

# Optimising Estonian rations: limiting acidosis risk due to high levels of acids in silage



Maaelu Arengu Euroopa  
Põllumajandusfond:  
Euroopa investeringud  
maapiirkondadesse

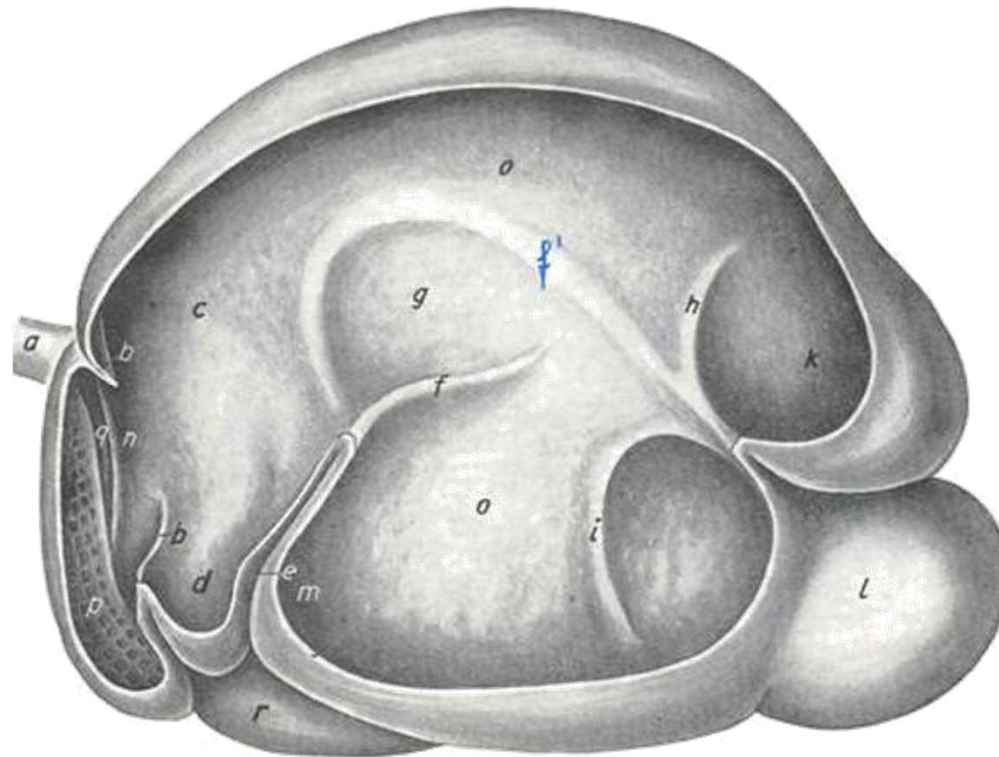


# How does the cow work ?



**To feed the cow = to feed the rumen first**

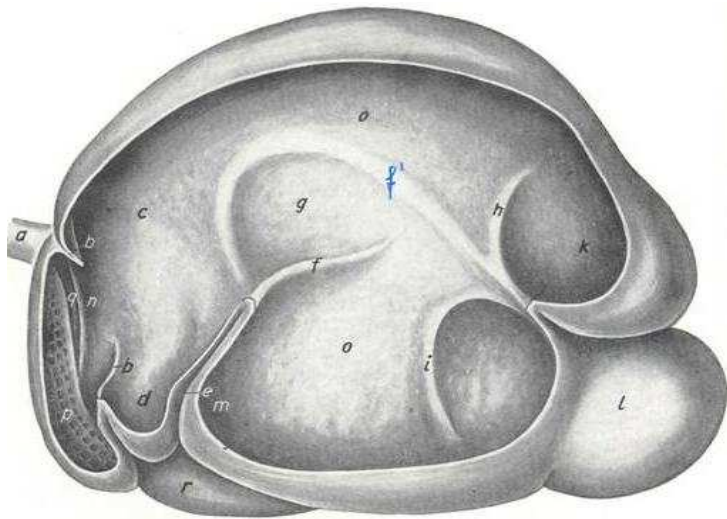
RUMEN = fermentation tank of 200 L (billions of bacteria and protozoa) able to digest vegetal fibres



# Rumen a complex ecosystem



- 200 LITERS
- STABLE temperature : 40°C
- Billions of bacteria and protozoa, sensitive to pH
- pH can vary from 5 to 7, average 6.2
- Conditions for efficient rumen = stable pH



fermentations in rumen produce ACIDS :  
volatile fatty acids VFA (C2/C3/C4 + Lactic)

C2 = acetate  
C4 = butyrate  
C3 = propionate  
Lactic acid

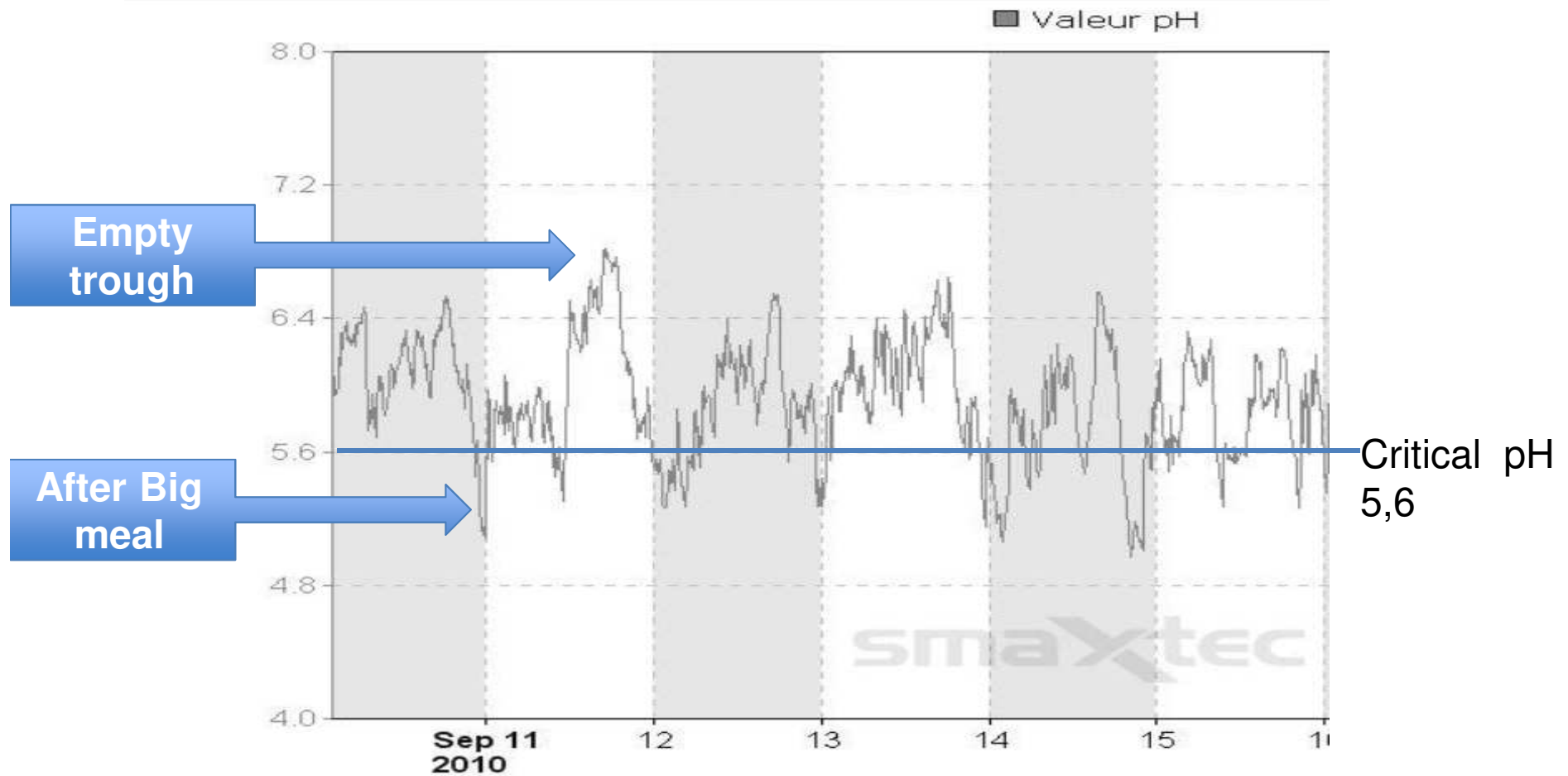


Milk fat



Lactose

# Rumen pH variation

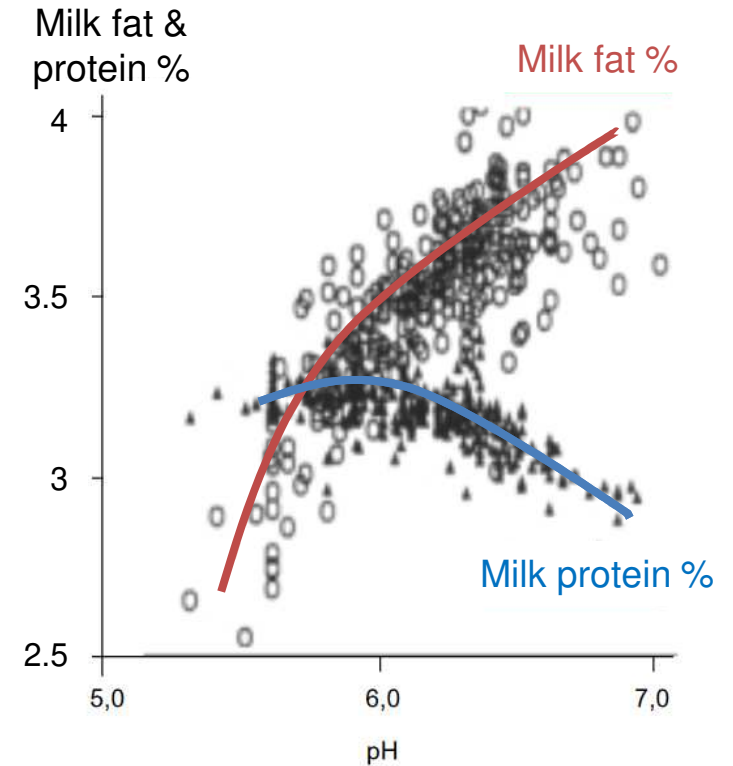
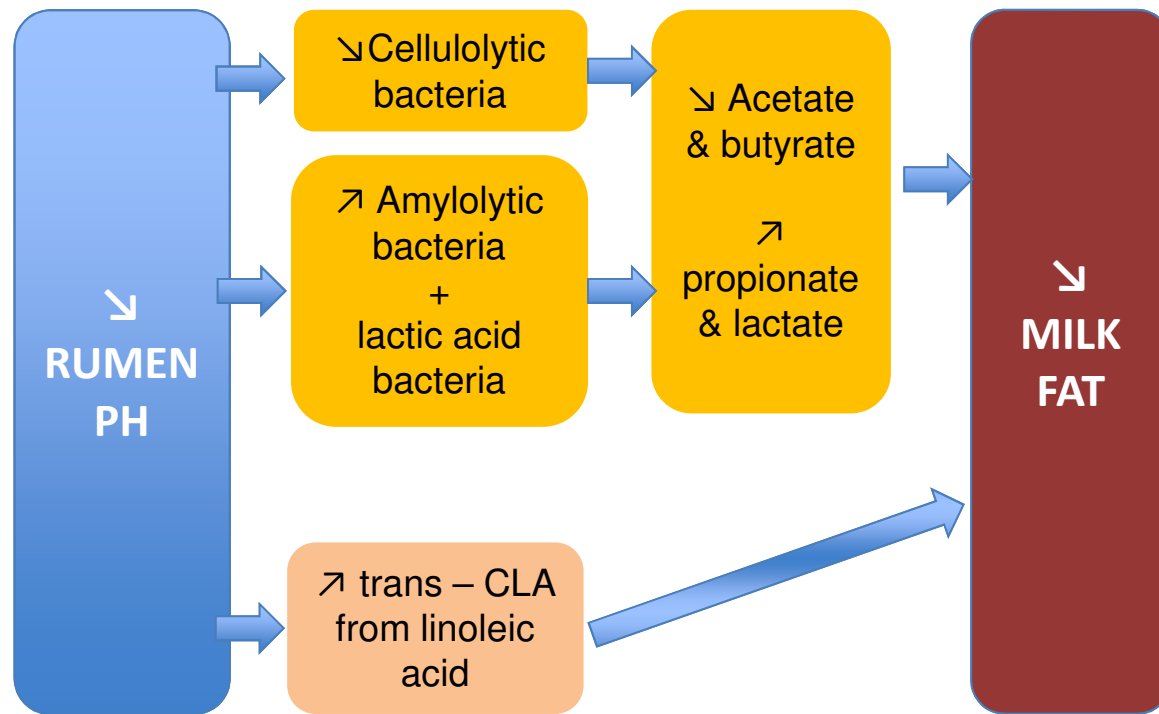


# Empty feed bunk in robot milking system how much milkings / hour on 24 h basis ?



Empty feed bunk between 3 and 5 AM

# Relationship between rumen pH and milk quality



INRA, Sauvant et al, 1999

# Silages are acid products



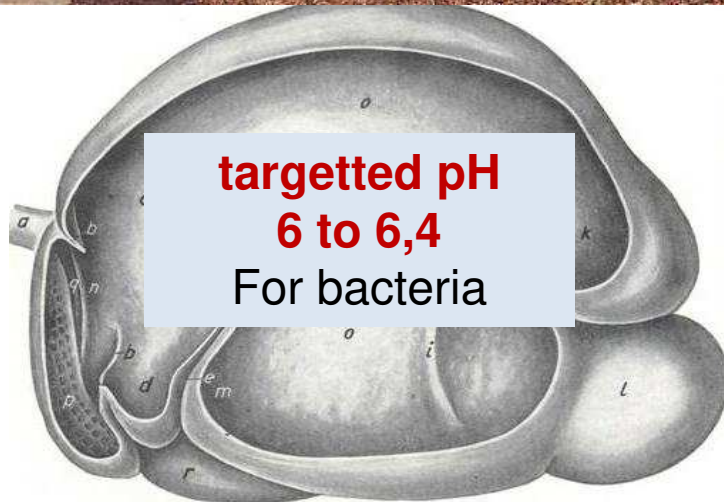
Grass or corn silage = 12 to 16 kg DM intake

**pH = 3,5 to 4,5**

Lactic acid = 50 to 80 g / kg DM

Acetic acids = 25 g / kg DM

**Total acids intake = 1 to 1,5 kg / day**  
**Equivalent to 30 L vinegar**



RUMEN

**Fermentation of carbohydrate in VFA**  
**= 6 kg acids**  
**Equivalent to 120 L vinegar**

# Alfalfa silage



Client : GAEC DES VIOLETTES DEP 70  
 Commercial : A. CORNILLET VILLERS CHEM ET MONT LES ETREL

fourrage **Ensilage luzerne + Loher**

date prélèvement 27-sept.-19  
 date analyse 4-oct.-19  
 n° analyse 1538737

autre information

## Valeurs analytiques

Unité (rapporté à la MS totale)				Unité (rapporté à la MS totale)			
MS	%	24,7	●	25-55	CB	g	247 ● 250-400
UFL	Mcal	0,90 ●	0,8-1	NDF	g	342 ● 400-550	
UFV	Mcal	0,88 ●	0,8-1	ADF	g	271 ● 250-400	
PDIA	g	35,3 ●	20-50	ADL	g	55 ● 20-100	
PDI	g	83,9 ●	65-100				
BPR	g	103,4 ●	20-50	sucres	g	25 ● 20-90	
NI ref	%PV	2,73		Acides ferm	g	150 ● 50-80	
M.O	g	893,9	> 900	Mat. Grasse	g	27 ● 20-40	
dMO	%	78,8 ●	65-85	ac. Gras	g	15	
MAT	g	235 ●	150-230	D NDF 30 h	%	53 ● 45-70	
azote NH3	%	3,5 ●	0-5	NDF nd	g	161 ● < 200	
protéine soluble	%	56,2 ●	35-62	Minéral	g	106 ● 60-140	
dE	%	75,19	65-75	P	g	3,0	
DT6_N	%	86,35	70-75	Pabs	g	2,1	
dr_N	%	84,37	60-75	Ca	g	14,8	
				Caabs	g	5,9	
pH		4,2 ●	3,8-5	Mg	g	1,9	
acide lactique	g	111,30 ●	40-80	BACA	meq	322 ● 200-400	
acide acétique	g	19,00 ●	<30	S	g	2,2	
acide butyrique	g	0,00 ●	0	Na	g	0,4	
				K	g	26,8 ● 20-40	
				Cl	g	8,7	
				Cu	mg	10	
				Zn	mg	108	
				Mn	mg	63	
				fer	mg	607 ● <100	
INRA 1986							
UFL	Mcal	0,88 ●	0,8-1				
PDIA	g	39 ●	20-50				
PDIN	g	147 ●	80-150				
PDIE	g	86 ●	65-100				



# Ray grass silage



Client : GAEC DU VIEUX MANOIR DEP 22  
 Commercial : A. CORNILLET POMMERIT LE VICOMTE

fourrage **Ensilage RGI** date prélèvement 27-sept.-19  
 autre information date analyse 4-oct.-19  
 n° analyse 1538740

## Valeurs analytiques

Unité (rapporté à la MS totale)

Unité (rapporté à la MS totale)

MS	%	32,5	●	25-55
UFL	Mcal	0,99	●	0,8-1
UFV	Mcal	0,97	●	0,8-1
PDIA	g	22,8	●	20-50
PDI	g	74,1	●	65-100
BPR	g	36,9	●	0-20
NI ref	%PV	1,97		
M.O	g	896		> 900
dMO	%	81,3	●	70-87
MAT	g	162	●	100-180
azote NH3	%	2,0	●	0-5
protéine soluble	%	50,8	●	35-60
dE	%	77,7		65-75
DT6_N	%	81,85		70-75
dr_N	%	74,04		60-75
pH		4,20	●	3,8-5
acide lactique	g	101,90	●	40-80
acide acétique	g	11,00	●	<30
acide butyrique	g	0,00	●	0

CB	g	214	●	250-400
NDF	g	395	●	400-550
ADF	g	238	●	250-400
ADL	g	15	●	20-100
sucre	g	75	●	20-90
Acides ferm	g	132,9	●	50-80
Mat. Grasse	g	28	●	20-40
ac. Gras	g	12		
D NDF 30 h	%	69,7	●	45-70
NDF nd	g	120	●	< 200
Minéral	g	104	●	60-140

P	g	3,7		
Pabs	g	2,6		
Ca	g	4,9		
Caabs	g	2,0		
Mg	g	1,6		
BACA	meq	537	●	200-400
S	g	1,7		
Na	g	1,7		
K	g	31,1	●	20-40
Cl	g	8,1		
Cu	mg	7		
Zn	mg	51		
Mn	mg	54		
fer	mg	342	●	<100

INRA 1965				
UFL	Mcal	0,96	●	0,8-1
PDIA	g	32	●	20-50
PDIN	g	101	●	80-150
PDIE	g	84	●	65-100

# Acid contents of silage – VITALAC ANALYSIS



		Corn Silage	Grass silage	Alfalfa and Clover Silage
<b>LACTIC ACID</b> gr/kg DM	<b>Targets</b>	40-80	40-80	40-80
	<b>Average 2019</b> (max – min)	49 (11 – 96)	47 ( 0 – 133)	28 (0 - 137)
<b>ACETIC ACID</b> gr/kg DM	<b>Targets</b>	< 30	< 30	< 30
	<b>Average 2019</b> (max – min)	19 (2 - 40)	14 (0-46)	12 (0 – 53)
<b>PH</b>	<b>Targets</b>	3,8 - 4,2	3,8 - 5	3,8 - 5
	<b>Average 2019</b> (max – min)	3,9 (3,4 – 4,6)	4,4 ( 3,6 - 5,5)	5 (4,4 – 5,4)

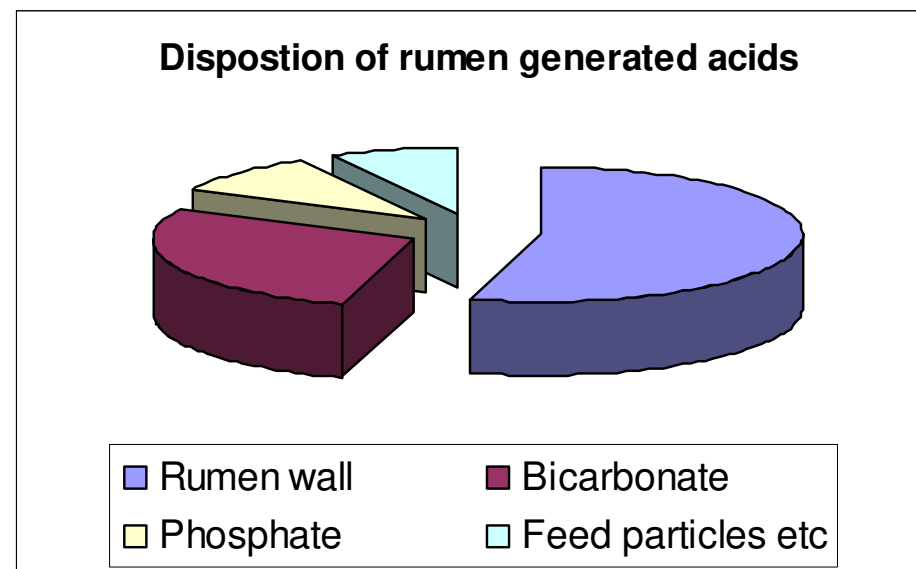
## Becoming of silage ACIDS in the rumen



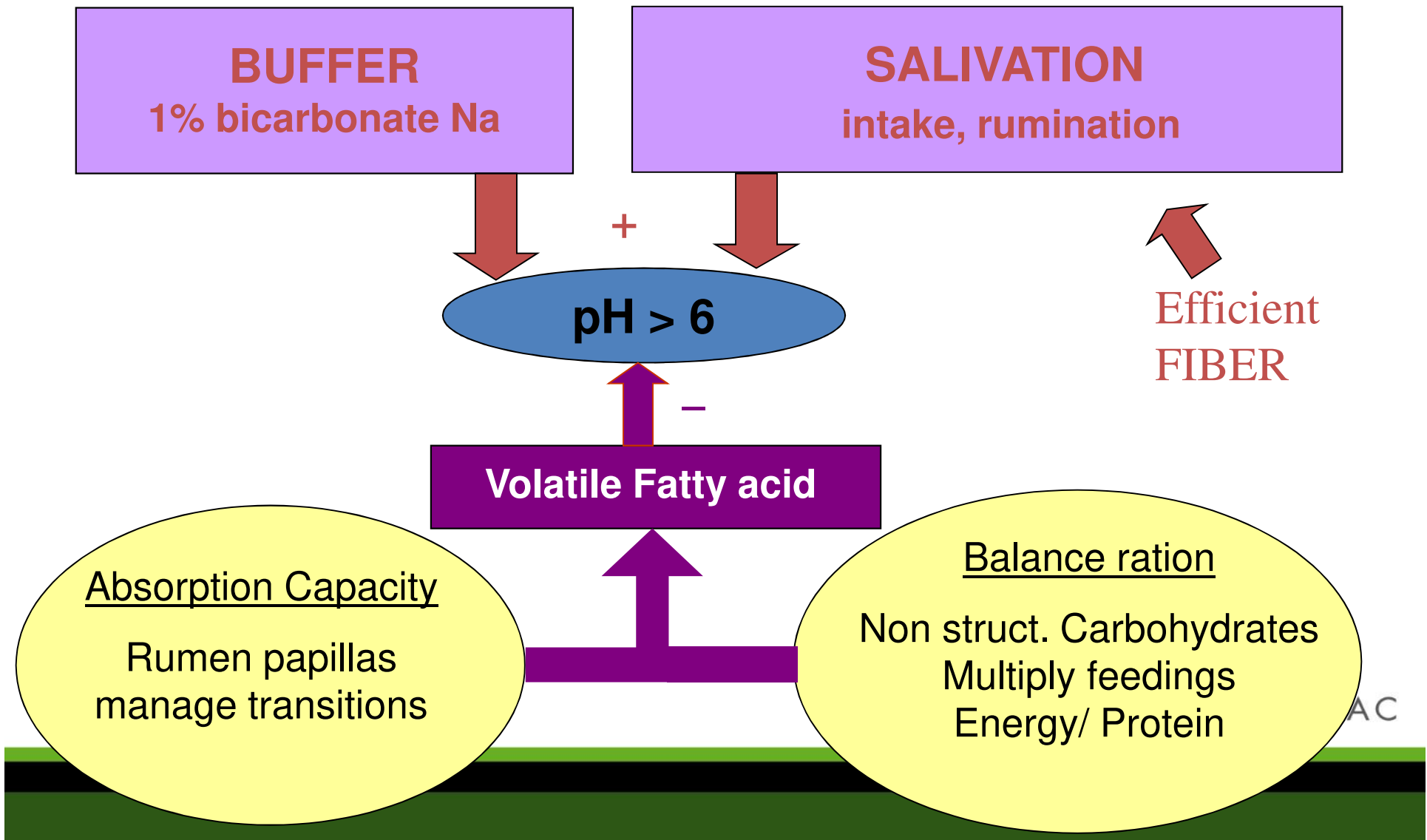
**EQUIVALENT 150 L VINEGAR / day**

- 50% absorbed by rumen wall
- 30% neutralized by saliva buffer
- 10% neutralized by phosphate buffer
- 10% go to abomasum with small particles

**→ buffer capacity of rumen is often overflowed**



# Regulation of rumen pH



# Results of irregular Rumen pH



- Heterogen manure
- Bad digestion
- Irregular intake
- Low performances : milk / growth
- Low immunity : somatic cells/ mastitis
- Foot problems



# EVALUATION OF ACIDOSIS RISK



ACIDOSIS RISK	LOW 1	MEDIUM 2	HIGH 3	score
MILK YIELD / COW / Year	< 6500	6500 / 8000	> 8000 10000	<b>3</b>
Intake kg DM / d / cow	<20	20/23	> 23 24	<b>3</b>
% concentrate / DM basis	< 40%	40-60% 50	> 60%	<b>2</b>
% corn silage DM basis	< 25%	25- 45% 35	> 45%	<b>2</b>
PAL grass silage (meq / kg)	< 850	850 - 1000	> 1000 900	<b>2</b>
Total				<b>12</b>

Total Score > 8 = low risk  
 9-12 = high risk  
 > 12 very high risk

# Buffering the RUMEN



## TMR presentation and distribution

### 1) Presentation :

Fiber should be as fine as possible , limit long particules > 3 cm



problems = sorting



### 2) Distribution :

- 1 feeding / day + several pushing
- 2 feedings / day if 2 milkings
- 3 feedings / day if 3 milkings
- Pushing robot

### 3) Empty bunk =

not more than 2 H / 24 h



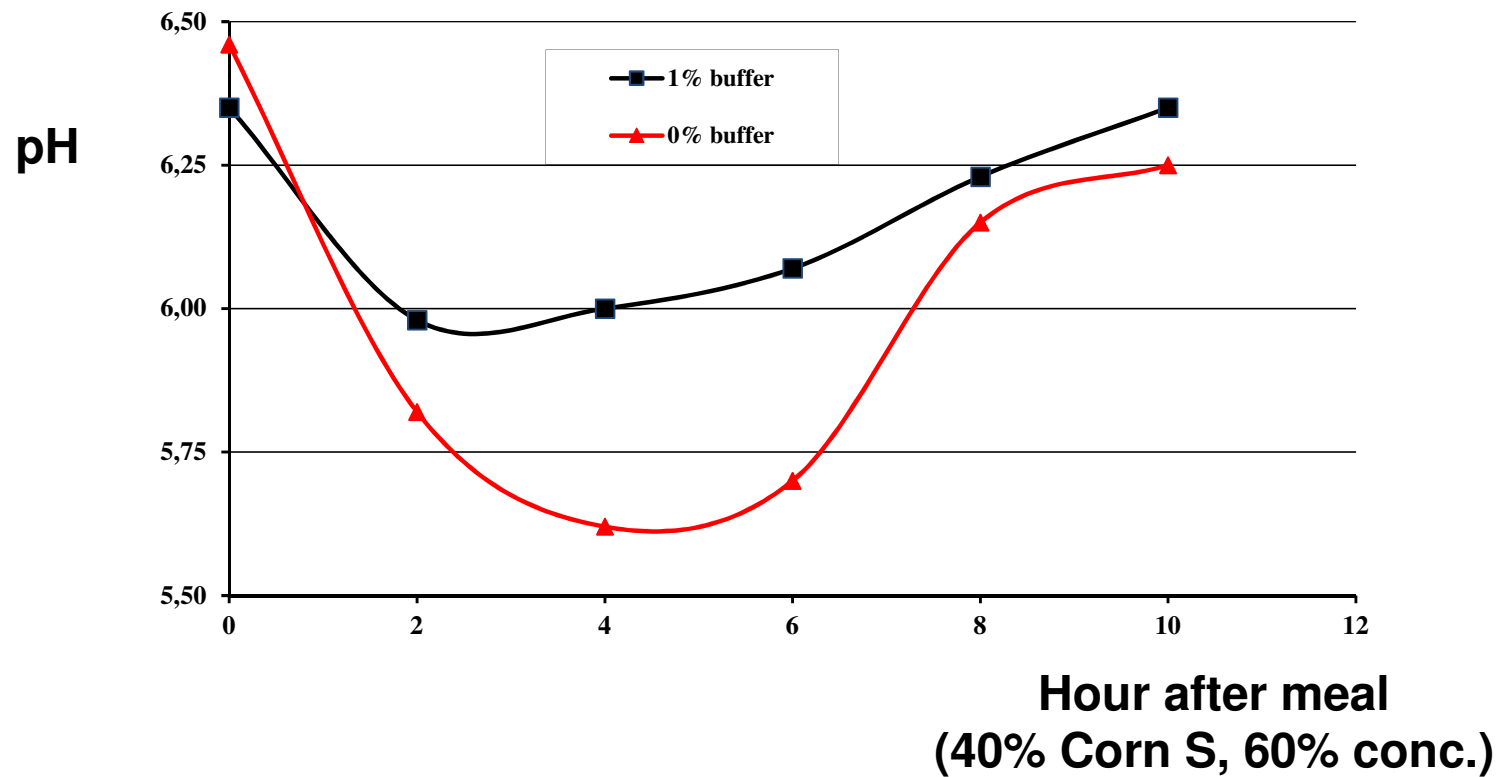
# Buffering the RUMEN



- **Sodium Bicarbonate :**
  - ❑ 100 g to 300 g / cow / d
  - ❑ This is a chemical buffer
  - ❑ + effect on DCAD + 14000 meq / kg
- **Magnesium oxyde : MgO**
  - 30 to 50 g / cow / d
  - Intestinal buffer + high content of magnesium 48%
- **Live Yeast =**
  - Binds O<sub>2</sub> : maintain anaerobic conditions in the rumen, that stimulate microflora growth
  - By lysis, provide usefull metabolites to microflora
  - Stimulate lactate using bacteria : this help to maintain rumen pH > 6



# Evolution of rumen pH with or without buffer



Erdman *et al.*, 1982  
J Dairy Sci 65:712

 VITALAC

# Live Yeasts - Evolution of rumen pH after a meal



Marden, 2007

- T = control
- 0,5B =  $5 \cdot 10^9$  UFC
- 5B =  $50 \cdot 10^9$  UFC

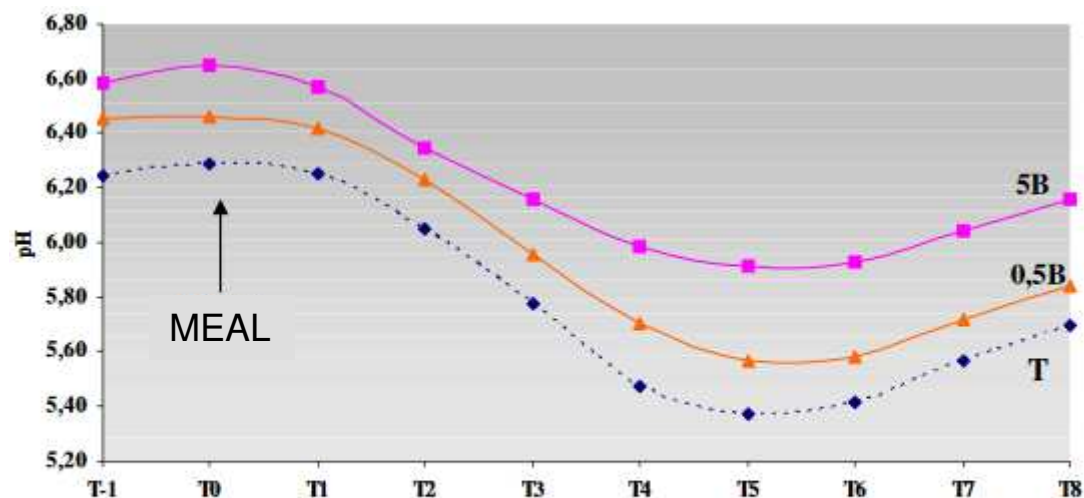


Fig. 33. Evolution du pH ruminal chez la vache en lactation (effet dose)

# Vitalac innovation : Ration Alkalinization by acids neutralization



- Increase pH of total mix ration by neutralization of acids
- Bring soluble protein GMO free
- Improve gut health and performances



# Ration Alkalinization by acids neutralization, concept



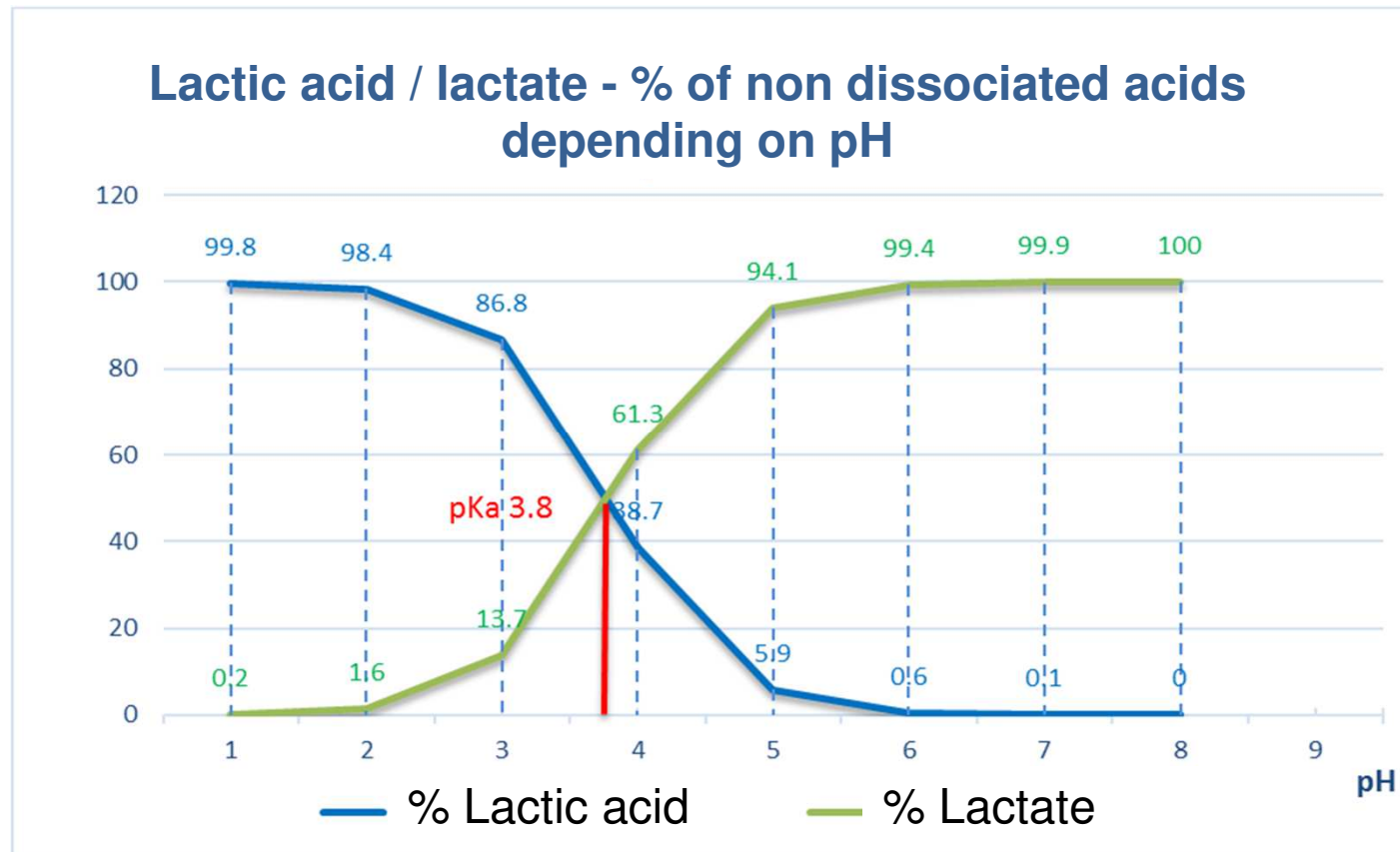
**Ration Alkalinizer  
(R. ALK):  
Urea + enzymes + buffer**

**Release AMMONIA**

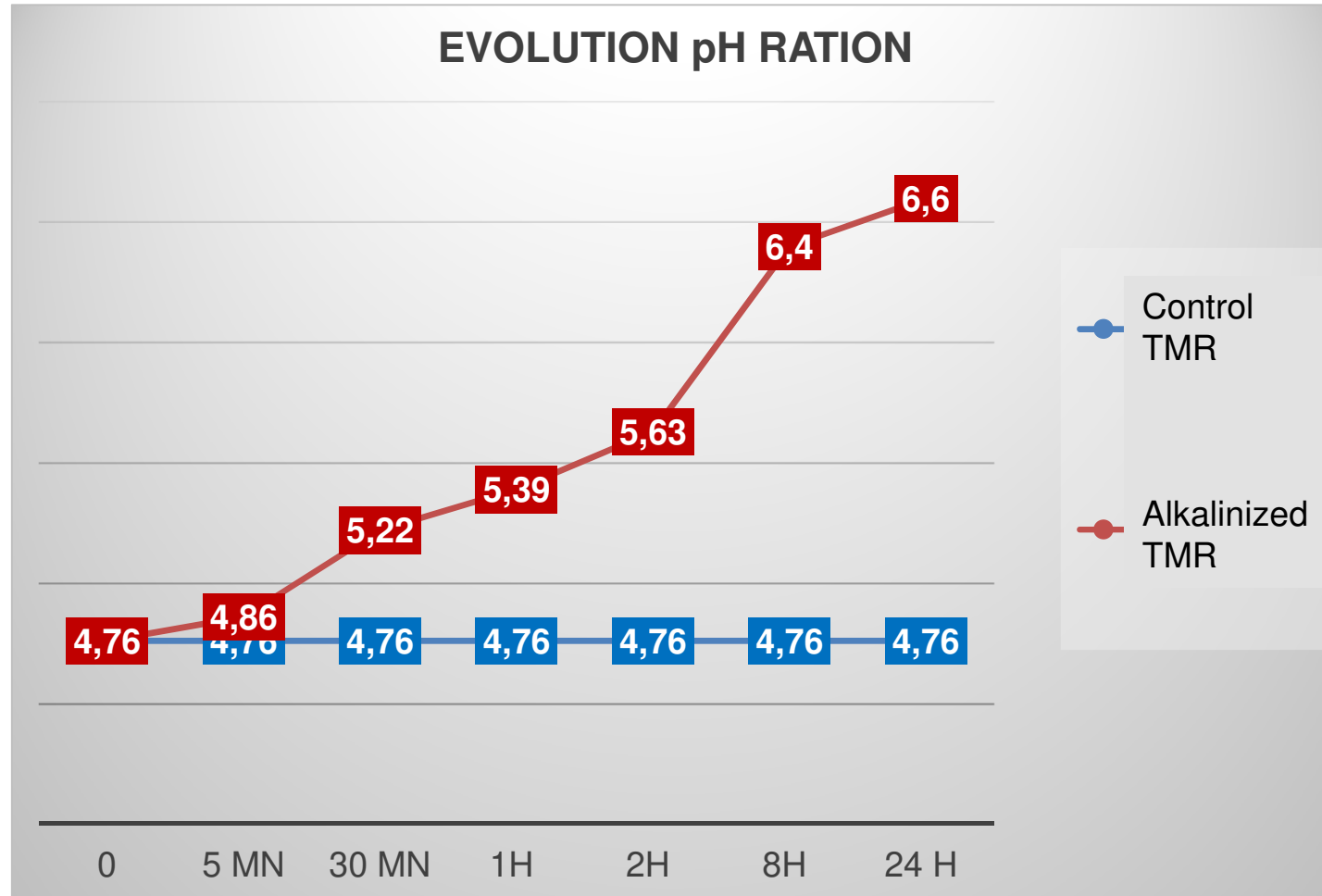
**Binds lactic and acetic acids  
and produces  
Ammonium lactate and acetate**

**pH ↗**

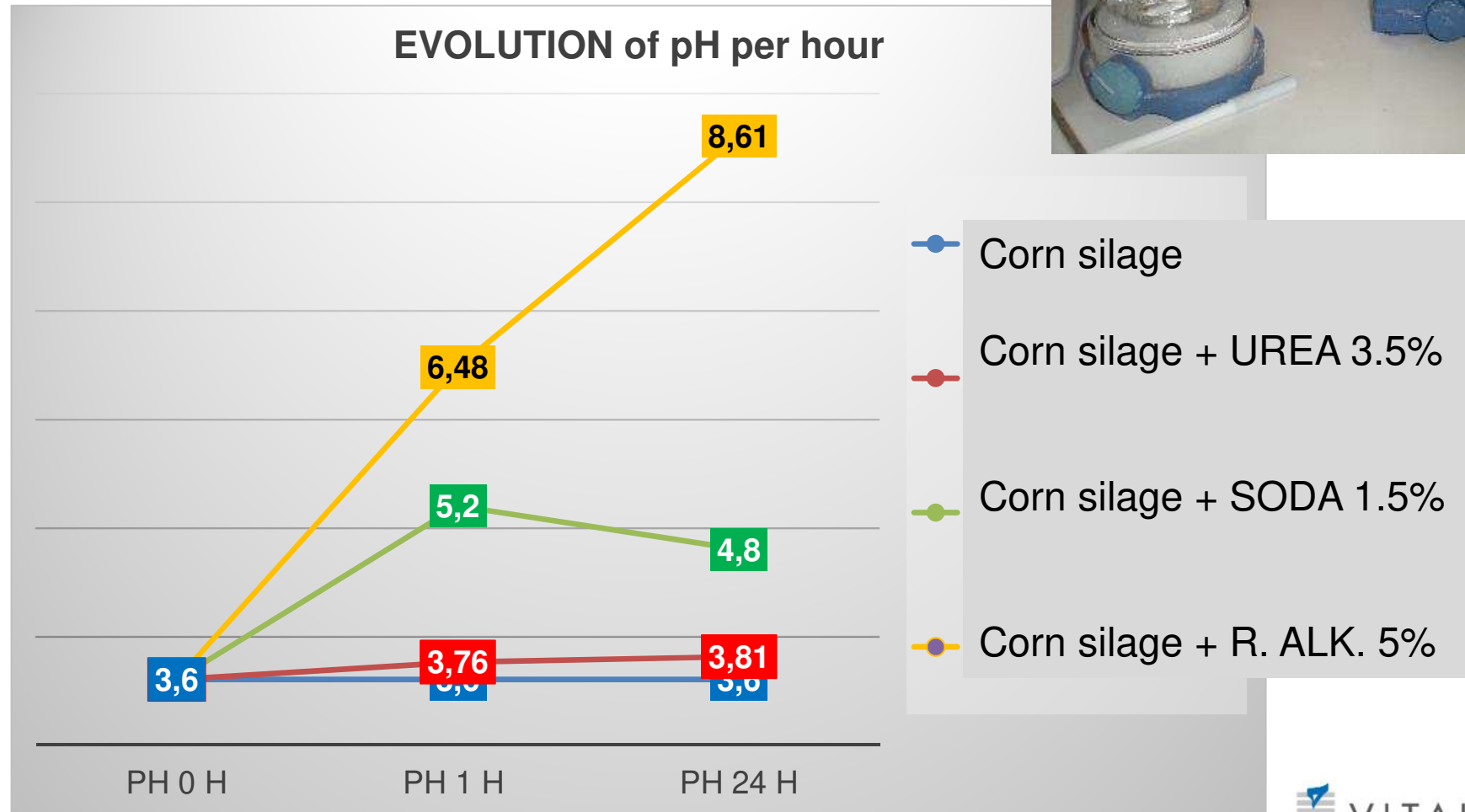
# Dissociation curve of lactic acid



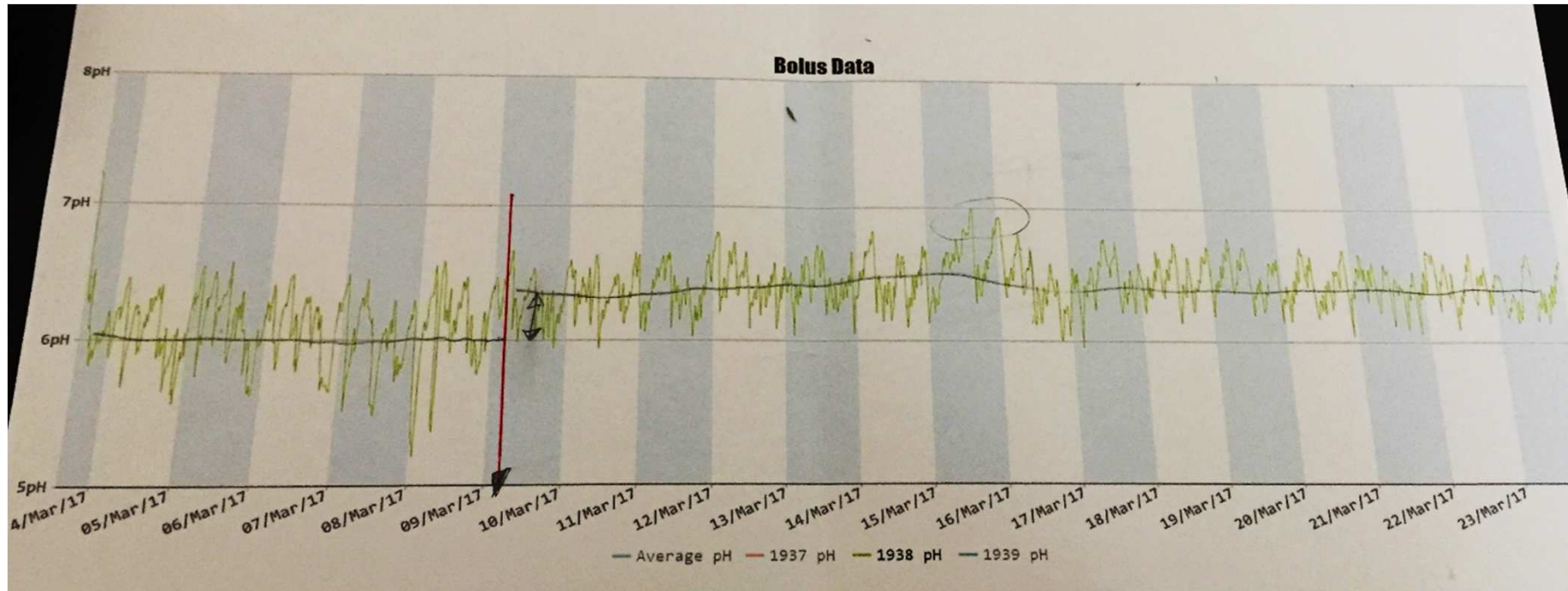
# In vitro trial on TMR (total mix ration) pH raise 1 point in 1 hour



# Ration alkalization (R. ALK) is better than soda for buffering corn silage



# Trial with rumen boluses ROBOT MILKING FARM



**Before R. ALK**

29 kg MILK / cow  
2,5 milkings

**WITH R. ALK.**

32 kg MILK / cow  
2,7 milkings



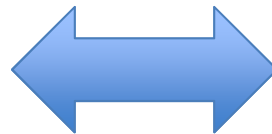
# Formulation of TMR with RATION ALKALINIZER



- Ammonium salts are a good source of soluble protein for rumen bacteria
- Can reduce amount of meals in ration = soya / rape / urea
- Can increase level of starch in ration because of buffer effect
- Complementary buffer with SODA and yeast

0,35 kg R. ALK

(125% protein)



1 kg SOYABEAN MEAL

1,4 kg RAPESEED MEAL

1 kg RAPE MEAL + 50 g UREA

0,7 kg SOYA MEAL + 50 g UREA

# Indications of R. ALK.



- **Rations with high acidosis risk :**
  - **Acids silages acides** (high moisture grass silage or corn silage)
  - **Cereals or sugar beet** in ration > 2kg DM
  - Signs of acidosis on herd
- For an additional security against acidosis

Prevention  
acidosis /  
Securing  
TMR

- **Replacing urea** by a source of degradable N providing an extra benefit of acidosis prevention
- **Partly replacing protein meal**
- **Reduction of feed cost**
  
- Stable ration = key of success

# Effects seen on farm



- On animals :
  - Dungs + homogeneous, better digested
  - Increased rumination
- On performances :
  - Increase of production + 1 kg milk
  - Better persistency = + milk in middle and end of lactation
  - Decreased somatic cell counts, sign of a better digestive health
  - Summer: limits acidosis due to heat stress → less impact on milk fat
  - Improves income over feed cost

# RESULTS IN FARMS



<b>Elevages</b>	<b>R. ALK. DOSE</b>	<b>Changes in ration REDUCTION</b>	<b>Milk yield /cow / d</b>	<b>Milk gain</b>	<b>Evolution IOFC Ct € / cow / d</b>
<b>Farm T.</b>	<b>325 g</b>	<b>0.6 kg soya meal 80 g urea</b>	<b>35.5</b>	<b>+1.9</b>	<b>+60</b>
<b>Farm C.</b>	<b>200 g</b>	<b>1 kg rapemeal</b>	<b>37</b>	<b>+1</b>	<b>+39</b>
<b>Farm B.</b>	<b>300 g</b>	<b>0.4 kg soya meal 50 g urea</b>	<b>38.4</b>	<b>+1</b>	<b>+35</b>
<b>Farm G.</b>	<b>250 g + 1.5 kg Barley</b>	<b>1 kg soya meal</b>	<b>38.8</b>	<b>+ 3</b>	<b>+96</b>

# Example in Estonian Ration



TMR 22.5 kg DM 16% PROTEIN	CONTROL	R.ALK
Grass silage 14% protein kg DM	7	6.5
Corn silage kg DM	6	6
Barley kg	5	6.5
<b>R. ALK</b>		<b>0.3</b>
Rapeseed meal	4	2.7
Mineral premix	0.2	0.2
Salt	0.05	0.05
Soda	0.2	0.1
TMR COST €	3	3
% STARCH	20	24
% PROTEIN	15	15
Milk yield / protein %	30	32

# THE PROCESS OF CEREALS HYDROLYZATION



CEREALS  
+  
UREA  
+  
ENZYMES

REACTION  
TIME  
=  
3 WEEKS

HYDROLYZED  
CEREALS  
PH 9  
+ 5 POINTS  
PROTEINS



LAC

# HYDROLYZED CEREALS



**REACTION TIME = 3 WEEKS**  
**STORAGE ON CONCRETE UNDER PLASTIC SHEET OR IN PLASTIC SAUSAGE**



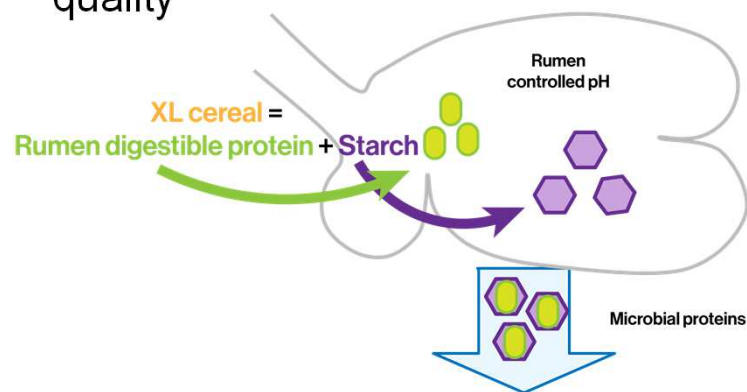
If DM = 70%, remove the plastic sheet after 5 days

# OBTAIN AN ALKALINIZED 18% PROTEIN WHEAT



## + 5 points protein

- **Save feed cost on protein meals :**  
1kg of treated wheat makes you save 140gr of soybean meal
- **Increase microbial protein production** in the rumen :  
Creation of protein of high nutritional quality



## Alcalinized cereal : pH 9

- Increase starch in the formulas **without risk of acidosis**
- **Protects and stimulate rumen microflora** = digestive comfort and health
- **Preservation of cereals** during 1 year



# Which cereals can be treated in farm?



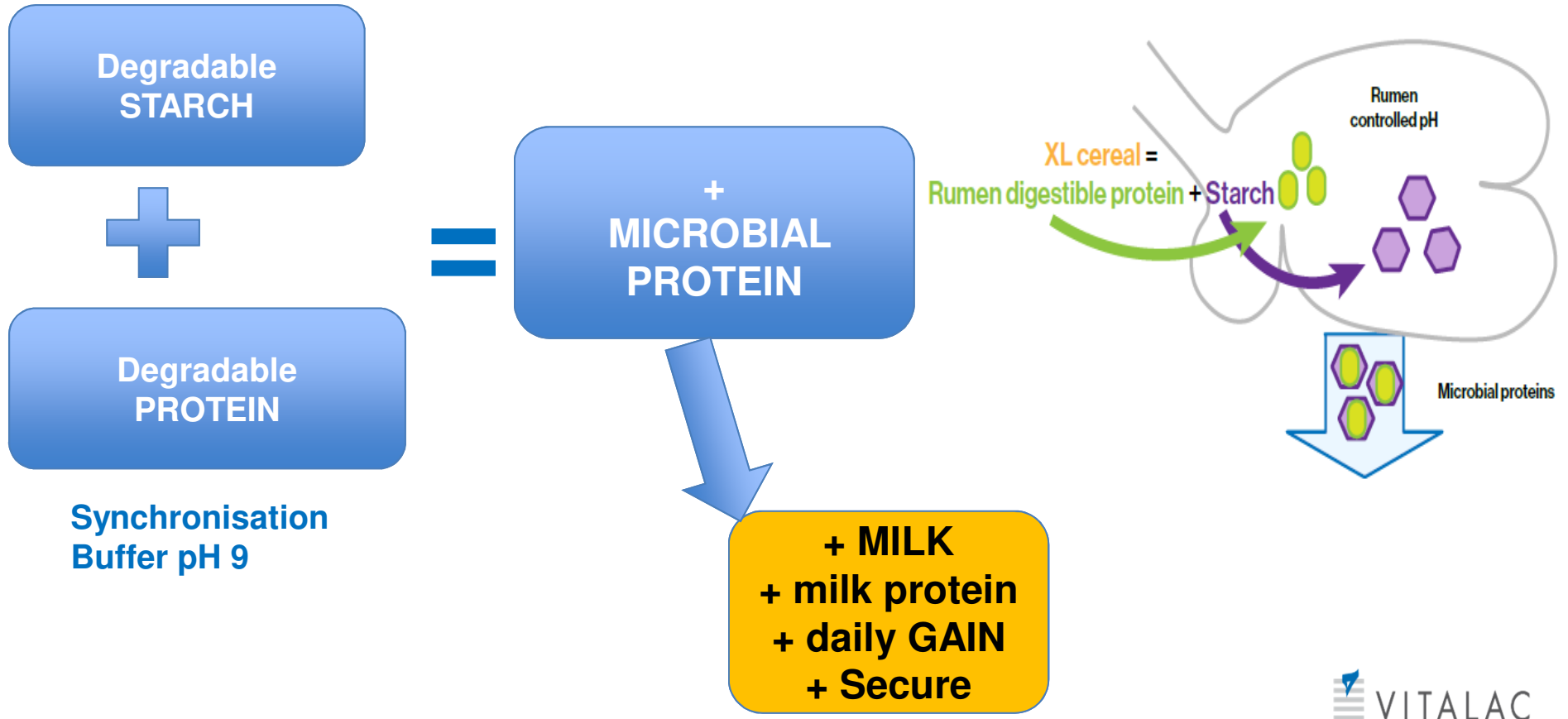
- **Wheat, barley and other straw cereals, corn powder : 25kg/T**

Cereal	% CP before treatment	% CP after treatment	Difference
Wheat	12,5 %	17,9 %	+ 5,4 points
Barley	11,2 %	17,1 %	+ 5,8 points
Corn	7,6%	13,4%	+ 5,8 points

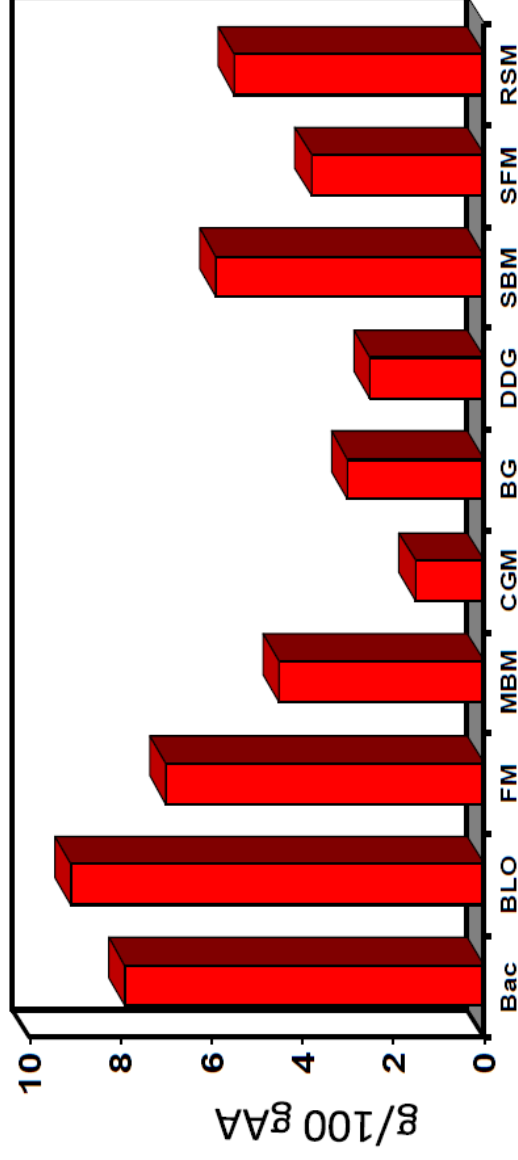
- **High moisture corn : 25 or 37,5kg/T**

Cereal	% CP before treatment	% CP after treatment	Difference
HMC 25 kg/T	7,6 %	13,4 %	+ 5,8 points
HMC 37,5 kg/T	7,6%	16,2 %	+ 8,6 points

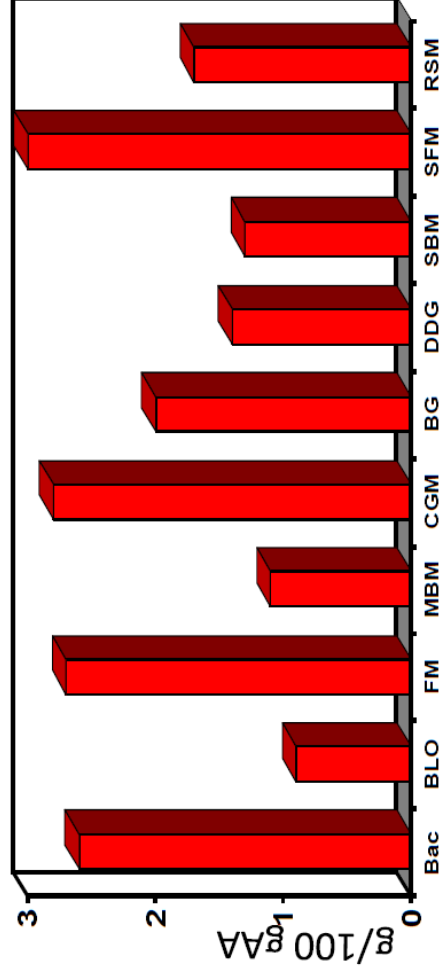
# HYDROLYZED BARLEY



# Lysine in bacteria and supplements



# Methionine in bacteria and supplements



# HYDROLYSED CEREALS : WAY OF ACTION



## pH increase

**An alkaline pH, equal to 9**

- You can raise starch in ration with no acidosis risk
- Protects and stimulate rumen microflora = digestive comfort and health
- The treated cereals can be preserved for up to 1 year



# ZOOTECNICAL EFFECTS ON DAIRY CATTLE



- Up to +1,5L of milk and + 0,1 point of milk protein
- Health and digestive security
- Better feed efficiency

# Conclusion 1 – new trends in buffering the rumen



- Preventing rumen acidosis = preventing milk fat drop
- Traditionnal buffers (soda, etc) are still of interest
- New ways of alkalinizing the ration :
  - Acid neutralization by ammonia through ration alkalizer
  - Hydrolyzed cereals
  - Both techniques also bring soluble protein that can increase microbial protein production
  - Both allow to increase starch → increase milk protein

# Conclusion 2 – decreasing dependance to protein meal is possible



VL - dairy - dairy breed HOLSTEIN Weight kg 700

**kg Milk : 32.8 M.Fat g/L : 43 M.Prot g/L : 34**

Type of feed stuff	kg as fed	kg DM	Nutrients	/ kg DM
			CP g	<b>153</b>
			UFL	0.91
			PDI g	90
			RPB	12
Barley silage	5.00	1.75	Ca g	8.63
Grass silage 17.5% CP	25.00	8.75	P g	3.84
Corn silage 29,8	25.00	7.45	DCAD meQ	276
			DM %	39%
			Conc. %	25%
			Fat g	27.3
HYDROLYZED BARLEY	6.00	4.95	Sugar g	56
R. ALK.	0.30	0.28	Starch g	<b>223</b>
PROTECTED LYSINE + METHIONINE	0.10	0.09	Lys/Met	<b>2.95</b>
Rapeseed meal oil < 5%	1.00	0.89	ADF g	190
			NDF g	350
Mineral premix	0.65	0.65	NDF f %	29.6
Sodium bicarbonate	0.10	0.10	CF g	173
			water need L	83
			Cost Diet € / d	<b>3.39</b>
<b>Total diet kg</b>	<b>63.2</b>	<b>24.9</b>	Milk urea g/L	<b>230</b>