“Feeding the transition cows – an update”.

J.E. van Eys

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Organization:

1. Introduction – Background (evolution in cow milk production)
2. Effect of transition events on Immune system
3. DMI and Energy supply of Transition cow
4. Functional nutrients – additives relative to E
5. Conclusions.

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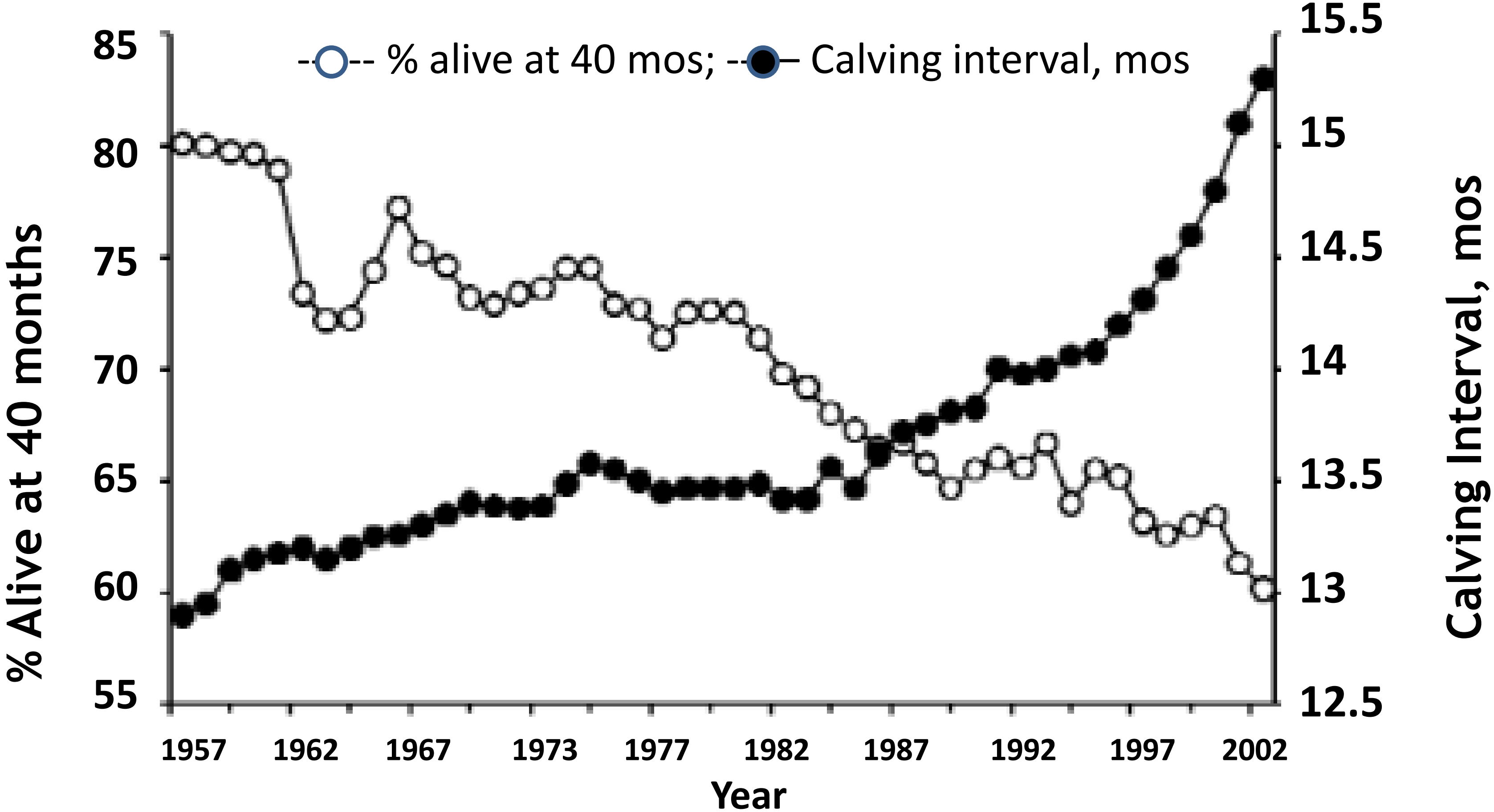
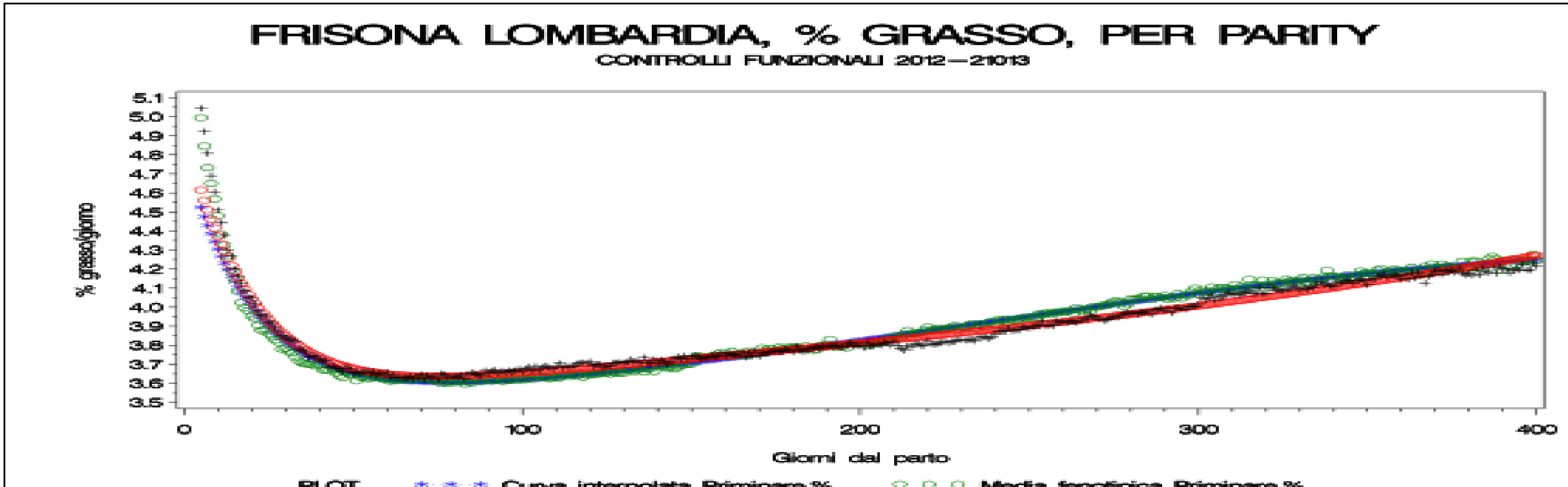
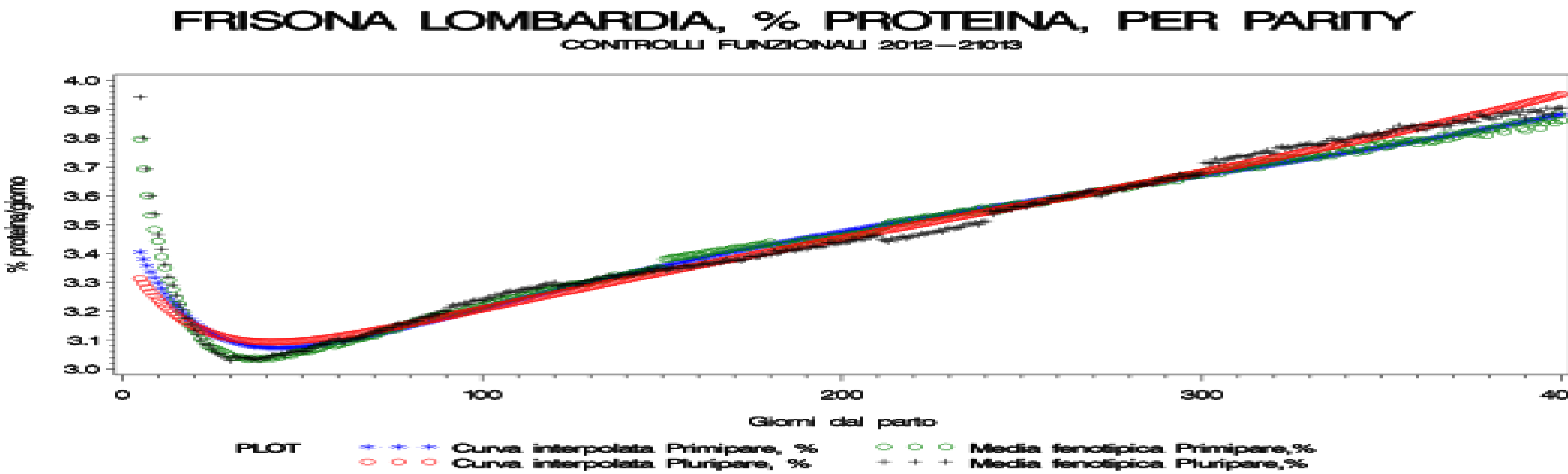
Average calving interval and proportion of cows alive at 48 months of age over time for Holstein cows in the N-E USA.



(Oltenacu & Algers,2005)

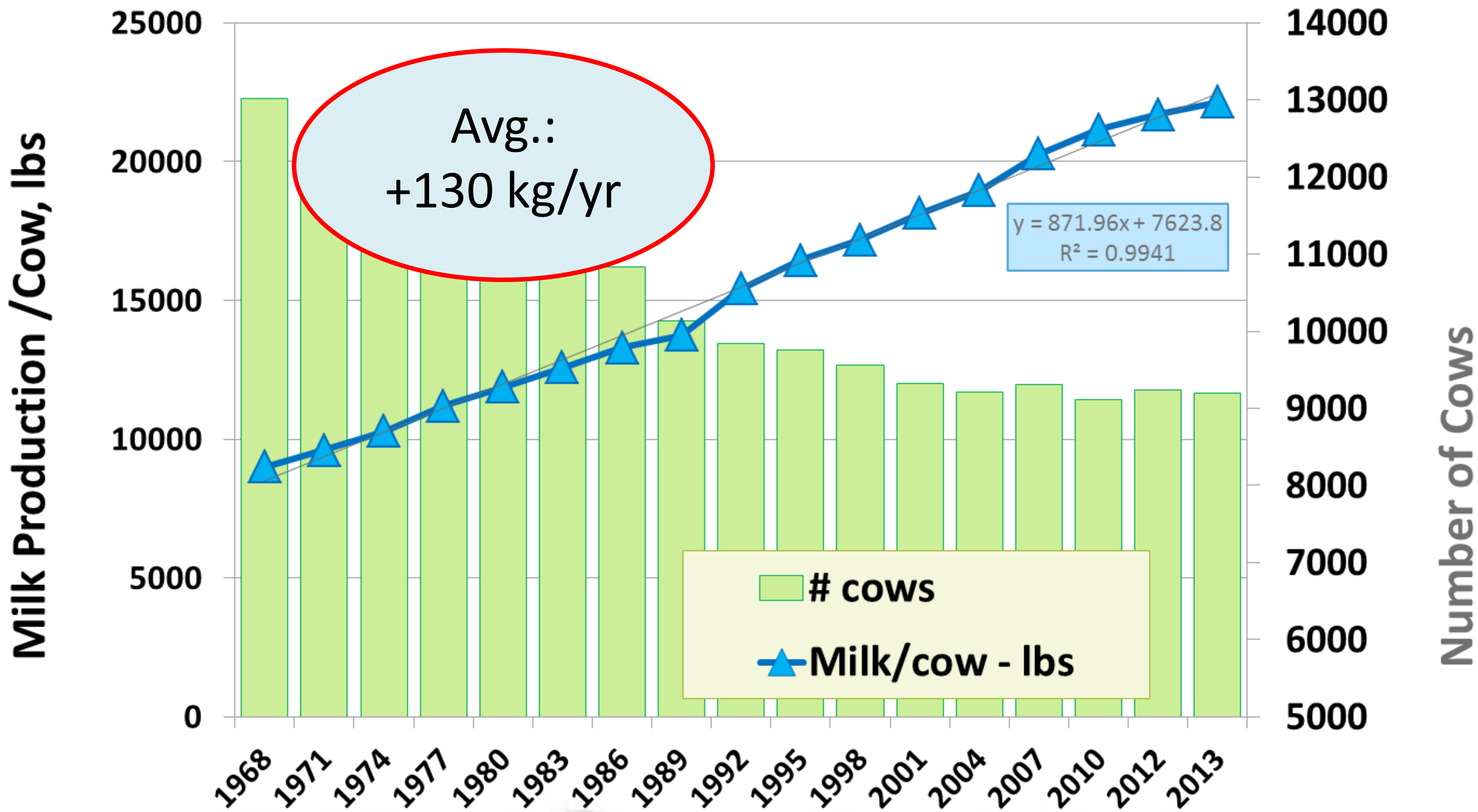




Elaborato da Ufficio Studi A.I.A.

(Courtesy, G. Sartoretto, 2015)

Evolution of Cow Numbers and Cow Milk Production in the USA.



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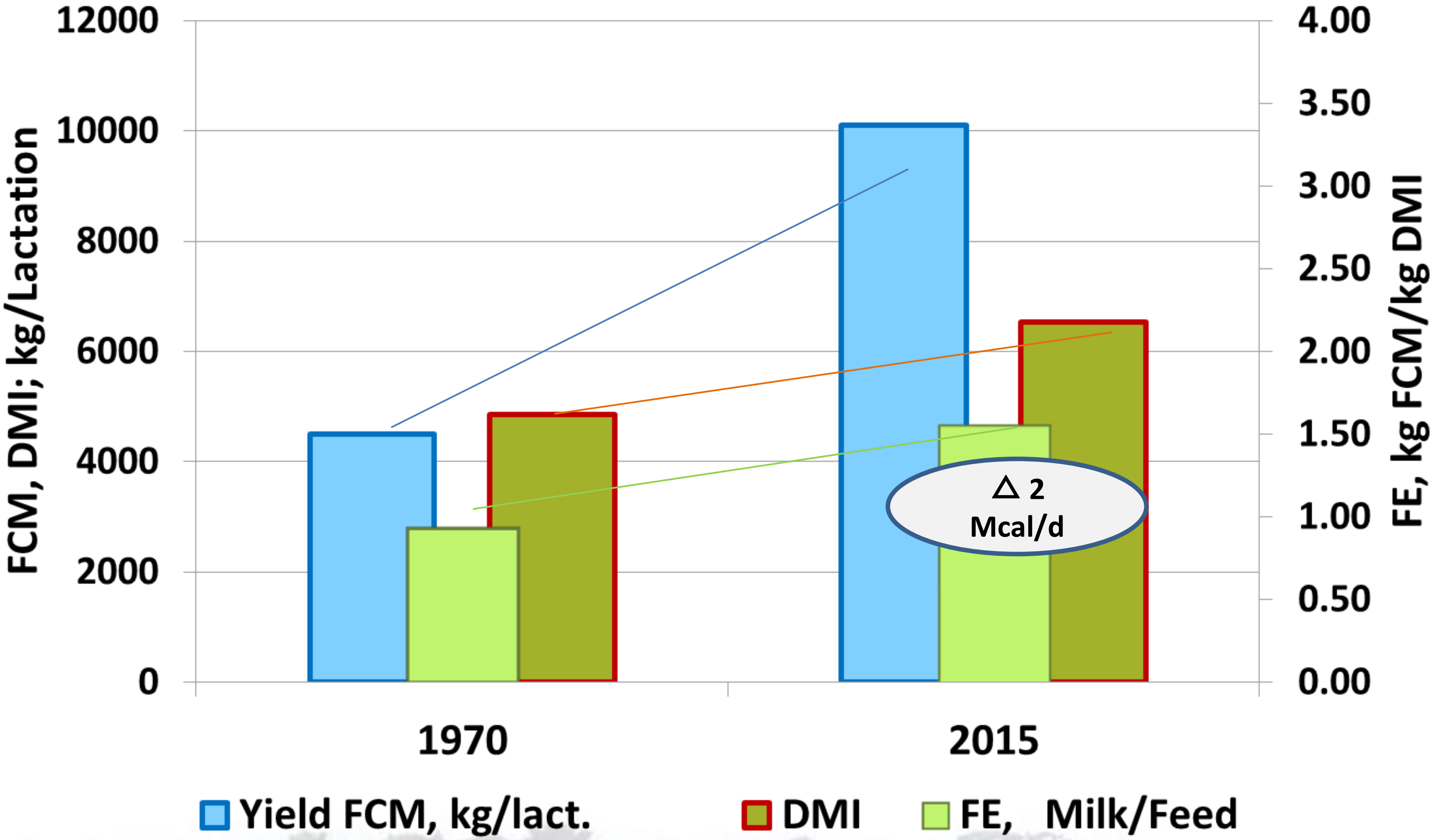
Changes in Dairy Cattle Production Parameters; 1970 - 2015.



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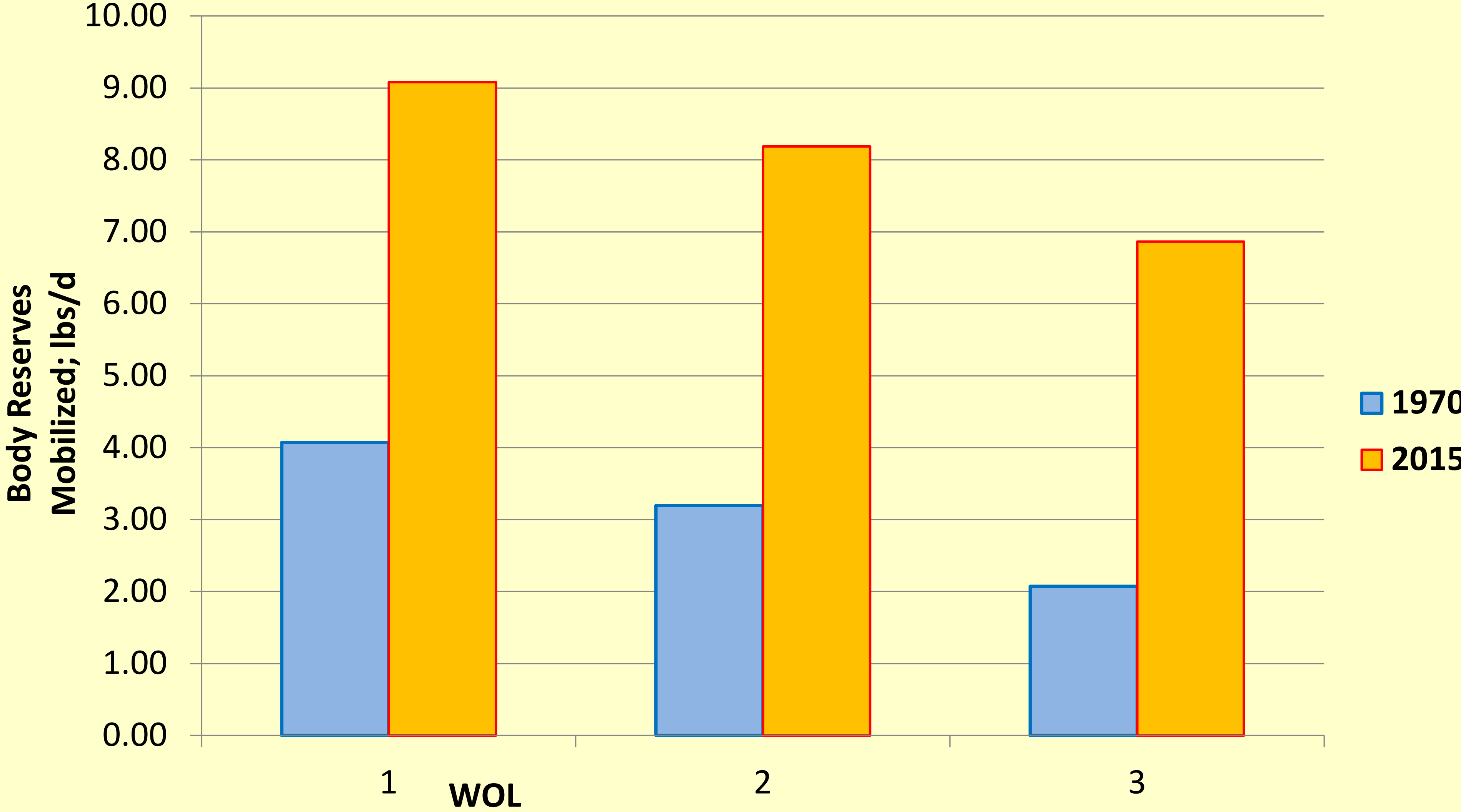
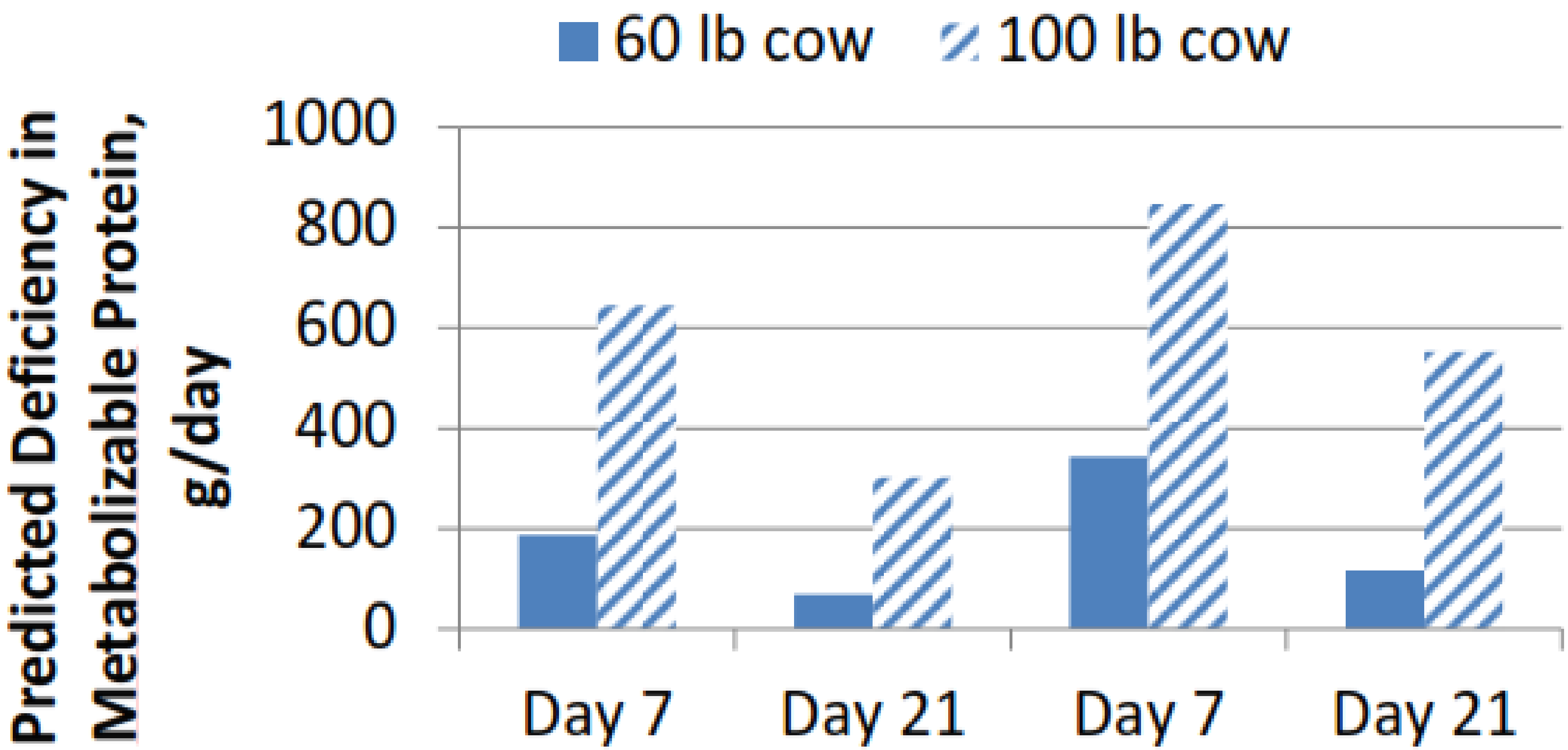
Estimated Mobilization of Body Reserves; wk 1-3; by Year of Production.

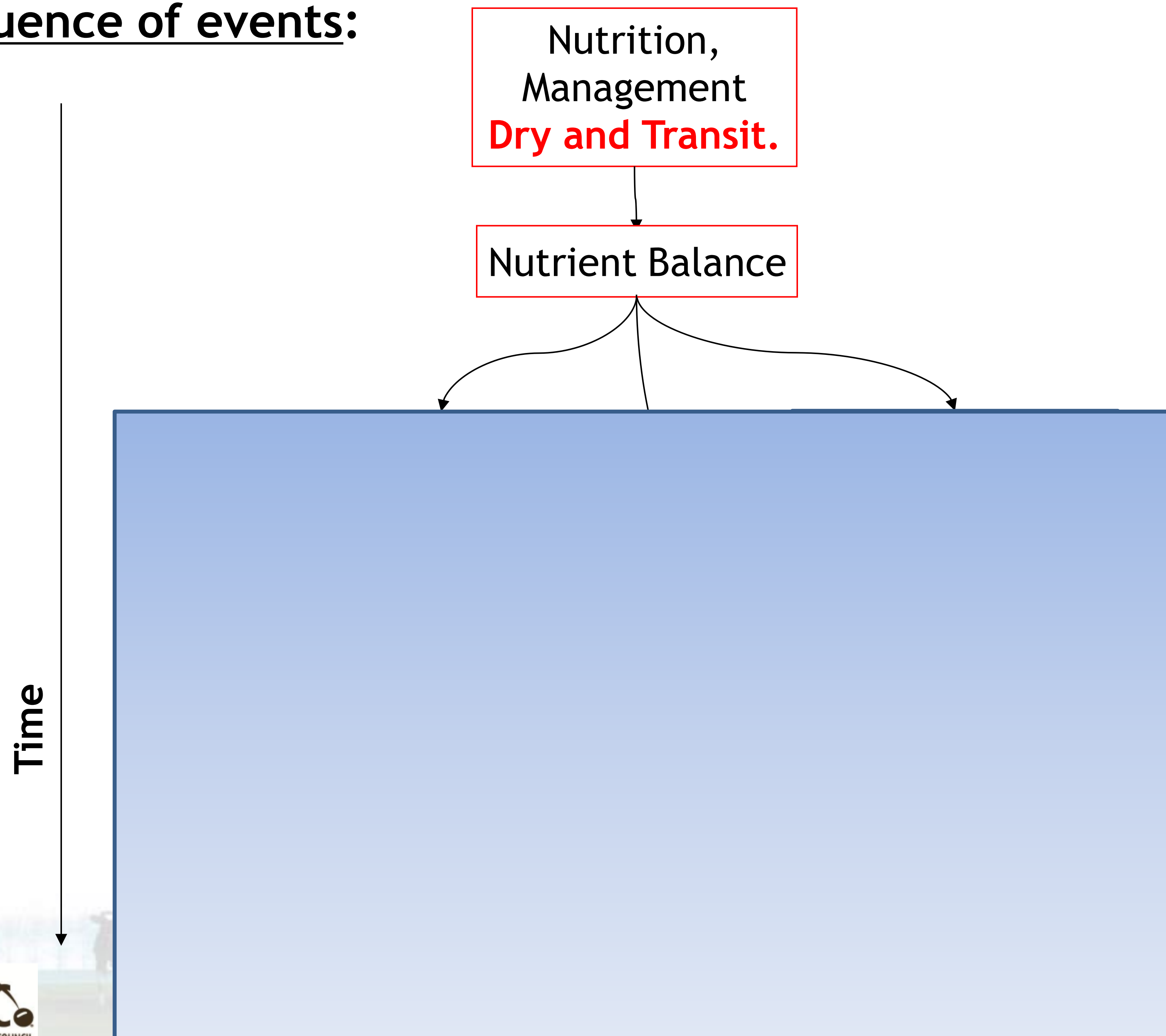


* Adjusted for body size and Average Milk Production; Multi-pari.



(Grummer and Ordway, 2012)

Sequence of events:



Association of fatty liver with health status in dairy cows.

Disorder	Association[1]	Reference
Displaced abomasum	+++	Wada et al., 1995; Rehage et al., 1996
Impaired immunoreactivity	++	Wentink et al., 1997; Zerbe et al., 2000
Ketosis	+++	Gröhn et al., 1987; Veenhuizen et al., 1991
Laminitis	+	Fronk et al., 1980; Rehage et al., 1996
Mastitis	++	Morrow et al., 1979
Metritis	++	Haraszti et al., 1982; Heinonen et al., 1987
Milk fever	+	Higgins & Anderson, 1983; Gröhn et al., 1987
Retained placenta	+	Haraszti et al., 1982; Hainonen et al., 1987

(Bobe et al., 2004)

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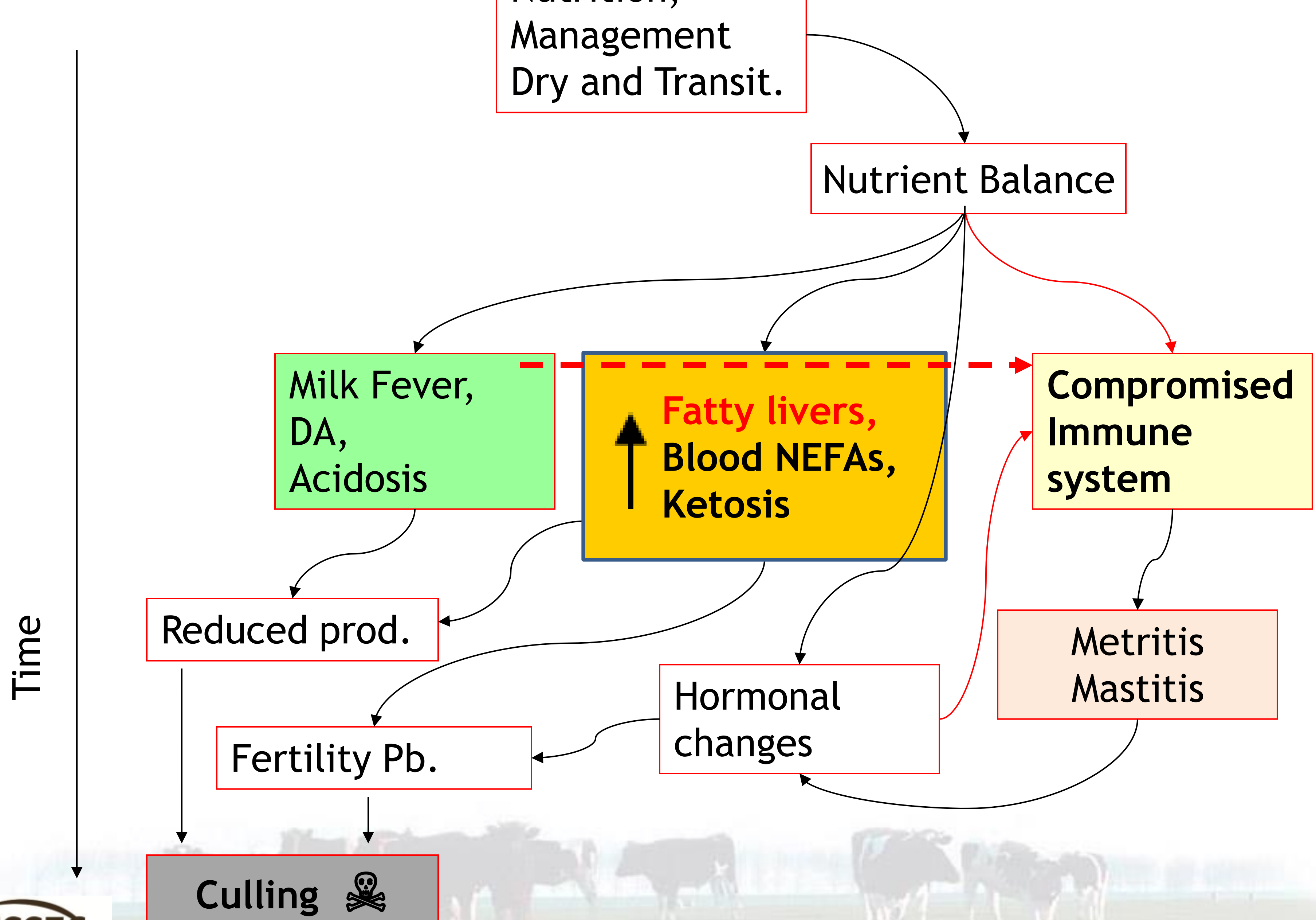
- **Classical nutrient formulation or models inadequately describe nutrient requirements and supply for transition cow (early lactation).** Especially evident for the modern high producing cow (relative to the "old" type cow).
- Fail to address:
  - Mobilization of larger body reserves (incl. muscle)
  - Metabolic adaptations (variable in organ/tissue)
  - Greater immune challenge and the (specific) nutrient requirements of the immune system.
- Additives try to overcome this lack in a systemic approach through addressing specific aspects.

→ partial solutions that should or need to be combined (stacked).

Sequence of events:



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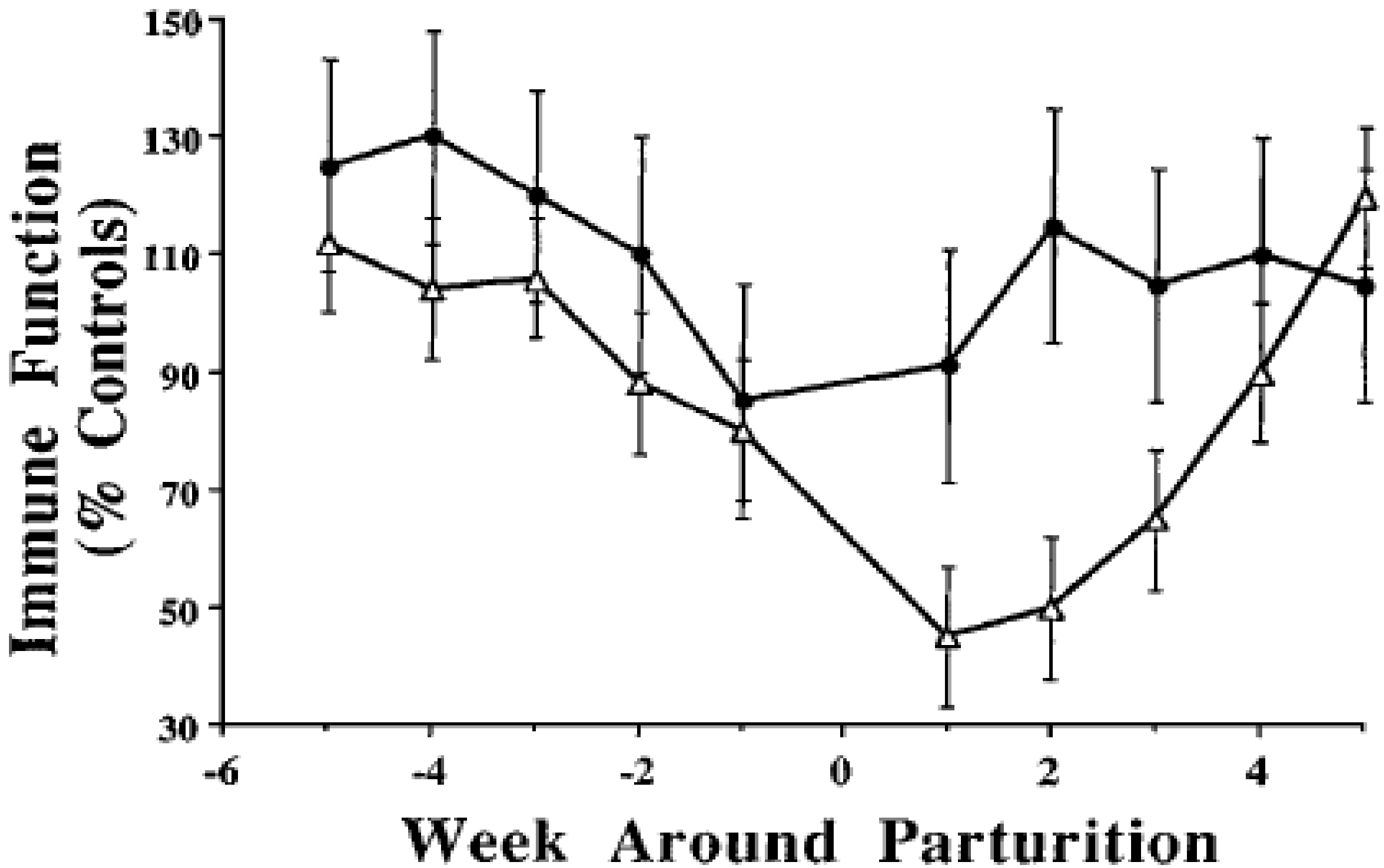
Immune changes system around parturition.



Neutrophil function (iodination; Δ)
Lymphocyte function (blastogenesis; ●)
(Goff and Horst, 1997; Adapted from data of Kehrli et al., 1989.)

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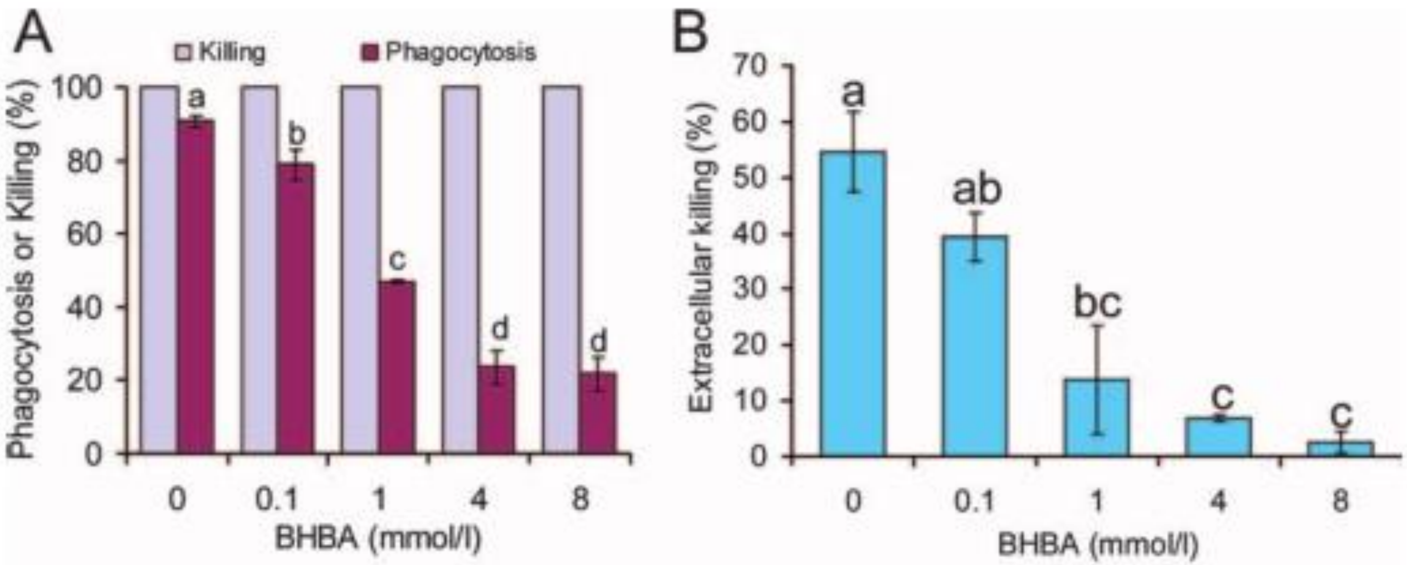
Feeding the immune system - nutrients and metabolites

<u>Reduction</u> in Immune cell function:

Glucose depression:

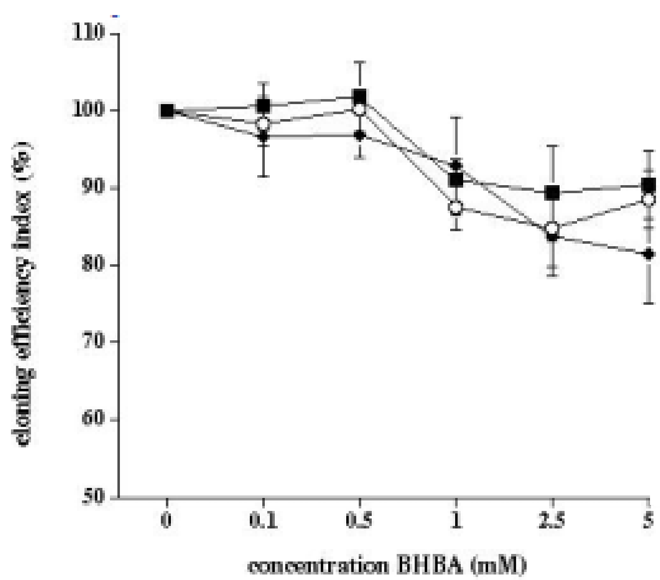
- Glucose uptake by immune cells is critical for cell function (against infection)
- Required by most phagocytic cells (i.e. macrophages, PMN); preferred metabolic fuel during inflammation.
- Uptake of glucose by phagocytic cells non-insulin dependent (GLUT1 transporter)
- Inhibition of glucose uptake → decreases phagocytic capacity

In Vitro effect of BHBA on phagocytosis and extracellular killing by bovine neutrophils.



(Grinberg et al., 2008).

BHBA inhibits bone marrow cell proliferation in cows.



(Hoeben et al., 1999).

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DMI and Energy supply of Transition cow:

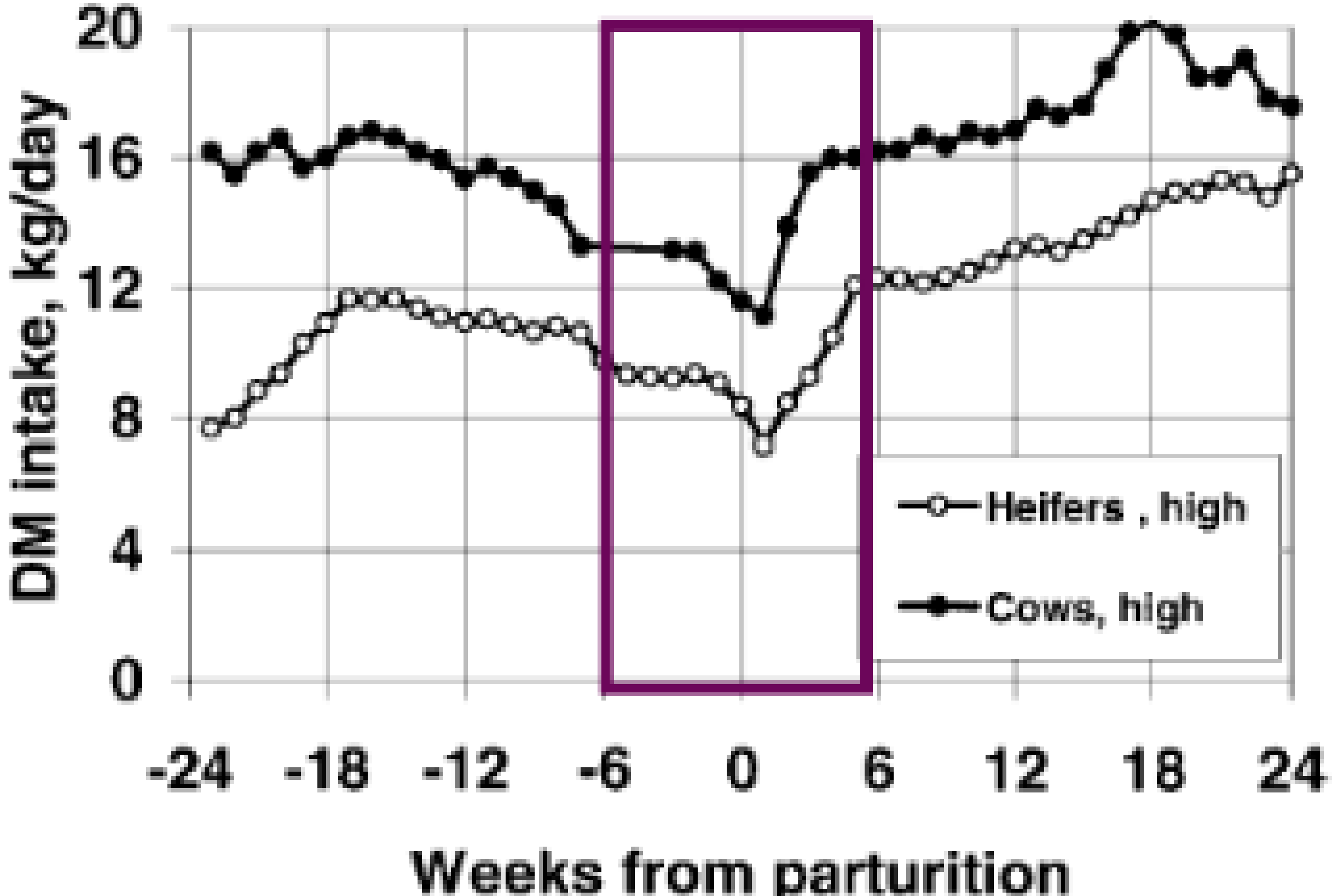
1. The (increasingly) negative energy balance resulting from reduced DMI leads to a risk of acidosis and accumulation of NEFAs and TGA in liver.
2. Hormonal balances along with the changes in energy metabolism reduce immune cell activity
3. Opportunistic bacteria exploit the reduced immune activity leading to increased infections.

→ Dry Period Management
→ Increase DMI
→ Improve energy balance (through balanced C2/C3 nutrients)
→ Reduce TGA accumulation/NEFA
→ Stimulate immune-cell activity

Feeding and management strategies to reduce transition challenges:

- Avoid over-conditioning which leads to excessive lipid mobilization
- Apply Management and Nutrition Strategies to improve feed intake (Nutrient or diet specific factors).
- Avoid management and environmental stress.

Feed Intake in Transition cows; MP and PP.

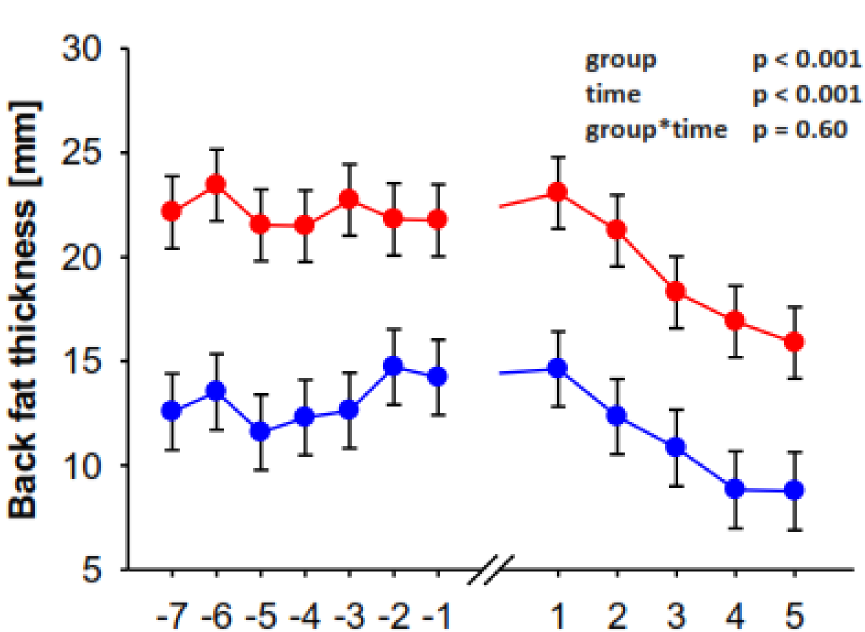


Ingvartsen & Andersen, 2000

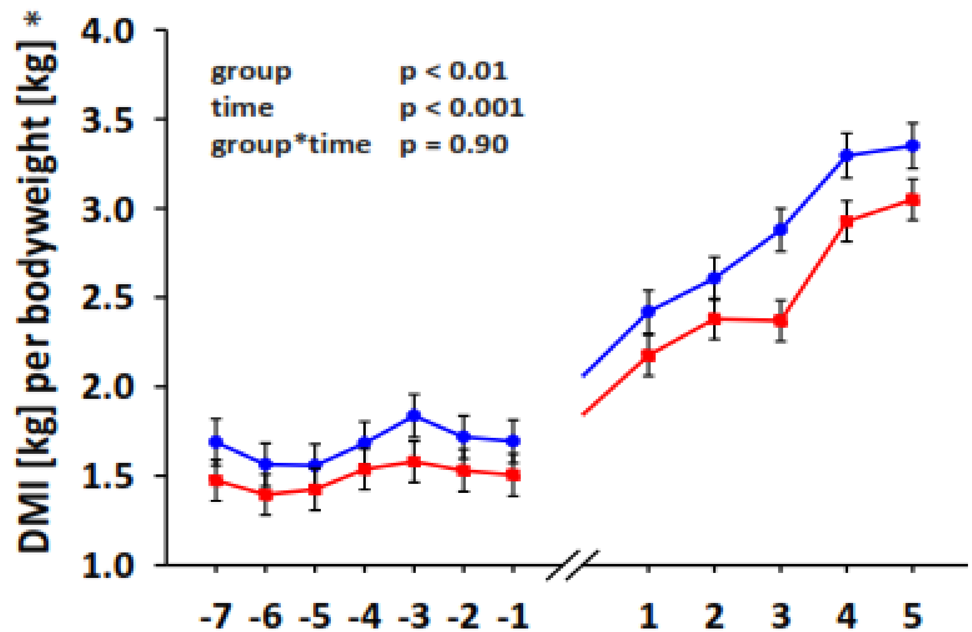
BCS and Feed Intake pre- and post-partum in cows differing in fat mobilization.

(How does lipolysis affect feed intake of dairy cows during the transition period?

A. Back-Fat thickness



B. Feed Intake.



---------------Time (d) relative to calving. ----------------

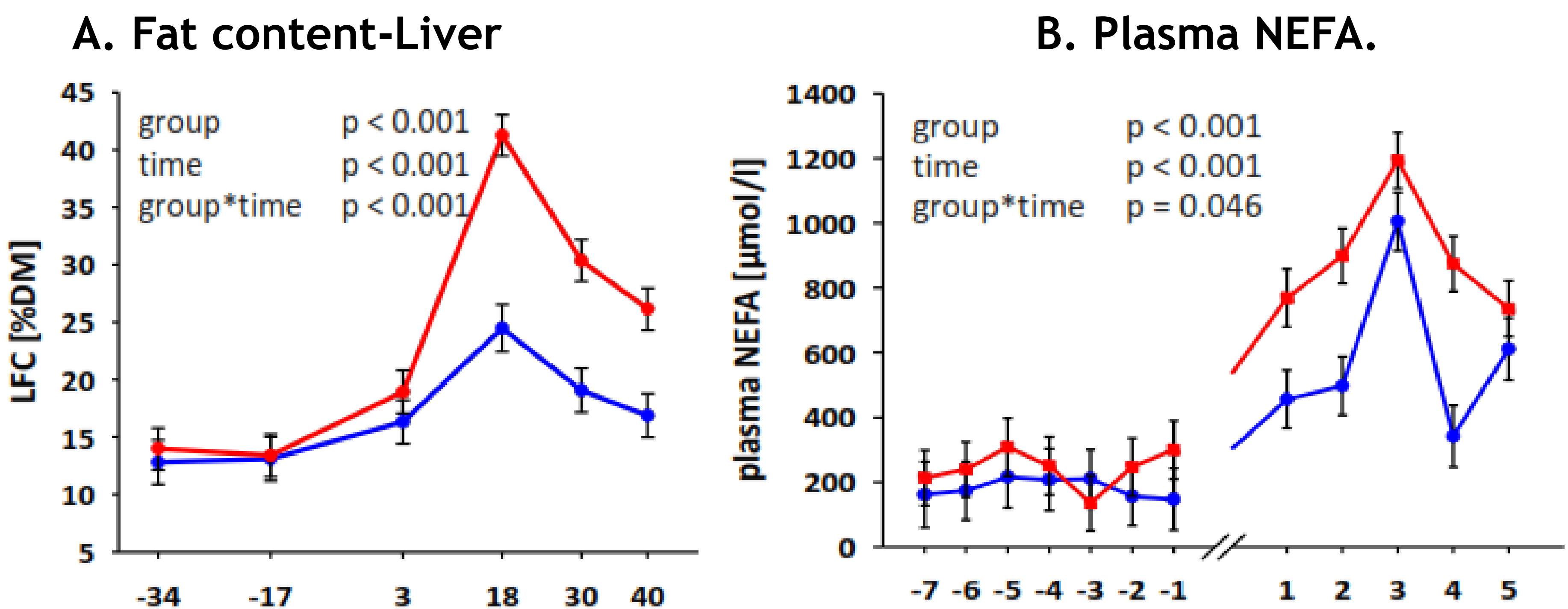
---O--- High Lipolysis

---O--- Low Lipolysis

Hammon *et al*., *2009*

Liver Fat content and Plasma NEFA post-partum in cows of different BCS and lipolysis.

(How does lipolysis affect feed intake of dairy cows during the transition period?



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Feed intake and Plasma BHBA post-partum in cows of different BCS and lipolysis.

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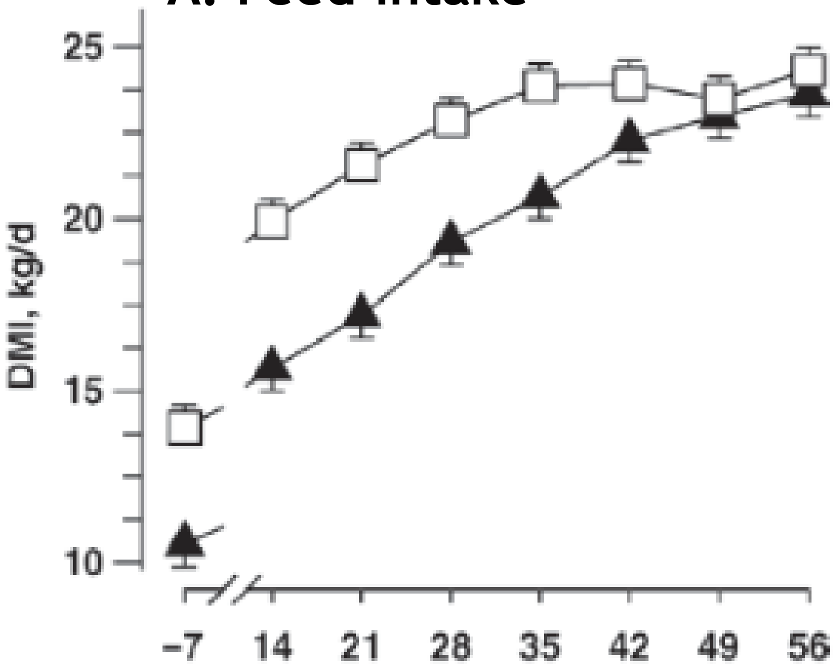
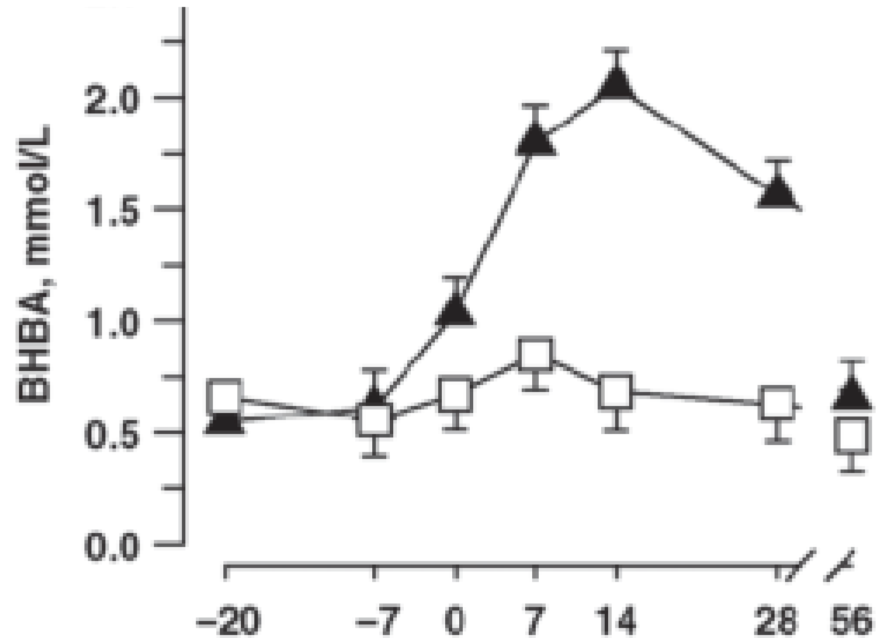
A. Feed intake



B. Plasma ß-HBA.

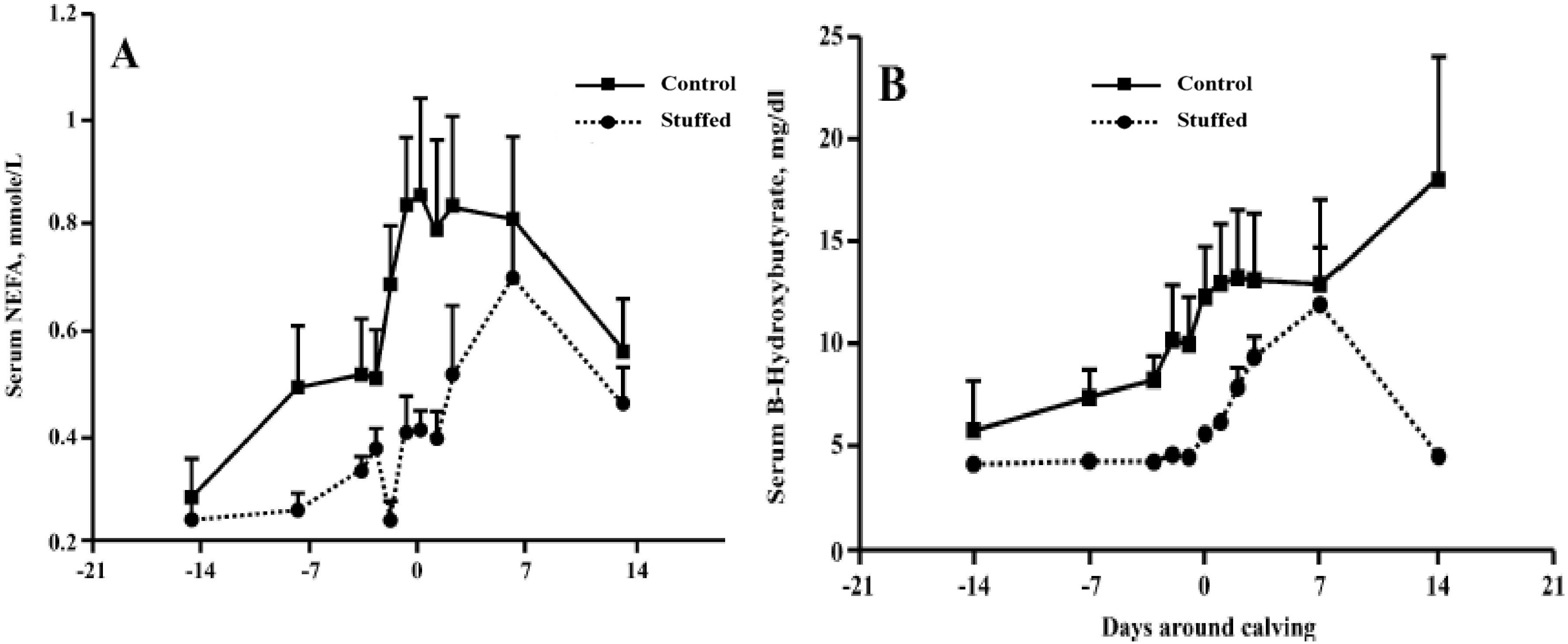


---------------Time (d) relative to calving. ----------------

▲ High Lipolysis
□ Low Lipolysis

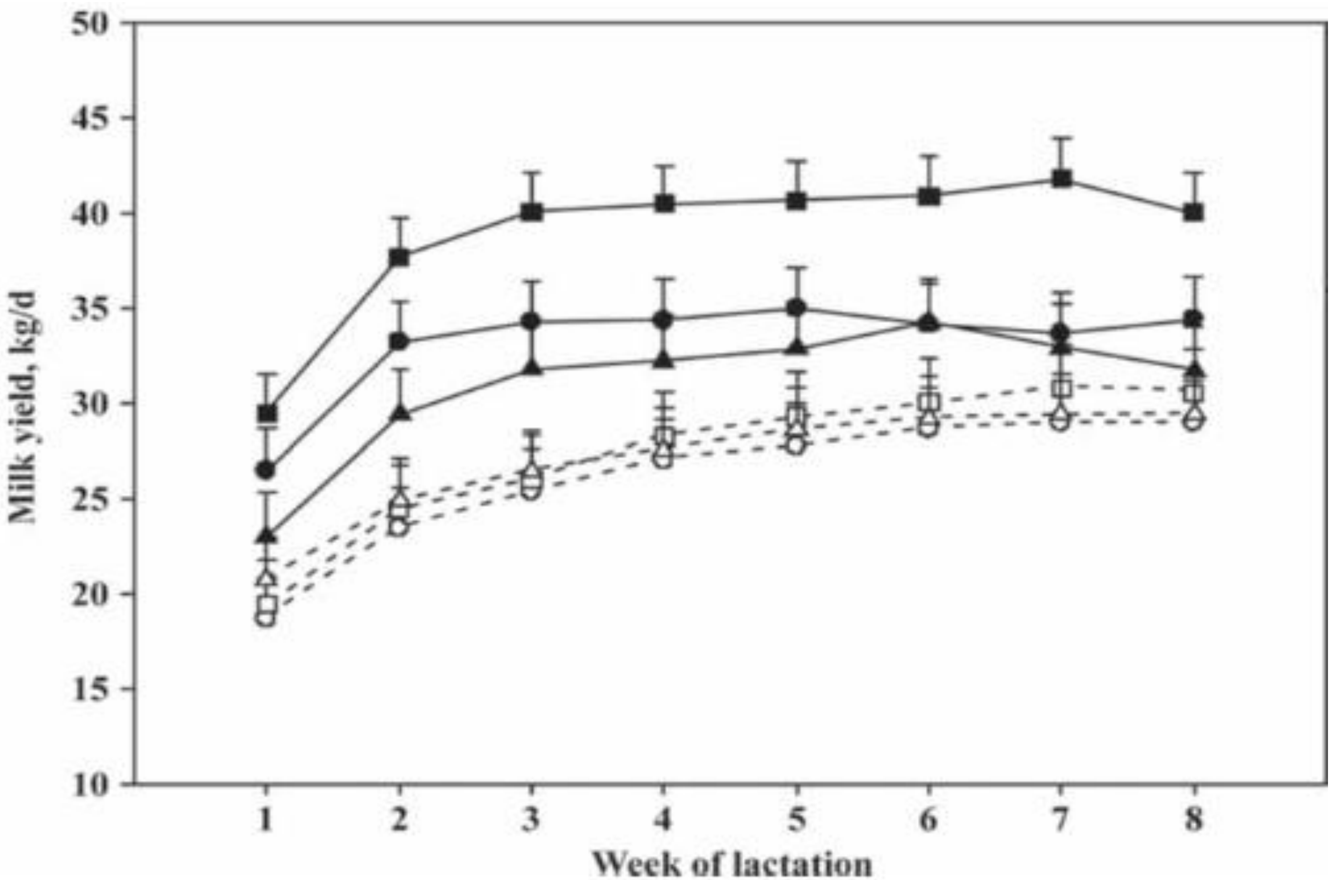
Hammon *et al*., *2009*

Effect of (forced) energy supplementation during short transition period on serum NEFA (mmole/L) and BHBA (mg/dl).



(Stabel et al., 2003)

Effect of pre-partum energy levels on post partum milk production (kg/d).



Dry period lengths:

Multi-pari:

- Contr.- NRC (
- 150 % - NEl (
- 80% NRC NEl (

Primipari:

- Contr.- NRC (
- 150 % - NEl (
- 80% NRC NEl (

(Jancovick et al., 2011; 2012)

Addressing the “demand-side” of the restricted E balance:

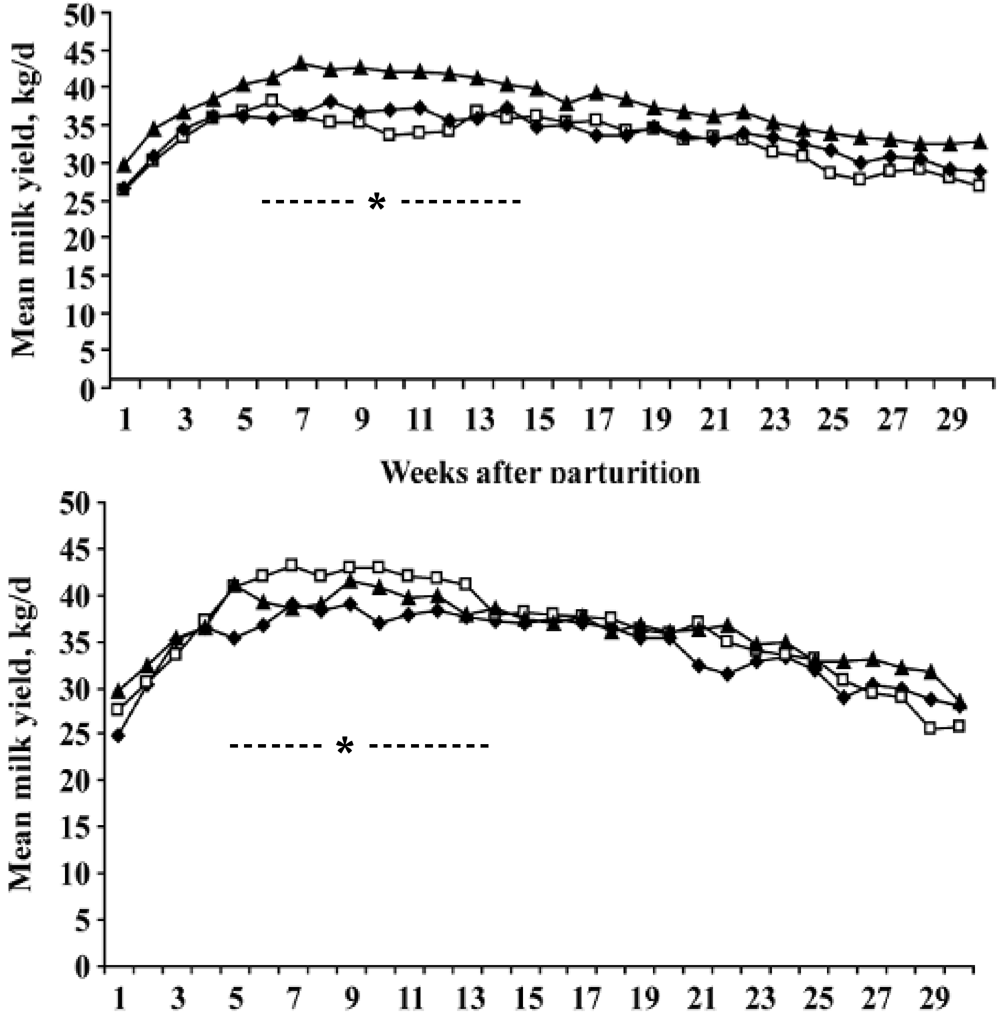
Reducing the dry period:

- Maintain higher metabolic activity prior to calving.
- Attenuated metabolism shift at calving
- Reduced production post calving (but same over lactation)

Daily milk production (kg/d) in Holstein cows assigned to different dry period lengths.

Primi-parous cows (n=55)

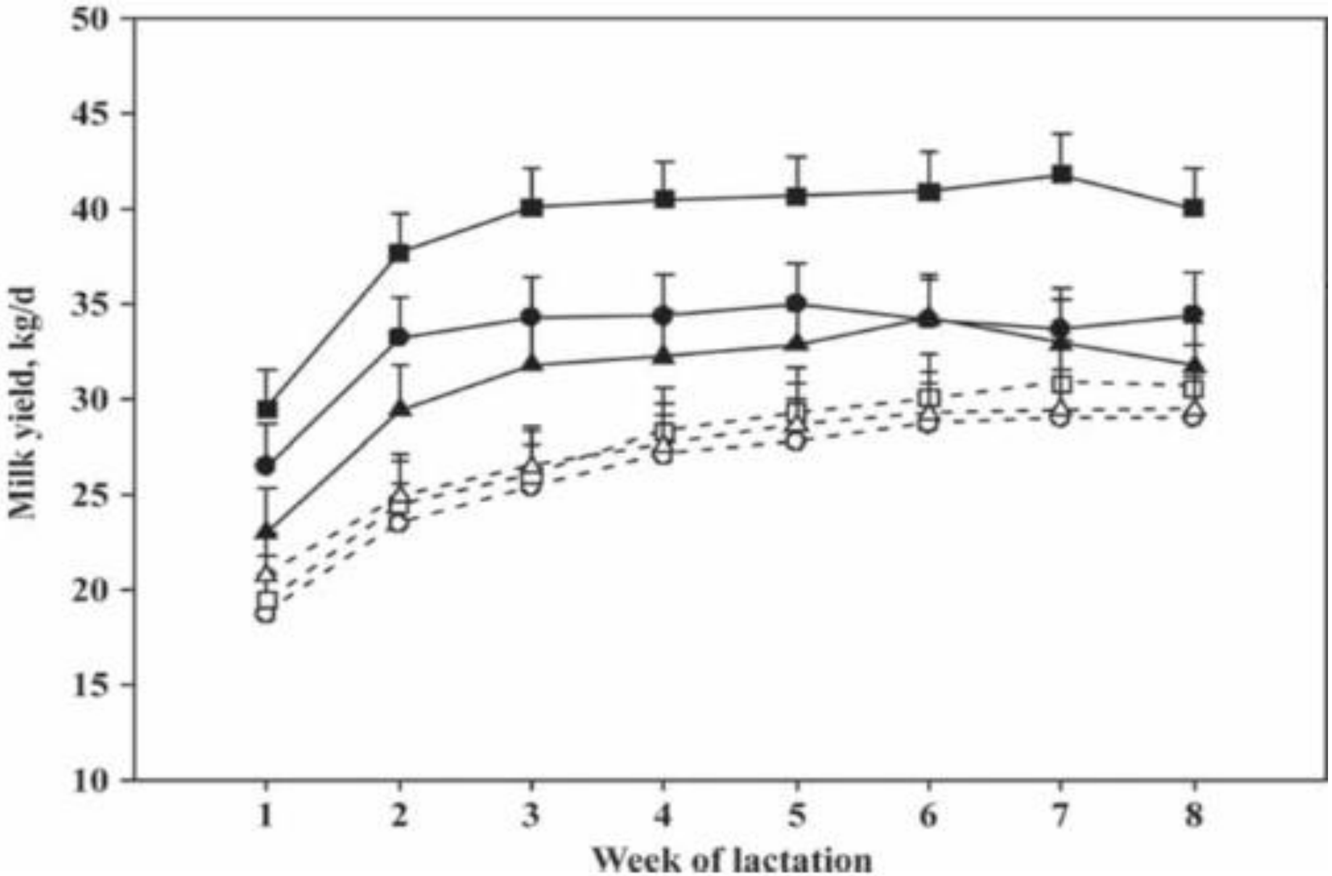
Multi-parous Cows (n= 53)



Dry period lengths:
- 35-d (□)
- 42-d (◆)
- 56-d (▲)

(Pezeshki et al.2007; J. Dairy Sci. 90:5531–5541)

Effect of pre-partum energy levels on post partum milk production (kg/d).



Dry period lengths:

Multi-pari:

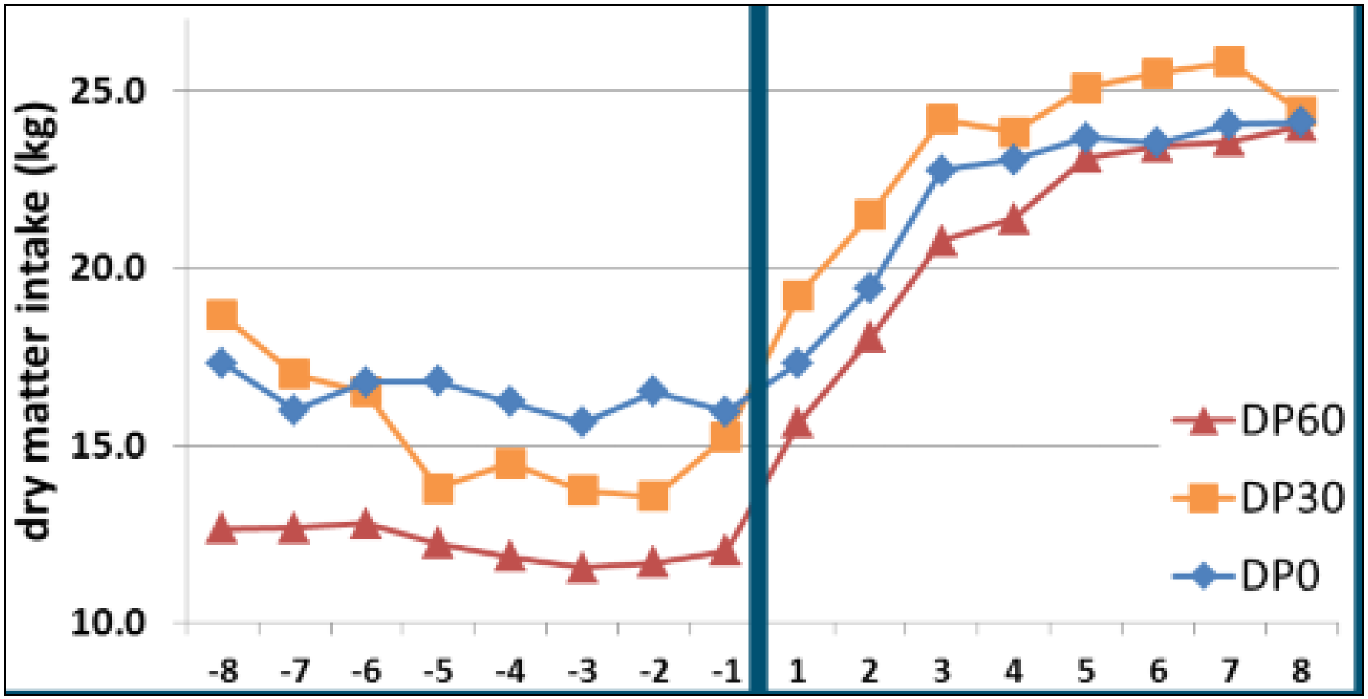
- Contr.- NRC (—●—)
- 150 % - NEl (—■—)
- 80% NRC NEl (—▲—)

Primipari:

- Contr.- NRC (-○- -)
- 150 % - NEl (-□-)
- 80% NRC NEl (-△-)

(Jancovick et al., 2011; 2012)

DMI of cows as affected by length of dry period (d).



Weeks relative to calving

Average DMI:

Trt.	Kg/d
DP60	21.2
DP30	23.7*
DP0	22.2

*(P<.05)

(Goselink et al., 2012;
Livestock Research, Wageningen UR)

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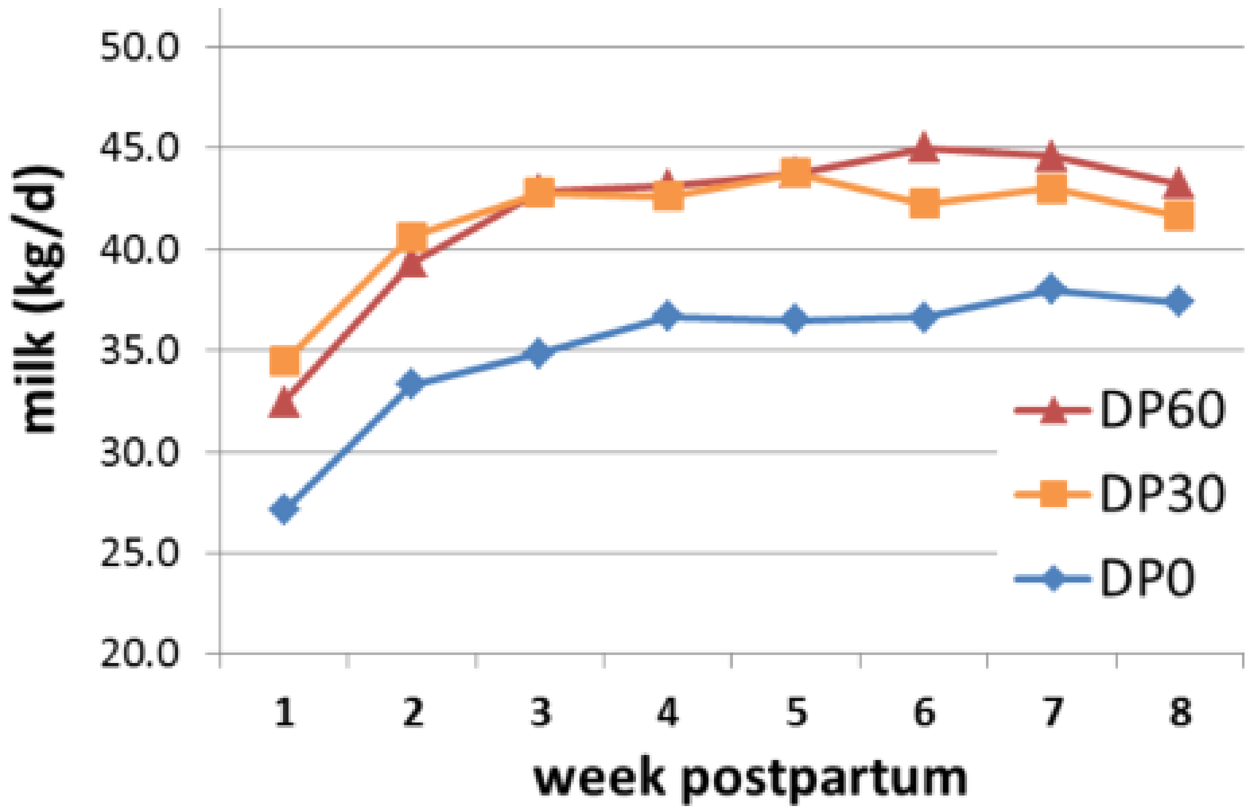
Milk Production of cows as affected by length of dry period (d).



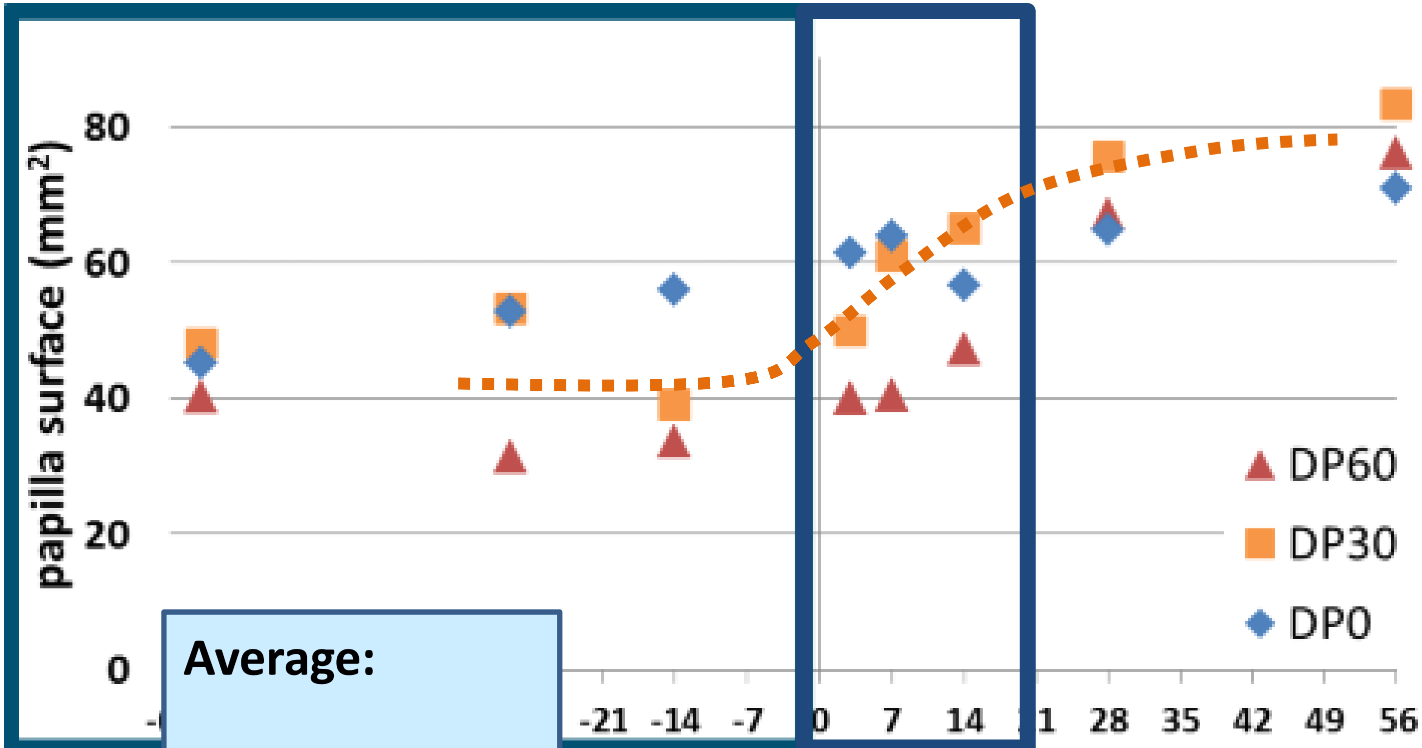
Average MP:

Trt.	Kg/d
DP60	41.8*
DP30	41.4*
DP0	35.1

*(P<.05)

(Goselink et al., 2012;
Livestock Research, Wageningen UR)

Rumen papilla surface of cows as affected by length of dry period (d).



Average:

Trt.	mm²
DP60	42.5
DP30	58.6
DP0	60.6

Average:

Trt.	mm²
DP60	35.1
DP30	46.8
DP0	51.3

(Goselink et al., 2012;
Livestock Research, Wageningen UR)

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Incidence of metabolic disorders according to parity and dry period management strategy.

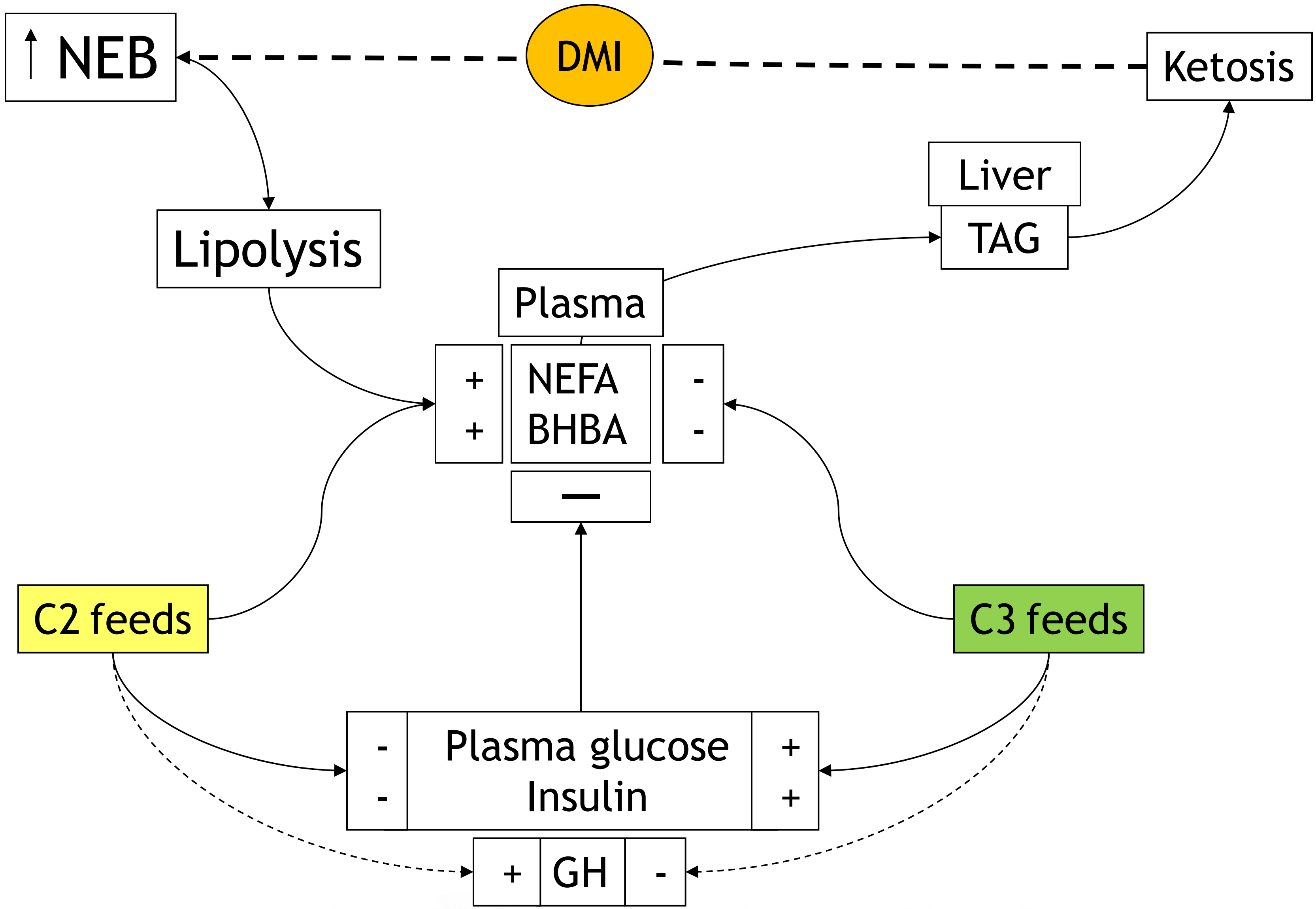
	Parity 2		Parity 3	
Dry period:	60d	35d	60d	35d
Item				
Cows, n	190	224	238	198
Incidence of metabolic disorders, %				
Dystocia	1.4	1.6	2.7^{b}	1.2^{a}
Ketosis	**27.1**	**16.4**	**35.5**	**30.0**
Ketosis, severe	**8.8**	**5.5**	**13.8**	**13.3**
Displaced abomasum	2.3	3.7	8.2	7.4
Milk fever	2.1	4.5	16.3	18.9
Milk fever, severe	0.4	0.3	3.5	3.0
Retained placenta	19.0	16.5	11.2^{a}	22.4^{b}
Metritis	7.3	5.1	4.5	6.0

Superscripts differ; $P = 0.05$.

(From: Santschi et al., 2011)

Formulating rations for glycogenic (C3) vs lipogenic (C2);

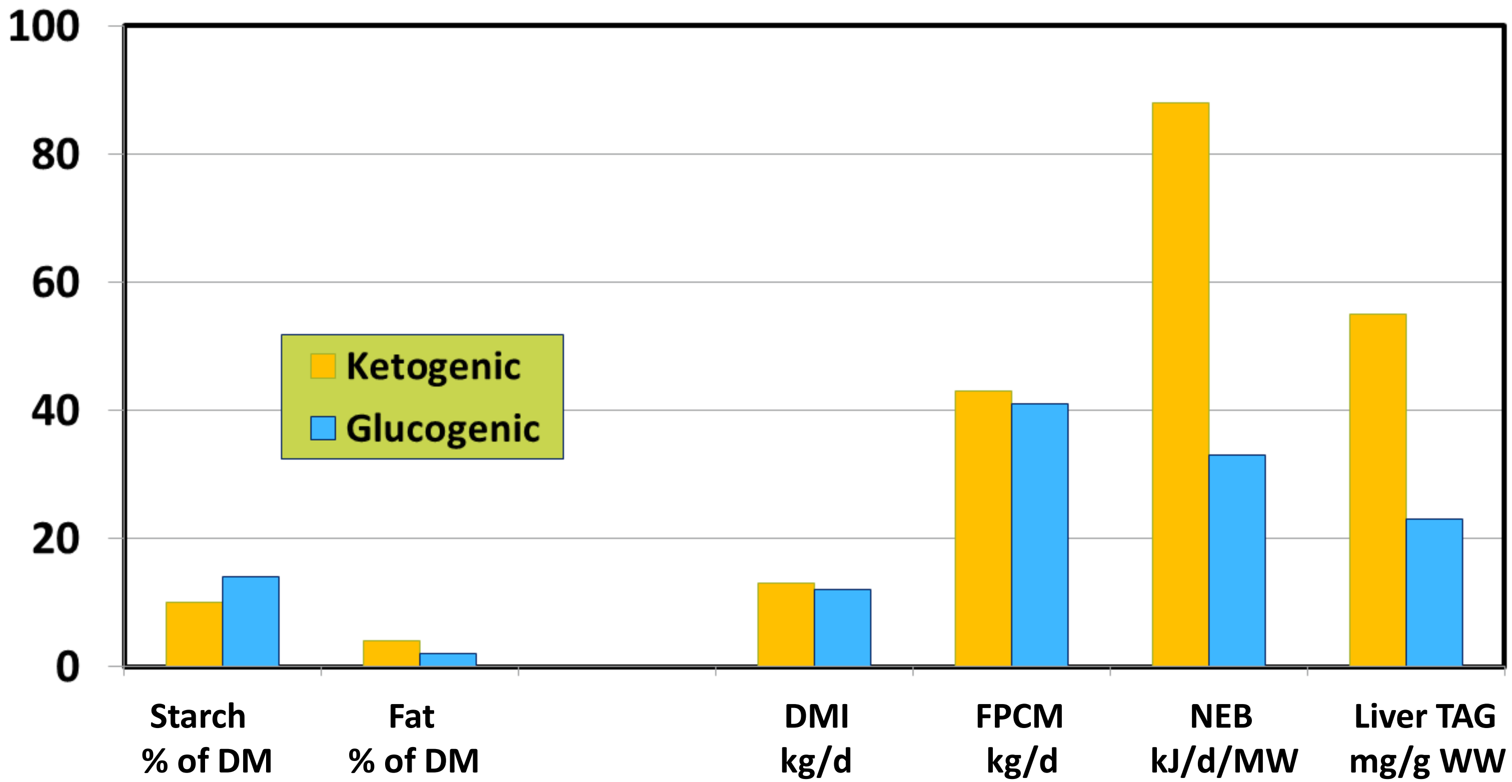
is an increased supply of dietary glucogenic precursors advantageous?



→

- C2/C3 ratio can be effectively manipulated by source of dietary energy
- Manipulation is dependent on the availability of the energy source as a precursor for C2 or C3
- effect is dependent on the balance of C2 and C3

Glucogenic vs Ketogenic diets.

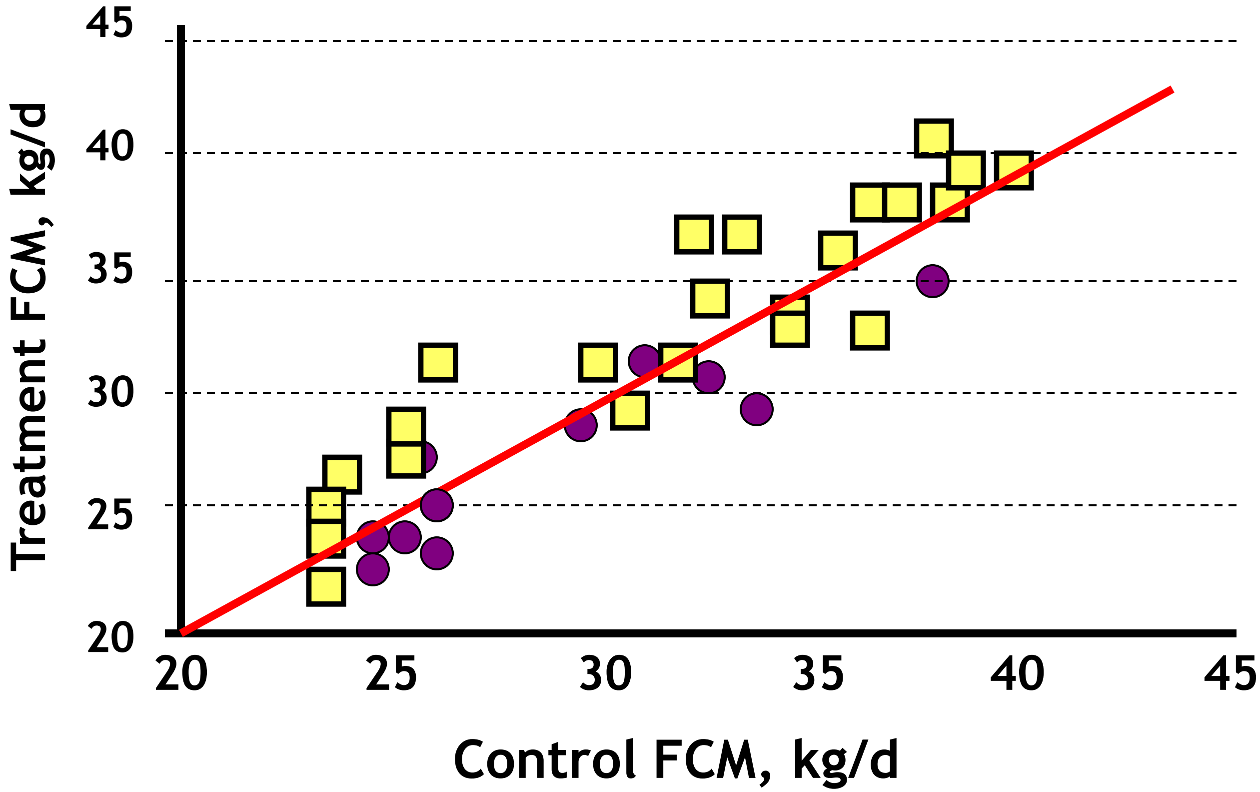


Glucogenic diets:

- No DMI difference
- Lower milk fat
- Improved energy balance
- Lower plasma NEFAs
- Lower liver TG levels

(van Knegsel et al., 2007)

Effect of C2(□) or C3 (●) nutrients on FCM production*.



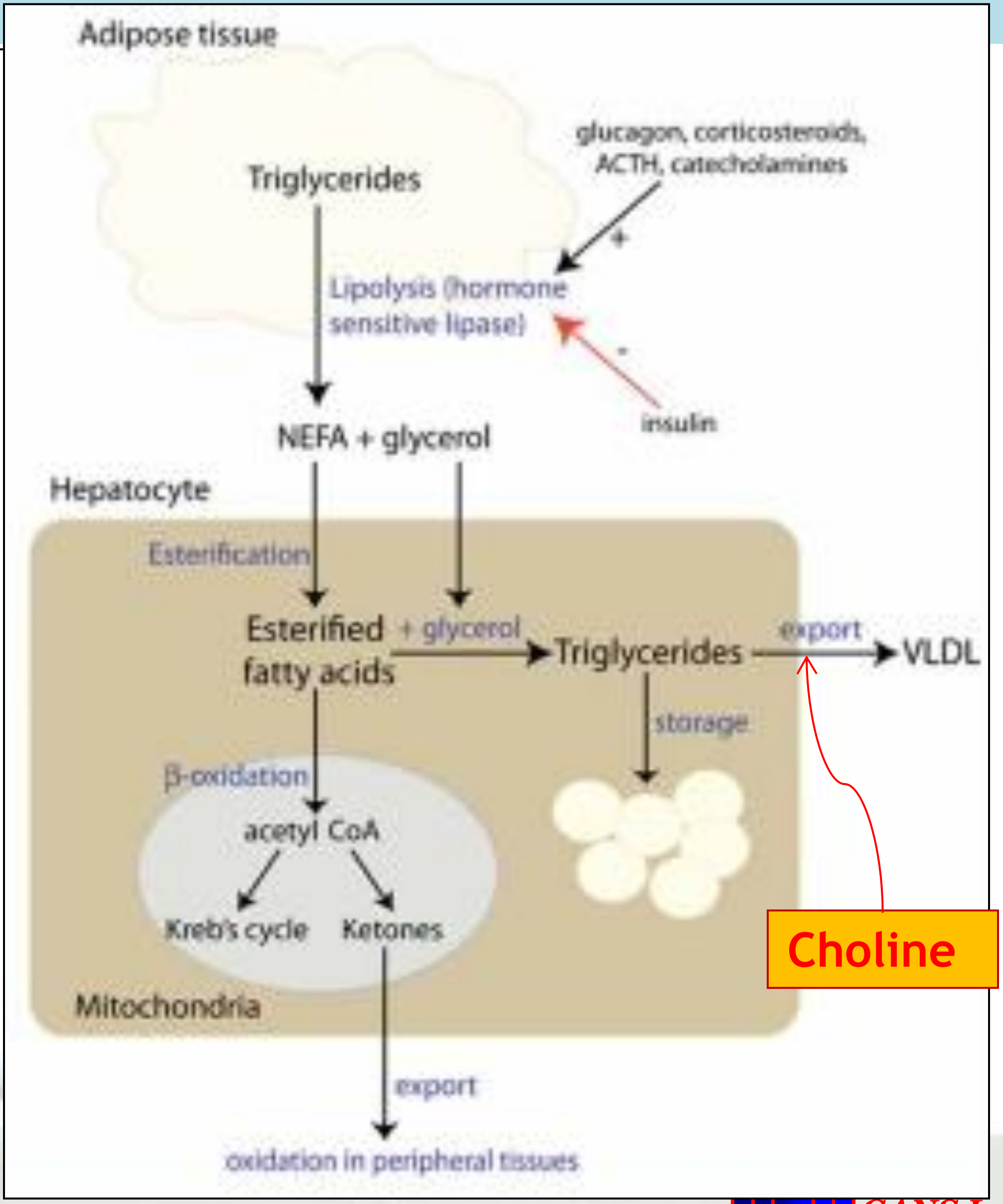
*Points are based on means per treatment group.
v. Knegsel et al., 2005

Improving liver function.

Protected Choline

Lipid (energy) mobilization @ the time of E deficiency.

- Adipose tissue:
  - Lipolysis → NEFA
  - (hormonal control)
- Liver:
  - Fat:
    - synthesis
    - transport
    - storage
  - B-oxidation →ketones
- Blood
  - NEFA
  - B-HBA



Protected Choline:

- The water soluble vitamins choline (and niacin) play a major role in:
    - **liver function (reduction of fatty livers)**
    - **fat metabolism**
    - **reduction of metabolic diseases (ketosis)**
    - increased milk fat
    - choline (methyl donor) has a methionine sparing effect.
- Ingredients and microbial fermentation do not provide choline and niacin in sufficient amounts to meet requirements of high producing cows; esp. in the transition period.
- Both vitamins – in the free form - are normally rapidly **degraded in the rumen.**
- To meet requirements of high producing cows choline an niacin **should be provided in a rumen protected form**.

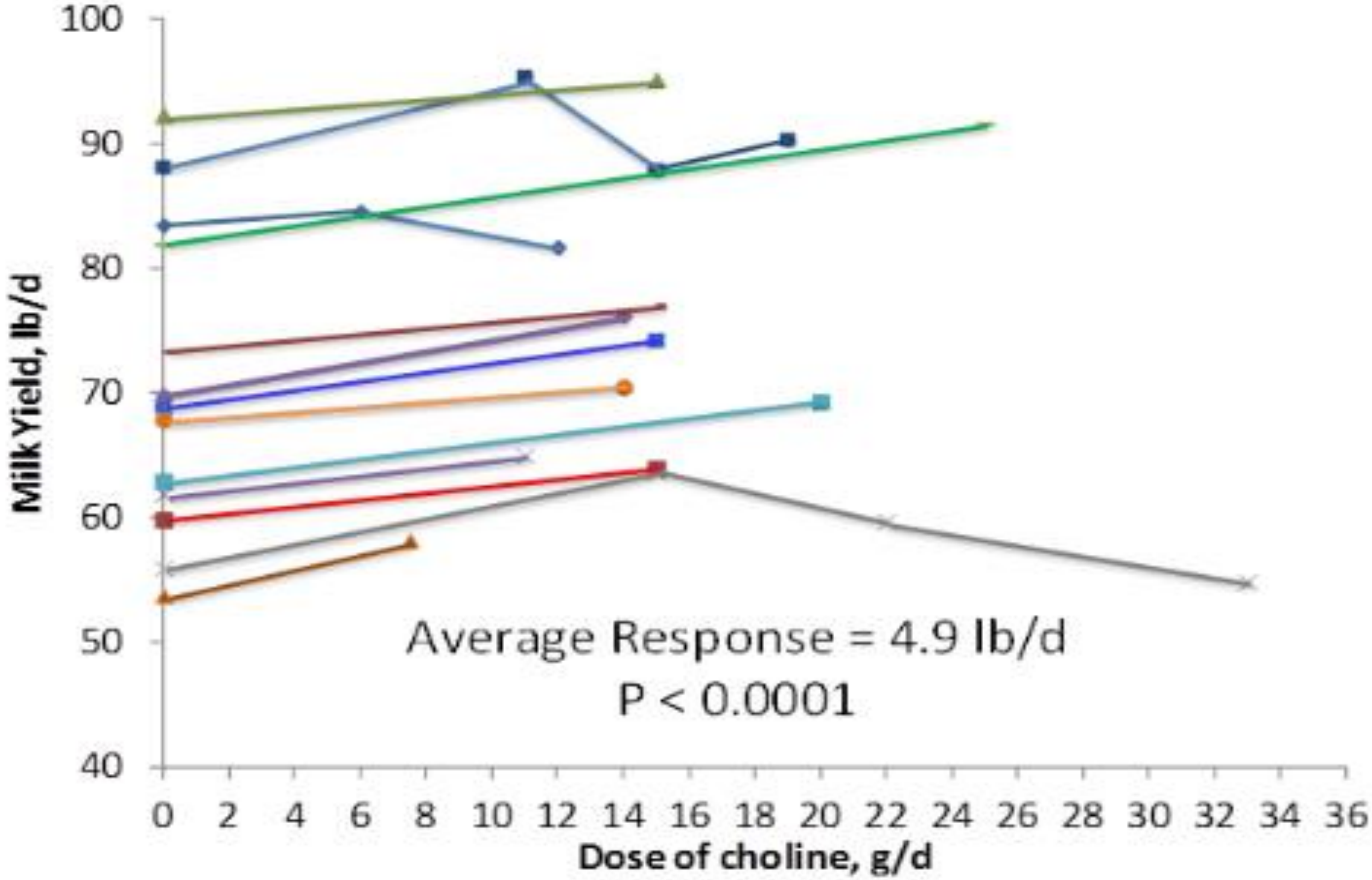
Rumen-protected choline

Effects:

- **Prevention of fatty liver**
  (assist in the formation of lipoproteins that function to export triglyceride from the liver . Choline serves as a precursor for phospholipids, an essential component of lipoproteins.
- **May spare methionine** (both are methyl donors in metabolism); reduces methionine requirements.
- **Increases milk yield and milk fat percent** (protein?)

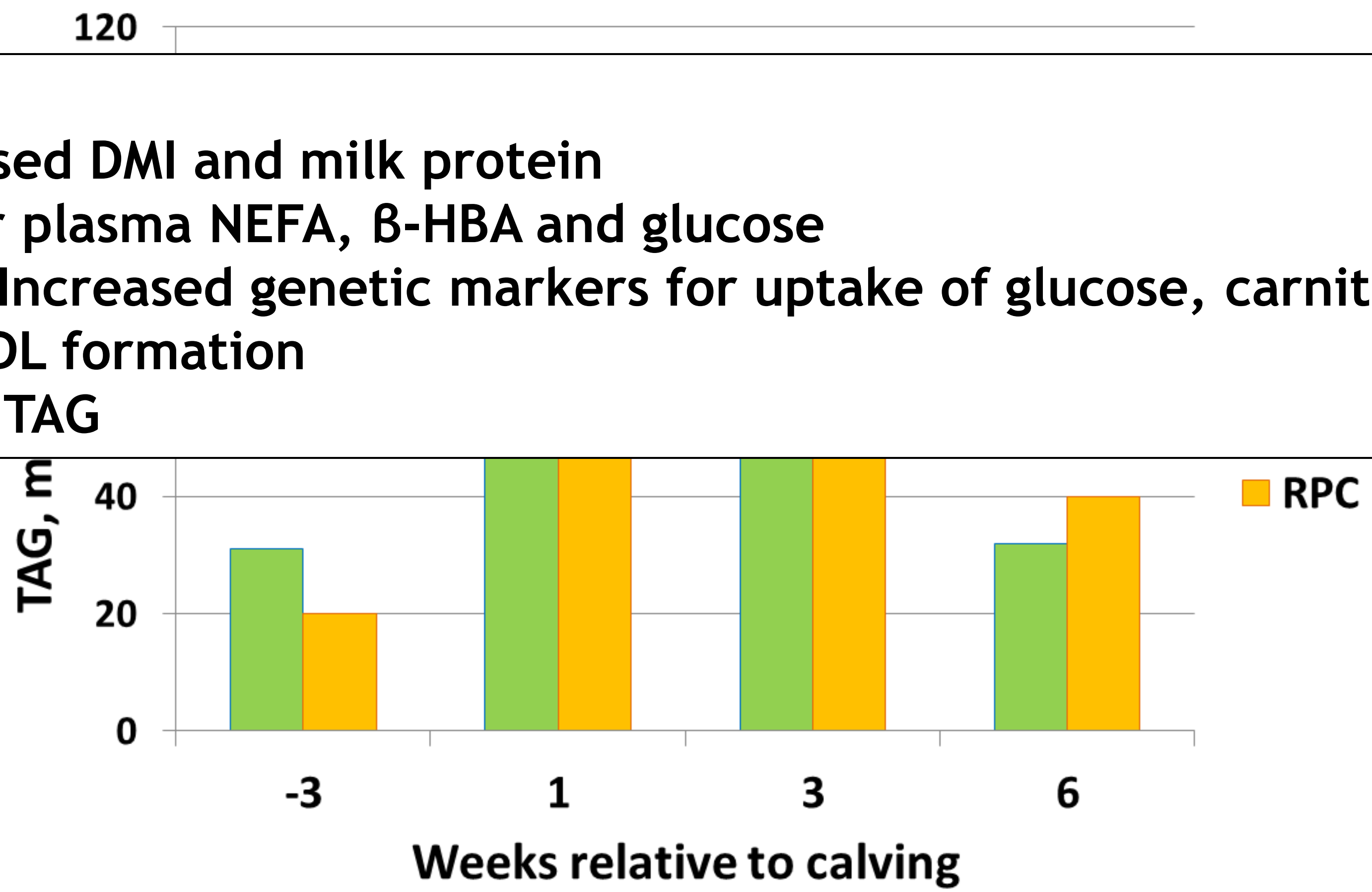
Recommendation:
Feed rumen-protected choline (RPC; 15 grams/h/d or 60 g Nutri-chol). Especially in transition cow diets – until 60 – 90 days in lactation.

Effect of RPC on milk yield, lb/d; meta-analyses (n=13).



(Grummer, 2012)

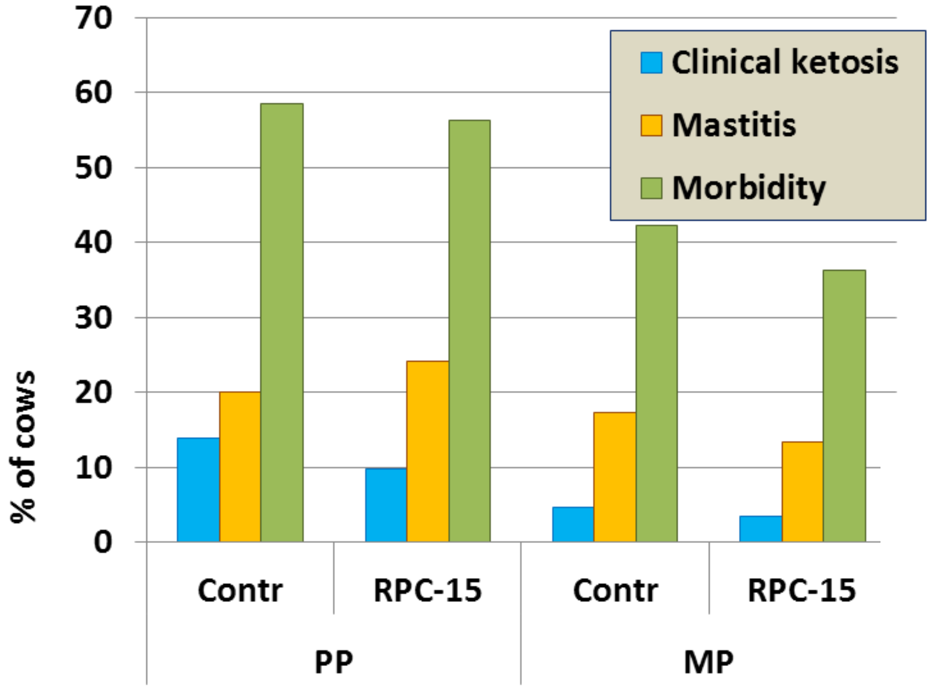
Modeled effect of choline supplementation on concentrations of TAG in the liver of periparturient cows.



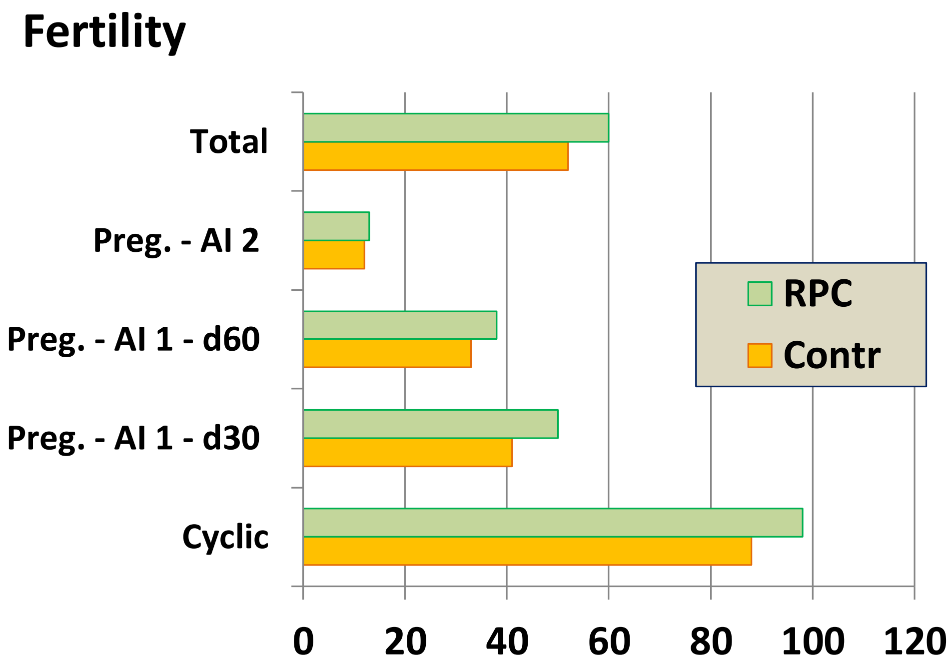
RPC:
- Increased DMI and milk protein
- Similar plasma NEFA, ß-HBA and glucose
- Liver: Increased genetic markers for uptake of glucose, carnitine and VLDL formation
- Lower TAG

(Zom et al., 2011; Goselink et al., 2013)

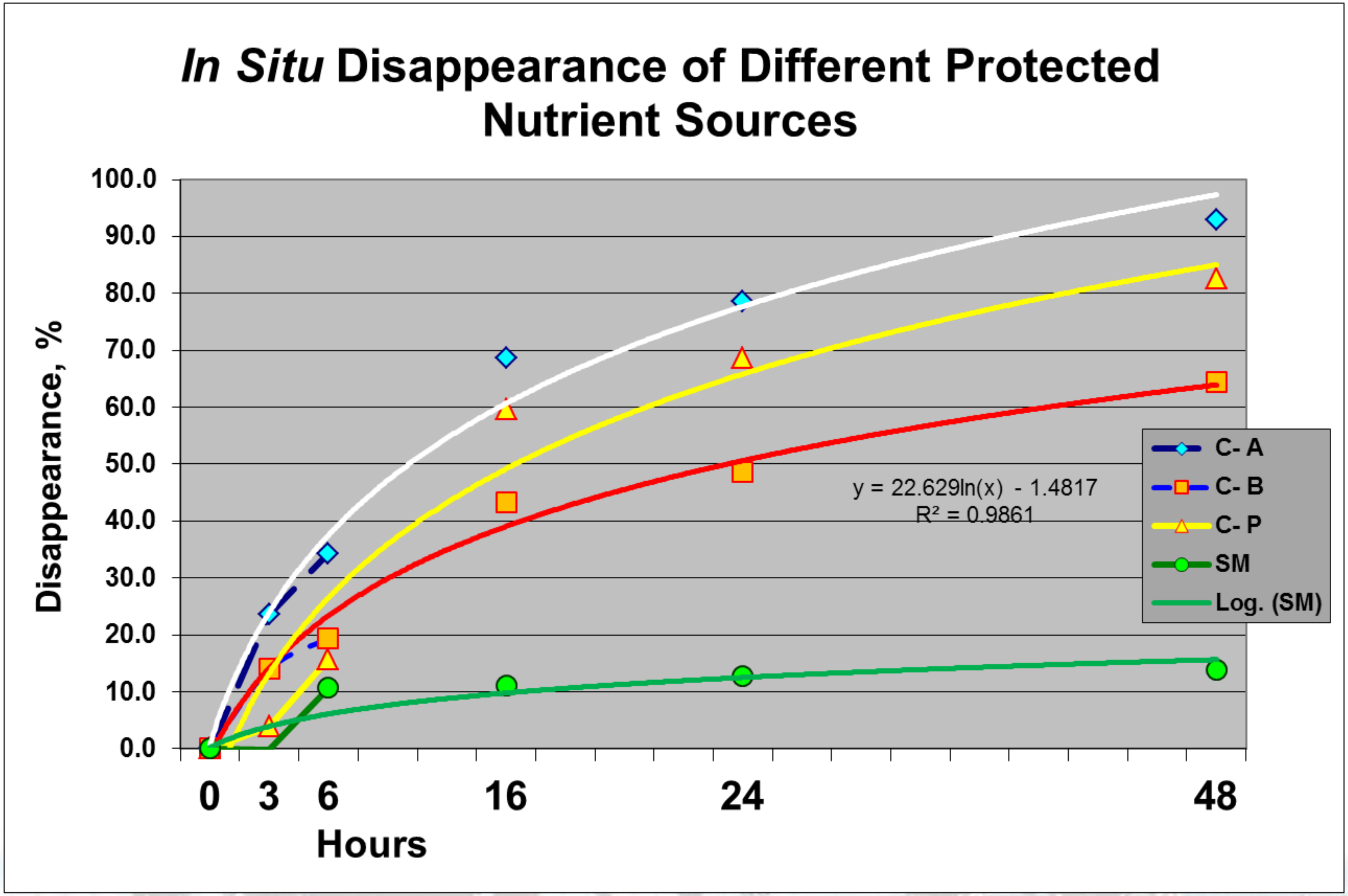
Effect of Choline on Cow Health and fertility.



(Lima et al., 2011)



Rumen protection? Source of variation



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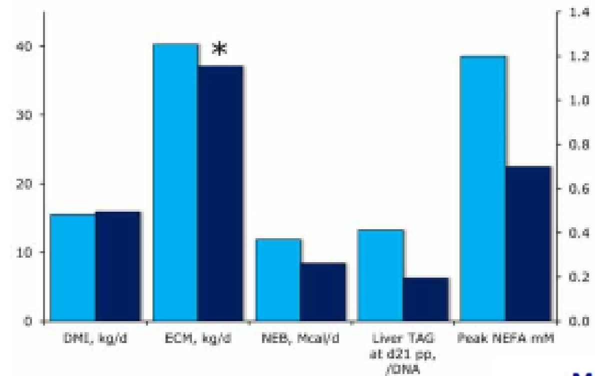
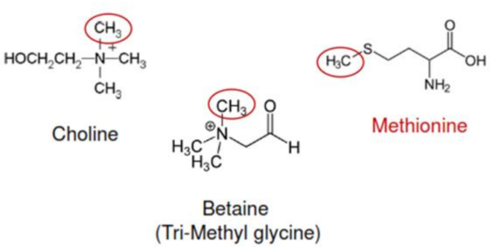
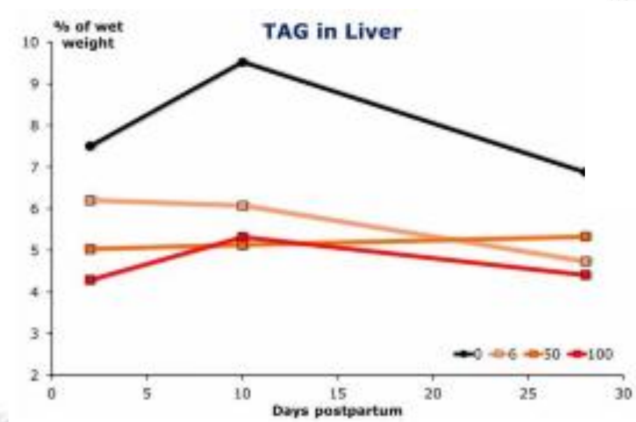
Other additives that affect liver function:

- Niacin
- Carnitine
- Methionine
- Betaine
- Folic Acid
- Vit. B12



Methyl donors in ruminant nutrition





Choline : another methyl donor……

significance in the transition cow.

Methyl donor substitution or potentiation.

Health problems in Holstein cows fed supplemental rumen-protected methionine and choline (4-wks pre - 20-wks post-partum)

	Treatment			
Item	**Contr.**	**RPM**	**RPC**	**RPM + RPC**
Retained placenta				
Displaced abomasum				
Uterine problem				
Milk fever				
Dystocia				
Ketosis				
Foot/leg problems				
ECM, kg/d				

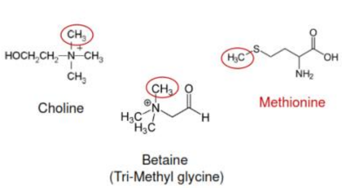
RPM, rumen-protected me

RP-Methionine (Methyl donor) → Hepatic expression of :

- **DNA- methylation**
- **Metabolism:**
  - **Methionine**
  - **Glutathione (and production)**
  - **(Taurine)**
- **Inflammation**
- **Oxidative stress**

(Osorio et al., 2014)

Methyl donors in ruminant nutrition



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Conclusions:

1. Genetic progress and management changes have increased demands and stress on the dairy cow – especially evident in the transition period (when physiological, immunological and nutritional demand changes over a short period of time).
2. Energy and nutritional management of the peri-parturient cow is basic in solving the challenges of the modern peri-parturient cow.
3. Reducing the severity of these changes (e.g. by reducing the dry period) facilitates the cow's capacity to cope.
4. Ration formulations based on changes in C2 and C3 improve DMI p.p. and result in positive modifications in blood metabolic profiles.

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Conclusions (Cont'd):

1. Genetic progress and management changes have increased demands and stress on the dairy cow - especially evident in the transition period (when physiological, immunological and nutritional demand changes over a short period of time).
2. Energy and nutritional management of the peri-parturient cow is basic in solving the challenges of the modern peri-parturient cow.
3. Reducing the severity of these changes (e.g. by reducing the dry period) facilitates the cow's capacity to cope.
4. Alterations in diet formulation based on C2 and C3 precursors appear to result in favourable metabolic profiles (including modifications in plasma levels of insulin, IGF-1 and other hormones affecting performance.

5. The increased demand – and the requirements of the sub- systems that needs to be addressed can not be met with classical nutrition; requires system-specific nutrients: supplements or additives.

6. Positive results have been obtained with individual additives that address (some) specific aspects of the challenges to the peri-parturient cow.

7. Our challenge is to develop (and use) the solutions that combine in the most synergistic fashion the various interventions – including additives - that are effective and at our disposal.

U.S. SOYBEAN EXPORT COUNCIL

GANS Inc.

Questions?

Thank You!