

Precision nutrition for nursery calves

Noah B. Litherland, PhD
Dairy Youngstock Technical Specialist
Madison, WI



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Outline for Today

- A focus on precision nutrition of the individual calf
 1. Milk
 - Understanding variation
 2. Drinking water
 3. Impact of starter grain intake
 4. Digestive processes of the calf
 5. Practical recommendations



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Is your Calf Nutrition Program Hitting the Target?

Accurate Precise



Error-Prone & Doubtful Repeatable & Reproducible




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Objectives of PD: Individual Calf Management

- Recognize the individual vs. the group average.
- Recognize and prevent problems before they become clinical.
- Minimizing use of medication through prevention.
- Predict, control, and evaluate variation.
 - 4 critical stages



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Four Critical Transitions between developmental stages



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Take Home Message

- If calves are not growing or are losing body weight, then the start of first lactation is being delayed and potentially compromised.



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Evaluating precision in your calf nursery program

- Set a goal for calf growth.
- Have your nutritionist evaluate the program.
- Measure calf growth.
- Are calves meeting growth goals?
- If calves are not meeting growth goals, evaluate the whole system to find constraints.



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Quiz question

- What is the targeted total solids content of your milk or milk replacer?
- What is the actual total solids content?
- What is the osmolality?
- Does it matter?

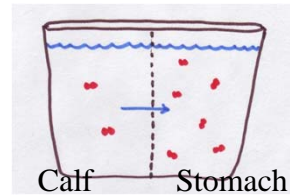


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Osmolality

- Excessive osmolality (or saltiness) of oral fluids can quickly dehydrate a young calf.
 - Salty fluids pull water and can cause diarrhea.
 - Dehydration is a loss of water, electrolytes, and oxygen
 - ↓ of Water = ↓ of oxygen = ↑ risk of Clostridial growth
- Excessive osmolality can also slow the GI flow and “stall” the movement of nutrients in the intestines.



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Impact of milk replacer mixing consistency on osmolarity

Amount of water (Quarts)	Weight of 20:20 CMR powder (Ounces)	% Solids of final mixture	Osmolarity of final mixture
1.25	8	16.1	419
1.25	10	19.3	520
1.50	8	13.8	348
1.50	10	16.6	434
2.0	8	10.7	260
2.0	10	13.0	325



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A Reliable, Practical, and Economical Protocol for Inducing Diarrhea and Severe Dehydration in the Neonatal Calf

Pamela G. Walker, Peter D. Constable, Dawn E. Morin, James K. Drackley, Jonathan H. Foreman, and John C. Thurmon

- Scours (osmotic/maldigestive diarrhea) induction protocol.
 - Very high plane of nutrition (5 % of BW/d).
 - Sucrose solution (600 mOsm/L).
 - “Calves suckled the milk replacer-sucrose solution readily”.



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Impact of inducing scours on calf physiology

	Baseline	24 h	48 h	P-value
Body weight, lb	87.2	78.7	75.4	<0.05
Skin tent duration, sec.	2.1	ND	8.9	<0.05
Plasma volume, L	3.4	ND	2.5	<0.05
Cardiac output, L/min.	8.8	4.5	3.9	<0.05
Urine, mL/h	81	61	12	<0.05
Fecal consistency (0 to 3)	0	3	3	<0.05
Fecal dry matter, %	28	ND	9	<0.05

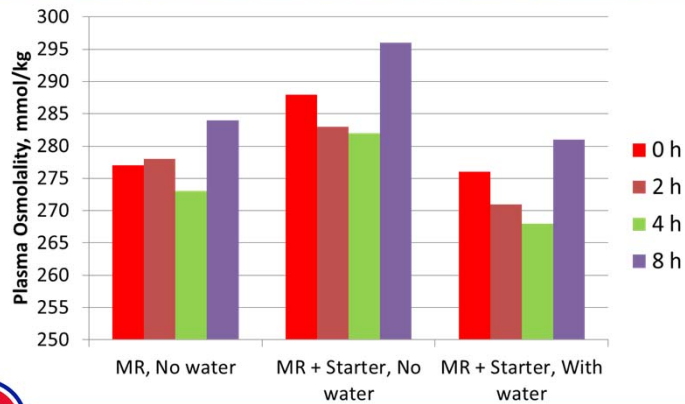


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Water Balance in Nursery Calves

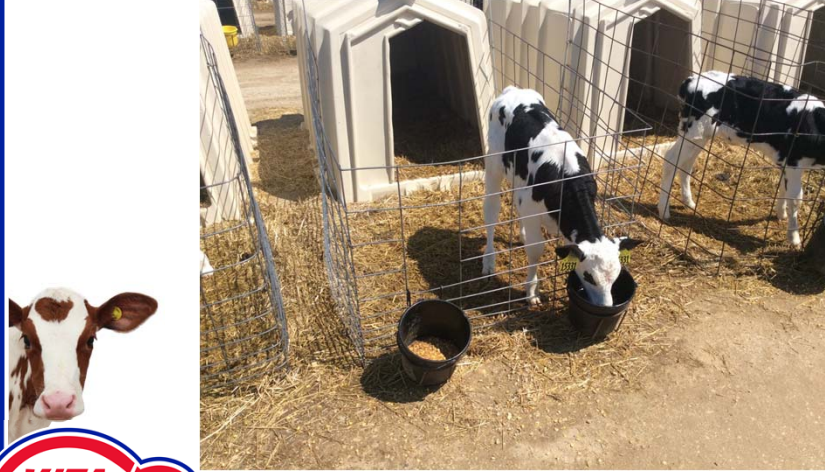
	Milk Replacer		Milk replacer + Dry feed	
	No water	With water	No water	With water
Urine osmolality, mmol/kg	450	1007	1007	527



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Adequate Drinking Water will allow the calf to self-adjust.



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Digital Refractometer

- Colostrum (Brix) and waste milk solids (% solids)



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Calculating % Solids

$\% \text{ Solids} = \text{Milk replacer} / (\text{Milk replacer} + \text{Water})$

Example:

0.68 lb of powder (w/ 2 × feeding)
(1.5% of a 90 lb calf)

If you want to feed 13% solids, then:

$$(0.68 \times 0.87) / 0.13 = 4.5 \text{ lb water}$$

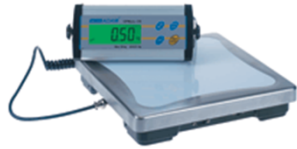
$$\% \text{ Solids} = 0.68 / (0.68 + 4.5) = 13.0\%$$



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Buy your sweetheart something they can really use!



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Week 1 Whole Milk Composition

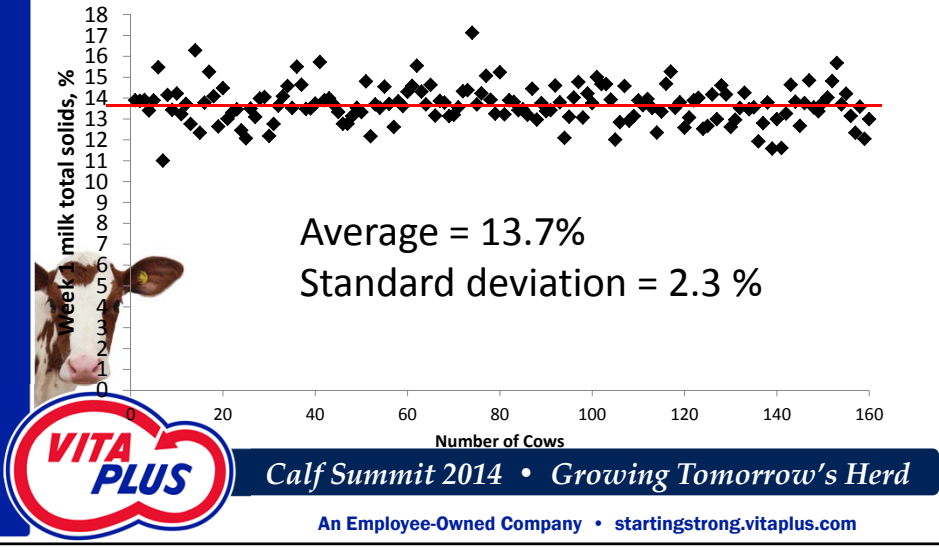
	% Whole Milk		% Total Solids
Protein	3.7	Protein	27.1
Fat	4.3	Fat	31.4
Lactose	4.7	Lactose	34.3
Ash	1.0	Ash	7.3
Total solids	13.7	Total solids	13.7



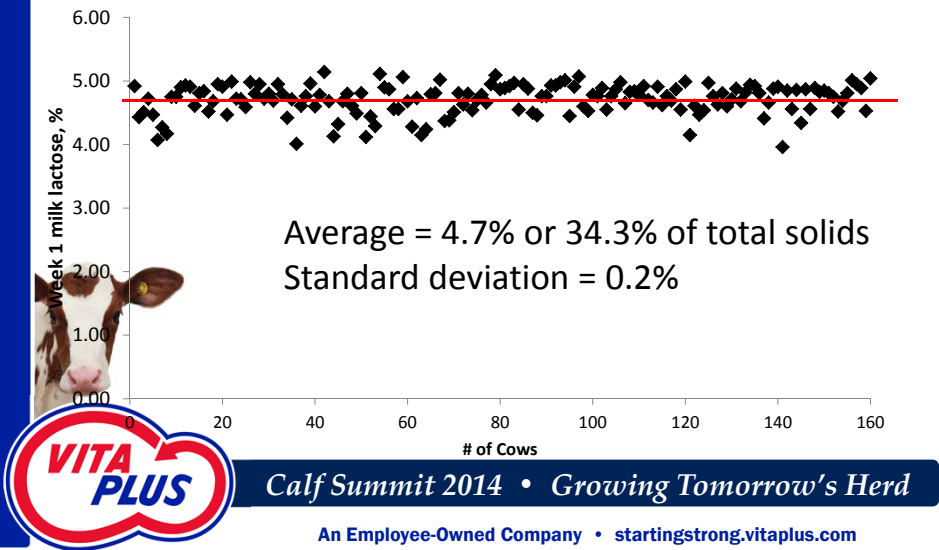
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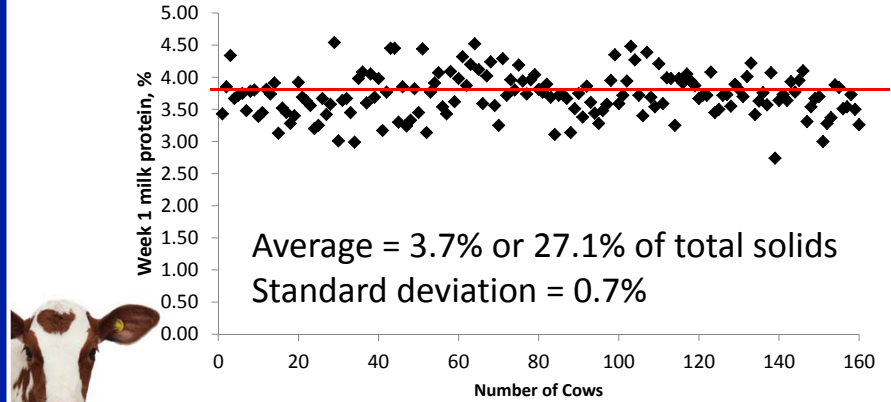
Early lactation milk total solids are consistent among cows



Early lactation milk lactose concentration is consistent among cows



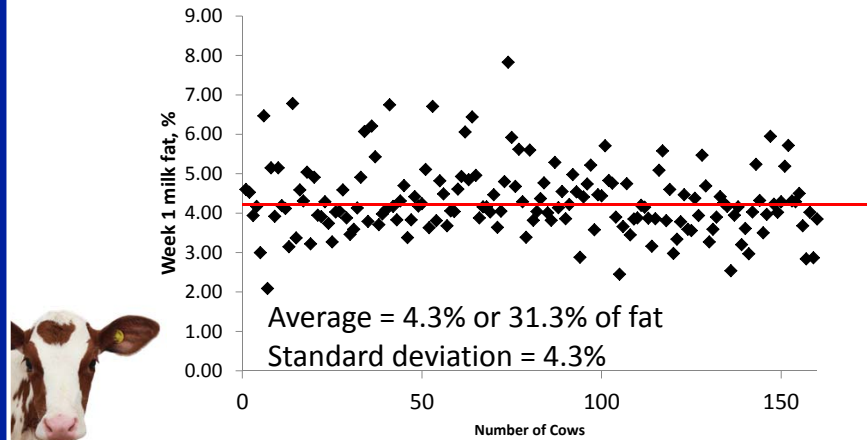
Some Variation in Milk Protein



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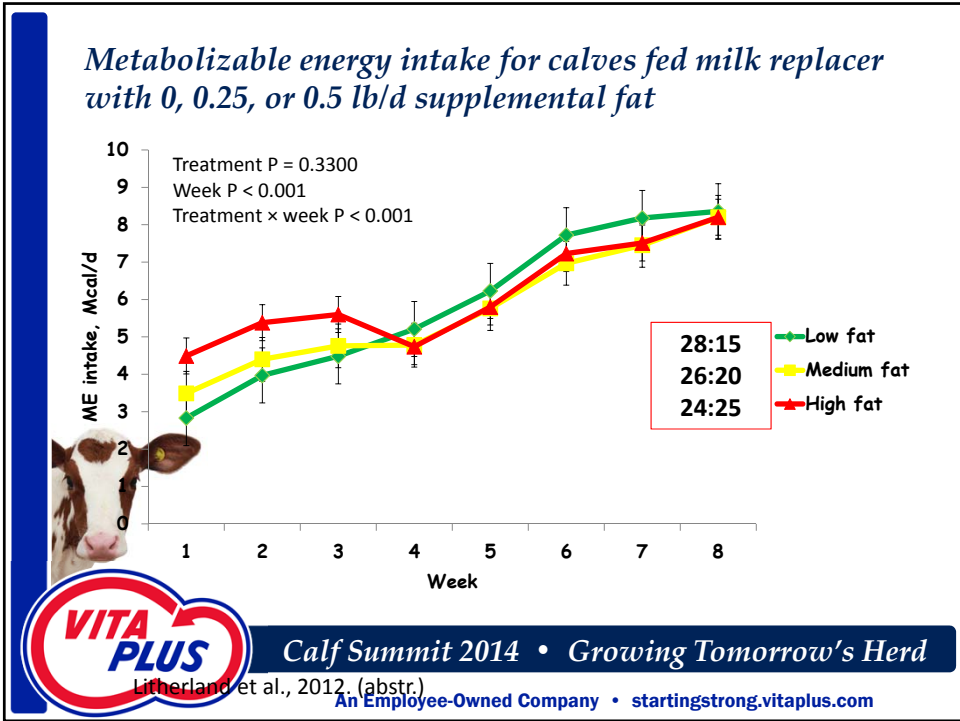
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Greater Variation in Milk Fat



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Calf ADG was Greater for Fat Supplemented Calves Through d 21

	Treatment			SEM	P-value
	Low fat	Medium fat	High fat		Treatment
ADG, lb/d					
21 d	1.1 ^a	1.8 ^b	1.6 ^b	0.18	0.02
42 d	1.6	1.8	1.8	0.1	0.25
56 d	1.8	1.9	1.8	0.08	0.55

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U of MN Research Feeding Approach

- Fed milk replacer as a % of calf BW.
 - Non-med.
- Starter grain- texturized 18% protein.
- Calves raised in hutches from d 2 to d 56.
- Fed twice daily from d 2 to 42.
- Fed once daily from d 43 to 49.
- Weaned on d 50.
- Removed from the trial on d 57.



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Expressing Intake as a % of BW

Body weight, lb	ADG, lb/d	DMI, lb/d	DMI, % of body weight
90	0.9	1.5	1.6
100	0.9	1.6	1.6
110	1.3	2.1	1.9
120	1.8	2.6	2.2
130	1.8	2.7	2.1
160	1.8	4.5	2.8
180	1.8	4.8	2.7
200	2.0	6.0	3.0
220	2.0	6.3	2.8

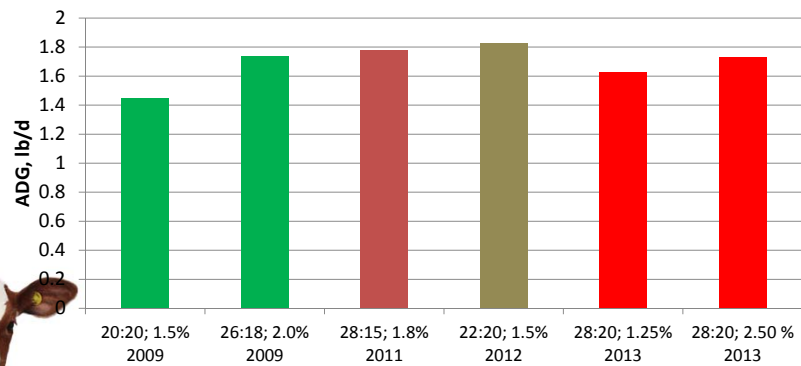


NRC, 2001 Nutrient Requirements of Dairy Cattle

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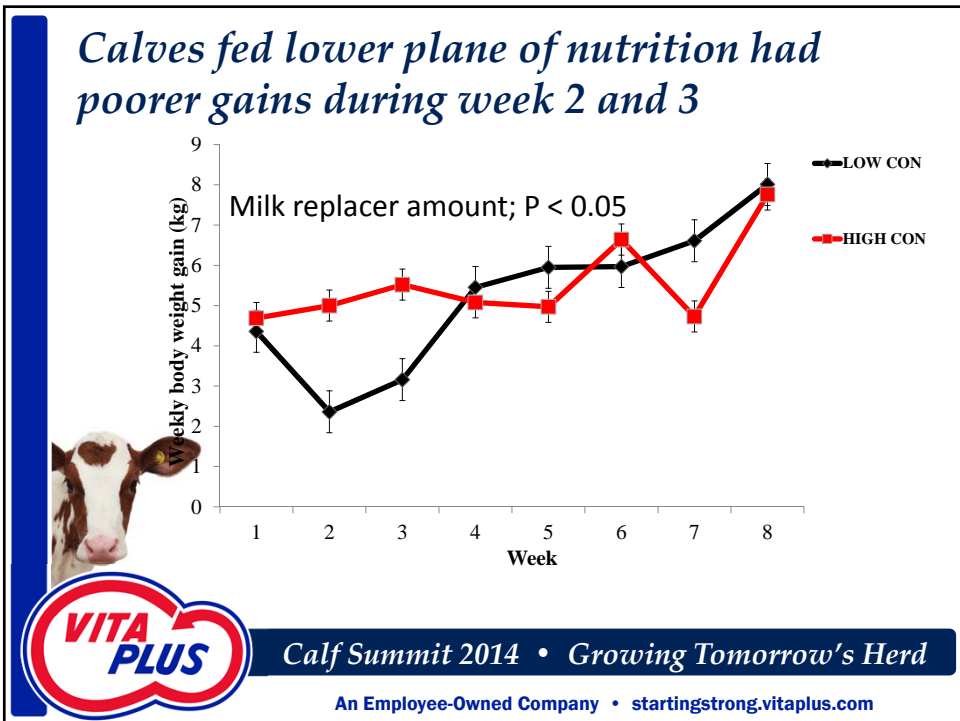
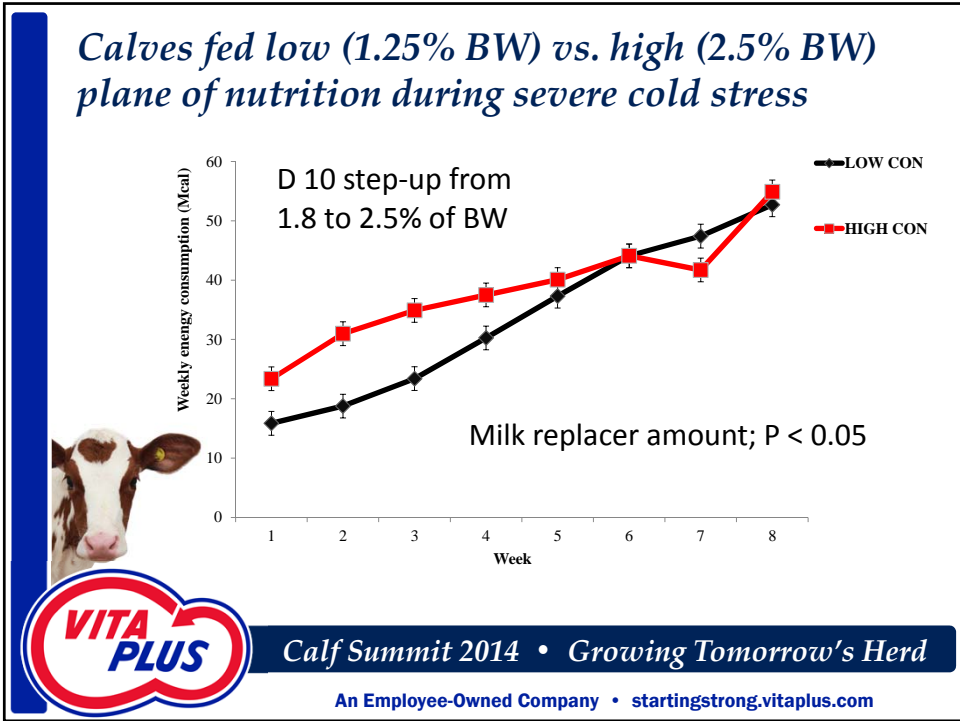
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U of MN, St Paul Research ADG of calves fed varying planes of nutrition from milk replacer



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Amino Acid Balancing

- Amino acids are the building blocks for growth and structural development.
- Goal: Meet amino acid requirements for maintenance and growth without overfeeding crude protein.

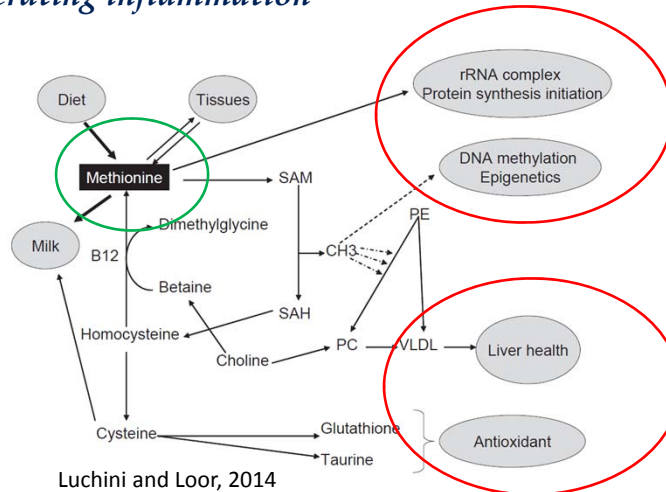


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What does Methionine do?

1. Initiation of protein synthesis
2. Moderating inflammation



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Supplemental plasma (IgG and Albumin has some health benefits)

	Treatments			P-value	
	WPC	Bovine plasma	Porcine Plasma	Control vs plasma	Bovine vs. porcine
Mortality, %	25.0	7.5	5.0	< 0.05	NS
ADG, lb/d d 0 to 28	0.18	0.26	0.17	NS	0.08
Starter intake, lb/d	0.34	0.43	0.42	0.05	NS
ADG:DMI	0.35	0.58	0.44	0.09	NS



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Fatty Acid Balancing

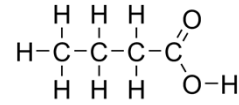
- Fatty acids:
 - Source of energy
 - Signaling molecules (hormones)
 - Regulation of nutrient use
 - Some impact on bacteria



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Functional Fatty Acids



- Short-chain FA's
 - C4:0 Butyric acid- GI tract maturation
- Medium Chain FA's
 - C12:0 and C14:0
 - Natural antimicrobial
- Long chain unsaturated FA's
 - C18:2 and C18:3
 - Immune function



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Exploring the impact of milk replacer program on growth and starter intake



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Fuel source changes with age

Developmental Stage	Energy Substrate	Source
Fetal	Glucose	Maternal blood
Pre-ruminant (milk fed)	Glucose and LCFA	Milk lactose and fat
Ruminant	VFA (mainly acetate)	Rumen fermentation



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Respiratory Disease and Nutrition

- Stress- suppresses immune response.
 - Weaning (Hubert et al., 2011)
 - Dehorning (Ballou et al., 2011)
 - Transportation (Hubert et al., 2011)



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STRESS Hormones are sensed by bacteria and then bacteria misbehave

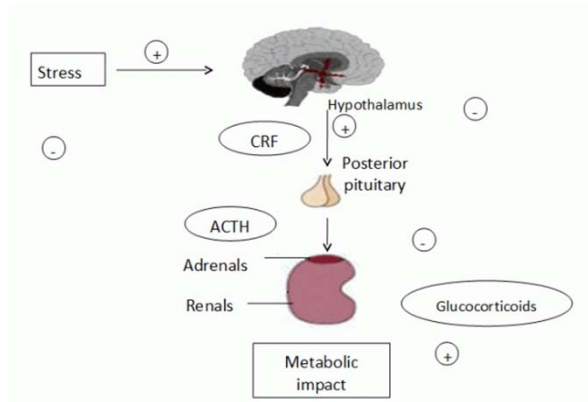


Figure 1. Hypothalamic-pituitary-adrenal axis

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- Calf starter grain guidelines


- Palatable and fresh
- Calves should be consuming grain by 3 weeks.
- Rule of 24. Distance from ground to the bottom of the inside of the bucket should not be greater than 24 inches.



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	20:20 (1.8 lb /d)	20:20 (2.2 lb/d)	24:18 (1.8 lb/d)	24:18 (2.2 lb /d)
Predicted calf growth, lb/d				
0 lb/d starter grain (90 lb calf)				
Energy allowable gain	1.5	2.2	1.6	2.1
Protein allowable gain	1.1	1.5	1.5	1.8
1.0 lb/d starter grain (110 lb calf)				
Energy allowable gain	2.1	2.6	2.0	2.6
Protein allowable gain	1.6	1.9	1.9	2.3
2.0 lb/d starter grain (130 lb calf)				
Energy allowable gain	2.5	2.9	2.5	2.9
Protein allowable gain	2.0	2.3	2.3	2.7
3.0 lb/d starter grain (160 lb calf)				
Energy allowable gain	2.7	3.1	2.7	3.1
Protein allowable gain	2.4	2.7	2.7	3.1

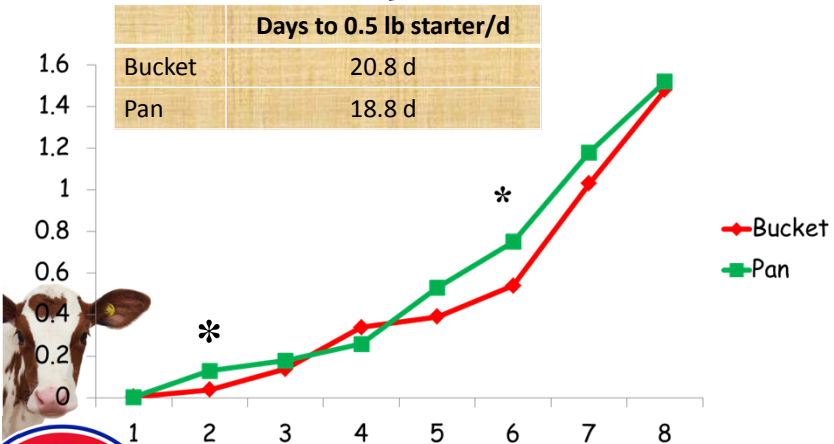


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Starter intake (% of BW) for calves fed in buckets or shallow pans

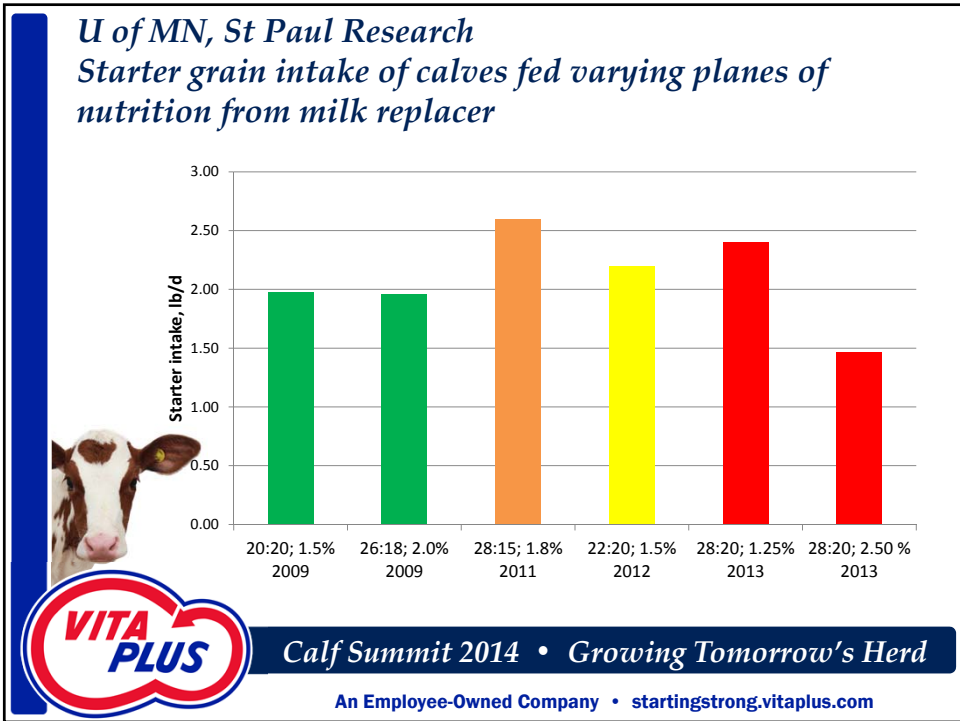
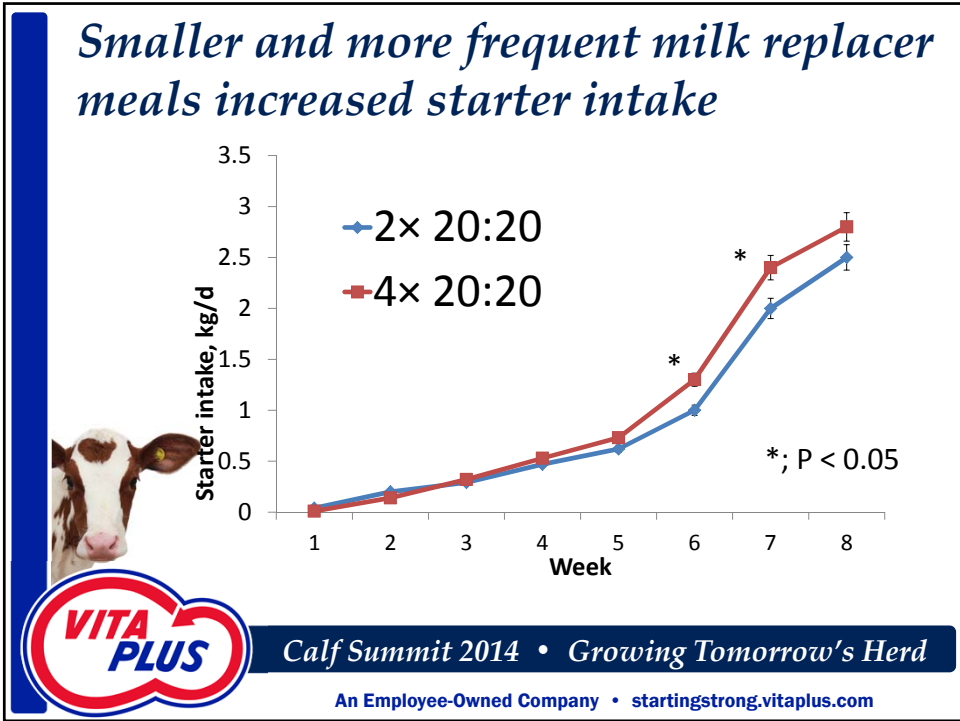
	Days to 0.5 lb starter/d
Bucket	20.8 d
Pan	18.8 d



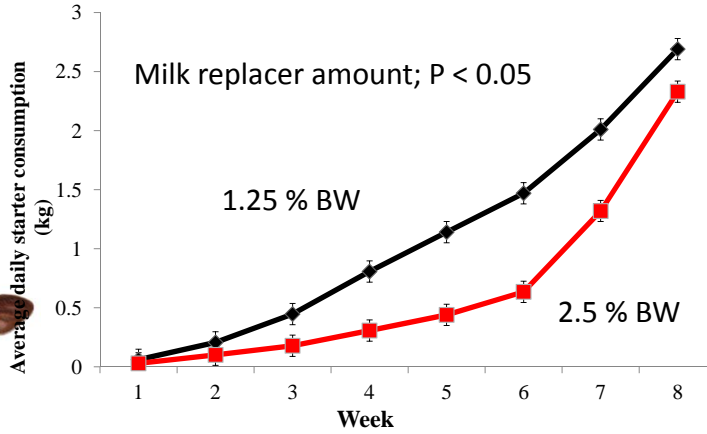
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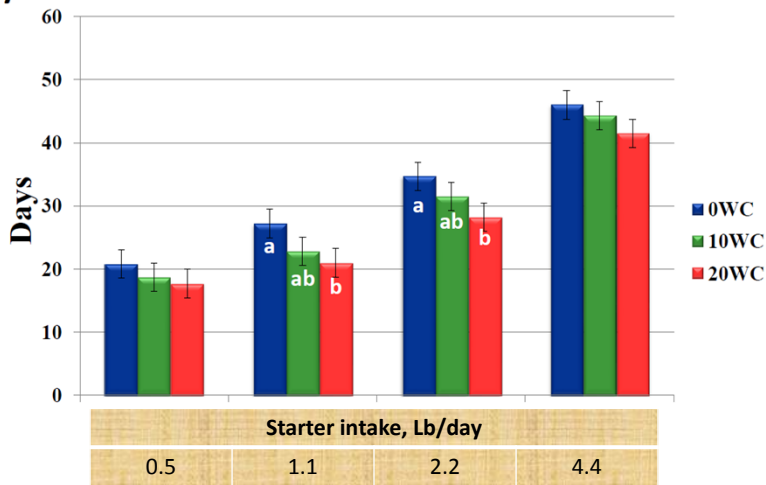
Higher plane of nutrition decreased starter intake even during heightened energy requirements of thermal stress (Winter, 2014)



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Days to reach benchmarks amounts of starter consumption



Values with different superscripts differ at $P \leq 0.05$



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Pearson correlations between starter intake and maturity of gastrointestinal development.

	250g/d	500g/d	1000g/d	2000g/d
SMI length	-0.71*	-0.63*	-0.66*	-0.64*
Empty RR weight	-0.29	-0.46*	-0.47*	-0.67*
Empty O weight	-0.31	-0.43**	-0.28	-0.21
Day 56 gain	-0.60*	-0.72*	-0.63*	-0.63*

* Indicates a value of $P \leq 0.05$

** Indicates a value of $0.05 < P \leq 0.10$



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Measuring Starter Grain Intake



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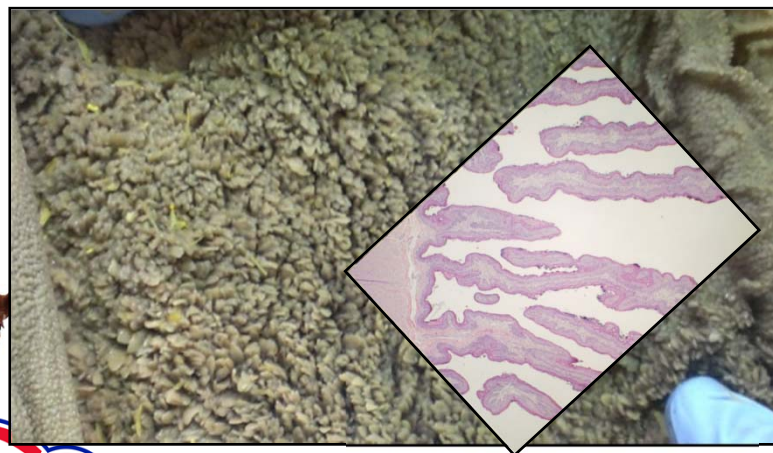
Measuring Starter Grain Intake



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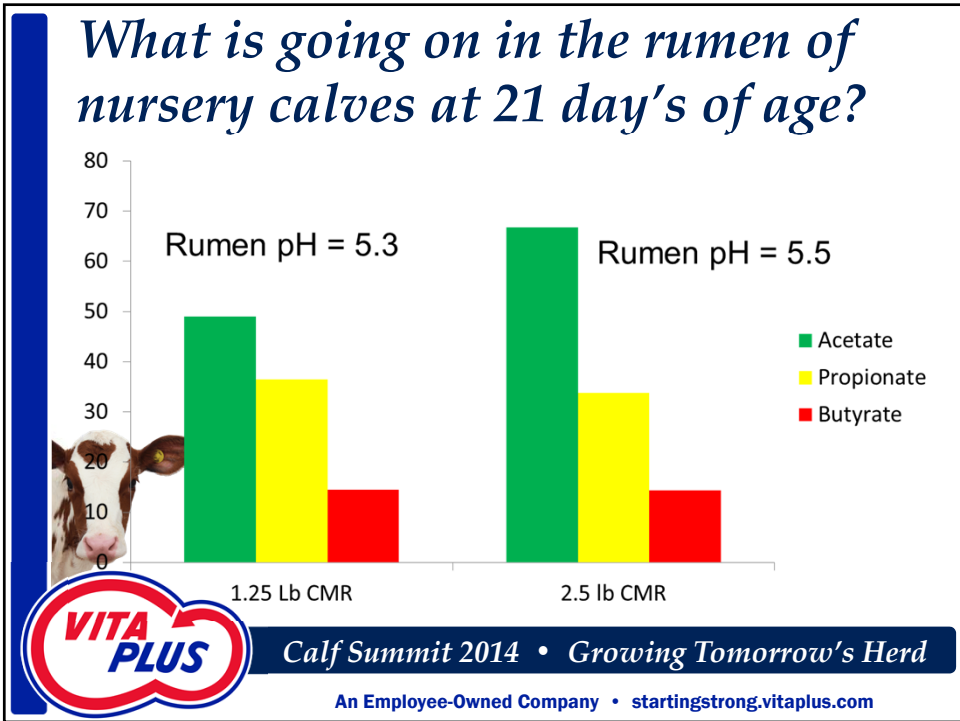
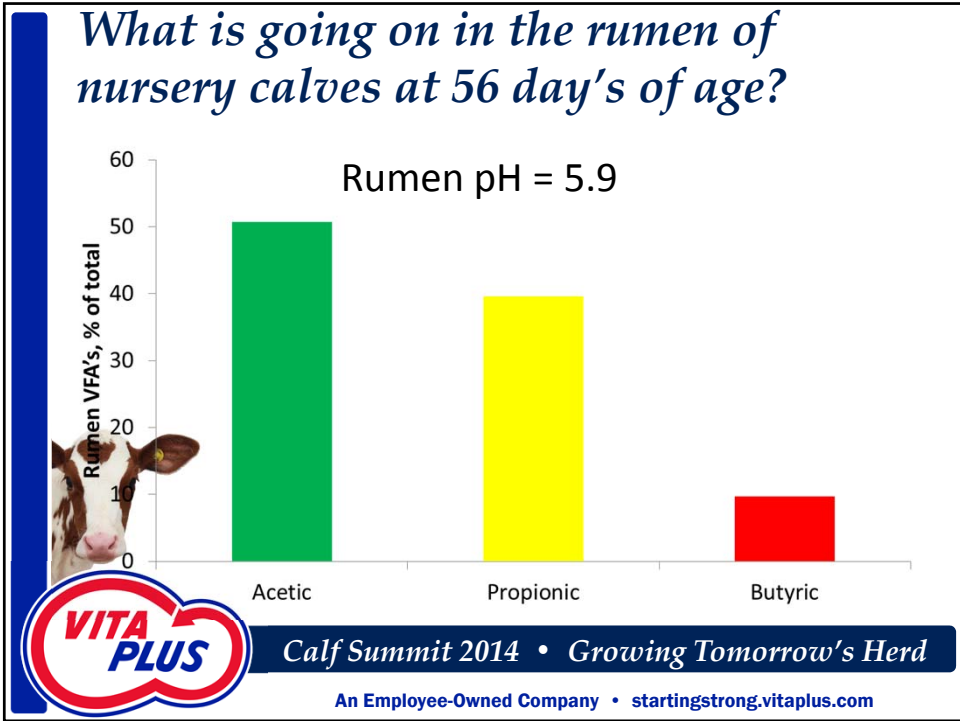
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What is going on in the rumen of nursery calves?

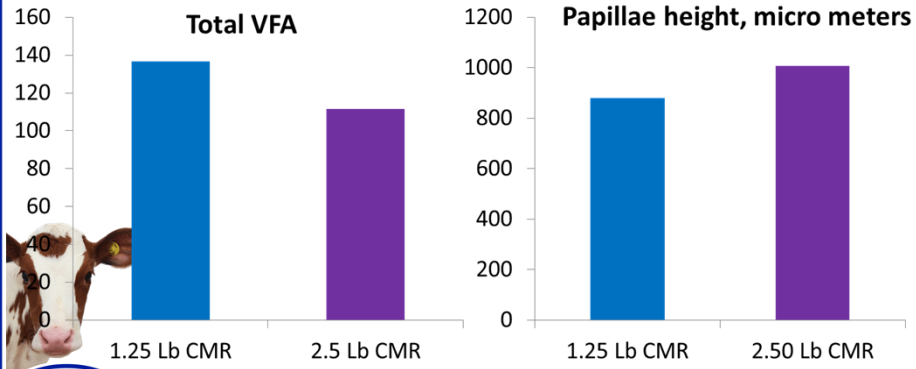


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What is going on in the rumen of nursery calves at 21 day's of age?



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Exploring feed digestibility in nursery calves

	Study A	Study B	Study C
	49 days	43 days	22 days
Dry Matter Digestibility, %	76.3	75.2	86.9



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*Optimizing starter grain digestibility in calves at weaning.
Calves need to eat AND digest starter grain.*

	Treatment ¹				P - value	
	LF	MF	HF	SEM	Linear	Quadratic
DMI, lb/d	6.4	6.2	5.9	0.4	0.437	0.764
Total tract apparent DMd, %	73.5	80.5	75.1	3.9	0.469	0.079
Apparent DMd, lb/d	4.8	5.1	4.4	0.4	0.540	0.347

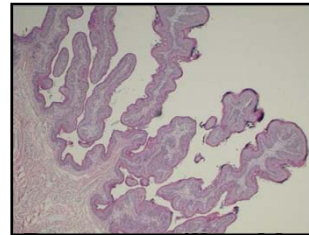
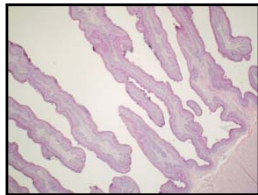


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Can we over-feed starter grain?

**Rumen papillae;
tall and slender.**



**Rumen papillae; blunted
and fused.**



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LaBerge et al., 2013. (MN Nutrition Conf.)
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One starter grain prior to weaning?

- Is there an advantage to:
 - 1. Start with a high starch starter
 - 2. Switch to a lower starch/higher fiber starter?
 - Digestible fiber such as soy hulls.



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Factors Regulating Starter Intake in Nursery Calves

1. Accessibility
2. Nutrients from milk replacer
3. Energy demands (growth, environment)
4. Palatability/quality of starter



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What does precision calf nutrition look like?

- **Milk**
 - Amount, nutrients, solids, temperature, timing.
- **Starter**
 - Amount, nutrients, access, timing.
- **Water**
 - Amount, timing, temperature.
- **Sanitation**
- **Consistency**



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Some Key Concepts: Precision nutrition

Variable	Recommendation
Feeding rate	1.5 to 2.25 % of Birth body weight
Total solids	12.5 to 14 % Solids
Feeding temperature	100 to 105°F
Feeding frequency	2 to 3/d



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Take Home Messages

1. Precision nutrition for calves:

- a. Results in increased calf growth and health.
- b. Reducing variation reduces risk.
- c. Increased efficiency of nutrient use.
- d. Can have huge impacts on starter intake.



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Take Home Messages

2. Precision nutrition for the calf requires:

Understanding variation:

1. Feed ingredients
2. Mixing and preparation
3. Sanitation
4. Impact of the weather
5. Impact of calf health



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Take Home Messages

3. Precision nutrition allows us to:

- a. Use growth data to help make culling decisions.
- b. Measure efficiency.
- c. Evaluate changes in the feeding program.



d. Make informed decisions!!



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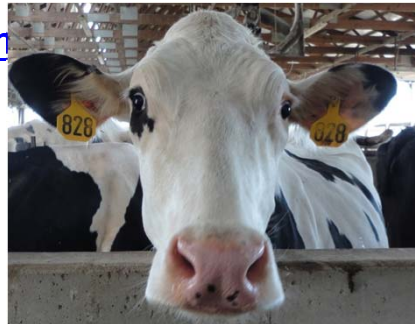
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Thank you for your time!

Noah Litherland

nlitherland@vitaplus.com

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What is precision dairying?

- Use of technology to measure physiological, behavioral, and production indicators on individual animals to improve management strategies and farm performance.



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Spend some time in your calf's environment....In your pajama's.



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