Jersey: 60 lb / 45 lb = **1.33**
- **ECM / DMI**
  - Holstein: 82.9 lb / 50 lb = **1.66**
  - Jersey: 76.4 lb / 45 lb = **1.70**

# Sources of Phenotypic RFI

- Noise measuring milk or intake or energy balance
  - increase precision in measurements
  - increase cow numbers
- Real differences in feed utilization that are temporary for that animal
- Real differences within an animal that are repeatable
- Real differences within an animal that are heritable (genetic RFI)