To eat or not to eat, that is the question!

Every wonder why your animals eat what they eat? Don’t eat what you think they should eat? Or worse yet, don’t eat what your fancy smancy computer-based ration balancing program tells you they require?

Well, I have some bad news for you if you think it’s the animal that is wrong!

I am well-adapted for selecting my own foods and balancing my own rations!

All the parts are still here...

Rumen

...and are still used!

Historical Context

Ruminant digestion and nutrition - 400 million years
Fossil remains of cattle-like animals in India - 2 million years
Ancestors of modern cattle, the aurochs - 750,000 - 500,000 years
Domestication - 8,000 to 9,000 years
Year around full feeding and confinement - 60 years
What the heck is that? Smells okay!

If they don’t like it, they are not likely to eat it again!

Postingestive Feedback

Disclaimer

I’m whatever you want me to be!

Behavioral principles have universal application!
Herbivores

I ain't no machine!

Carnivores

Omnivores

Biscuitivores

Fundamental Tenet

Animal ≠ Machine

I ain't no machine!
I am a living, breathing, feeling, social creature, that has likes and dislikes, feels pain, discomfort, and stress. I prefer familiar foods to novel foods, mixed diets to monotonous diets, familiar environments to unfamiliar environments, and furthermore, I prefer to...

to be with companions rather than with strangers!

The more we recognize and accommodate the nutritional and behavioral needs of our animals, rather than dictate what they are going to get, and under what circumstances, the more contented and productive they and we will be, and...

Grazing Behavior and Diet Selection

Are on-going and dynamic interactions... that represent millions of years of co-evolution and adaptation, and are extremely complex.
Defoliation
- Trampling
- Altering nutrient dynamics

Nutrients (energy, protein, vitamins, and minerals)
- Defense mechanisms (stickers, prickers, toxins, thorns, and growth form)
- Spatial and temporal variation in: forage quality, quantity, toxicity, and availability

Every Individual is Unique
- I'm Special
- They look different: some are larger, some are smaller, some are different colors.
And if you think they look different on the outside, you should see what they look like on the inside!

The result of these differences is no two animals is likely to eat the same foods and in the exact same amounts.

Food Preferences

Foraging behavior and diet selection are unique to each individual creature, even though the individuals are the same species.

If animals are so smart Darrell, why do they do such dumb things??
Making Sense Of Animal Behavior Is Easy

Behavior Is A Function Of It's Consequences!

- Positive Consequences Increase The Likelihood Of A Behavior
- Negative Consequences Decrease The Likelihood Of A Behavior

E.L. Thorndike, 1911

"The law of effect"

"Of several responses made to the same situation, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation, so that, when it recurs, they will be more likely to recur; those which are accompanied or closely followed by discomfort to the animal will, other things being equal, have their connections with that situation weakened, so that, when it recurs, they will be less likely to occur.

"Satisfaction"

"Discomfort"
Forage quality

- **Black medic**
  - CP = 25.6
  - ADF = 14.5
  - NDF = 24.1
  - NEL = 0.79

- **White clover**
  - CP = 21.8
  - ADF = 26.2
  - NDF = 41.6
  - NEL = 0.69

- **Dandelion**
  - CP = 20.8
  - ADF = 18.0
  - NDF = 41.5
  - NEL = 0.65

- **P. ryegrass**
  - CP = 22.3
  - ADF = 29.4
  - NDF = 51.0
  - NEL = 0.59
Animals process information about foods through two interrelated systems...

...with taste having a major influence on both

Cognitive System

Affective System

So many choices. So little time. How is a girl to know?

Animals process information about foods through two interrelated systems...

Cognitive System

Affective System

...with taste having a major influence on both

Cognitive Or Voluntary System

This System Integrates The Senses Of Sight, Smell, Touch And Taste With Information Gained From Mom, Peers, And Trial And Error Experience To Make Conscious Choices Concerning What To Or What Not To Eat

Learning Through Mom

Mom eats it

Baby watches

Baby eats what mom eats!

Animal nutrient requirements vary with age and physiological condition

Animal Age And Physiological Condition

PROVENZA, et. al., 1998
Affective Or Involuntary System

This System Represents A Sub-Conscious Connection Between An Animal’s Brain And Gut That Links The Taste Of A Particular Food With Its Unique Postingestive Consequences

Neural Convergence

Neural Convergence

Learning through consequences

Brain Stem

So what does it mean when we say a food is palatable or preferred?

Looks good, might taste good, but I never tried it, so I don’t like it!

Preference

Has traditionally been defined in terms of an animal’s response to a particular food i.e., if when given the choice between two foods, an animal eats one food but not the other, it is presumed the animal prefers one but not the other.
What do we mean by palatability?

Has traditionally been defined as an attribute of a food i.e., if it smells good, tastes good, has a wonderful texture etc., the food is considered palatable.

However, these definitions are not exactly right! Because there is no such thing as a food that is always palatable and always preferred.

I knew that!

So what is palatability?

Palatability is the interrelationship between flavor and post-ingestive feedback from nutrients and toxins, determined by an animal’s age & physiological condition, a food’s chemical characteristics, and an animal’s experiences with the food.

Preference depends on how adequately a food satisfies an animal’s particular nutritional needs.

Preference for:

<table>
<thead>
<tr>
<th>Animal Previously Consumed</th>
<th>Preference for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Energy &gt; Protein &gt; Water</td>
</tr>
<tr>
<td>Energy</td>
<td>No change</td>
</tr>
<tr>
<td>Protein</td>
<td>No change</td>
</tr>
</tbody>
</table>

Meal to meal preference for energy and protein depends on whether energy and protein requirements were satisfied during previous meals.

PROVENZA, et al., 1998
Palatability and preference are dynamic

“Hey, we’re sick of clover, we want grass”

It has been stated “animals select the best and leave the rest”

However, the question is do animals always select the highest quality feeds?

Best
Better
Good

Nutrient profile of 9 inch tall orchardgrass 10/5/98

<table>
<thead>
<tr>
<th>Layer</th>
<th>CP</th>
<th>NDF</th>
<th>NEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOP</td>
<td>27.4</td>
<td>38.5</td>
<td>79</td>
</tr>
<tr>
<td>MIDDLE</td>
<td>22.9</td>
<td>44.6</td>
<td>76</td>
</tr>
<tr>
<td>BOTTOM</td>
<td>14.0</td>
<td>60.0</td>
<td>67</td>
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</table>
Anecdotally, these observations indicate when given a choice, cows can and do discriminate among alternatives and attempt to balance nutrient intake to maintain dietary homeostasis.

Research Question

If I change the ratio between crude protein and energy in the barn ration, i.e., the grain, will the cows alter the composition of the diet they select from pasture to compensate?
**Pasture Net Energy for Lactation (Mcal/kg)**

<table>
<thead>
<tr>
<th></th>
<th>CLOVER</th>
<th>GRASS/ CLOVER</th>
<th>GRASS</th>
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</tr>
<tr>
<td><strong>1.61</strong></td>
<td><strong>1.50</strong></td>
<td><strong>1.43</strong></td>
<td></td>
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</tbody>
</table>

**Grain Mixes**

<table>
<thead>
<tr>
<th>CP</th>
<th>NE_L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix 1</td>
<td>11%</td>
</tr>
<tr>
<td>Mix 2</td>
<td>21%</td>
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</tbody>
</table>

**Research Design**

* (A-B-A Reversal)

**A** days 1-4: Cows were fed morning and night 10 pounds of an 11% CP pelleted grain mix and turned out to graze with no other feeds being fed.

**B** days 5-8: Cows were fed morning and night 10 pounds of a 21% CP pelleted grain mix and turned out to graze with no other feeds being fed.

**A** days 9-12: Cows were returned to the base diet fed on days 1-4.

Diet selection and foraging locations were recorded every 5 minutes during the first two hours post milking on each of the 12 days a.m. and p.m.

**So What Did My Brilliant Bovines Do?**

**Diet composition by period if selection is by chance**

**Diet composition by period May 2004 orchardgrass treatment**
Milk production by period May 2004 orchardgrass treatment

Milk Production (LBS)

11%                   21%                    11%

Protein

Postingestive feedback is a very rapid process, and it can change what an animal prefers to eat in a matter of minutes.

So be careful what you feed in the barn or bunk!

Feeding too much protein here = A decrease in dry matter intake here

Animal Factors
Influencing Dry Matter Intake

Dry Matter Intake

- Kind of animal
- Environmental conditions
- Physiological condition of the animal
- Experience with the food

Dry Matter Intake

- Bite Rate
- Bite Size
- Time Spent Grazing

DMI

50 - 70 bites per minute is common
93 bites per minute has been observed!
(28,000 - 35,000 bites per day)

Biting rate/minute
Amount of feed taken/bite

- 0.02 of an ounce per bite or less
- 2.0 to 4.0% of body weight/d in dry matter

Amount of time spent grazing

- 8 hours is average but can range between 5 and 13 hours

Grazing animal activity periods

- Grazing = 8 hours
- Ruminating = 8 hours
- Resting = 8 hours

Experience with the food

- I wonder if it is nutritious?
- I wonder how much there is?
- I wonder what it is?
- I wonder if it is toxic?
- I wonder if it tastes good?
All Foods Contain Toxins!

And it is generally not in the best interest of an animal to be the first in the herd or flock to eat the most toxic plant in the pasture!

No experience with a food

“Neophobia”

Hey, what is this stuff?

Food Neophobia

Rice Intake

Food Neophobia

Rice Intake
But what about dairy cows on pasture?

Hey, what is this stuff?

Too much experience with a food “Transient taste aversion”

Oh no! Not the same stuff again?

Percent Grass in Diet

<table>
<thead>
<tr>
<th>Period</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>%Comp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% in Diet</td>
<td></td>
<td></td>
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</tbody>
</table>

Familiar | Novel

Do cows, like people, get sick of eating the same old thing!
**Conditioned Taste Aversions**

Eating any food causes a temporary or transient aversion to the flavor of the food just eaten. Eating a food to satiety or too often causes strong aversions to form. These taste aversions result in varied diets.

Oh No! Not more grass!

**Plant Factors**

*Influencing Dry Matter Intake*

**Forage Quantity**
To get the most out of your pasture, you have to get the most pasture into your animals.

Low yielding pastures (forage height less than 4 inches) cause animals to walk further, graze longer, eat less, and produce less meat, milk, and fiber.

Pastures that are too tall and rank (forage height greater than 10 inches) cause animals to decrease bite rate, take fewer bites, take longer to fill up, and produce less meat, milk, and fiber.
And pastures where animals have to walk between bites really miss the point of pasture being a source of food!

Forage Quantity

Pasture yield is a function of height plus density

Effect of forage height on DMI and behavior

- DMI is reduced because forage quality is declining and leaf length is too long
- Maximum DMI: bite size is reduced but grazing time and bite rate increase to compensate
- DMI declines because the animal cannot adapt

Pasture yield is a function of height plus density

Height

Density

DMI is reduced because forage quality is declining and leaf length is too long

Maximum DMI: bite size is reduced but grazing time and bite rate increase to compensate

DMI declines because the animal cannot adapt
Pasture is a high quality food

- **CP** = 14 - 34%
- **ADF** = 20 - 30%
- **NDF** = 33 - 50%
- **NSC** = 9 - 20%
- **NE<sub>L</sub>** = .65 - .75 Mcal/lb

The longer a plant grows, the higher the quantity but the lower its quality!

Leafy Vegetative
(6-8 inches tall)

Forage Quality
% NDF
Neutral Detergent Fiber

<table>
<thead>
<tr>
<th>% NDF</th>
<th>6-8 Inches</th>
<th>10-12 Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>33%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td></td>
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</tbody>
</table>

DMI as a % of body weight

<table>
<thead>
<tr>
<th>DMI %</th>
<th>6-8 Inches</th>
<th>10-12 Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4%</td>
<td></td>
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</tbody>
</table>

Milk production
1400 lb cow

<table>
<thead>
<tr>
<th>Milk Production</th>
<th>65-70 lbs</th>
<th>90-100 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-8 Inches</td>
<td>10-12 Inches</td>
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Forage Toxicity
(Plant Secondary Metabolites)

There is more to a plant than nutrients!

Pasture plants also contain toxins

- **LEGUMES**
  - ALFALFA - CANAVANINE, SAPONINS
  - RED CLOVER - NITRATE
  - ALSIKE CLOVER - NITRATE
  - WHITE CLOVER - NITRATE, GLYOSEIDE, TANNINS
  - BROOM TREFOIL - CN
  - SWEET CLOVER - DI COUMARIN

- **GRASSES**
  - TALL FESCUE - ERGOVALINE
  - P. RYEGRASS - ERGOVALINE
  - R. CANARYGRASS - ALKALOIDS
  - S. VERNAL GRASS - COUMARIN

Virtually every food on planet earth is toxic to some degree...

...the secret to survival is knowing just how much one can swallow!
And the best way for us to ensure that our animals are not getting a toxin overload or suffer losses in dry matter intake due to taste aversions is to plant pastures with high species diversity.

---

**Behavioral-Based Management Considerations**

Start grazing young!

---

Beware the law of least effort!
Beware the law of least effort!

YOU WANT ME TO GRAZE WHERE?

Ensure Pasture Forage Is Of The Proper Quality, Quantity, And Diversity

Legumes, Legumes, Legumes!

Un-supplemented livestock prefer clover 70:30% over grass!
Food neophobia
Never make your cows guess!

WHAT IS THIS STUFF ANYWAY?

CC''MON STOP BEING SUCH A BIG SISSY TAKE A BITE!

SHOO! STOP BENDING MY NECK TAKE A BITE!
PSM – the solution to pollution is dilution!

Be careful what you feed in the barn or bunk and...

...don’t over-feed PROTEIN!

Let them have the leftovers

In the final analysis, if we are looking to optimize the performance and health of our livestock and do so at reduced cost, with the least amount of environmental damage, and with the least amount of stress on both human and animal alike, we must stop dictating to them what they are going to get, and start accommodating what it is they really want and need to live contented healthy lives.