Feeding the Robotic Milking Herd

Jack Rodenburg
(43 years in dairy advisory work)

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Feeding management is critical to robotic milking success !

The Goal - Frequent, uniformly spaced, voluntary milking

- results in high production
- results in few fetch cows and less labor

Feed is the only motivation that brings the cow to the milking stall !

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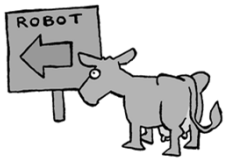
Your cows will want to walk happily to the robot if:

1. cow is healthy



2. cow has good access and good claws

3. cow gets reward

When milking is voluntary, the relationship between feed intake, production, health and behavior becomes more critical and complex.

High feed intake "Causes" High milk production

Frequent milking "Causes' Higher production which "causes" Higher feed intake

Heat Stress

Milking Frequency

↑↓

Milk Production

↑↓

Feed Intake

↑↓

Milking Frequency

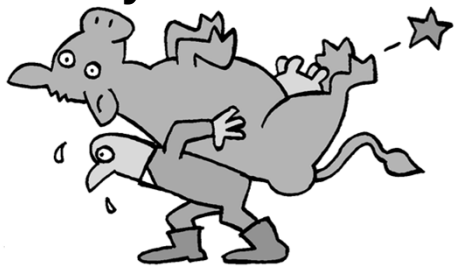
- Fixed interval milking is a uniform stimulus for milk production, feed consumption etc.

- In robotic milking, an external stimulus that changes any variable sets off a chain reaction.

Promote Factors that stimulate production, feed intake and activity

- Minimize heat stress
- Maintain foot health
- Maintain udder health
- Stimulate appetite …..body condition
  transition feeding
  avoid metabolic disorders

Healthy feet are critical



Lameness decreases robot visits and increases fetch rates.

(Bach 2007) *(Borderas 2008)*

Standard Feeding Recommendations Option 1

- Balance a partial mixed ration (PMR) at 17 lbs of milk below the group average, and feed it ad. lib. in the manger.

- Feed 4 to 18 lbs. of pelleted concentrate in the milking stall, according to production.

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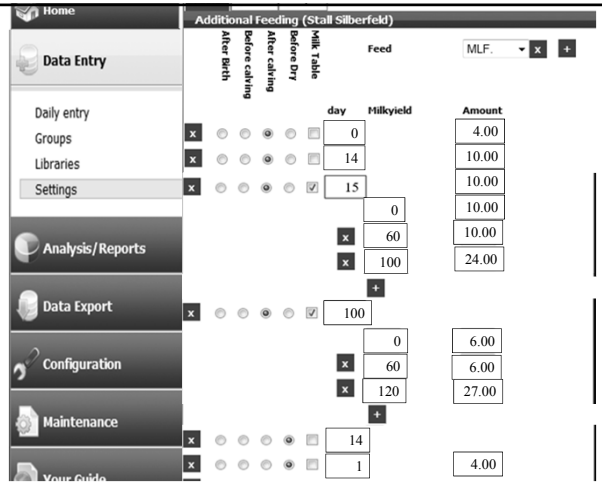

PMR balanced for 63 lbs. milk offers 12 to 18 lbs. concentrate depending on intake

Also control:
- feed speed
- max. per visit
- max. inc./dec.↕

Pay attention to body condition !

"Fixed feed thin cows" . . . But remember to switch them back when condition improves

Lead feed healthy cows more aggressively

Increase feed speed if pellet quality allows

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Option 2 : All concentrate fed according to production in the robots and computer feeders

- Forage only in the bunk keeps late lactation cows coming

- No feed in the computer feeder for cows eligible for milking

- Works with mash because both feed speed and palatability are less critical

How we fed tiestall herds 40 years ago (all in Lbs.)

Milk	20	30	40	50	60	70	80	90	100
Hay	14	14	14	14	14	14	13	12	11
C. Silage	35	35	35	35	35	35	33	30	28
16% conc.	-	5	10	15	20	25	30	35	40
Top dress	-	-	-	-	-	-	3	6	9

How we fed tiestall herds 40 years ago

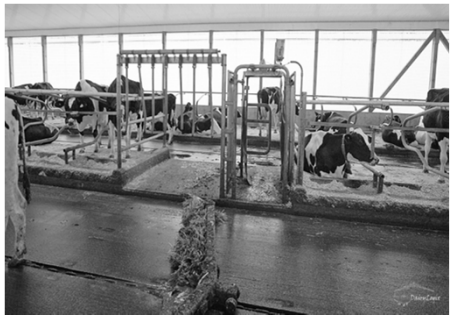
Benefits:

- Cows eat lbs. of feed and require lbs. of nutrients . . Not ratios
- You set the pace for increasing grain feeding in early lactation
- Feed costs are lower for late lactation low producers
- Risk of over conditioning late lactation cows is lower

Drawbacks:

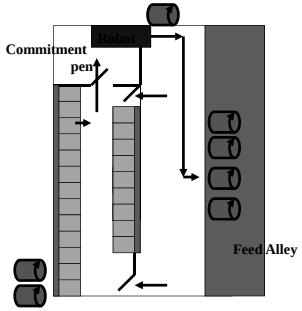
- Forage intake is variable and unknown so fibre level varies
- Rumen environment is less stable decreasing efficiency of digestion.

Option 3 : Feed 4 to 5 lbs of concentrate per day to all cows in the robots and feed a PMR balanced close to herd average production



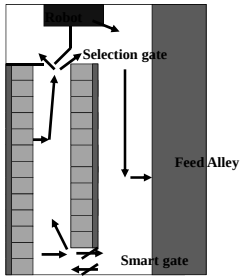
- permits more use of home grown grain
- does not work with free traffic
- Simple but not the ideal answer long term because it relies on guided traffic

Guided Cow Traffic: Cows can only access feed after passing through the robot

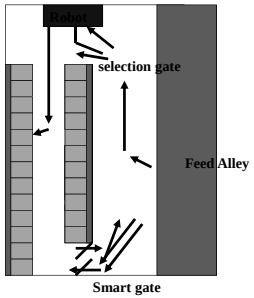


Feed in the bunk and robot both attract cows

Guided Traffic (with Pre-selection): Eligible cows directed to robot and others to bunk



Feed First Guided Traffic: Free bunk access, Eligible cows directed to robot and others to freestalls



Free vs. Guided Cow Traffic

(Thune 2002)

	Free	Guided	Guided with Pre-selection
No. Milkings	2.0	2.6	2.4
No. of Meals	12.1	3.9	6.5
Ave. time waiting at robot (minutes/day)			
Dominant Cows	78	140	124
Timid Cows	95	240	168

Free vs. Guided Cow Traffic

(Bach 2009) per cow per day (DeLaval VMS)

	Free	Guided	P-value
No. milkings	2.2	2.5	<0.001
Fetched milkings	0.5	0.1	<0.001
TMR intake (lbs. DM)	41.0	38.8	0.24
No. of meals of TMR	10.1	6.6	<0.001
Pellet intake (lbs.)	5.5	5.5	0.99
Milk production (lbs.)	65.7	68.1	0.32
Milk fat %	3.65	3.44	0.06
Milk protein %	3.38	3.31	0.05

Free vs. Guided Cow Traffic

(Tremblay 2016) North American Lely Systems

2.4 lbs. more milk per cow and 148 lbs. more milk per robot with free traffic

Free vs. Guided Traffic

- Guided traffic decreases the emphasis on feeding in the robot and reduces the number of fetch cows. When there are very strong economic incentives to do so this may be justified but cow comfort will suffer.
- Free cow traffic results in greater cow comfort especially for timid cows. New fetch cows are often new cases of mastitis or lameness so they offer management information.

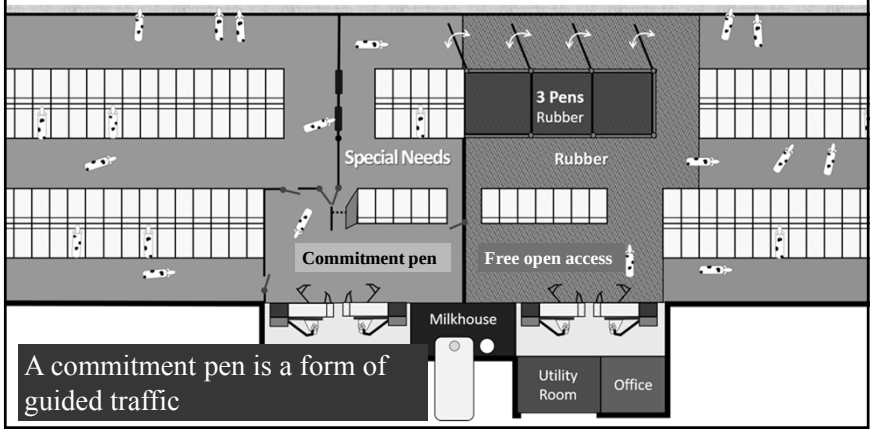
Free vs Guided Cow Traffic

Both can work very well with good management **But** when things go a little wrong:

- Guided traffic COWS suffer fewer meals and longer waiting times (and foot health and rumen health issues)
- Free traffic FARMERS suffer increased fetching. (a warning to step up management)

I design for both but for me cow comfort is key, so I have a strong preference for free traffic!

The problem is the commitment pen **The problem is no sort capability**



A commitment pen is a form of guided traffic

With free traffic the feed in the robot is the only motivation for the cow to be milked!

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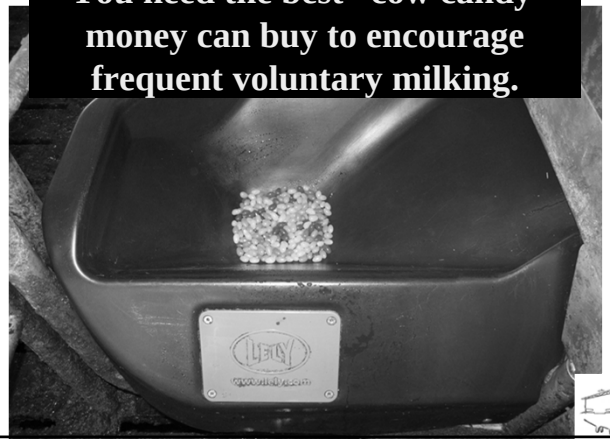
Is this motivation working ??

You need the best "cow candy" money can buy to encourage frequent voluntary milking.



What does **"cow candy" look like?**

Research on palatability is limited

(Amaral-Phillips, 1993, Maiga, 1997, Sporndly,2006)

High	Medium	Low	Lowest
Brewers grains	Soymeal	Raw beans	Corn gluten
Distillers grains	Roasted beans	Canola meal	Blood, meat and fish meals
Hominy	Corn		Tallow
Molasses	Barley		Palm kernel expeller
Beet pulp	Wheat mids		Most mineral and vitamin products
Heat treated canola			

Eating rate limits feed intake in robotic milking applications

- typical eating rate for a pelleted feed is 0.4 to 0.7 lbs. per minute. (feed speed)

-If milking takes 6 to 8 minutes maximum concentrate fed per milking is 2.4 to 5.6 lbs.

Well managed herds with excellent quality pellets are using feed speeds up to 0.9 lbs. per minute and feeding up to 6 lbs. of concentrate per milking and 20 or more lbs. per day

Case study (Rodenburg and Wheeler, 2002)

- A "low cost" pellet with gluten meal, canola and tallow and poor pellet strength caused a build up of fines in the feeder. It was replaced with a stronger pellet with 3 (vs. 0) % molasses, and 96 (vs. 65)% high palatability ingredients.

Case study (Rodenburg and Wheeler, 2002)

	Low Quality Pellet	High Quality Pellet
voluntary visits / day	**3.40**	**4.04**
voluntary milkings / day	**1.72**	**2.06**
% Lazy cows	**27.3**	**12.7**
% Lazy milkings	**16.0**	**7.1**
Milk production (lbs.)	**58.6**	**59.7**

Pelleted Concentrate Trials

(Rodenburg, Fokker and Hand, 2004)

cracked corn	200	wet molasses	30
soya hulls	165	animal veg fat	10
wheat shorts	165	vit.min. premix*	24
barley	100	sodium bicarb.*	9
bakery meal	100	salt *	3
soybean meal	77	fenugreek	0.3
corn distillers	72	pellet binder	5
extruded soymeal	40		1000

*left out in trial 3

TRIAL 1: 37 cows in high attendance herd A

	Exp. Pellet	Comm. Pellet #1	
Pellet Strength (pdi.)	91.2	96.0	
Visits/cow/day	3.95	4.80	p<.05
Milkings/cow/day	2.69	2.81	p<.05
% Involuntary Visits	0.60	0.53	ns
Milkings fetched/day	1.49	0.96	

-stronger commercial pellets with fewer fines were associated with increased frequency of visits and milkings in a high attendance situation

Concentrate Trial

TRIAL 2: 36 cows in low attendance herd B

	Exp. Pellet	Comm. Pellet #2	
Pellet Strength (pdi.)	92.5	91.2	
Visits/cow/day	3.13	2.95	ns
Milkings/cow/day	2.33	2.21	ns
% Involuntary Visits	10.1	10.3	ns
Milkings fetched/day	7.89	9.98	

Small differences in concentrate formulation did not influence frequency of visits in a low attendance situation

Concentrate Trial

TRIAL 3: 36 cows in low attendance herd B (no mineral in pellet formula)

	Exp. Pellet no Mineral	Comm. Pellet #2	
Pellet Strength (pdi.)	92.5	91.2	
Visits/cow/day	3.54	3.57	ns
Milkings/cow/day	2.29	2.35	ns
% Involuntary Visits	12.20	12.14	ns
Milkings fetched/day	8.78	8.67	

Excluding unpalatable minerals ingredients from the concentrate formulation did not influence frequency of visits in a low attendance situation

TRIAL 4: 36 cows in moderate attendance herd C

	Exp. Pellet	Comm.Pellet#3 + High Moist. Corn	
Pellet Strength (pdi.)	86.9	97.7	
Visits/cow/day	3.06	3.33	p<.05
Milkings/cow/day	2.35	2.50	p<.05
% Involuntary Visits	2.80	1.76	p<.10
Milkings fetched/day	3.4	3.2	

High moisture corn and a high strength commercial pellet were associated with increased frequency of visits and marginal decrease in number of cows fetched in a moderate attendance situation.

Rolled high moisture shelled corn is palatable and supports high eating rates

Effect of pellet ingredients on milking behavior and production (Madsen, 2010)

Pellet Type	Milkings	Refusals	Fetchings	Lbs. Milk
	(per cow per day)			
Standard	2.96	2.09	0.026	57.5
	(Expressed as standard minus test feed)			
Barley	-0.03	-0.05	0.028	0.22
Wheat	0.17	0.44	0.019	3.53*
Barley/Oats	0.35**	1.87	0.009	2.65
Corn	0.02	0.31	0.50	0.44
Fat Rich	-0.36*	-0.39	0.042	0.17
Dried Grass	-0.93***	-1.16	0.17	-9.04***

*= p<0.05 **=p<0.01 ***=p<0.001

Effect of Flavoring agents (Migliorati 2005, 2009)

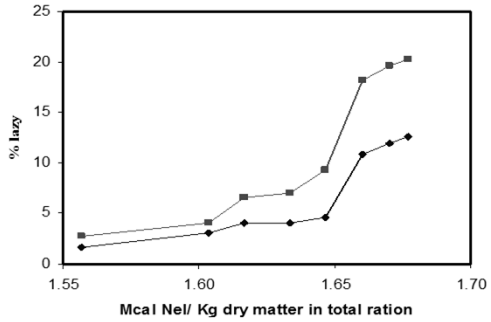
- added 150 ppm commercial Fenugreek/vanilla product plus 500 ppm “sweetening agent”
- 2005 trial this increased production and passes through the pre-selection gate, but not milkings
- 2009 trial this increased milking frequency 4 % and production 3.5%

High vs Low Starch Pellet (Halachmi 2009)

- Compared pellets with 53% starchy grains vs 25% starchy grains plus soyhulls and gluten)
- No impact on milking frequency
- Higher production on the low starch pellet.

High Grain Diets and Robotic Milking

(Rodenburg and Wheeler, 2002)



3. If there is a lot of concentrate/candy available at the bunk, cows are less motivated by the concentrate/candy in the milking stall.

Why do high grain diets increase the number of fetch cows?

1. High grain diets increase the risk of laminitis ..... poorer mobility reduces voluntary milking.
2. Cows on high grain diets spend less time eating and ruminating and more time resting (Robinson, 1997) and eat fewer meals (Friggens,1998) ..... less active cows reduces voluntary milking

Does it Have to be pelleted?

(Penner 2017) 8 Cows Guided Traffic

	pelleted barley	steam rolled barley	*P* value
Conc. Intake lbs.	5.5	5.4	0.14
Milking frequency	3.55	3.29	0.27
Milk yield lbs.	81.8	70.3	0.17

Even with guided traffic, pelleted the concentrate

Effect of quantity of concentrate fed in the robot on milking behavior and production. (Migliorati 2005)

- Feeding 8.8 lbs. concentrate plus 0.16 lbs. per lb. of milk vs. 2.2 lbs. plus 0.16 lbs. per lb of milk resulted in the same milking frequency and production with guided traffic.
- No mention of fetch cows

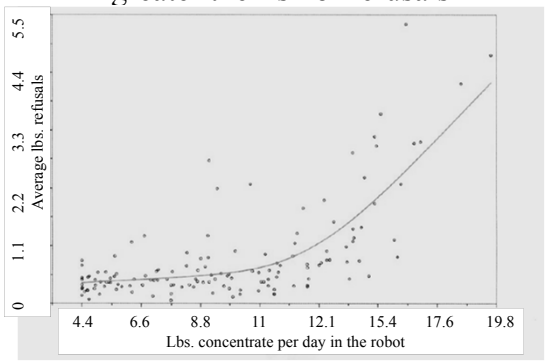
Effect of quantity of concentrate fed in the robot on milking behavior and production (Halachmi 2005)

- Feeding 2.6 lbs. concentrate per milking vs. offering up to 15 lbs. per day resulted in the same milking frequency and production with guided traffic.
- Concentrate consumed was 7.7 vs 11.0 lbs.
- No mention of fetch cows

Effect of quantity of concentrate fed in the robot on milking behavior and production (Bach 2007)

- Feeding 6.6 lbs. concentrate per day vs. 17.6 lbs. per day with a high corn silage diet resulted in the same number of fetch cows with free traffic.
- Milking frequency was 2.6 (low conc.) vs. 2.8 (high conc.) but this was not significant ($P = 0.13$)
- Not fetched cows were milked more often 2.7 vs. 2.4 ($P < .05$) and trended to more milk 69.9 vs. 65.9 lbs. ($P = .16$)

The more you feed in the robot the greater the risk of refusals



Penner 2017 feed first guided traffic

Table 3. (Penner et. al.) Effect of providing a low energy PMR (LE-PMR) and high robot concentrate allowance vs a high energy PMR (HE-PMR) and low robot concentrate allowance in a guided traffic setting.

Parameter (lbs./cow/day)	LE-PMR	HE-PMR	SEM	*P*-value
Total DMI,	51.8	56.6	1.23	0.13
Robot concentrate DMI	11.0	1.1	0.1	<0.001
PMR DMI	40.8	55.3	1.18	0.002
Milk yield	74.1	80.0	2.95	0.09
Milkings (per day)	2.82	3.27	0.19	0.09

Feeding 11 lbs of concentrate separate from the PMR depressed DMI from 56.6 lbs. to 51.8 lbs (each lb of concentrate consumed in the robot decreased PMR intake by 1.33 lbs.)

Penner 2017 feed first guided traffic

	Low PMR energy density		High PMR energy density	
Variable	Low robot	High robot	low robot	High robot
DMI lbs./day	58.9	60.6	60.0	51.1
PMR lbs./day	54.2	46.9	55.6	47.6
Robot lbs./day	4.4	13.9	4.4	13.4
Milk lbs./day	82.4	84.7	84.9	88.2
Fat %	3.70	3.55	3.57	3.46
Milkings/day	3.56	3.74	3.52	3.67

Feeding 13.9 lbs of concentrate separate from the PMR (vs. 4.4) did not depress DMI (each lb of concentrate consumed in the robot decreased PMR intake by 0.92 lbs.)

Amount of concentrate in the robot ??

- Bach and Penner both recommend less than current recommendations.
- Only one trial used free traffic (with a very high energy ration)
- Impact on milking frequency is likely small
- I still expect higher production, lower feed costs and healthier cows with the traditional PMR approach.

Monitor "Rest Feed"

- High amounts of rest feed on a balanced ration indicate you need to put more in the PMR and less in the robot

Grouping Strategies for Robotic Milking

- Include all stages of lactation in the group to use robot capacity efficiently.
- Groups of 2 and 3 robots outproduce 1 robot groups
- Grouping by age/size for better stall sizes and less stress
- Well established social order is important so don't group by stage of lactation.

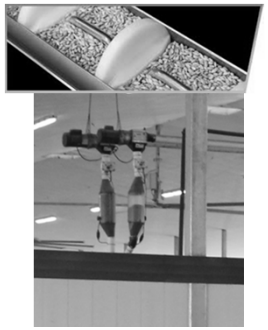
Grouping Strategies for Robotic Milking

It is not being done but if a stable social order is very beneficial, would a group of 45 cows calving in the same month produce enough extra to pay for under utilizing the robot for the last 200 days of lactation?

. . . . . Probably not but someone with spare cash should test this

Practical Tips for Pellet Delivery

- Use two bins per feed type, and empty the bin completely
- Bend flex augurs in the same direction they turn
- Chain disc conveyors causes less fines ?
- Calibrate frequently
- Use clear plastic hoppers on the robots



Feeding During Robot Start Up

- Formulate the PMR and begin feeding it 2 weeks before you begin robotic milking.
- Top dress the pelleted concentrate at the manger so cows are familiar with it.

Feeding During Robot Start Up

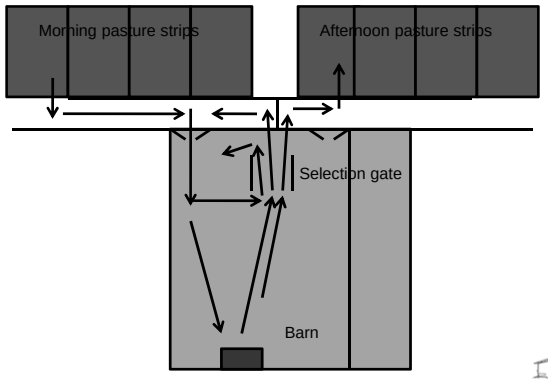
- Please start with this known recipe for success.
-If you want to re-invent these feeding strategies, because you know it better, wait until your client has an established record of high milking frequency, few fetch cows and high production.

Grazing and Robotic Milking

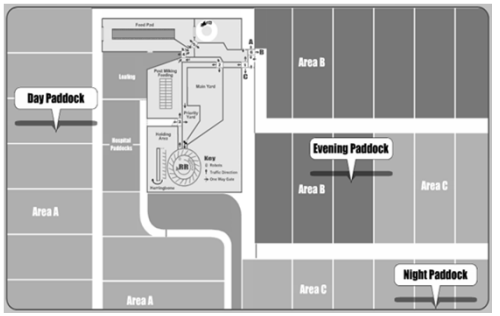
- When pastures are more than 1300 ft from the barn, milking frequency, milk production and time on pasture decrease (Wiktrosson, 2002, Sporndly, 2004)

- Supplementary forage or water in the barn (vs in pasture) did not alter milking behaviour or production. (Sporndly and Wredle, 2004, 2005)

Grazing Strategy (Van Mourik 2010)



- Guided cow traffic to 3 new pasture areas/day
- 3 way grazing vs 2 way increased milkings 40% and production 20%(Lyons 2013)



New feeding opportunities with robotic milking

-These systems record daily milk production, milk composition, body weight, concentrate consumption and rumination activity.

- They dispense several types of concentrate and liquid supplement according to feed tables based on production, and stage of lactation.

-You can feed cows as individuals!

Dynamic Feeding Software

(Wesselink, 2011)

- Optimizes grain allocation to individual cows based on grain and milk prices, and yesterdays production and milk composition.

- Includes and adaptive process that tests the individual cows response to changes in grain feeding.

- Initial tests on Dutch dairies increased income over feed cost, usually by allocating less grain to certain cows.

Precision Dairy Management

- Robotic milking
- Rumination monitoring with neck mounted pedometers.
- In line milk analysis for components and BHB, and MUN etc. with tools like DeLaval's Herd Navigator.
- Automated ration formulation and delivery.

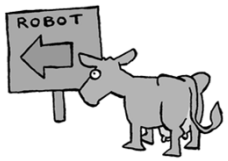
There will be awesome opportunities for more precise feeding available in the next decade !

Take home messages

- Choose for free cow traffic
- Offer a hard pelleted concentrate free of fines made with palatable ingredients in the robot.
- Feed it according to production at 5 to 17 lbs per cow along with a partial mixed ration formulated for 17 lbs. less milk than the group average.
- balance across production levels and monitor rest feed
- Explore the opportunities for precision feeding made possible by this technology

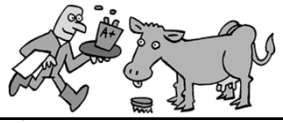
Check your success factors:

1. cow healthy



2. cow has good access / good claws

3. cow gets reward



Thank you for listening