

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_L 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

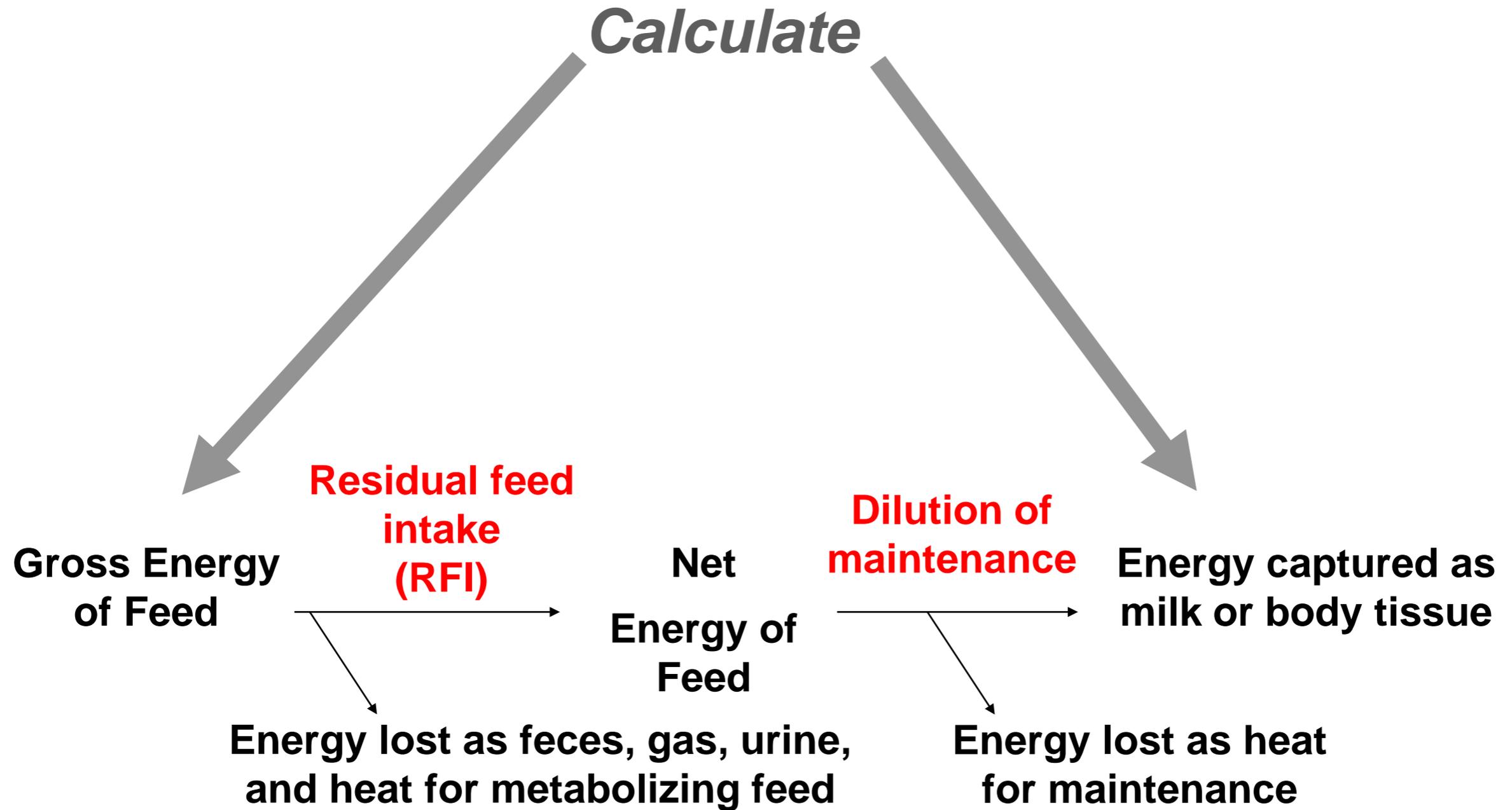


What could go wrong?

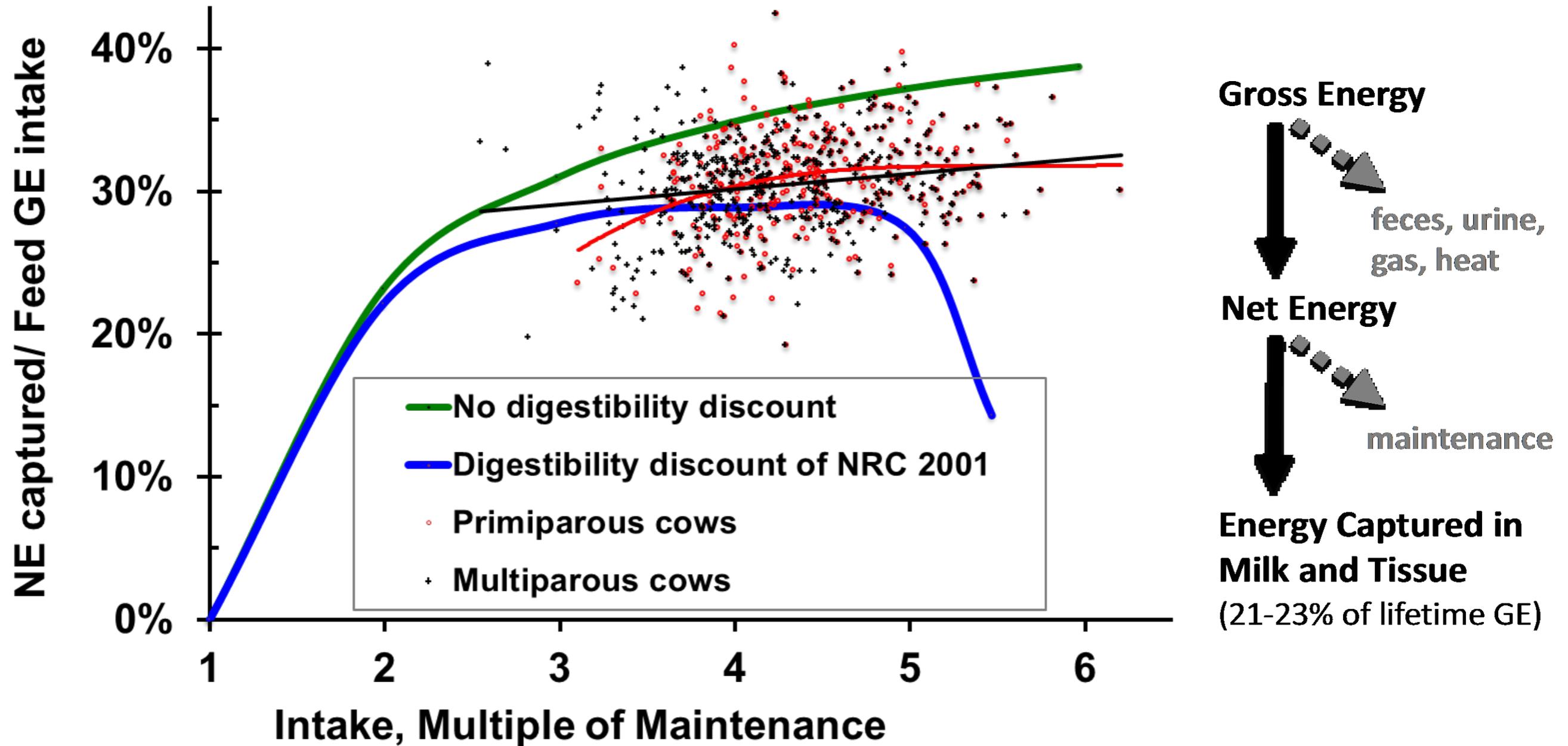
- Cows can appear to be very feed efficient if they steal feed from other cows
 - Result: we select for the most dominant cows
 - Solution: modify facilities to prevent stealing and monitor data closely
- Cows can appear to be very feed efficient if they mobilize body stores to make up energy deficits
 - 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?

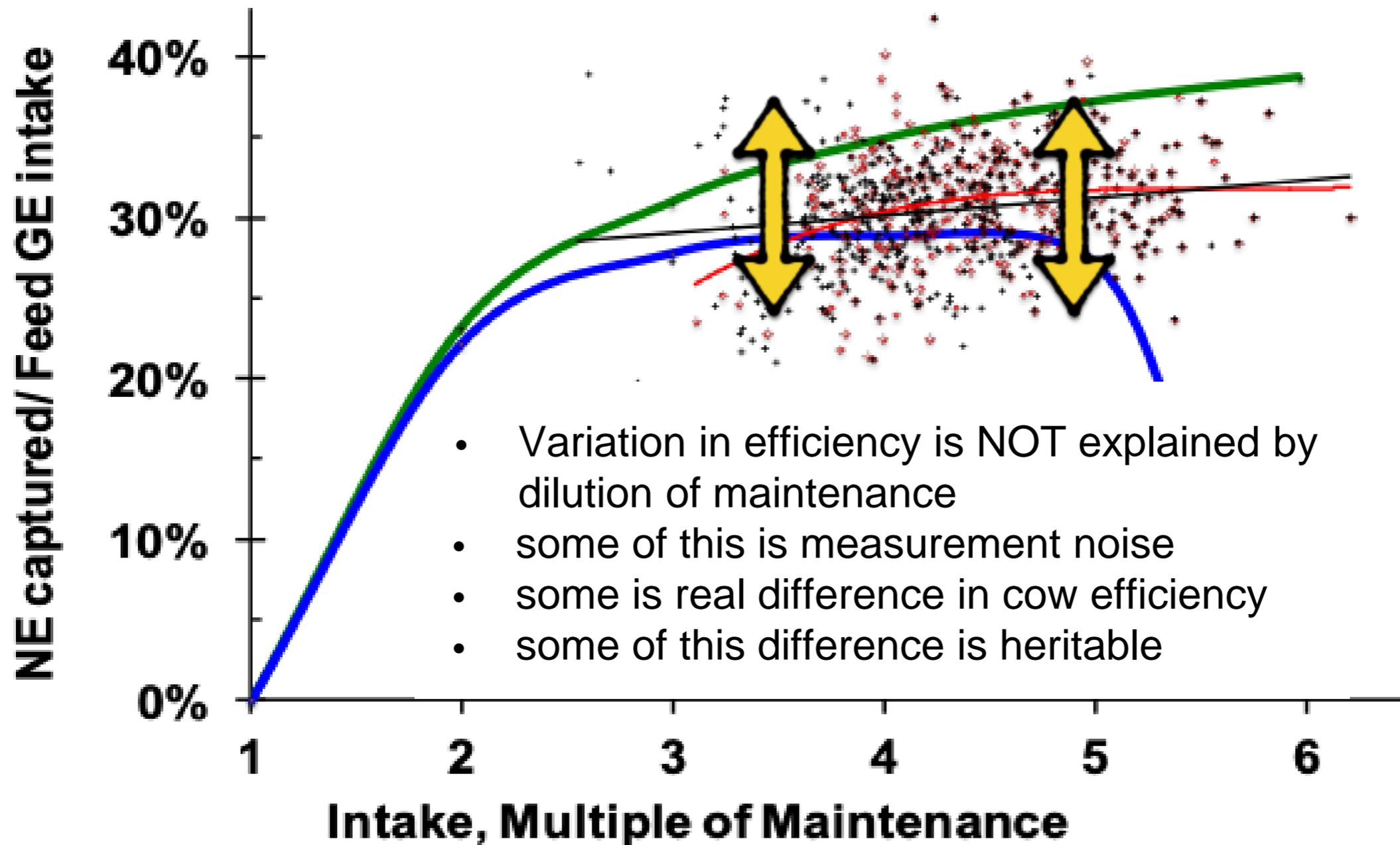


Gross Feed Efficiency vs. Residual Feed Intake



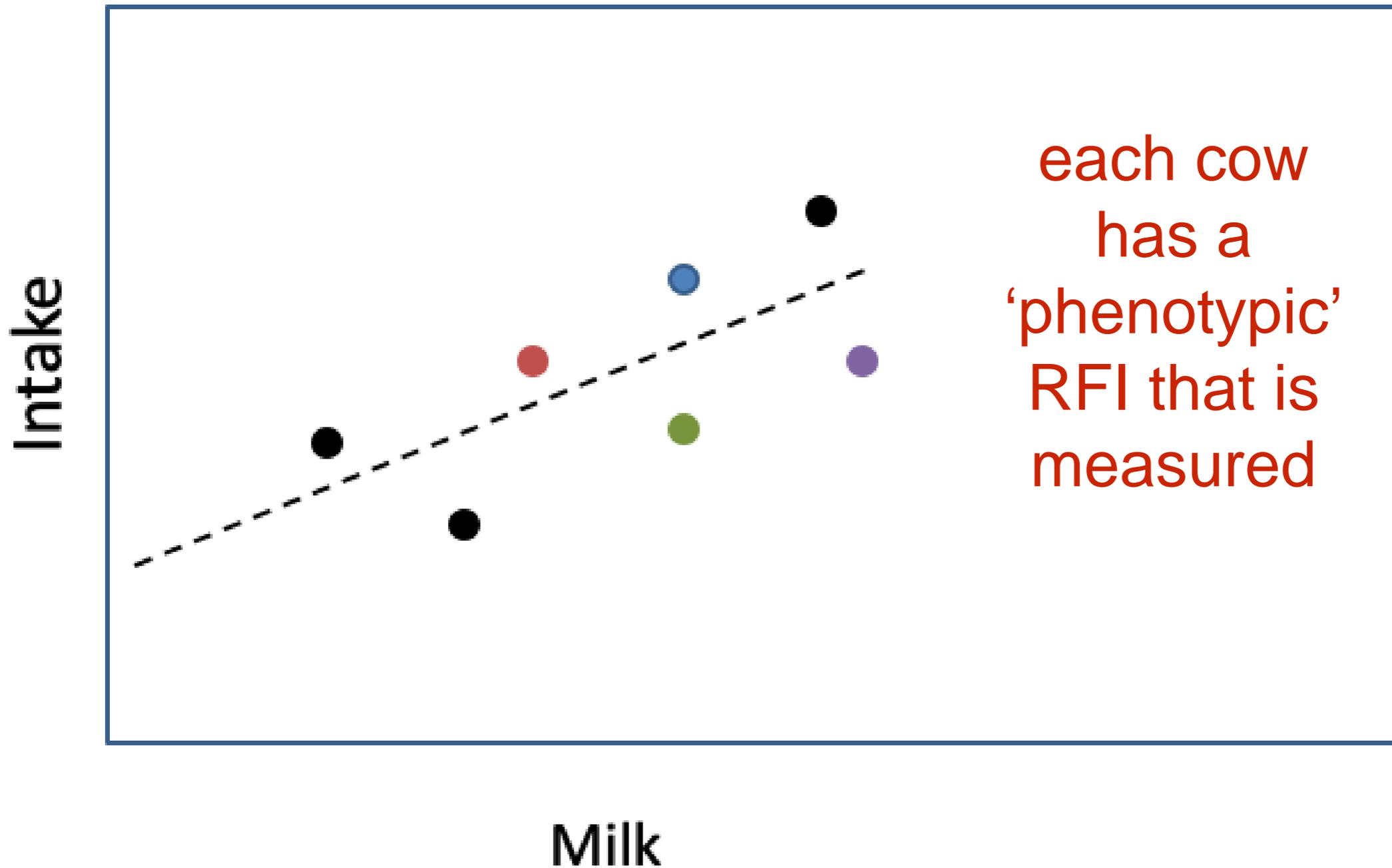
maintenance requirement is about 10 Mcal NE (25 Mcal GE, or 6 kg of feed) and each multiple is about 15 kg of extra milk

Gross Feed Efficiency vs. Residual Feed Intake



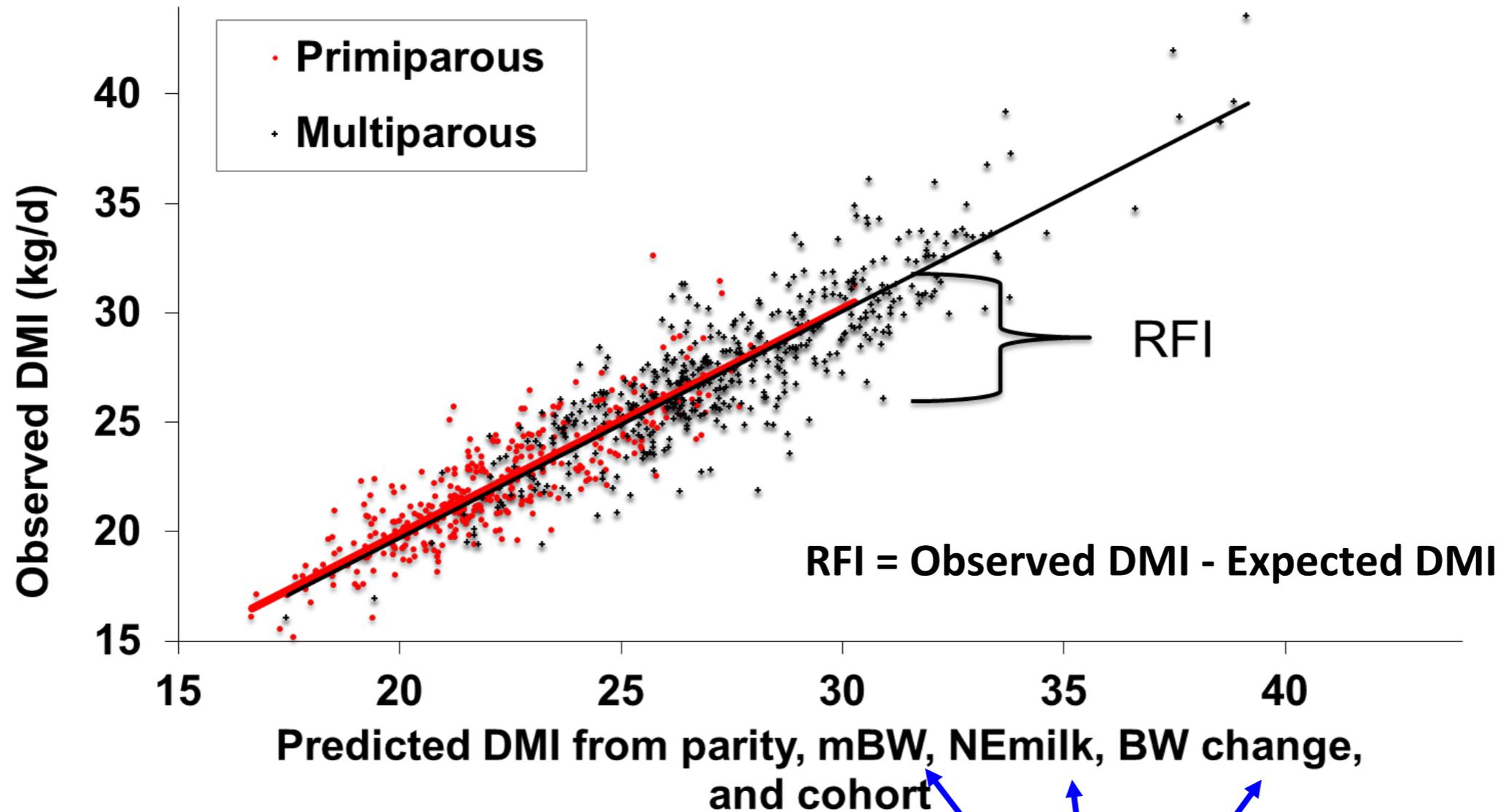
Residual Feed Intake (RFI): in a simplistic sense

**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



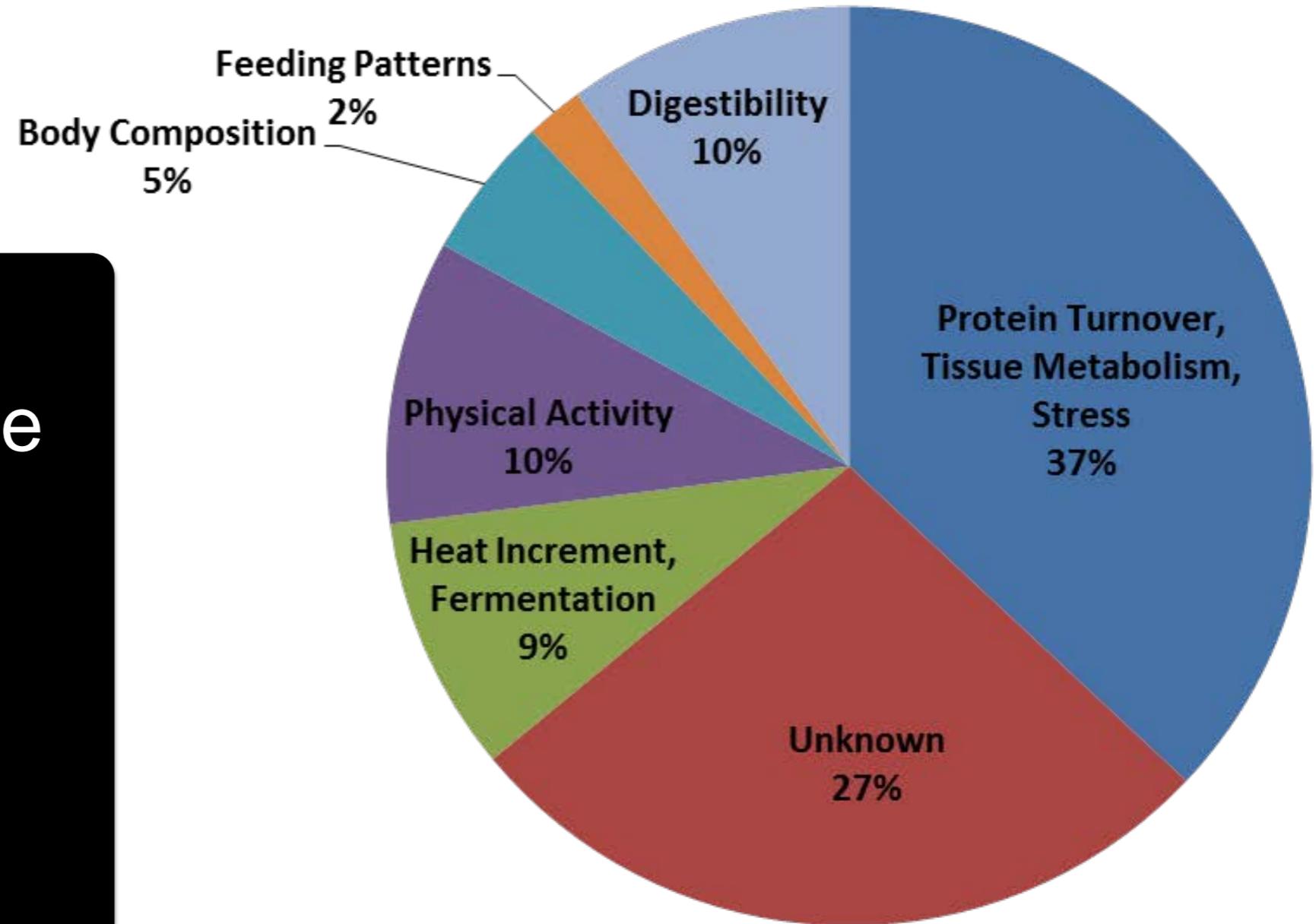
VandeHaar, 2013

A negative RFI is what we want!

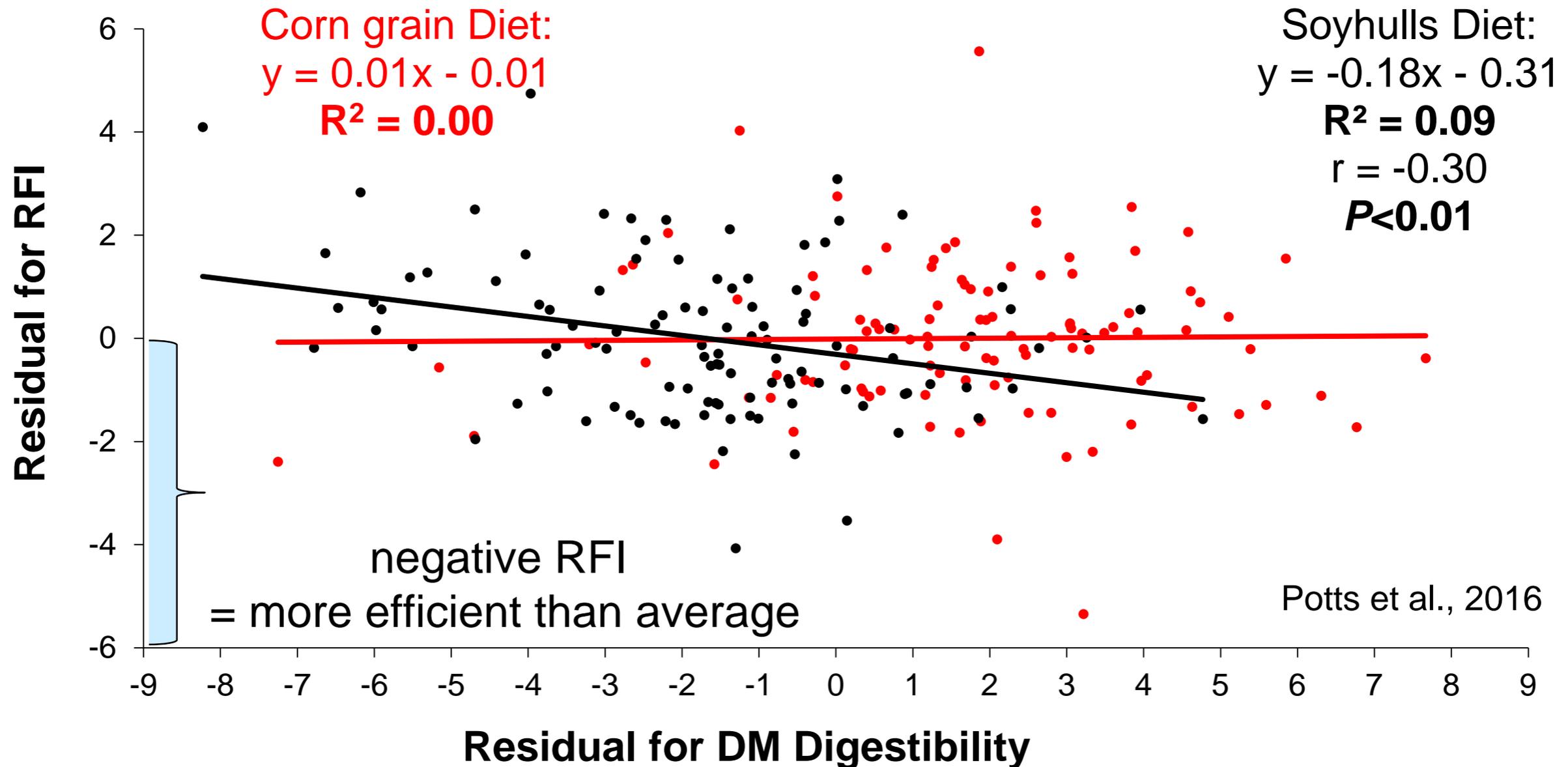
However, there is more to efficiency than RFI. We also want high production.

Sources of Phenotypic RFI

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

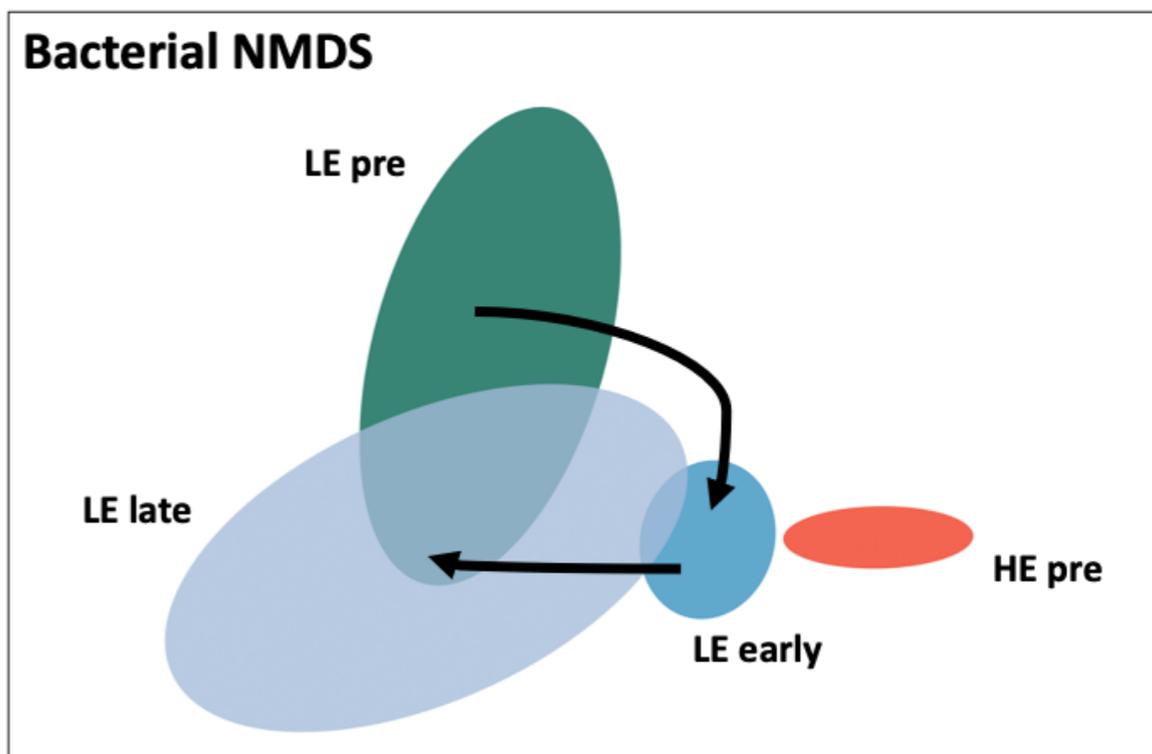
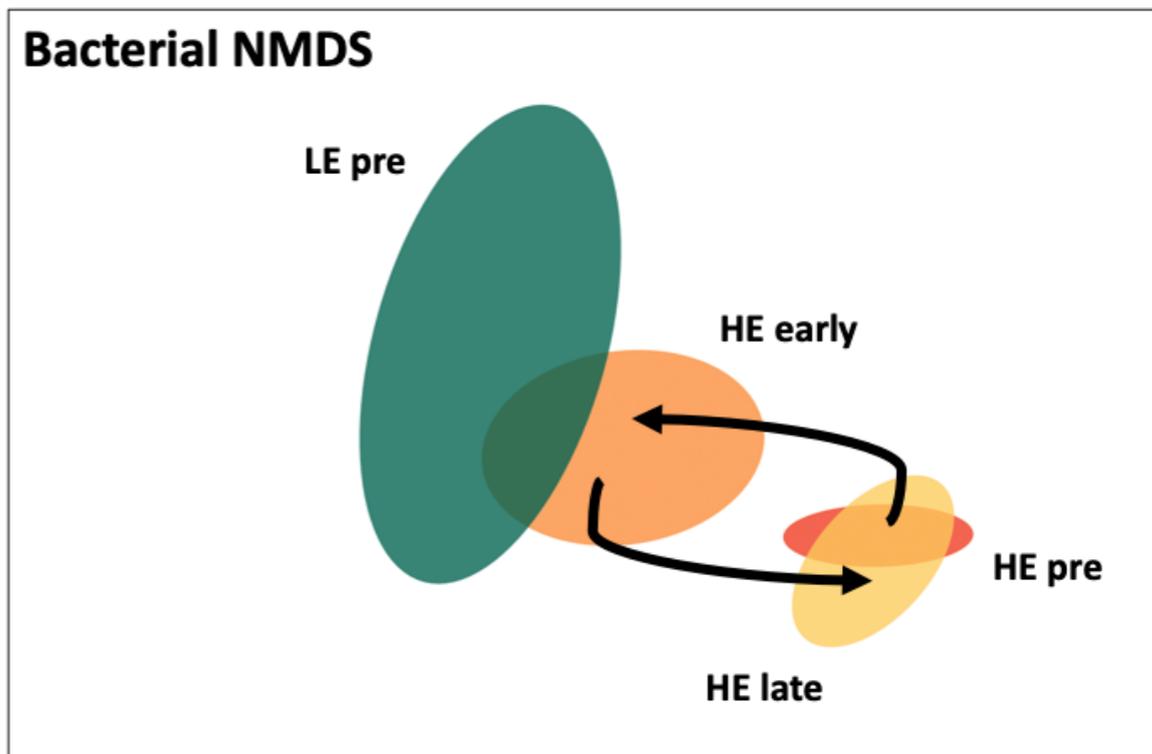
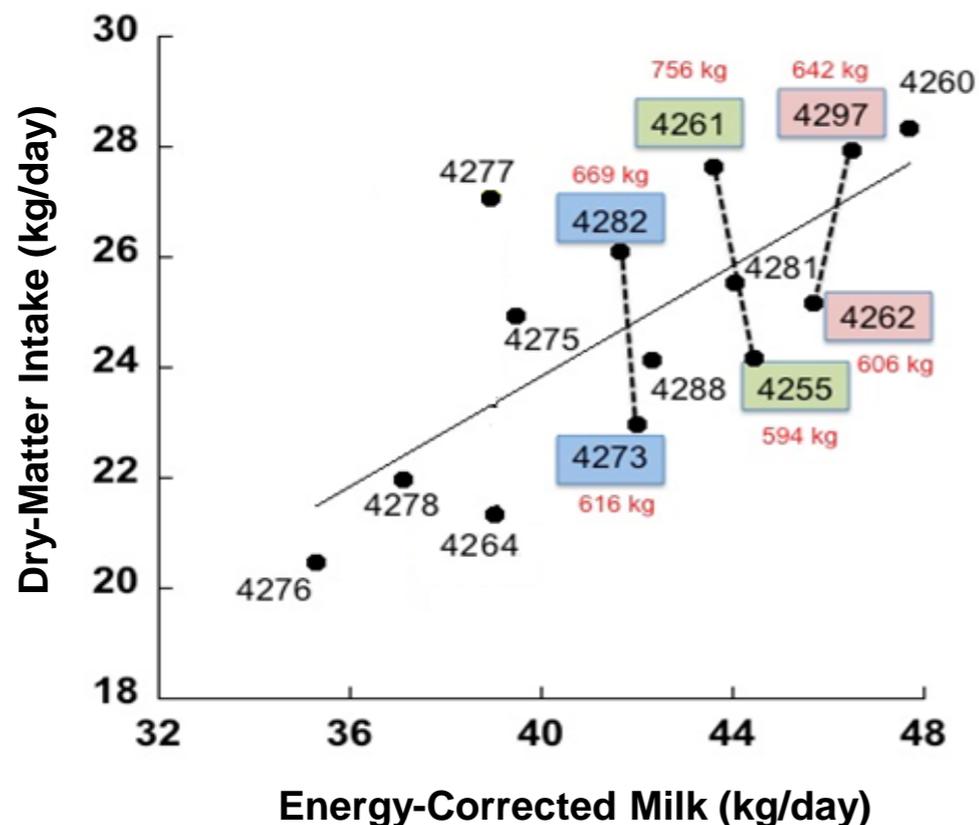


Does diet digestibility contribute to RFI?



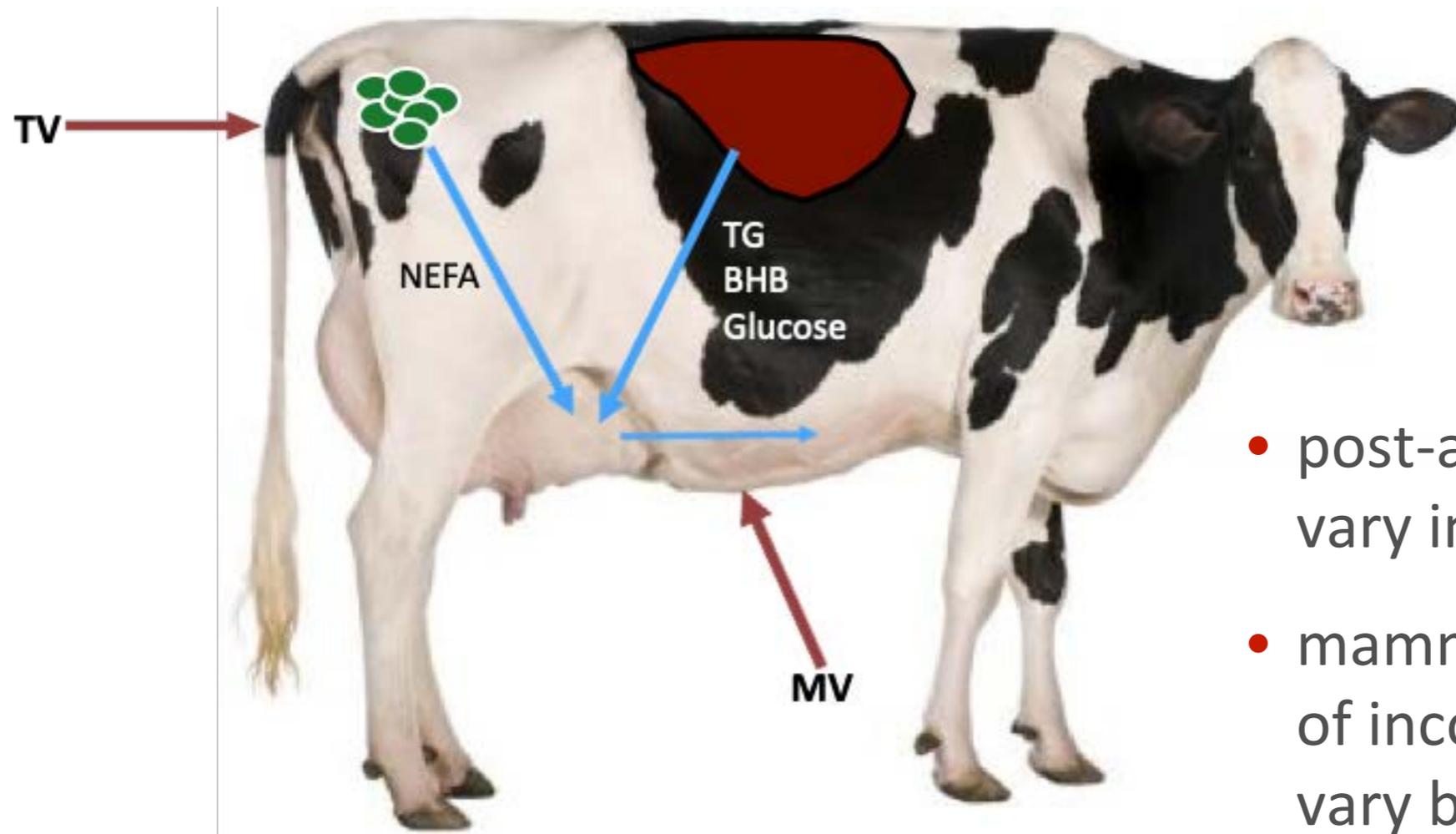
Diet digestibility accounted for 10 to 30% of RFI when cows are fed low starch diets, but not when fed high starch diets

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

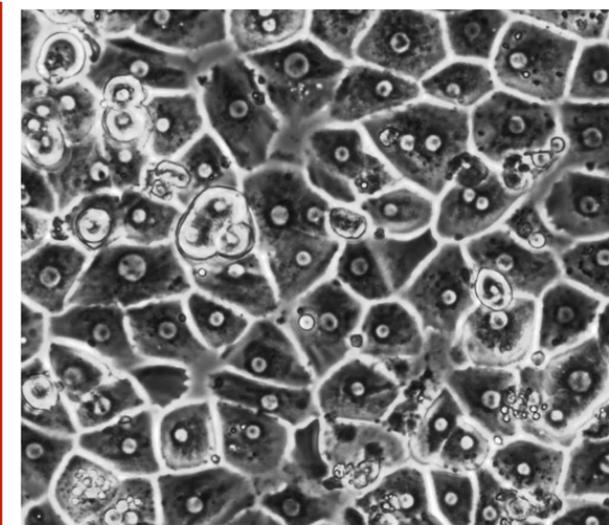
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Questions?



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)