20th ANNUAL NORTHEAST OHIO REGIONAL DAIRY CONFERENCE

Grow them well. Management tips from birth to weaning

Featured Speakers - Mike Van Amburgh Ph.D. and Bill Weiss Ph.D.

February 20, 2019

Fisher Auditorium/Shisler Center
Wooster, Ohio

Presented by the Dairy Veterinarians of the Killbuck Valley Veterinary Medical Association

Killbuck Valley Veterinary Medical Association
Co-Presidents: Laura Conley, D.V.M. and
Shaun Wellert., D.V.M.
Treasurer: Carlton Schlatter, D.V.M.

The Killbuck Valley Veterinary Medical Association is an association of veterinarians in private practice, teaching, research, and industry in the geographic area surrounding the path of Killbuck Creek. The association is affiliated with the Ohio Veterinary Medical Association at the state level, and includes veterinarians primarily in OVMA District 8; we also include some veterinarians from District 7 to the north and District 4 to the west. The KVVMA is registered as a 501(c)(3) organization with the State of Ohio.

The purposes of the Killbuck Valley VMA are to provide professional continuing education to our membership, provide a conduit for the membership to communicate with the OVMA, and provide public service as needed to our geographic area and local communities as our professional expertise allows.

Our annual dairy producer meeting is made possible with the generous support of local businesses and is a public service of our group, recognizing the importance of the dairy industry in our local geographic area as well as the state of Ohio in general. By our continued support of this type of educational meeting for Ohio dairy industry personnel, we of the KVVMA are striving to maintain and expand this important industry, insure the continued production of dairy products of the highest quality, and improve and protect the well-being of the dairy cow herself.

We welcome you to our 2019 meeting. We hope you find the meeting educational and stimulating and welcome your comments and suggestions.

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SCHEDULE

9:00 - 9:55 AM:	Registration, Refreshments & Visit with Exhibitors
9:55 - 10:00 AM:	Welcome and Opening Remarks Shaun Wellert , D.V.M. - KVVMA Co-President
10:00 - 10:45 AM:	Featured Speaker – Mike Van Amburgh, PhD *Colostrum & Immune System*
10:45 - 11:15 AM:	Break & Visit with Exhibitors
11:15 AM - 12:00 PM:	Featured Speaker – Mike Van Amburgh, PhD *Growth, Nutrient & Herd Level Dynamics and Management Part 1*
12:00 - 1:20 PM:	Lunch (provided) & Visit with Exhibitors
1:20 - 2:15 PM:	Speaker – Bill Weiss, PhD *Controlling Feed Costs without Hurting Production*
2:15 - 2:45 PM:	Break & Visit with Exhibitors
2:45 - 3:30 PM:	Featured Speaker – Mike Van Amburgh, PhD *Growth, Nutrient & Herd Level Dynamics and Management Part 2*
3:30 PM:	Door Prizes (*must be present to win)*
	Adjourn

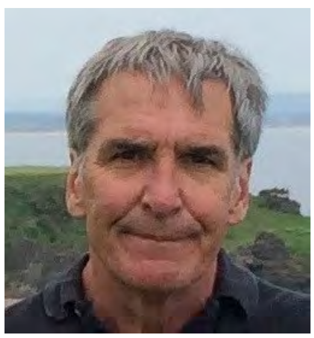
Mike Van Amburgh, PhD
Cornell University

Mike Van Amburgh is a Professor in the Department of Animal Science and a Stephen H. Weiss Presidential Fellow at Cornell University where he has a dual appointment in teaching and research. His undergraduate degree is from The Ohio State University and his Ph.D. is from Cornell University.

He teaches multiple courses and leads the Cornell Dairy Fellows Program, advises approximately 50 undergraduate students and is the advisor for the Cornell University Dairy Science Club.

Mike currently leads the development of the Cornell Net Carbohydrate and Protein System, a nutrition evaluation and formulation model used worldwide and through that effort is focused on enhancing the efficiency of nutrient use by ruminants to improve the environmental impact of animal food production. A significant focus of his current work is to understand whole animal and ruminal nitrogen metabolism and amino acid supply and requirements to enhance the development of the Cornell Net Carbohydrate and Protein System. Further, his group is active in developing methods to better describe the interaction between forage and feed chemistry, rumen function and nutrient supply to compliment the model.

He has authored and co-authored over 70 journal articles and many conference proceedings and is the recipient of several awards including the American Dairy Science Foundation Scholar Award, the Land O'Lakes Teaching and Mentoring Award from ADSA, the American Feed Ingredient Association Award for Research, the CALS Professor of Merit Award and the CALS Distinguished Advisor Award and in 2016, was named a Stephen H. Weiss Presidential Fellow, the highest teaching award given by Cornell University.



Bill Weiss, PhD
Ohio State University

Bill Weiss is a Professor of Dairy Cattle Nutrition in the Department of Animal Sciences at The Ohio State University in Wooster. He earned degrees from Purdue University and Ohio State. He has been on the faculty of Ohio State since 1988 with a joint research: extension appointment. His main research areas are: 1) incorporating variation in cow and diet factors into ration formulation; 2) factors affecting digestibility in dairy cows; and 3) relationships between minerals and vitamins and health of dairy cows. He has authored more than 500 journal and popular press articles and is a frequent speaker at national and international conferences. He was a member of the 2001 Dairy National Research Council (NRC) committee and is currently serving as vice chair of the 2018 Dairy NRC committee.

We gratefully acknowledge the support of our sponsors, without whom this meeting would not be possible.

Please take time to visit with those sponsors
who are present today, and thank those
who are not present when you encounter them.

The veterinarians of the Killbuck Valley Veterinary Medical Association would like to thank all of our sponsors for their continued support of this educational effort for the dairy industry. A strong dairy industry is a tremendous asset for all of us in northeastern Ohio.

We would like to thank the Dairy Farmers of America, DMS and Smith Dairy for their generous donation of dairy products.

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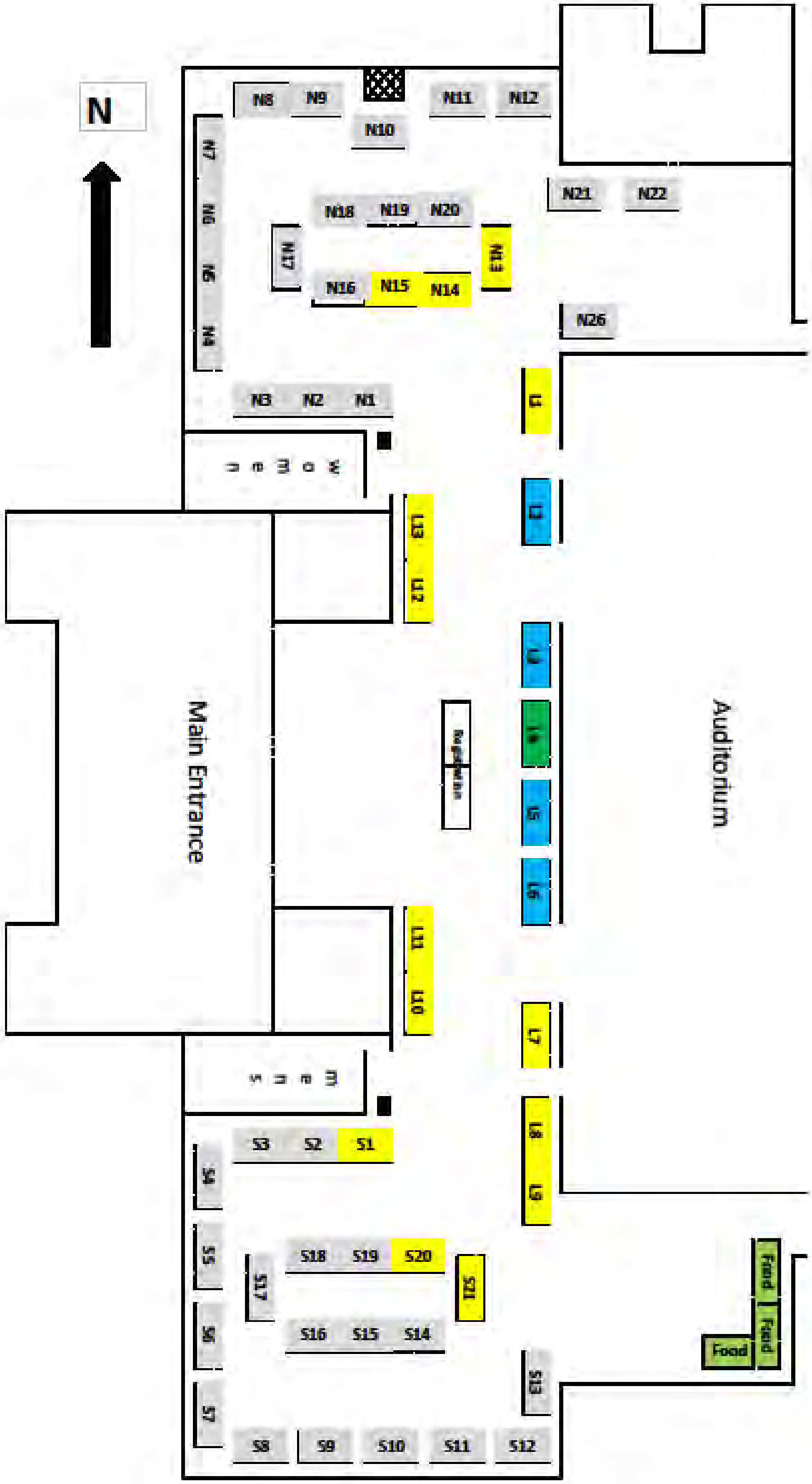
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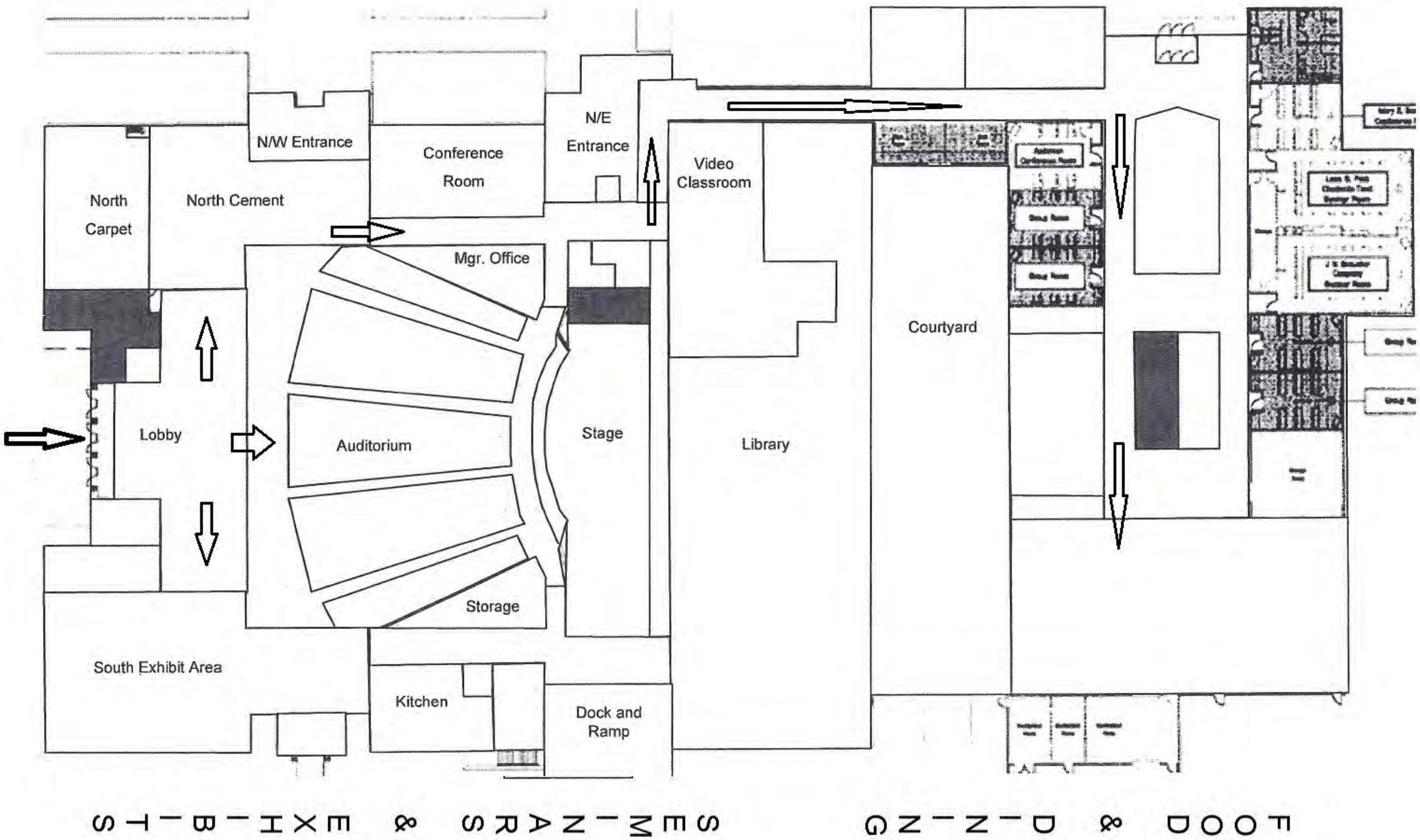
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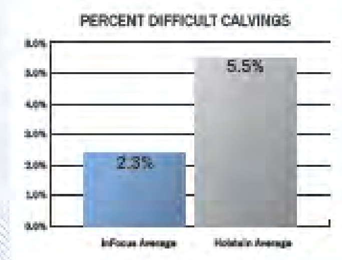

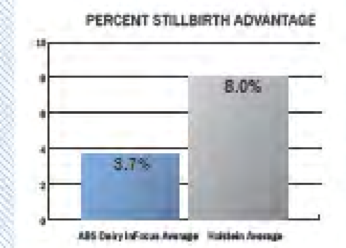

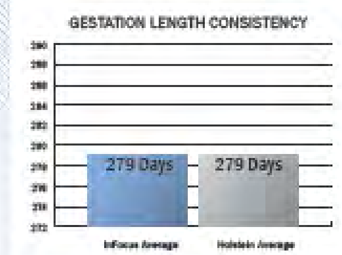

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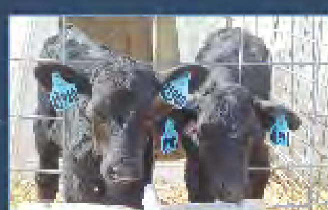

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14HO7426	EQUINOX	140	37	103	$8.00
7HO11621	MAYFLOWER	136	80	56	$15.00
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7HO13504	JAGUAR	180	75	105	$20.00
14HO14225	JUDGE	175	77	98	$17.00
7HO14333	FUTURE	175	74	101	$20.00
7HO14439	TRILOGY	174	67	107	$22.00
7HO12811	LOPEZ	172	57	115	$12.00
7HO12788	FRAZZLED	171	71	100	$22.00
7HO13917	HAGAR	169	64	105	$13.00
7HO14127	LOUIE	169	76	93	$15.00
7HO14264	SPEEDY	169	73	96	$17.00
7HO14402	EXCALIBUR	169	61	108	$22.00
7HO12868	ADVANCE	166	73	93	$20.00
7HO12819	OUTSIDERS	165	60	105	$15.00
7HO12821	EVEREST	165	55	110	$17.00
7HO14438	GODDARD	161	64	97	$17.00
7HO12943	CURRY	160	75	85	$15.00

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7JE5011	MEGAPOWER	118	39	79	$13.00
14JE704	JX CALVIN {4}	117	56	61	$18.00
7JE1477	JX SAINT {4}	98	42	56	$13.00
14JE652	JX MARLO {2}	96	29	67	$18.00
7JE1331	VARICK	95	41	54	$16.00
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7JE1503	JX RONALDINHO {3}	147	69	78	$16.00
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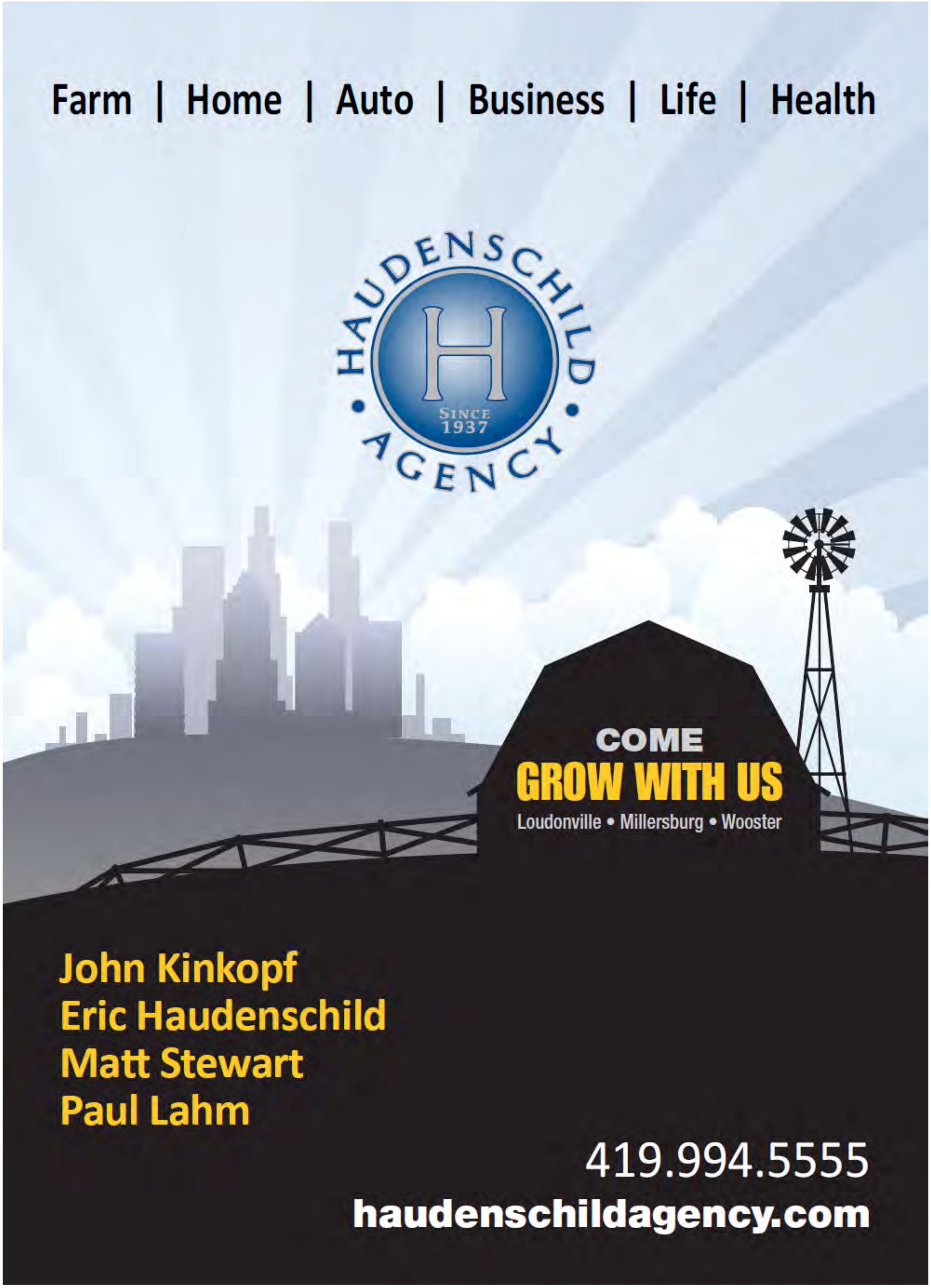
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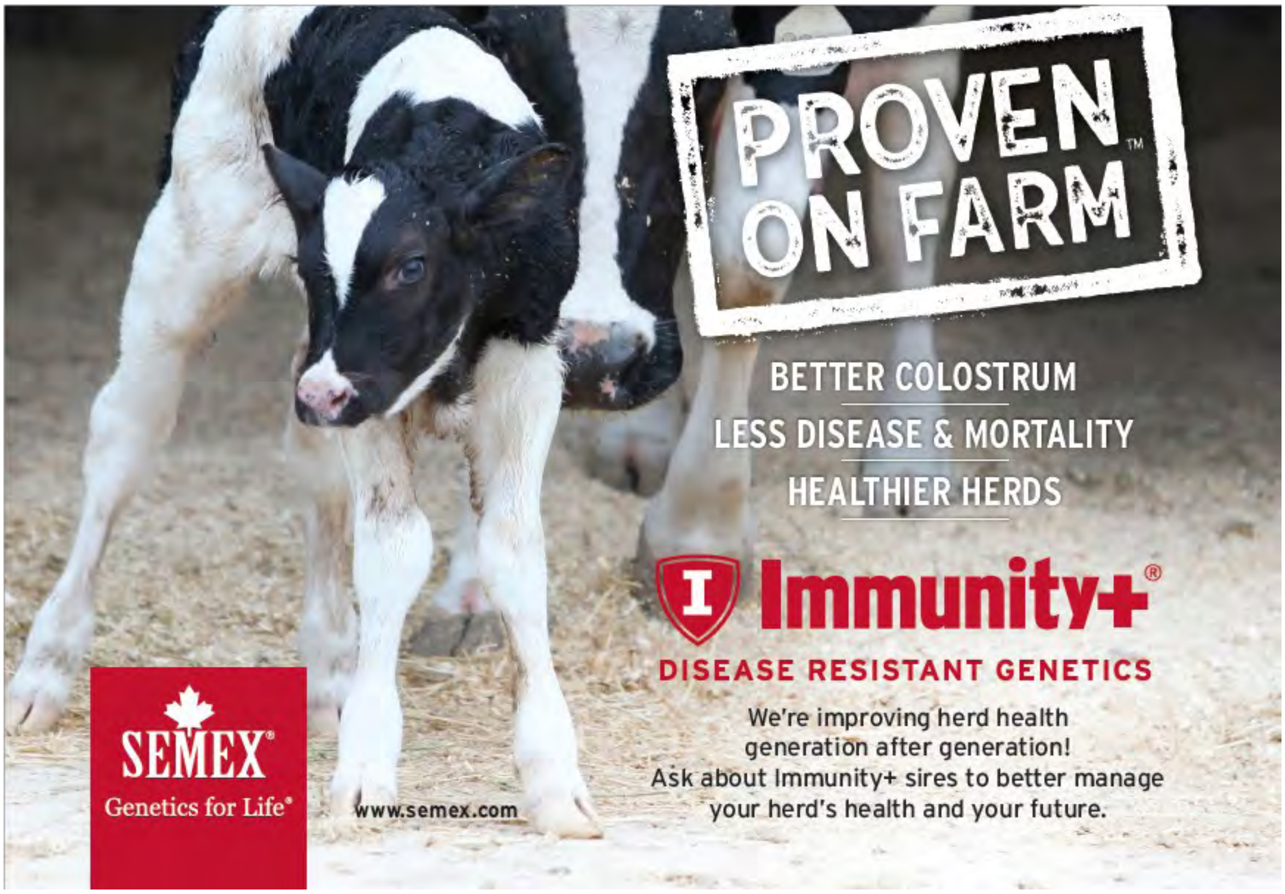
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605 Pro-Ject Drive
Elmwood, WI 54740

Colostrum and Immune System

Mike Van Amburgh

Contact: Greg Spear
gregory.spear@boehringer-ingelheim.com
440.478.1350

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Non-Immunoglobulin Factors in Colostrum: Communication from the Dam to the Calf

Mike Van Amburgh
Dept. of Animal Science
Email:mev1@cornell.edu; cell: 607-592-1212

Overview of today's talk

- Introduction
- Effects of colostrum on growth and nutrient use
- Role of colostrum in gastrointestinal tract development
- Colostrum components and the immune system
- Colostrum components and changes in metabolism
- Summary

Goal of The Replacement Program

The primary goal of all heifer programs is to raise the highest quality heifer that can maximize profits when the animal enters the lactating herd.

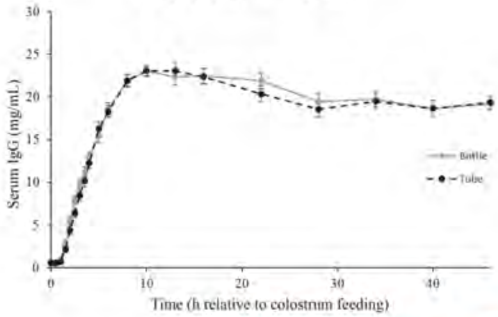
A quality heifer is an animal carrying no limitations – nothing that detracts from her ability to produce milk under the farm's management system.

Optimize profits by obtaining the highest quality heifer at the lowest possible cost usually in the least amount of time.

Snapshot Evaluation of the Potential Quality of The Replacement

- 1st Calf Heifers "Treated" as Calf/Heifer* ≤30%
  24 hrs. → 3 mos. ____, 4 mos. → fresh ____
- DOAs in first calf heifers ≤7%
  Male DOAs. ____, Female DOAs ____
- 1st Calf avg. peak ≥80% of Mature
  1st Calf lactation total yield ≥80% of Mature
- 1st Calf Culls ≤ 60 Days in Milk ≤5%
- 1st Calf ME's ≥Mature
- 1st Calf "Treated" in Lactation* ≤15%
- 85% retention (any herd) to 2nd lactation ≥85%
- Lower #1 reason for 1st lact. culls(continuous improvement)

Colostrum by Bottle or Tube Feeder – 3 L



M.Desjardins-Morrissette et al, JDS

The lactation cycle and the opportunity to provide bioactive factors to the offspring

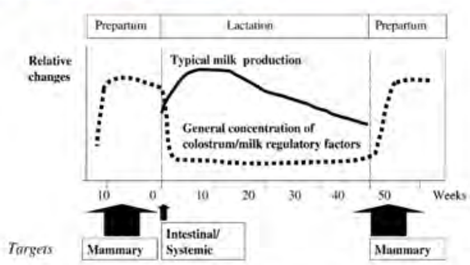


Fig. 1. Common pattern and target opportunity of regulatory/bioactive components in mammary secretions of dairy cows.

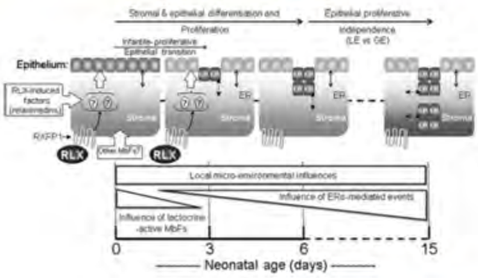
Blum and Baumrucker, 2002

Relatively new definition related to the topic of epigenetic programming in neonates:

•Lactocrine hypothesis (Bartol, Wiley and Bagnell, 2009)

- maternal programming extended beyond the uterine environment through ingestion of milk-borne morphological factors - milk in this case can include colostrum
- In neonatal pigs, maternal relaxin from colostrum stimulates development and differentiation of the uterus (15 vs 30 ml colostrum)
- Mediates the expression of estrogen receptors – stimulates on differentiation of stroma and epithelial cells and then proliferation

Role of colostrum Relaxin in female piglets on expression of estrogen receptors and development

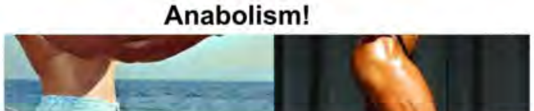


(Bartol, Wiley and Bagnell, 2008)

What Does Mom Want for Her Calf?

She wants them to grow and be healthy –

Anabolism!



With or without the steroids?

Colostrum vs milk

Components	Units	Colostrum	Mature Milk
Gross Energy	MJ/L	6	2.8
Immunoglobulin G	g/L	81	<2
Lactoferrin	g/L	1.84	Undetectable
Insulin	µg/L	65	1
Glucagon	µg/L	0.16	0.001
Prolactin	µg/dL	280	15
Growth hormone	µg/dL	1.4	<1
IGF-1	µg/dL	310	<1
Leptin	µg/dL	30	4.4
TGF-α	µg/dL	210	<1
Cortisol	pg/ml	1,500-4,400	710
17βEstradiol	pg/ml	1,000-2000	10-20

Blum and Hammon, 2000, Bonnet et al., 2002; Blum and Baumrucker, 2008

Composition of colostrum, transition milk and whole milk of Holstein cows

	Colostrum	Transition milk (milking postpartum)	
Parameter	1	2	3
Specific gravity	1.056	1.040	1.035
Total solids (%)	23.9	17.9	14.1
Fat (%)	6.7	5.4	3.9
Total protein (%)	14.0	8.4	5.1
Casein (%)	4.8	4.3	3.8
Albumin (%)	6.0	4.2	2.4
Immunoglobulins (%)	6.0	4.2	2.4
IgG (g/100 mL)	3.2	2.5	1.5
Lactose (%)	2.7	3.9	4.4
IGF-I (µg/L)	341	242	144
Insulin (µg/L)	65.9	34.8	15.8
Vitamin A (µg/100 mL)	295	190	113
Vitamin E (µg/g fat)	84	76	56

Foley and Otterby, 1978; Hammon et al. 2000

Importance of Colostrum Supply for the Neonate

- Colostrum provides immunoglobulins for establishing passive immunity
- Colostrum contains high amounts of nutrients, but also non-nutrient factors that support gut maturation
- Colostrum borne growth factors such as IGF-1 or hormones like insulin might act through specific receptors in the gut mucosa of the neonate to stimulate cell proliferation, cell differentiation, and protein synthesis
- Colostrum is a communication tool of the dam to direct calf development at the beginning of extra-uterine life

Inadequate Colostrum Intake Reduces Long Term Performance

Effects of Colostrum Ingestion on Lactational Performance, Prof. Anim. Scientist, 2005

Brown Swiss calves were fed 2 L or 4 L of colostrum and colostrum over another 6 to 8 feedings

	2 L	4 L
n	37	31
Daily gain, lb/d	1.76	2.2
Age at conception, mo	14.0	13.5
Survival through 2nd lact.	75.3	87.1
Milk yield through 2nd lact., lb	35,297	37,558

Source of Colostrum Replacement Important for Feed Efficiency – observable over first 29 days of life

Calves fed colostrum or a serum derived colostrum replacement demonstrated differences in feed efficiency

- **no differences in IgG status**

Variable	Colostrum		Colostrum Replacement	
	N	P	N	P
Total DMI, lb	34.5	33.1	30.1	32.1
Milk replacer DMI, lb	23.5	24.3	21.6	24.1
Starter DMI, lb	10.9	8.7	8.5	8.2
Feed efficiency,(gain:feed)	0.43	0.36	0.22	0.26
	0.40		0.24	

Jones et al. JDS 2004

INADEQUATE COLOSTRUM INTAKE DECREASES GROWTH OF CALVES ON INTENSIFIED FEEDING PROGRAMS

Johan S. Osorio and James K. Drackley

Colostrum status impacts feed efficiency but varies by level of nutrient intake

Conventional: 1.25 lb/d, 22:20
Intensified: 1.75 lb/d 7 days, 2.5 lb/d to 42 days 28:20
23% CP starter

	Conventional		Intensified	
Ig status	Poor	Good	Poor	Good
n	21	20	17	25
Mean serum IgG, mg/dL	558[a]	1,793[b]	609[a]	2,036[b]
Average daily gain, lb/d	1.17[a]	1.09[a]	1.39[b]	1.63[c]

[abc]means in same row with different letters are differ P<0.10

Effect of Colostrum level on Growth and Feed Efficiency

- Calves fed 4 L (+2L @12 hrs) or 2 L of pooled colostrum within one hour of birth
- Half of calves on each colostrum treatment assigned to "*ad libitum*" feeding regimen
- All calves are housed in a co-mingled pen and fed with an automatic feeder
- Daily intakes of milk replacer and weekly measures of body weight and hip heights
- Weekly blood samples

Soberon, 2011

Effect of High (4+2 L) or Low (2L) Colostrum and Ad-lib (H) Milk Replacer Intake on Feed Efficiency and Feed Intake in Pre and Post-Weaned calves (Soberon Ph.D. diss., 2011)

Treatment	HH	LH	
	Mean	Mean	Std dev
n	34	26	
IgG concentration, mg/dl*	2,746[a]	1,466[c]	98
Birth wt, lb	97	92	2
Weaning wt, lb	172[a]	159[c]	4
ADG pre-weaning, lb	1.74[a]	1.48[c]	0.06

Effect of High (4+2 L) or Low (2 L) and Ad-lib (H) Milk Replacer Intake on Feed Efficiency and Feed Intake in Pre and Post-Weaned calves

Treatment	HH	LH	
	Mean	Mean	SD
ADG birth to 80 d, lb	1.72[a]	1.45[b]	0.07
Hip height gain, birth to 80 d, cm/d	0.214[a]	0.184[c]	0.008
Total milk replacer intake, lb DM[1]*	97.8[a]	90.1[c]	2.4
Grain intake pre-weaning, lb[1]*	4.8[a]	4.6[a]	3.3
ADG/DMI, pre-weaning[2]*	0.60	0.67	0.042
ADG post-weaning[3], lb	2.4[a]	1.76[b]	0.13
DMI post-weaning[3], lb/d	6.4[ab]	5.7[c]	0.23

Colostrum components and gastrointestinal tract development

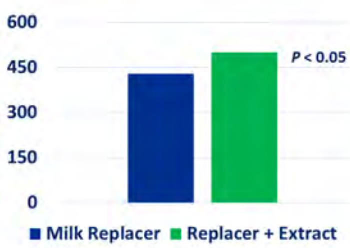
- Many studies have been conducted that demonstrate short term responses to hormones and growth factors found in colostrum
- General response is enhanced protein synthesis, increased enzyme expression, greater GIT development
- This development suggests:
  - The GIT is a stronger barrier to infection
  - Has more surface area for digestion and absorption
  - More capacity to digest more nutrients due to higher enzyme secretion

Feeding of a Colostrum Extract in Calves: Effects on Small Intestinal Villus Growth

Trait	Colostrum Extract	Colostrum 1st Milking
Gross energy, MJ/kg DM	19.7	24.9
Crude protein, g/kg DM	690	555
Immunoglobulin G, g/kg DM	44.2	159
Whey protein, g/kg DM	656	410
Crude fat, g/kg DM	3.2	265
N-free extracts, g/kg DM	173	104
Crude ash, g/kg DM	61.8	75
IGF-I, mg/kg DM	23	1.1
Insulin, µg/kg DM	365	67
Lactoferrin, g/kg DM	1.6	7.5

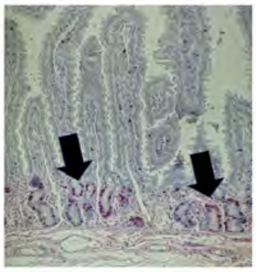
Roffler et al., 2003

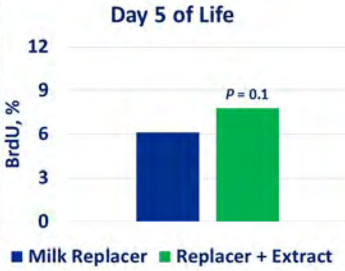
Influence on Villus Height in Neonatal Calves



Roffler et al., 2003

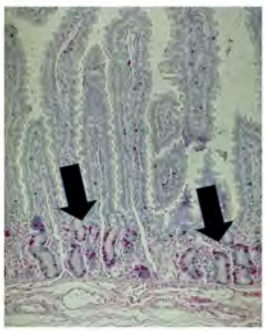
Influence on Crypt Cell Proliferation in Neonatal Calves
Milk replacer with and without a colostrum extract

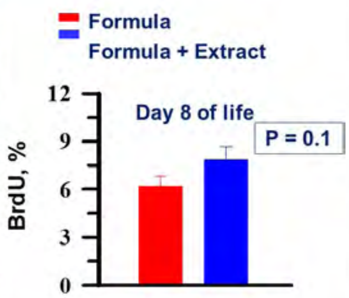




Roffler et al., 2003

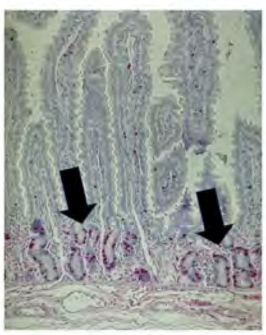
Colostrum Extract Feeding:
Crypt Cell Proliferation in Neonatal Calves

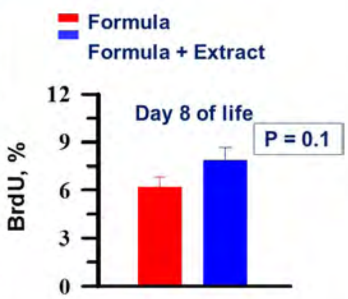




Blättler et al., 2001

Colostrum Extract Feeding:
Crypt Cell Proliferation in Neonatal Calves



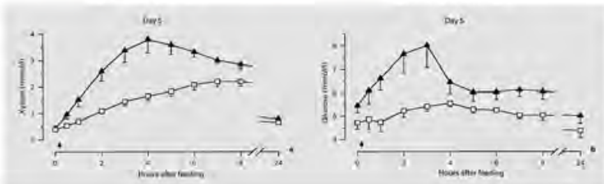


Blättler et al., 2001

Colostrum versus Formula Feeding:

Xylose Absorption in Neonatal Calves

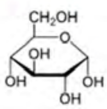
Plasma Xylose *Plasma Glucose*

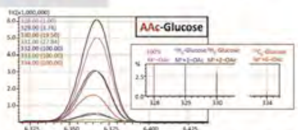


▲ *Colostrum*
☐ *Formula*

Rauprich et al., 2000

Colostrum Feeding and Glucose Uptake in Neonatal Calves





Steinhoff-Wagner et al., 2011

Effect of Colostrum Intake over 4 days on Glucose Metabolism and Energy Status

- 7 calves fed colostrum versus 7 calves fed milk-based formula 4 hrs on average after birth
  - Comparable in macronutrients
- Basal blood samples were drawn before morning feed and 2 hours after intake on day 1 to day 4
- Glucose absorption into blood using isotopes

Steinhoff-Wagner et al., 2011

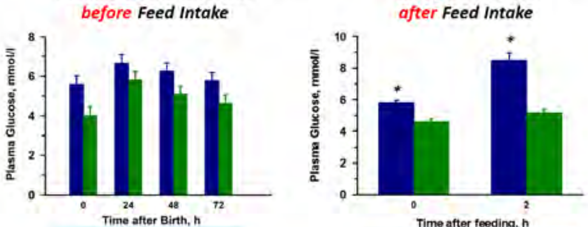
Composition of Colostrum and Formula

	Dry Matter g/kg	Ash g/kg FM	OM g/kg FM	Lactose g/kg DM	Crude Protein g/kg DM	Crude Fat g/kg DM	Crude Energy MJ/kg DM	IGF-I µg/l
Colostrum								
Day 1	239	10.7	228.2	200.9	523.2	194.6	22.1	373.4
Day 2	179	9.1	170.0	259.6	395.9	269.1	23.6	192.4
Day 3/4	151	8.1	143.2	341.0	296.8	292.8	23.3	85.6
Formula								
Day 1	240	20.9	219.0	200.9	514.0	173.4	22.5	n.m.
Day 2	179	12.9	165.7	259.8	409.3	246.4	23.8	n.m.
Day 3/4	153	10.5	142.6	338.3	338.3	246.2	23.5	n.m.

n. m. = not measureable

Steinhoff-Wagner et al., 2011

Plasma Glucose: Postnatal Concentrations and Changes after Feed Intake



Statistics

Main Effects:
- *Diet* $P < 0.001$
- *Time* $P < 0.05$
- *Diet × Time* $P < 0.7$

Statistics

Main Effects:
- *Diet* $P < 0.001$
- *Time* $P < 0.001$
- *Diet × Time* $P < 0.001$

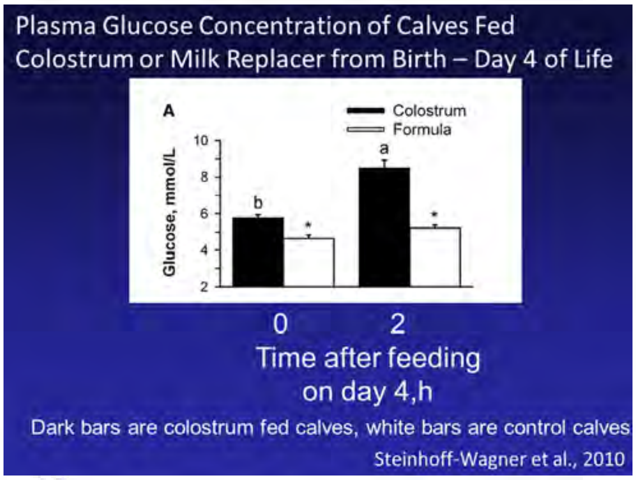
*: Sig. Diet Effet at Time Point

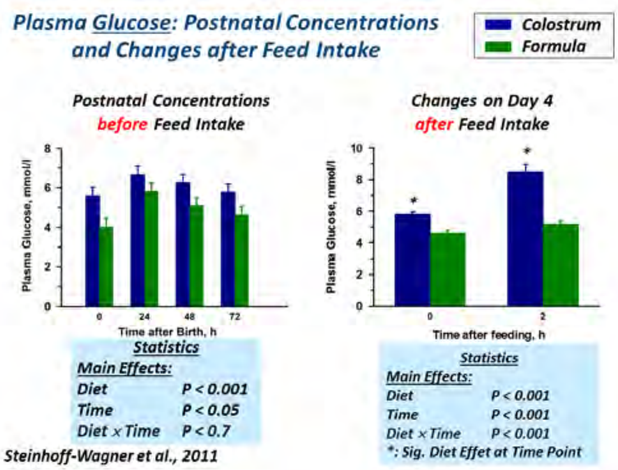
Steinhoff-Wagner et al., 2011

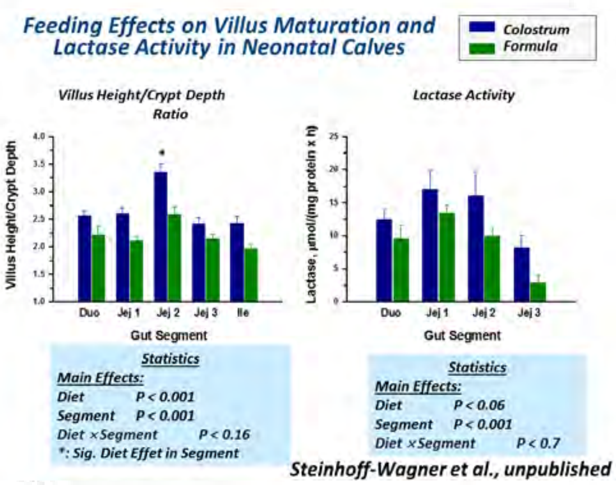
Plasma Insulin Concentration of Calves Fed Colostrum or Colostrum like formula from Birth – Day 4 of Life

Dark bars are colostrum fed calves, white bars are control calves

Steinhoff-Wagner et al., 2011


Plasma Glucose Concentration of Calves Fed Colostrum or Milk Replacer from Birth – Day 4 of Life
A
Colostrum
Formula
Glucose, mmol/L
10
8
6
4
2
b
a
*
0
2
Time after feeding on day 4,h
Dark bars are colostrum fed calves, white bars are control calves
Steinhoff-Wagner et al., 2010


Plasma Glucose: Postnatal Concentrations and Changes after Feed Intake
Colostrum
Formula
Postnatal Concentrations before Feed Intake
Plasma Glucose, mmol/l
Time after Birth, h
0
24
48
72
Statistics
Main Effects:
Diet P < 0.001
Time P < 0.05
Diet × Time P < 0.7
Steinhoff-Wagner et al., 2011
Changes on Day 4 after Feed Intake
Plasma Glucose, mmol/l
Time after feeding, h
Statistics
Main Effects:
Diet P < 0.001
Time P < 0.001
Diet × Time P < 0.001
*: Sig. Diet Effet at Time Point


Feeding Effects on Villus Maturation and Lactase Activity in Neonatal Calves
Colostrum
Formula
Villus Height/Crypt Depth Ratio
Villus Height/Crypt Depth
Duo
Jej 1
Jej 2
Jej 3
Ile
Gut Segment
Statistics
Main Effects:
Diet P < 0.001
Segment P < 0.001
Diet ×Segment P < 0.16
*: Sig. Diet Effet in Segment
Lactase Activity
Lactase, µmol/(mg protein x h)
Duo
Jej 1
Jej 2
Jej 3
Gut Segment
Statistics
Main Effects:
Diet P < 0.06
Segment P < 0.001
Diet ×Segment P < 0.7
Steinhoff-Wagner et al., unpublished

Colostrum vs Milk Replacer for first 4 days of life - summary

Glucose uptake increased – similar nutrient supply
- Colostrum enhanced glucose uptake via insulin or enhanced enzyme activity in gut or simply maturation of gut

Plasma glucagon higher – better glucose status, indication of higher reserve capacity

Plasma protein levels higher – more protein available for growth, higher protein synthesis, less protein for glucose

Plasma urea lower – less protein turnover and lower protein utilization for glucose production

Steinhoff-Wagner et al., 2011

Effect of Insulin Supplementation of a Colostrum Supplement on Insulin Absorption and Glucose Uptake

- 6 bulls and 6 heifers, were obtained from the Teaching and Research Dairy in Harford New York.
- Calves were dried, weighed, and received IV catheters before first feeding and a blood sample was taken immediately prior to first feeding
- Land O' Lakes Colostrum Replacer was used as colostrum, and calves were fed on average 1.25 hr after birth.
- 1000 IU of human insulin (Novolin) was added to the treatment group 1st feeding

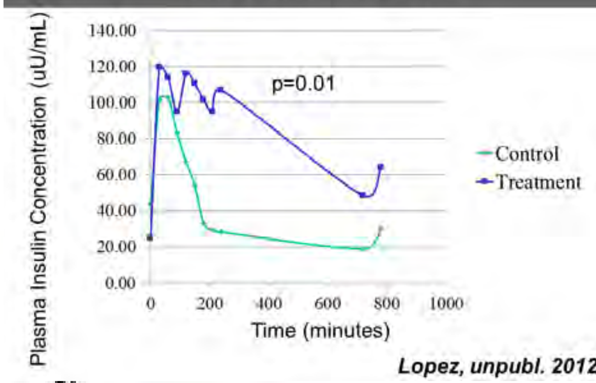
Lopez, unpubl. 2012

Sampling

- Samples were obtained every 30 minutes for the first 4 hours from the catheter following first feeding
- Calves were fed their second feeding (colostrum replacer) 12 hours post first feeding
- Final samples were obtained immediately before and 1-hour after second feeding

Lopez, unpubl. 2012

Insulin Curves



Lopez, unpubl. 2012

Plasma Glucose and Insulin of Calves Provided Supraphysiologic levels of Insulin in a Colostrum Replacer

	Control	Treatment	S.E.	P
Insulin, uU/ml	56.75	85.45	7.99	0.01
Glucose, mg/dL	69.81	81.74	3.56	0.02

Lopez, unpubl. 2012

What happens to immune cells in colostrum?

- Data generated over the last 15 -20 years demonstrates that leukocytes and other immune related cells in colostrum are "trafficked" into circulation in the calf
- Does this have any impact on the activity of the neonatal immune system?
- Other implications for the calf?

Immune cell transfer from colostrum to circulation

- Maternal leukocytes can be detected in calf circulation within 12 hr, peak at 24 hr and disappear by 48 hr. (Reber et al. 2008)
- Cells appear to be sequestered into tissues and lymph nodes after 48hr (Tuboly and Bernath, 2002; Williams, 1993).
- However, cells have been measured up to 5 wks after colostrum administration (Reber, et al. 2005)
- Long-term there appears to be greater cellular immunity in calves that received the whole colostrum compared to cell free colostrum (Reber et al. 2005; 2008)

Immune cell transfer from colostrum to circulation

- Calves fed whole colostrum have greater cellular immunity as defined the activation markers CD25 and CD26 by 7 days after birth
- Also greater antigen presenting capacity on cell surfaces
- Calves fed whole colostrum have greater cellular immune responsiveness to vaccinations

Reber et al. 2008

Effect of maternal cells transferred with colostrum on cellular responses to pathogen antigens in neonatal calves

- Calves were fed whole colostrum, frozen colostrum, or cell-free colostrum within 4 hours after birth.
- Leukocytes were obtained from calves before feeding colostrum and 1, 2, 7, 14, 21, and 28 days after ingestion.
- Proliferative responses against bovine viral diarrhea virus (BVDV) and mycobacterial purified protein derivatives were evaluated.
- Dams received a vaccine containing inactivated BVDV, but were not vaccinated against mycobacterial antigens.

Donovan et al. 2007. Am J Vet Res. 68:778–782

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Take home for colostrum management

Colostrum feeding for 4 days….

First milking colostrum within 6 hr of birth – 4 qt for large breeds

First milking colostrum at 12 hr

Second milking colostrum for day 2

Third and fourth milking colostrum for days 3 and 4

Summary

- Mom is trying to send information to the calf via mammary secretions – some of our management approaches have short circuited this “information flow”
- Colostrum contains factors that impact intestinal development and nutrient supply independent of nutrient consumption
- Colostrum can positively impact pre and post weaning feed efficiency (from 12 to over 50%)
- The dam makes colostrum for more than one day, and this has additional impacts on calf development

Thank you for your attention

NOTES

Growth, Nutrient and Herd Level Dynamics and Management, Part 1

Mike Van Amburgh


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Animal Health

Growth, Nutrient Requirements and Herd Level Dynamics and Management: Impact on Production and Profit

Mike Van Amburgh and Rodrigo Molano
Dept. of Animal Science
Email:mev1@cornell.edu; cell: 607-592-1212

Overview of today's discussion

- Identifying disruptors…. All the best biology in the world will not overcome a lack of monitoring and feedback of the system
- What are the major management disruptors that impact heifer profitability at the farm level and what is their value?
- Benchmarking
- Inventory
- Age at first calving
- Summary

Herd Replacement Objectives

- Focus on return on investment – over their productive life
- Minimize non-completion (animals that are born and never enter lactation)
- Optimize the productivity of the animal (manage them for their genetic potential starting at birth)

Herd Replacement Objectives

- Optimize profits by obtaining the highest quality heifer at the lowest possible cost usually in the least amount of time.
- Focus on return on investment – over their productive life
- Minimize non-completion (animals that are born and either never milk or finish a lactation)
- Optimize the productivity of the animal over their productive life (manage them for their genetic potential starting at birth)

Key Areas

- Quality
  - Outstanding growth, few to no treatments, high quality environment, good airflow, low ammonia, minimize organic material contamination, meet all the growth benchmarks for optimum milk yield
- **Costs: 20 to 30% of costs to operate the business**
  - Total costs ($1,900 - $2,400 depending on region)
  - Feed (53% if total heifer costs; $1.42-$2.05/d)
  - Labor
  - Non-completion/performance (10% or higher)
- Number raised
- Capturing value of excess heifers

Growth Benchmarks to Optimize First and Subsequent Lactation Milk Yield

Birth to weaning:	double body weight
Puberty:	45% mature weight
Breeding and Pregnancy:	55-60% mature weight
First lact. post-calving BW:	82 to 85% mature weight

Mature weight determined at middle of 3rd and 4th lactation – 80 to 200 days in milk on healthy cows, not cull cows

STUDY GOAL

TO IDENTIFY SPECIFIC
DAIRY PRODUCTION MEASURES
THAT ARE CORRELATED WITH THE
FINANCIAL HEALTH OF A DAIRY

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THE DATA

- **425** farm-year records from clients in upper Midwest
- **90** total variables, 54 numeric
- **85** farms represented (not counting censored)
- **10** calendar years
- **5.0** year-end records per farm (avg.)
- **1071** average lactating cows per farm (range from 95 to 4700)

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RELATIONSHIP BETWEEN NFI AND KEY MEASURES

VARIABLE	CORRELATION w/NFI	KEY LEARNINGS
21 day pregnancy risk	0.17	Increased days open is expensive (small sample)
ECM shipped, lb./cow/day	0.15	More milk per cow is profitable – effect of marginal milk
Heifer survival rate, %	0.15	Keeping calves healthy is beneficial
Number heifers	0.07	Heifer inventory not related to profitability – supports culling strategy
Milk shipped, herd total, cwt	0.05	Profitability not related to total lb. shipped
Herd size, lactating	-0.03	Herd size not related to profit
Labor cost*	-0.06	Labor cost is unrelated to profitability
Death loss (%)	-0.10	Death losses negatively impact profitability
Somatic cell count	-0.14	Investing to produce high quality milk is profitable
Net herd replacement cost**	-0.30	Lowering replacement costs helps profitability, value of cull cows

*Labor cost, $/cwt ECM (includes wages, benefits, [illegible])
**Net herd replacement cost, $/cwt ECM (difference between replacement cow value and book value of dead + sold cull cows for dairy or beef)

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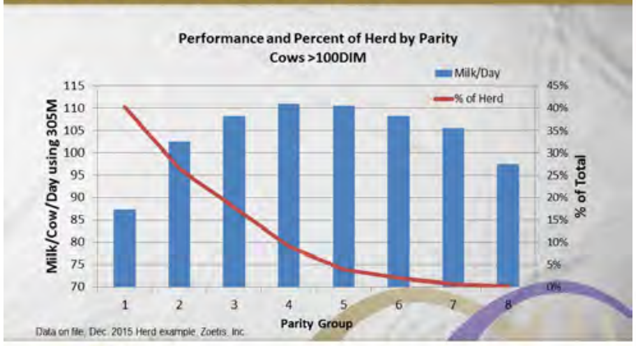
LONGEVITY - DRIVEN PROFIT



CLARIFIDE plus

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RELATIONSHIPS BETWEEN NET HERD REPLACMENT COSTS AND OTHER MEASURES

VARIABLE	CORRELATION w/ NHRC
Cull + death rate, %	0.38
SCC x 1000	0.35
Profitability (NFI, $/cwt ECM/day)	-0.32
ECM/cow/day, lb./day	-0.46

DIFFERENCE IN PROFIT BETWEEN HIGHEST 1/3 AND LOWEST 1/3 (BASED ON NHRC, $/cwt ECM, COP)	~$633 K/year for 1071 cow herd*

*Top third (NHRC = $0.88/cwt) produced 88.5 lb. ECM/cow/day; bottom third (NHRC = $2.02/cwt) produced 76.4 lb. ECM/cow/day

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Nutrient Requirements of Pre-weaned calves

Energy content of typical feeds

Milk replacer 20:20: 4.67 Mcals ME / kg DM
2.1 Mcals ME/ lb

Milk replacer 28:20: 4.74 Mcals ME / kg DM
2.2 Mcals ME / lb

Whole milk 26:31: 5.32 Mcals ME / kg DM
(Holstein) 2.4 Mcals ME / lb

Accounting for maintenance requirements

- The maintenance requirement of a calf can be described by the following equations:
  - Mcal ME x $BW^{0.75}$ so for a calf weighing 41 kg the maintenance requirement is:

$(41\ \text{kg})^{0.75} \times 0.1 = 1.61$ Mcals ME

Scale for heat loss due to body weight:

- One adjustment is to scale for surface area to account for the additional heat loss and the following equation and example is used: $0.14 \times BW^{0.57}$ $(0.14 \times 41^{0.57}) = 1.16$. Thus, to account for the additional heat loss due to body size the requirement for the 90 lb calf is adjusted:

1.61 Mcals ME x 1.16 = 1.87 Mcals

Jersey Requirements and Heat Loss

- Surface area to body weight relationship is greater – means greater heat loss potential
- Actualized maintenance requirements are ~ 20% greater than Holsteins
- Need higher fat diets to meet energy demand at level of intake – described in Bascom et al. work from Virginia Tech

Adjust for conditions outside of thermoneutral temperature

For every degree C below thermoneutral (~68° F ~ 15° C) the energy requirement increases by 0.027 Mcals ME.

So for the same calf at 0° C the adjustment would result in $(41^{0.75} \times 0.027) \times 15 = 0.64$ Mcals for a total maintenance requirement of **1.87 + 0.64 = 2.51 Mcals**

Maintenance Requirements of Calves at Various BW and ambient temperatures.
Values are in Mcal ME per day

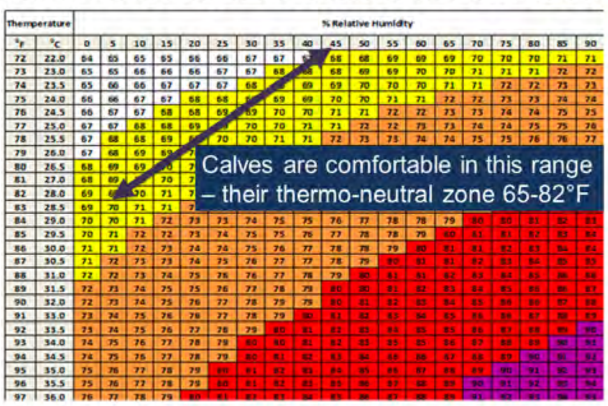
Temp., °F	68	59	50	32	14	5	-4	-13	-22
BW, lb									
55	1.1	1.3	1.4	1.7	2.0	2.2	2.3	2.5	2.6
66	1.3	1.5	1.6	2.0	2.3	2.5	2.7	2.8	3.0
77	1.4	1.6	1.8	2.2	2.6	2.8	3.0	3.2	3.4
88	1.6	1.8	2.0	2.4	2.9	3.1	3.3	3.5	3.7
99	1.7	2.0	2.2	2.7	3.1	3.4	3.6	3.8	4.1
110	1.9	2.1	2.4	2.9	3.4	3.6	3.9	4.2	4.4

Feed for Maintenance

To estimate feed required for maintenance using a 20:20 milk replacer: 4.67Mcal/kg

2.51 Mcals/4.67 Mcals/kg = 0.54 kg (1.2 lb) of milk replacer powder to meet the maintenance requirements of the calf.

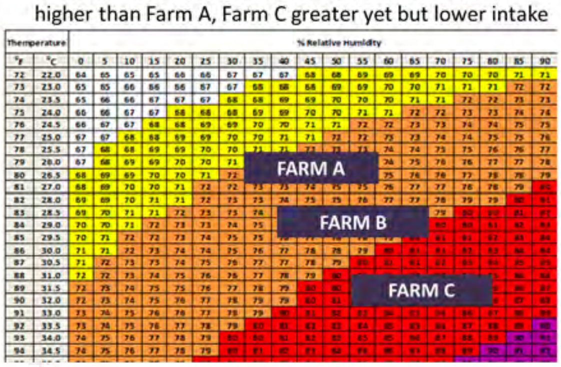
Heat Stress and Performance of Calves



Summary of Feed Cost and Measured Gains During June and July 2014			
Feed Basis (As-Fed)	Farm A	Farm B	Farm C
Housing Type	Barn with mechanical ventilation	Barn with natural ventilation	Hutches, back propped up for increased ventilation
Pounds Milk Replacer fed per calf	1.50	1.82	1.25
Pounds grain fed per calf	0.47	0.86	1.00
Average Daily Gain (ADG)	2.00	1.88	0.67
Feed cost per animal per day	$3.01	$3.72	$2.65
Feed cost per pound of gain[1]	$1.69	$1.97	$3.94
Gross Feed Efficiency (Gain:Feed)	1 : 0.99	1 : 1.43	1 : 3.36

Heat Stress/Management Impact

- Farm B fed more, and still achieved lower ADG
  - Maintenance requirements for Farm B calves were higher than Farm A, Farm C greater yet but lower intake



Updated Nutrient Requirements of a 100 lb Calf Under Thermoneutral Conditions

Rate of gain, lb/d	ME[a], mcal/d	DMI, lb/d	ADP, g/d	CP, g/d	CP, % DM
0.44	2.35	1.12	87	94	18.0
0.88	2.89	1.40	140	150	23.4
1.32	3.48	1.67	193	207	26.6
1.76	4.13	1.98	235	253	27.5
2.20	4.80	2.39	286	307	28.7

Van Amburgh and Drackley, 2005

Weaning and Dry Matter Intake of Starter

- Behavior - a calf under natural conditions would learn to consume feed from the dam
- Adding flavors and odors to starter grain helps this process, especially for calves fed grain in situations where they receive no visual feedback about what other calves are doing.
- Making sure all nutrient requirements are met by the starter is also important – industry not willing to pay for that yet
- Other options are enzymes that enhance digestibility and reduce digestive stress

Starter Nutrient Content

	% Dry Matter
CP	24.8
Sol CP	6.2 (24.9)
aNDFom	21.0
ADF	10.0
Starch	21.2
Sugar	14.9
Soluble fiber	4.9
Ether extract	4.4
ME allowable gain, kg/d	1.16
MP allowable gain, kg/d	1.13

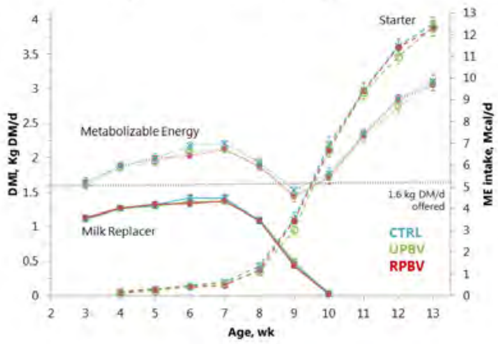
27

Rodrigo's calf starter

Pellet ingredients	**Amount, kg**	**% of DM**	**DM kg**
Wheat midds	0.6	0.199	397.09
Soyplus	0.6	0.199	397.09
Canola meal	0.2	0.066	132.36
Sugar	0.1	0.033	66.18
Dried whey	0.18	0.060	119.13
Blood meal	0.12	0.040	79.42
Metasmart dry	0.022	0.007	14.56
Minerals	0.02	0.007	13.24
Vitamins ADE	0.01	0.003	6.62
Rumensin premix	0.01	0.003	6.62
Flavor enhancer	0.01	0.003	6.62
Molasses	0.1	0.033	66.18
Fat	0.02	0.007	13.24
Yeast cell wall	0.02	0.007	13.24
External ingredients			
Beet pulp shreds	0.4	0.132	264.73
Flaked corn	0.61	0.202	403.71

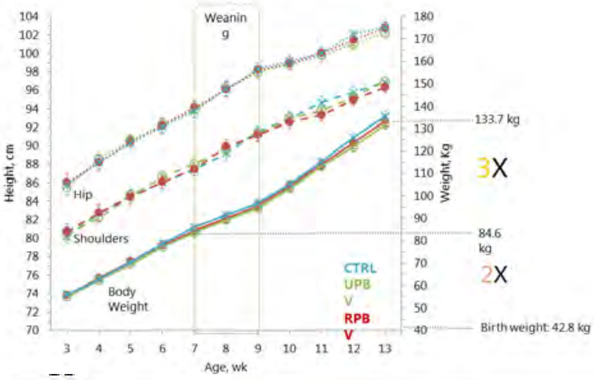
Results

Dry Matter and Energy Intake



Results

Body Weight and Stature

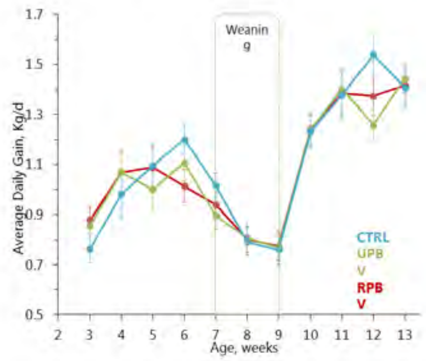


Results

Body Weight and Stature

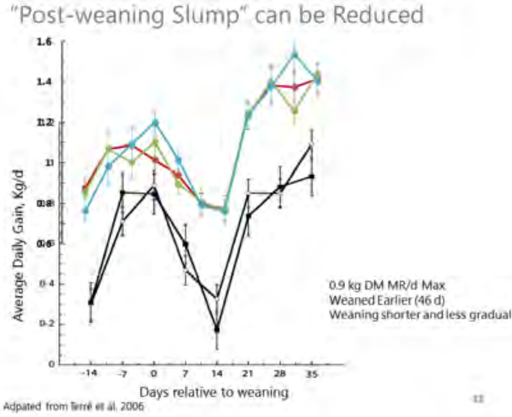
Results

Average Daily Gain



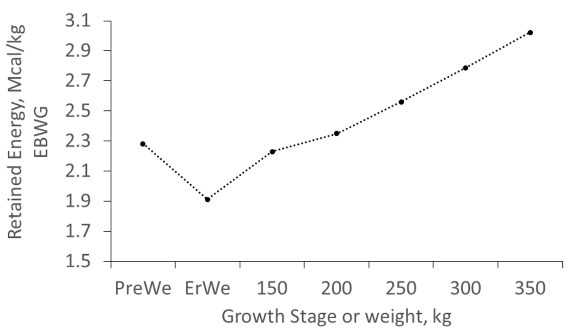
Results

"Post-weaning Slump" can be Reduced

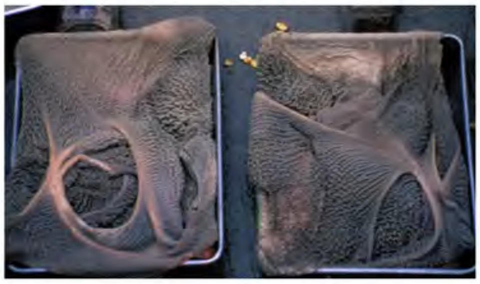


Adpated from Terré et al. 2006

Retained energy in empty body gain during different stages of growth and EBW of dairy heifers.

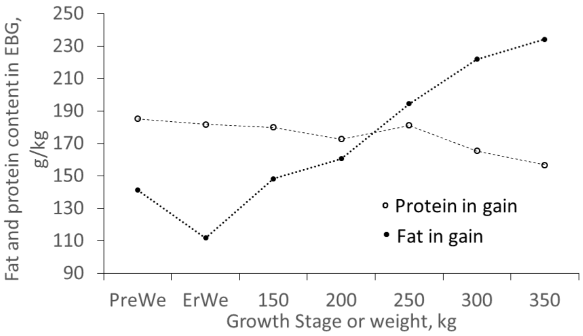


What does energy and protein requirements look like during development of the GIT?



Have two data sets: Stamey et al
Meyer et al.

Protein and fat contained in empty body gain during different stages and EBW of dairy heifers



Results

Feed Efficiency

Effects of Neonatal Nutrition on Productivity

Review of Available Data Sets – Meta Analyses

Mixture of several publications
Journal papers, abstracts, and proceedings
Suckling, whole milk and milk replacer

Hypothesis: increased nutrient intake that results in greater growth rates positively impacts first lactation milk yield


Soberon and Van Amburgh, 2013

Milk Yield Response to Increased Pre-weaning Milk or Milk Replacer Nutrient Supply

Study	Milk yield, lb
Foldager and Krohn, 1991	$3,092^{s}$
Bar-Peled et al., 1998	998^{t}
Foldager et al., 1997	$1,143^{t}$
Ballard et al., 2005 (@ 200 DIM)	$1,543^{s}$
Shamay et al., 2005 (post-weaning protein)	$2,162^{s}$
Rincker et al., 2006 (proj. 305@ 150 DIM)	$1,100^{ns}$
Drackley et al., 2007	$1,841^{S}$
Raith-Knight et al., 2009	$1,583^{NS}$
Morrison et al., 2009 (no diff. calf growth)	0
Moallem et al., 2010 (post-weaning protein)	$1,613^{s}$
Soberon et al., 2012	$1,556^{s}$
Margerison et al., 2013	$1,311^{s}$
Kinzeback et a, 2015	0

Outcome of Meta-Analyses

Milk yield effect of early life nutrition – asking the Yes/no question, does feeding a calf improve long-term productivity?

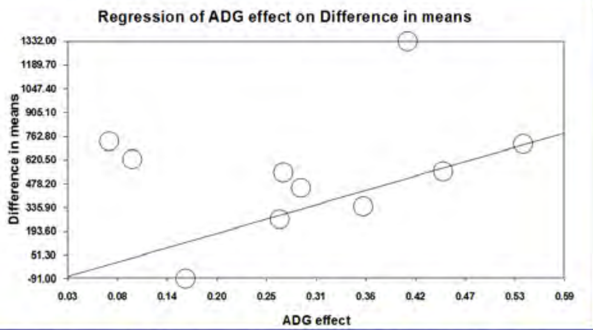
Difference in means, lb	SE, lb	Lower Limit, lb	Upper Limit, lb	Z-value	p-Value
435	117	205	664	3.72	<0.001

Odds ratio of effect

Odds Ratio	Lower Limit	Upper Limit	Z-value	p-Value
2.09	1.48	2.96	4.16	0.001

Soberon and Van Amburgh, 2013

Meta Regression - Effect of Pre-Weaning ADG on Milk Yield Outcome



Equation: milk yield = -118.5 lb + **1,527 lb***ADG (lb),
Z value = 2.42, *P* = 0.001

Soberon and Van Amburgh, 2013

Example – 100 lb calf

- A traditional U.S. feeding rate of milk replacer would be 1.25 lb/d (20:20) - enough energy for approx. 0.4 lb/d gain under no stress conditions
- Feeding 2.2 lb/d (28:20) – energy for approx. 1.6 lb/d gain under no stress conditions

Difference in ADG = 1.2 lb/d, thus

(1,541 lb* 1.2) = 1,850 lb additional milk expected in the first lactation

Cornell Herd - Effect of Pre-Weaning Daily Gain on Milk Yield

- In this evaluation, 22% of the variation in first lactation milk yield was explained by pre-weaning growth rate up to 42 - 49 days of age
- Correlation with genetic merit was 0

Soberon et al., 2012


What about "Detractors" and Milk Yield?
• Mean milk response from Cornell herd:
– 850 lb milk per lb pre-weaning ADG
• Calves treated with antibiotics (respiratory by SOP)
– 623 lb milk per lb pre- weaning ADG
• Calves not treated with antibiotics
– 1,407 lb milk per lb pre-weaning ADG
• Calves treated for respiratory issues didn't feel well, consume as much feed and grow as well those that weren't and didn't make as much milk

NOTES

NOTES

Controlling Feed Costs: without reducing production

Bill Weiss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Controlling Feed Costs:
without reducing production

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Bill Weiss
Dept of Animal Sciences
Wooster

Ohio Agricultural Research and Development Center   Ohio State University Extension

Feed Cost Control

- Ingredient selection
- Use of home grown forage
- Grouping
- Ration formulation specs
- Feed wastage and shrink

What's the right question?

- What is cheap ($/ton)
- What is cheap ($/nutrients supplied)
- Will it contribute to a diet that produces the most milk
- Will it contribute to a diet that has highest IOFC

Ingredient Selection: Rule #1

Dairy cows do not require feeds

↓

They require nutrients

Feeds are just packages of nutrients

Ingredient Price Comparisons

- Must be done on a nutrient basis
- Must include multiple nutrients
  - e.g., SBM provides CP, NEL . . .
- Local market dependent
- Varies over time

Ingredient Price Comparisons

- Different methods (software) available
- Results available in popular press/extension outlets

https://dairy.osu.edu/newsletter/buckeye-dairy-news

Corn Silage (DM basis)

Nutrient	Central OH Dec 2018	Corn Silage (DM Basis)		Value
NEL, $/Mcal	$0.068	0.65 Mcal/lb NEL	1,300 Mcal/ton	$88
MP, $/lb	$0.390	8% CP (5% MP)	100 lbs/ton	$39
eNDF, $/lb	$0.083	32% eNDF	640 lbs/ton	$53
neNDF, $/lb	-$0.033	8% ne-NDF	160 lbs/ton	-$5
		Value per ton DM		$175
		Value per ton wet		$61

'Bargain' feeds
(nutrient value > market price)

- **Corn grain**
- **Corn silage**
- **Corn gluten feed**
- **DDG**
- Expeller SBM
- Hominy
- Whole cottonseed
- Wheat midds

Red Bold = longer term bargains

Dec 2018 Central OH (Tebbe, BDN)

'Overpriced'
(MP, NEL, NDF value < market price)

- Alfalfa hay (40% NDF) ← $ value of quality
- Blood meal ← Lysine?
- Canola meal, expellers
- Canola meal, solvent
- Citrus pulp ←
- Fish meal
- Molasses ← $ value of sugar?
- Tallow

Sept 2018 Central OH (Tebbe, BDN)

"+/- Other Stuff"

1. Effect on production/efficiency
2. Less Quantifiable Factors
   - **Variability** (e.g., Distillers vs SBM)
   - **Quality issues** (e.g., mold)
   - **More than NEL, NDF, MP** (molasses)
   - **Service/support**

Feed Additives

Currently, it costs \$6 to \$8/day to feed an average cow

- + yeast
- + Monensin
- + biotin
- + choline
- + niacin
- + DFM
- + enzyme
- + carotene
- + buffer
- + binder
- + . . .

All this stuff can add >\$1.5/day

Quiz: Which feed additive is the best investment

Product A: Cost 5¢. If it works, net= 15¢; works 75% of time

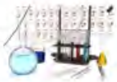
Product B: Cost 30¢. If it works, net= 70¢; works 25% of the time

Product C: Cost 10¢. Net= 4¢ and almost always works

Important Questions

1. What is the stuff supposed to do? (and how does it do it?)

2. Any proof that it works ?



3. How often does it work?

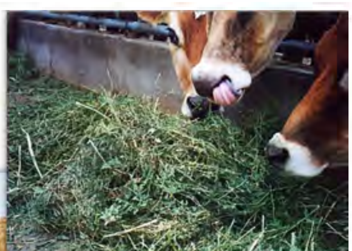
4. What is expected ROI ?
   - targeted vs 1 group TMR

Take advantage of homegrown high quality forages

1. <u>Good</u> corn silage is almost always a cheap source of nutrients
2. Home grown alfalfa silage is almost always reasonably priced

All bets are off if quality is not good

Quality….



or quantity?

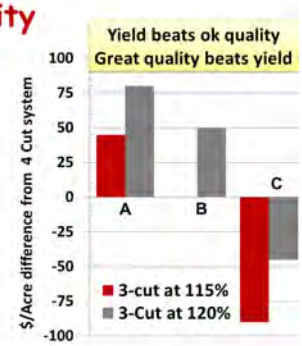
3-cut average vs 4-cut better stuff

Assumptions (Shoemaker et al., 2012)

- 4-cut yield = 6 tons DM (Avg Wooster OH)
- 3-cut @ 10% bloom yields 15-20% more than 4 cut at bud stage (Undersander)
- Costs from OSU budgets
- Value of alfalfa based on expected NDF, CP, NEL (SESAME program)

Alfalfa yield vs. quality

- **3-cut:** Always 44% NDF
- **4-cut**
  - A. 3 cuts with 40% NDF and 1 cut with 44% or
  - B. Always 40% NDF or
  - C. 3 cuts with 40% NDF and 1 cut with 36%



Shoemaker et al., 2012

Does quality matter at low inclusion?

Alfalfa hay at 15% of diet DM	
39 vs 43% NDF	No effect on milk and DMI
43 vs 50% IVNDFD (equal NDF)	No effect on milk and DMI

Expected Responses
~1.6 lbs of DMI
~3.5 lbs of milk
~+$20/ton

Raeth-Knight et al., 2010

Many Grouping Systems increase IOFC
(if done correctly)

1. Fresh (3wk) vs. all other cows
   - Fresh diet can be very expensive
   - May have carry over effects
   - May increase peaks
2. Two year old vs. older cows
   - Diets can be identical
   - Increase production of 2 yr olds

Increase Lifetime Production:
Keep 2 year olds in separate group

Two year old cows kept separate from older cows :

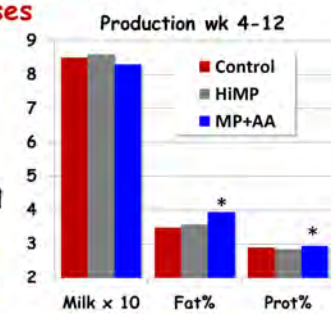
- Lay down more (better feet/legs)
- Eat more
- Eat more meals/day (better for rumen)
- Fewer aggressive interactions
- More milk

Carder and Weiss, 2017

Effect of Fresh Cow Protein on Carryover Responses

- Diets fed first 21 d
  - 16.5% CP
  - 18.5% CP
  - 17.5% CP + AA
- After 21 d all cows fed diet 1 until 86 DIM

Higher fat and protein for AA diet during fresh



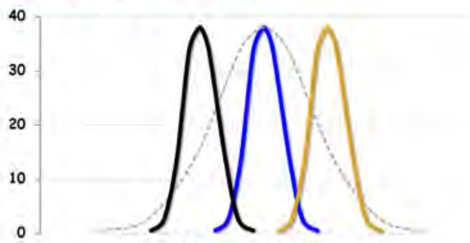
Many Grouping Systems increase IOFC
(if done correctly)

3. Group by production
   - Diets formulated for each group
   - Targeted use of additives
   - Forage quality inventory management

Grouping by Production

1 average with large variation

Grouping by Production



- 3 different means
- Smaller SD within pens

Formulating for Groups

1 group (mean = 75 lbs, SD = 13)
Protein for 75 + 13 = **88 lbs**

3 groups

Low (mean=60 lbs, SD = 4)
MP for **64 lbs**

Mids (mean = 75 lbs, SD =5)
MP for **80 lbs**

Highs (mean = 90 lbs, SD =6)
MP for **96 lbs**

Avg = 80 lbs

How Many Production Groups?

Costs

- increased labor (feeding, moving, etc)
- more pen moves
- more management time
- maybe more feed inventory

Benefits

- lower feed costs
- maybe better BCS
- better forage inventory management

How Many Production Groups?

I think 2 is usually enough (unless fat)

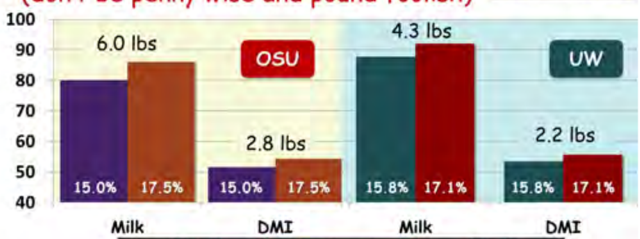
Cabrera, 2016 TSDNC

What should my formulation specs be?

Diets that are **inadequate** in nutrients are almost always **less profitable** than more expensive diets that are adequate in nutrients

Feed Right Amount of Protein
(don't be penny wise and pound foolish)

SBM= $350
Corn: $3.6/bu



+$0.72	Feed costs	+$0.40
$0.96	Milk ($16)	$0.68

Money is tight, pull vitamins and TM?

Selenium/vitamin E at NRC = ~$35/cow/yr

Returns (based on research responses)

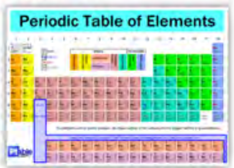
- Lower SCC
- Less clinical mastitis
- Less metritis
- Improved repro
- Total return: **$190/cow/year** (at $16/cwt)

Bayril et al., 2015

Safety Factors

Minerals and vitamins:

- Not highly dependent on milk yield
- Worry about uncertainty and antagonism
- 1 to 1.2 X NRC (for mean) is usually ok



Wasted feed and shrink

Wet Distillers after 2 weeks storage in summer

Shrink

Always expensive and often preventable

Production or purchase cost = $100/ton of DM	
Shrink	**Cost of forage fed**
15%	$118/ton of DM
20%	$125/ton of DM
30%	$143/ton of DM
50%	$200/ton of DM

Reducing Shrink

1. Proper silage making procedures
2. Proper silage feed-out procedures
3. Make hay at correct DM and protect during storage
4. Keep commodities under full cover
5. Proper feed bunk management
6. Maintain proper inventories especially for wet feeds

Feed to Correct Amount of Weighbacks

1. Do not restrict DMI (bare bunk >2 hours)
   -Bare bunk = no edible feed (e.g., just cobs)
2. If fed more than 1X: **1 or 2% of delivered**
   - 5 ton TMR/day/pen: About 150 lbs. left
3. If once a day feeding: **2 to 3% of delivered**
4. Watch bunk closely, adjust delivery weights

See Hoard's Dairyman, Nov 2018 for details

Summary

1. Use cost-effective (not cheap) feeds
2. Evaluate feed additives carefully
3. If you have good forage, take advantage
4. Have nutritionist formulate tighter diets
5. Reduce shrink
6. Proper weighbacks

Summary

1. **Separate first lactation cows**
   - return is in higher lifetime production
   - different diet may or may not be needed
2. **Separate fresh cows**
   - higher peaks
   - lower overall feed costs
3. **Separate on production**
   - high and low usually adequate

THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

OARDC

Dairy Nutrition Lab

oardcdairynutritionlab.osu.edu

Ohio Agricultural Research and Development Center | Ohio State University Extension

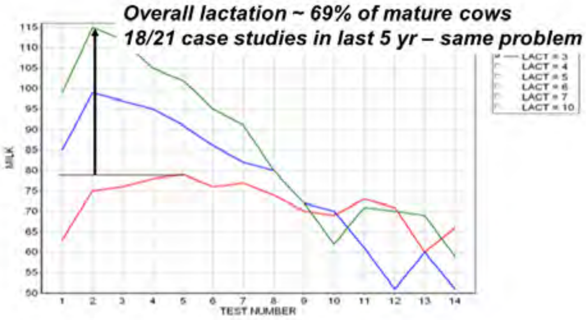
NOTES

Growth, Nutrient and Herd Level Dynamics and Management, Part 2

Mike Van Amburgh

PLOT MILK BY LACT

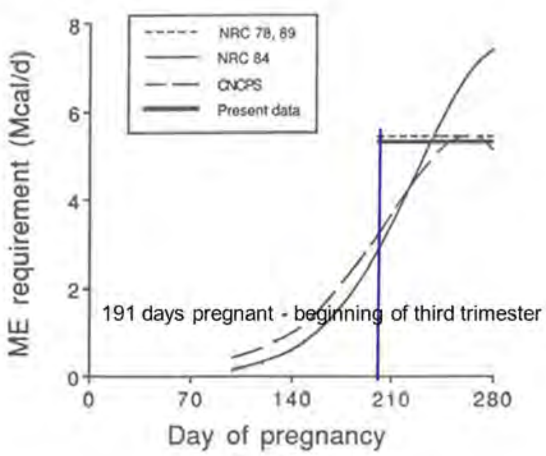
Peak ~ 69% mature cows
Overall lactation ~ 69% of mature cows
18/21 case studies in last 5 yr – same problem

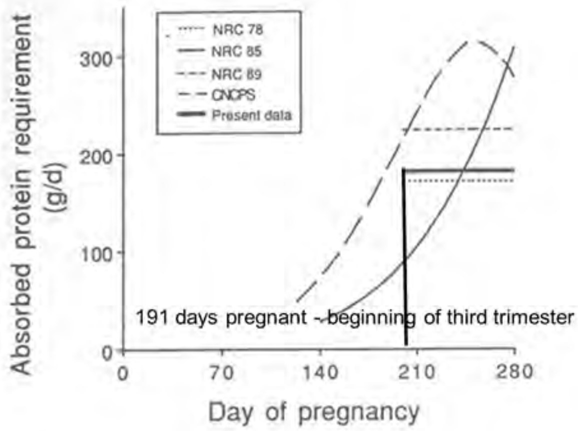


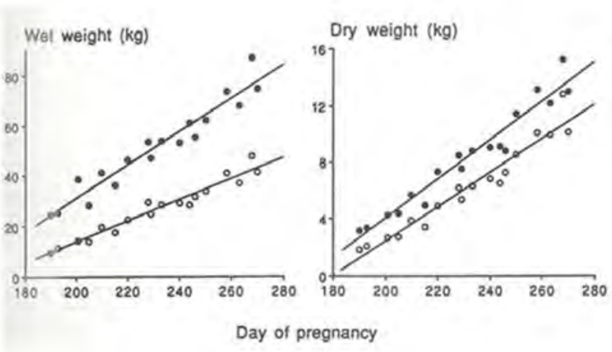
Fetal growth and requirements

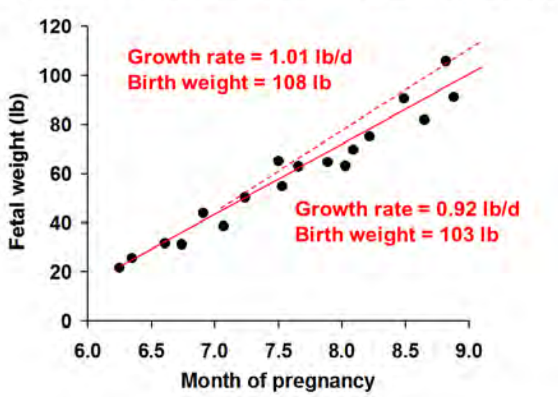
Do you have a pregnant heifer group?

Do you have a late pregnant heifer group?




NRC 78
NRC 85
NRC 89
CNCPS
Present data
Absorbed protein requirement (g/d)
191 days pregnant - beginning of third trimester
Day of pregnancy


Wet weight (kg)
Dry weight (kg)
Day of pregnancy

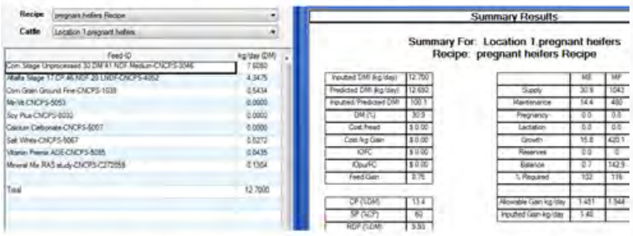

Fetal growth in multiparous Holstein cows (Bell et al., 1995)
Growth rate = 1.01 lb/d
Birth weight = 108 lb
Growth rate = 0.92 lb/d
Birth weight = 103 lb
Fetal weight (lb)
Month of pregnancy

Requirements of ME and MP for pregnancy

- Calculated based upon expected birth weight of calf and day of gestation
- Become meaningful beginning on day 191 of pregnancy
- Efficiency of ME use for pregnancy is 14%
- Efficiency of MP use for pregnancy is 33%

Pregnant heifers – 1,212 lb, 1,770 lb mature BW

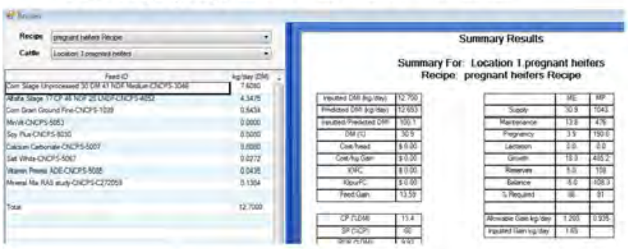
180 days pregnant – at the end of the 2nd trimester



Target gain: 3.15 lb/d
ME allowable: 3.2 lb/d
MP allowable: 4.3 lb/d

Pregnant heifers – 1,278 lb; 1,770 lb mature BW

200 days pregnant – into the 3rd trimester



Target gain: 3.63 lb/d
ME allowable: 2.65 lb/d
MP allowable: 2.06 lb/d

The Need and Importance for Monitoring Body Weight Gain and Age at First Calving and Productivity

Growth Benchmarks to Optimize First and Subsequent Lactation Milk Yield

Birth to weaning:	double body weight
Puberty:	45% mature weight
Breeding and Pregnancy:	55-60% mature weight
First lact. post-calving BW:	82 to 85% mature weight

Goal is to achieve 82% of mature size to achieve 80% of mature cow milk yield

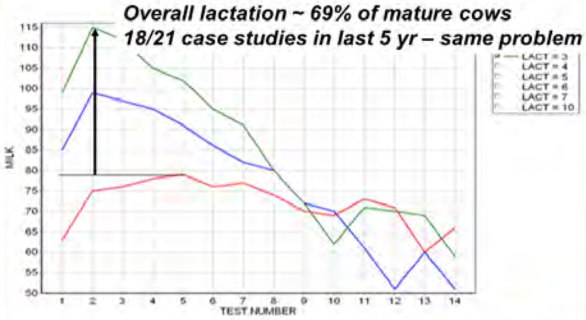
Mature weight determined at middle of 3rd and 4th lactation – 80 to 200 days in milk on healthy cows, not cull cows

PLOT MILK BY LACT

Peak ~ 69% mature cows

Overall lactation ~ 69% of mature cows

18/21 case studies in last 5 yr – same problem



Location

- Pen study ---16 cows in 12 pens (192 total)
  - Random allocation of cow to pen, pen to diet
  - 12 multiparous, 4 primiparous animals per pen

Photo: S. Fessenden

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Body weight and BCS

Item	Mean	Range
Lactation	2.4	1-6
DIM at trial start	115	50-180
Mature weight, lb	1,712	1,351-2,200
2+ lactation		
Body weight, lb	1,677	1,322-2,200
BCS	2.95	2.2-3.6
1st lactation		
Body weight, lb	1,351	1,051-1,578
BCS	3.1	2.87-3.5

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Growth in the First Lactation and Loss of Milk due to Partitioning

- Need to look at distribution
- 1,351 lb 1st lact/1,712 lb mature BW = 0.79 ~ 79% mature size
- 1,051 lb 1st lact/1,322 lb MBW = 0.79 ~79%
- 1,578 lb 1st lact/2,200 lb MBW = ~ 0.72 ~ 72%
- In this herd, heifers at the bottom of the distribution curve are close to the benchmark, whereas heifers at the top of the distribution curve are too light

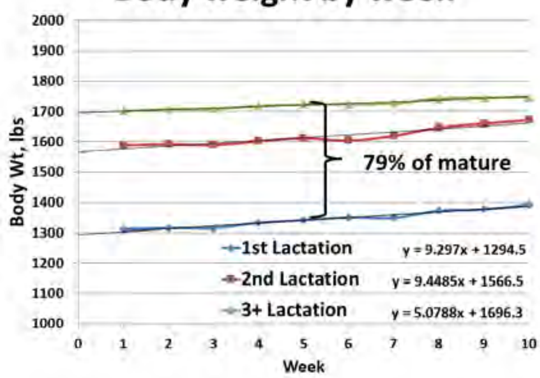
Cattle characterization

Cornell Research Dairy

1993 – mature body weight = 1,474±125 lb (668 kg)

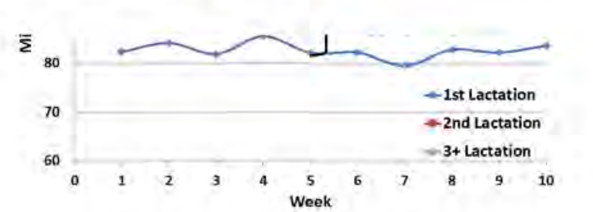
2016 – mature body weight = 1,777 ± 160 lb (803 kg)

Body weight by week



Milk production

20 yr of farm level observations suggest milk yield is nearly always within a couple units of the percent mature BW unless there is another constraint

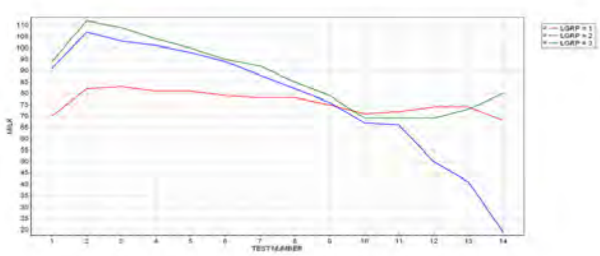


Discussion Group Heifer Project

Benchmarking performance to optimize milk yield

Herd	% Mature Peak
1	68
2	85 – false positive
3	75
4	82 – good herd
5	79 – acceptable
6	79 - acceptable
7	76
8	77
9	70
10	76
11	75
12	72

PLOT MILK BY LACTGRP – Fellows Case Study last spring – heifers producing at 82% of mature cows. 2x herd averaging 87 lb



Lactation Study Design

- The target growth system (Fox et al., 1999, NRC, 2001) was used to develop the growth, breeding, and post-calving body weight goals

Cornell Dairy Herd

- Mature size ~ 1,474 ± 120 lb
- Target AFC – 22 months
- Target post-calving BW (82% of mature weight ~ 1,209 lb)

Therefore the target pregnant weight was 55% of the mature size (811 lb) – breeding was initiated at 750 lb to achieve the target - independent of age

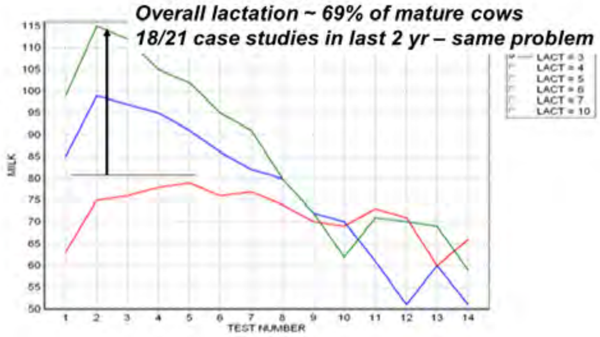
Post-hoc analysis of pre-pubertal growth rate, AFC, BW at calving, days in milk and 3.5% FCM yield of Holstein heifers fed a control diet or diet containing a FA supplement

	Control	Sunflower oil	EnerGII	CaCLA	Std. Dev.
n	16	16	17	16	
Pre-pubertal ADG, lb	1.90	1.92	1.96	1.87	0.15
AFC, mo	21.8	21.6	22.3	22.3	1.5
BW at calving, lb	1,227	1,199	1,241	1,267	76
Days in milk	299	294	294	290	10
Milk yield, 3.5% FCM, lb	25,057	24,599	25,538	25,344	2,450

Smith and Van Amburgh, 2003

PLOT MILK BY LACT

Peak ~ 69% mature cows
Overall lactation ~ 69% of mature cows
18/21 case studies in last 2 yr – same problem



Management scenario for many herds – value of monitoring

2014-2015 – Milk price was high for most of those two years

Cull cow prices were also high for same period

Cull value was almost equal to heifer rearing costs

Many herds now have more than 35% first lactation animals – upwards of 45% 1st lactation in some herds

Little to no monitoring once pregnant – calving in at weights below the benchmark of 82% mature body weight

Current scenario for many herds – value of monitoring for case study herd at 69% of lactation milk

Expected milk if target met: ~ 90 lb (40 kg) at peak

Assume ~225 lb (102 kg) for every pound at peak

11.5 lb (5.2 kg) greater peak * 225 = 2,583 lb (532 kg) unrealized milk due to not meeting the 82% mature size benchmark

Net milk: $16.80/CWT

$8.33 IOFC margin (Net milk – feed cost per CWT)

$8.33 * 25.8 CWT = $215.20 per 1st lactation heifer IOFC

800 cow herd * 40% 1st lactation heifers = 320 heifers * $215.20 IOFC =$68,852 IOFC not realized ($86/lact. cow)

Value of monitoring – $20 milk

Net milk: $20.80/CWT

$8.33 IOFC margin (Net milk – feed cost per CWT)

$12.33 * 25.8 CWT = $318.11 per 1st lactation heifer IOFC

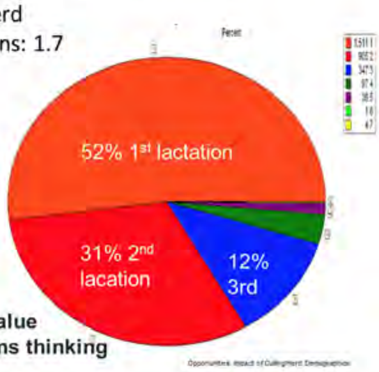
800 cow herd * 40% 1st lactation heifers = 320 heifers *

$318.11 IOFC = $101,795.20 IOFC not realized

($127/ lact. cow)

Case study herd demographics

- Extremely Young Herd
  - Average Lactations: 1.7



Why this outcome?

Sexed semen
Low NCR
Reasonable cull cow value
Little long-term, systems thinking

Impact of Young Herd Demographics and Lack of Benchmaks

1st lactation heifers are not paying for themselves

- Cost of Raising a heifer $3.35/day
- Average age at first calving = 22.9 months
- **$2,301 to rear a heifer**
- 26,400 M365 first lactation
- $20.20 milk price/cwt
- **$4,336 milk income first lactation**
- 50 lbs /day predicted DMI at $0.12/lb DM = $6/day
- calving interval = 381 - 59 avg days dry = 322 DIM
- **$1,866/cow feed cost for first lactation**
- Hoof trimming expense = $30/cow
- Breeding expense = $55/cow
- Veterinary service expense = $11/cow
- Medicine expense = $102/cow
- **$198/cow additional operating expense**

Average total costs to raise heifers – 17 farms in NY 2012
Labor up about 10% feed down about 10% so similar average

Costs, Per Day per Animal	Average	%	80th Percentile Range	
Feed	$1.598	53.3%	$1.296	$2.051
Labor	$0.358	12.0%	$0.215	$0.509
Bedding	$0.131	4.4%	$0.028	$0.293
Health	$0.060	2.0%	$0.028	$0.127
Breeding	$0.069	2.3%	$0.036	$0.107
Machinery, Operation & Ownership	$0.123	4.1%	$0.056	$0.225
Building, Operation & Ownership	$0.171	5.7%	$0.070	$0.300
Manure, Storage & Spreading	$0.073	2.4%	$0.024	$0.150
Non-Performance Expense	$0.114	3.8%	$0.034	$0.179
Interest on Daily Investment	$0.205	6.8%	$125.3	$165.3
All other Costs[1]	$0.094	3.1%	$0.183	$0.677
Total Cost per day per Animal	$2.996		$2.66	$3.43
Total Cost per Pound of Gain	$1.72		$1.53	$1.89
Total Cost per Animal Completing System	$2,090		$1,876	$2,263
Total Investment in Animal	$2,238		$2,026	$2,413

1 Trucking, Insurance, Custom Boarding, Professional Services

Wisconsin data: $2,377 in 2013

Jason Karszes

Impact of Herd Demographics – especially when benchmarks not met

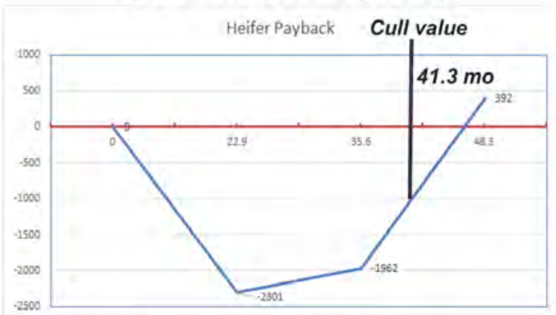
$ 4,336 milk income

- $ 2,301 cost to rear
- $ 1,932 1st lactation feed cost
- $ 198 operating expenses
- $ 963 labor expense
- $ 402 repairs expense
- $ 180 bedding and supplies
- $ 396 milk marketing
- $ 923 overhead expense

$-1896 loss/1st lactation animal

Opportunities: Impact of Culling/Herd Demographics

Heifer Breakeven and Profitability



Average Lactations = 1.7

Average Herd Life = 45 months

Breakeven Point = 46 months

What happens to Net Farm Income if we modify culling behavior to reduce inventory?

Total heifer cost $2,300

Reduction in heifer inventory due to lower turnover:

- 391 heifers

$899,300 in reduced costs for the herd

In this example, assuming 2,927 milking cows, that's **$155** increase in net farm income per cow

Number of Heifers Maintained, All Ages, for Various Calving Ages and Replacement Rates

Average Herd Size, Milking and Dry Animals	1000
Non-Completion Rate*, Dairy Replacements	8.00%

Calving Age Months	Cow Replacement Rate, Percentage 20	23	26	29	33	36	39	42	45
18	313	360	407	454	517	563	610	657	704
20	348	400	452	504	574	626	678	730	783
22	383	440	497	555	631	689	746	803	861
24	417	480	543	605	689	751	814	877	939
26	452	520	588	656	746	814	882	950	1017
28	487	560	633	706	803	877	950	1023	1096
30	522	600	678	757	861	939	1017	1096	1174
32	557	640	723	807	918	1002	1085	1169	1252

The Hidden Value of Inventory

1,000 cows milking and dry with 8% non-completion rate

Assume $2,200 replacement cost

With AFC 22 months and 33% cull rate – requires 631 Heifers

$1,388,200 heifer program cost

With AFC 24 months and 42% cull rate – requires 877

$1,929,400 heifer program cost

$541,000 difference over 2 years

850 milking cattle = $318 net farm income per cow

Cost of rearing to First Calving – Boulton et al, 2017 UK data

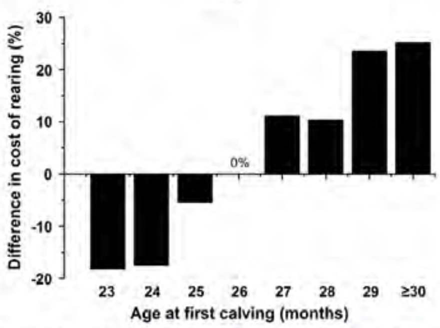


Figure 2 The estimated percentage difference in the total cost of rearing according to age at first calving, with 26 months taken as the base month (0%).

How Early Should Heifers Calve to Optimize Lifetime Productivity?

- Dairy Comp 305 ------------- A REAL Dairy -------------------- Page 1
- SUM AFC LFMPL LFMLK ME305 LACT FOR AFC=(18-31) BY AFC\TA

AFC	%COW	#COW	Av AFC	AvLFMPL	AvLFMLK	AvME305	Av LACT
1-7	3	26	19	21185	49389	23090	3.5
1-8	7	67	20	24173	60433	31994	2.4
1-9	21	207	21	22320	63008	27643	2.7
1-10	21	205	22	22024	70268	27712	2.9
1-11	12	120	23	17488	51059	26357	2.4
2-0	8	83	24	17266	46157	26026	2.2
2-1	4	42	25	13202	33566	27024	1.9
2-2	4	42	26	11077	21363	27133	1.4
2-3	4	39	27	11273	19609	28507	1.2
2-4	3	32	28	13003	15868	28699	1.1
2-5	3	30	29	15817	22281	28268	1.2
2-6	3	28	30	17731	19186	28472	1.0
2-7	2	21	31	17013	19652	27440	1.1
Total	100	980	23	18767	50307	27575	2.3

Within Herd Analysis of AFC on Productive Days, Milk Yield, Longevity

- Lactation records from
  - 2,519,232 first lactation cows
  - 937 herds in the Northeast and California
- Within herd analysis
  - Accounts for management, environment, and genetic differences among farms

Within Herd Analysis of AFC on Productive Days, Milk Yield, Longevity

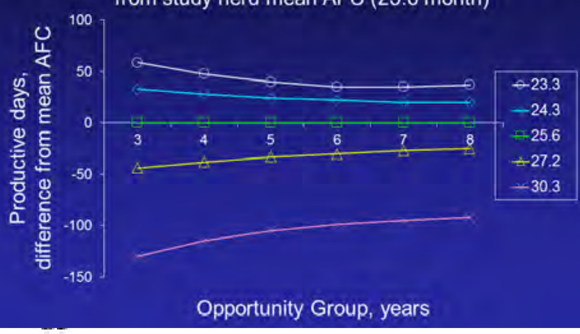
- Retrospective assignment to AFC treatment groups
  - Herd avg. AFC was calculated each year
  - Heifers were assigned to one of 5 AFC age groups:
    1) Less than -63 days from herd avg. AFC
    2) -22 to -63 days from herd avg. AFC
    3) -21 to 21 days from herd avg. AFC
    4) 22 to 63 days from herd avg. AFC
    5) Greater than 63 days from herd avg. AFC

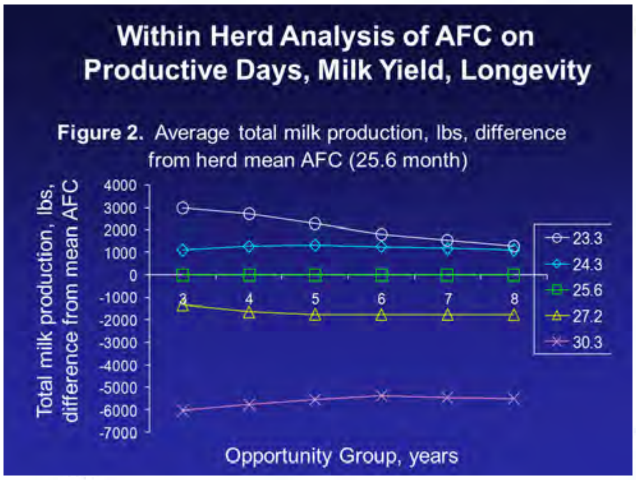
Within Herd Analysis of AFC on Productive Days, Milk Yield, Longevity

- Retrospective assignment to AFC treatment groups
  - Herd avg. AFC was calculated each year
  - Heifers were assigned to one of 5 AFC age groups:
    1) 23.3 months AFC
    2) 24.3 months AFC
    3) 25.6 months AFC
    4) 27.2 months AFC
    5) 30.3 months AFC

Within Herd Analysis of AFC on Productive Days, Milk Yield, Longevity

Figure 1. Average number of productive days, difference from study herd mean AFC (25.6 month)



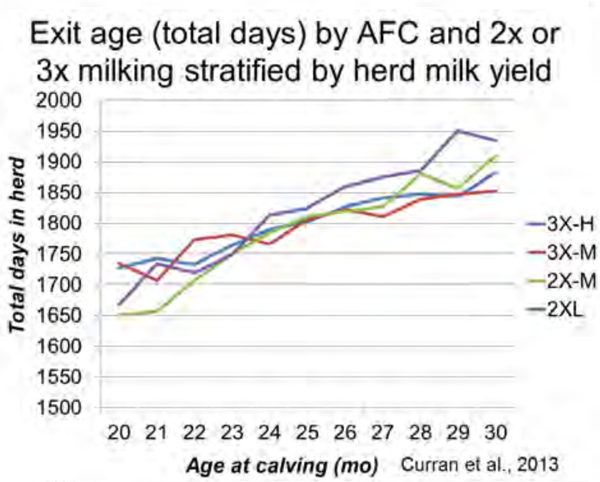


Study from Wisconsin – field/farm data from DHIA records evaluation of heifer calving in 2005

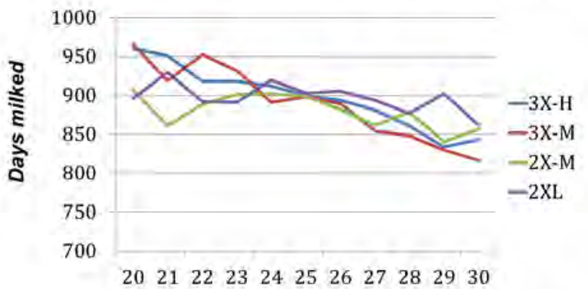
>69,000 heifers analyzed

Stratified herds by level of production –
- 3x milking high – 28,100 lb RHA,
- 3x milking medium -24,795 lb RHA,
- 2x medium – 24,795 lb RHA,
- 2x low – 20,387 lb RHA

Curran et al. Prof. Anim. Sci., 2013

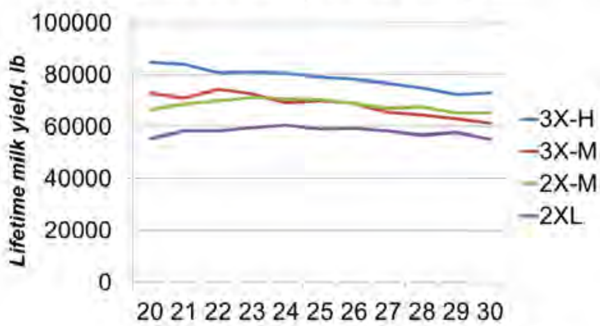


Herd life (days milked) by AFC and 2x or 3x milking stratified by herd milk yield



Curran et al., 2013

Lifetime milk (lb) by AFC and 2x or 3x milking stratified by herd milk yield



Curran et al., 2013

Herd Life, UK data 2011

BRICKELL AND WATHES

Table 3. Measures of longevity (mean ± SEM) for 211 Holstein-Friesian cows culled before third calving

	Lifetime phase culled			
Measure	Rearing period	Lactation 1	Lactation 2	Mean
n	53	79	79	
Age at culling (d)	469 ± 58	1,187 ± 32	1,520 ± 30	1,132 ± 36
Age at first calving (d)	—	832 ± 16	811 ± 14	821 ± 11
Herd life from first calving (d)	0	359 ± 29	710 ± 25	532 ± 24
DIM lactation 1 (d)	0	322 ± 29	367 ± 13	345 ± 16
DIM lactation 2 (d)	0	—	280 ± 21	280 ± 21
Total lifetime DIM (d)	0	322 ± 29	623 ± 27	474 ± 23
Longevity index[1] (%)	0	24 ± 2	40 ± 1	32 ± 1

[1]Longevity index was defined as the proportion of days alive spent in milk production (lifetime DIM divided by age in days at culling).

Brickell and Wathes, JDS, 2011

LSM of Milk, Fat and Protein by AFC using 24 mo as a base

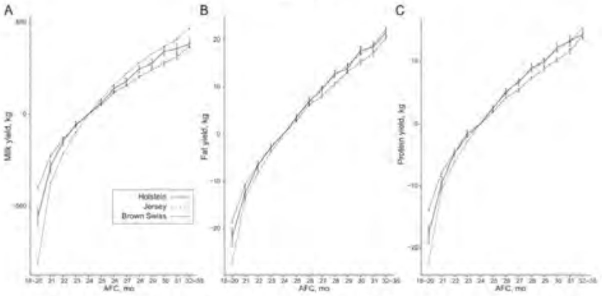


Figure 1. Least squares means of each age at first calving (AFC) group compared with a baseline of 24 mo for actual first-lactation (A) milk yield, (B) fat yield, and (C) protein yield in Holstein, Jersey, and Brown Swiss cattle. Standard errors are represented as bars above each data point.

Genomic evaluation of age at first calving

J. L. Hutchison, P. M. VanRaden, D. J. Null, J. B. Cole, and D. M. Bickhart

Lifetime Milk, Fat and Protein Yield for Holsteins, Jerseys and Brown Swiss

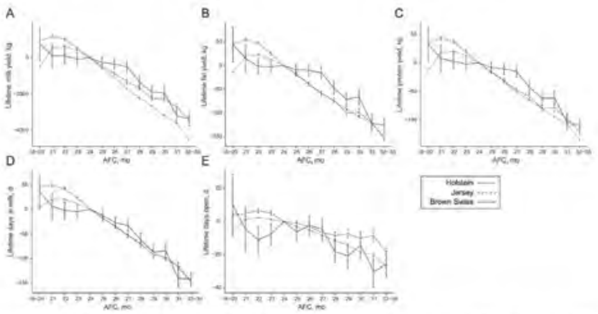
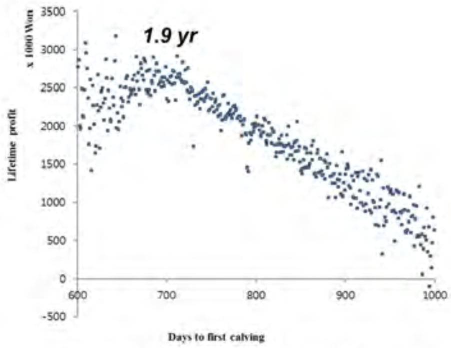


Figure 2. Least squares means of each age at first calving (AFC) group compared with a baseline of 24 mo for lifetime (A) milk yield, (B) fat yield, (C) protein yield, (D) DIM, and (E) lifetime days open in Holstein, Jersey, and Brown Swiss cattle. Standard errors are represented as bars extending from each data point.

Evaluation of Heifer Replacement Costs by Survivability at Age at First Calving

AFC	# into herd	Heifer Raising Cost	Actual Milk Production	Cost in Lactation	Milk Receipts	TOTAL Net Margin	Net Margin Per Heifer Completing
mo		$	pounds	$	$	$	$
21	13	1,913	21,293	2,114	4,401	5,132	467
22	159	2,004	23,474	2,330	4,852	71,267	536
23	256	2,095	21,468	2,131	4,438	28,177	134
24	148	2,186	22,094	2,193	4,567	14,742	113
25	64	2,277	23,309	2,314	4,818	12,492	219
26	58	2,368	22,431	2,226	4,636	216	4
27	25	2,459	22,825	2,266	4,718	170	7



The Effect of Age at First Calving and Calving Interval on Productive Life and Lifetime Profit in Korean Holsteins

Changhee Do*, Nidarshani Wasana, Kwanghyun Cho[1], Yunho Choi[1], Taejeong Choi[1], Byungho Park[1], and Donghee Lee[2]

2013

Summary

- Disruptors to dairy profitability are found in the heifer rearing program
- The heifer program is a cost center and the only way to reduce the impact is to lower the time to calving and optimize lactation yield and productivity over the lifetime
- Non-completion rate, inventory and age at first calving account for a large percentage of total Net Farm Income
- Lowering the cost requires feedback and information and systems thinking

Summary

- Productive days and milk is greater for heifers with lower AFC
- Economic analysis indicates that lower AFC is more advantageous
- Lower AFC requires fewer replacements per year to maintain herd size and this inventory reduction has significant financial implications

NOTES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