GLOBAL APPLICATION OF MILK QUALITY ANALYTICAL INSTRUMENTS

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DR. DANIEL SCHWARZ, FOSS, DENMARK

02 August 2019, Tainan, Taiwan

ANALYTICS BEYOND MEASURE

MILK TESTING – 60 YEARS OF INNOVATION

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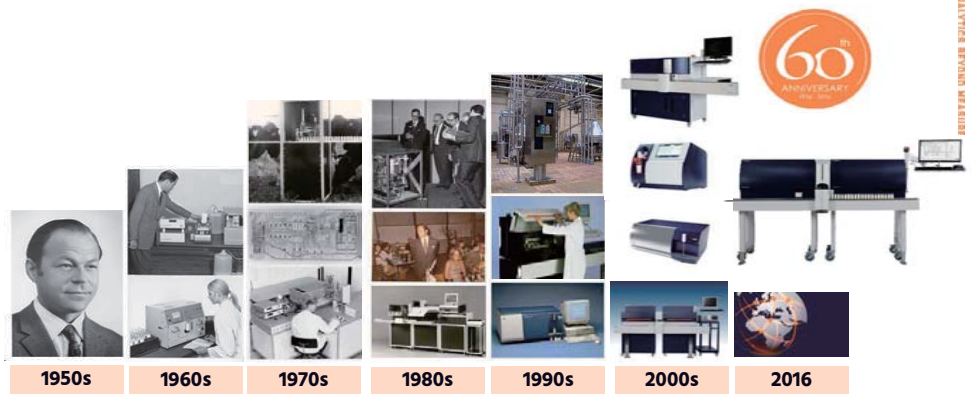

ANALYTICS BEYOND MEASURE

COMBIFOSS 7 DC

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New features:

- Optimized optics and flow system
- Lower working factor
- Performance range

→ *Higher quality of results*

New parameters:

- Differential Somatic Cell Count
- Fatty acid origin profiling

→ *Improved dairy farm management*

ANALYTICS BEYOND MEASURE

COMBIFOSS 7 DC GLOBAL SALES OVERVIEW

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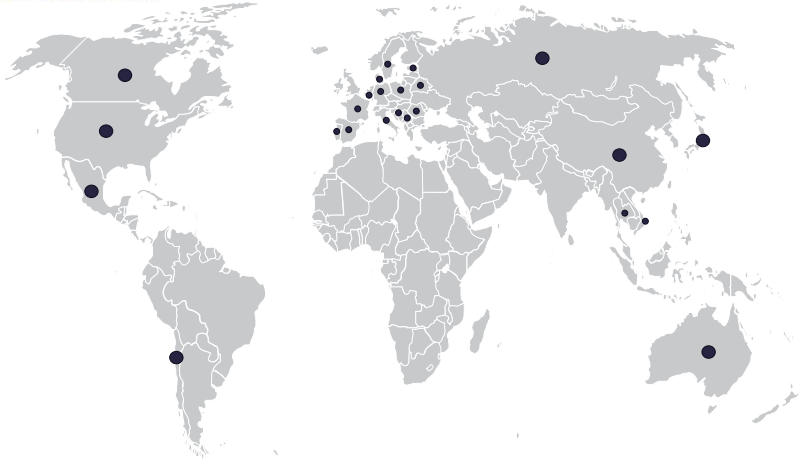

ANALYTICS BEYOND MEASURE

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DIFFERENTIAL SOMATIC CELL COUNT AND MASTITIS MANAGEMENT

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BACKGROUND

SCC – A NEW PARAMETER (1978)

- Investigation of factors affecting SCC:
  - **IMI status**
  - DIM
  - Parity
  - Season
  - Diurnal variations
  - Stress

Can. vet. J. 23:.119-125 (April 1982)

(62). Cell counts in composite samples taken from cows with all four quarters free of infection have been reported to average from 113 000 to 251 000 cells/mL depending on the cow's age (18). Other authors (16,40,55) have reported averages of 170 000 and 214 000 (arithmetic averages) and 106 000 cells/mL (geometric mean). Cows harboring commensals have been reported to have somatic cell counts in composite samples that average from 190 000 to 519 000 cells/mL, depending on the cow's age (18), and an average of 227 000 cells/mL has been reported when all age groups were considered (55). Cows harboring major pathogens produce, on average, cell counts over 600 000 cells/mL (18,41,55,62) although a geometric mean of 492 000 cells/mL has been noted (16). Some variation in the cellular response elicited by various major pathogens has been demonstrated (55,62) but it does not appear possible to differentiate amongst the major mastitis pathogens on the basis of somatic cell count alone.

DEVELOPMENT OF UDDER HEALTH

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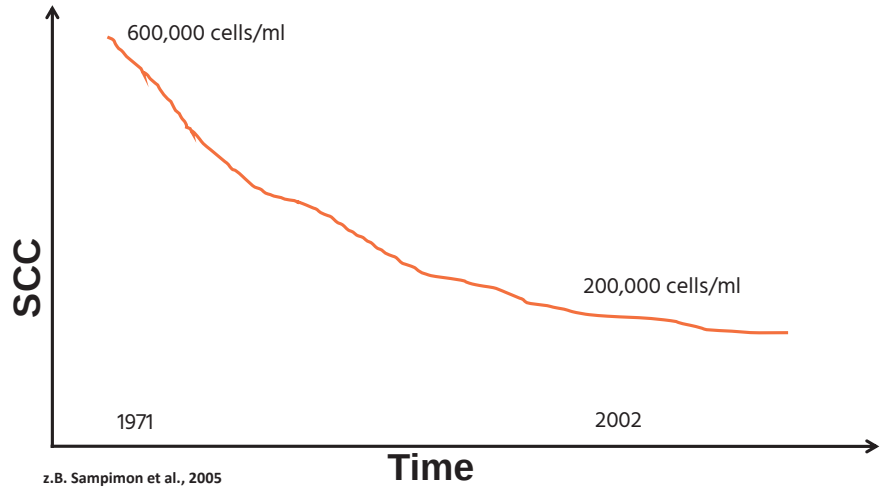

z.B. Sampimon et al., 2005

ECONOMIC LOSSES

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REASONS FOR COWS EXITING HERDS

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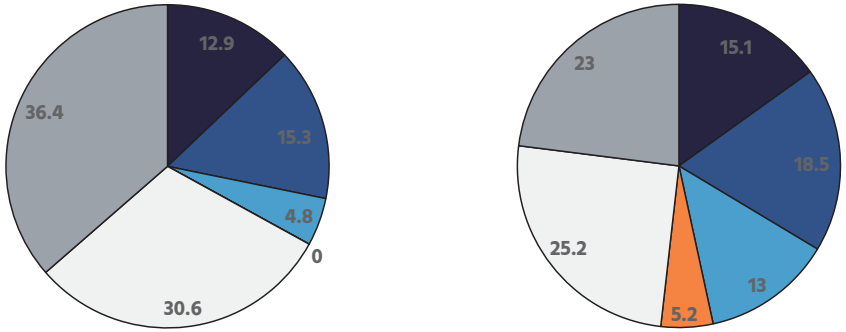
USA



CDCB, 2015;
vit Annual report 2016

MILK CELL DIFFERENTIATION

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DSCC – NEW DEVELOPMENTS

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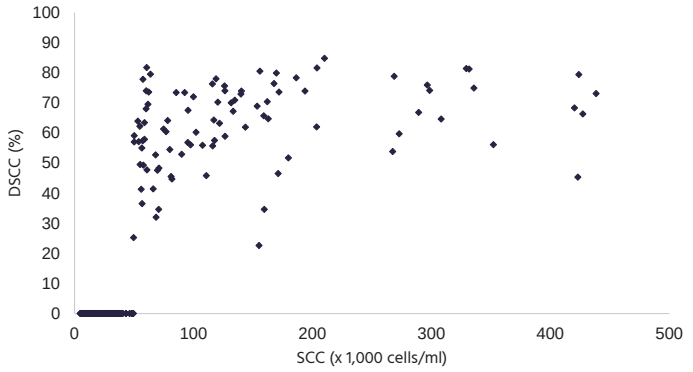
- New high-throughput method for standardised, practical, and cost-efficient determination of DSCC and SCC (Damm et al., 2017)



THE FOSS DSCC METHOD – FOSSOMATIC 7 DC

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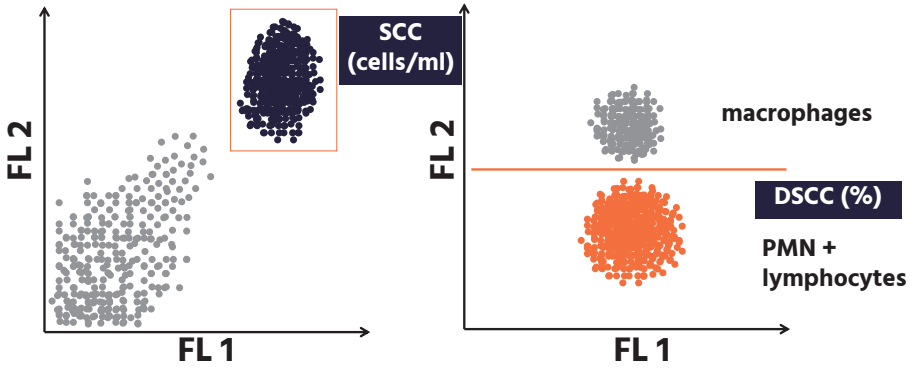
Analysis of SCC | **Analysis of DSCC**



Damm et al., 2017; Schwarz, 2017

Patented technology

MASTITIS CASCADE

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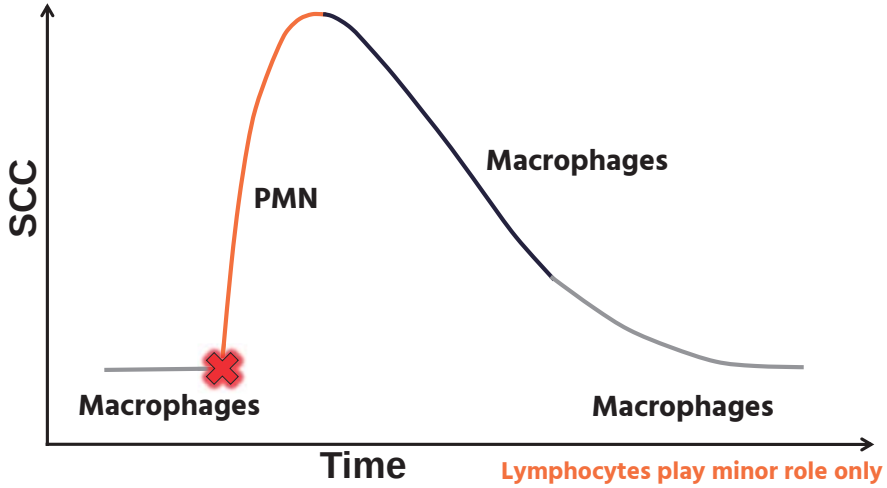

Lymphocytes play minor role only

DSCC – NEW DEVELOPMENTS

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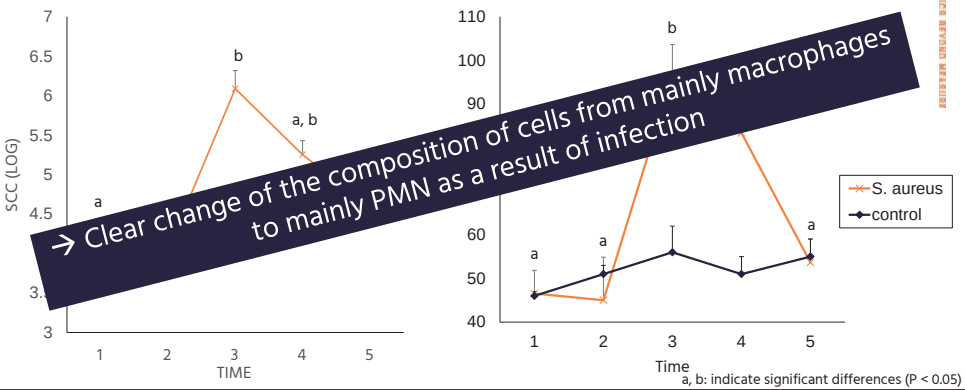
- Development of SCC and DSCC during mastitis under controlled conditions (Wall et al., 2018)



→ Clear change of the composition of cells from mainly macrophages to mainly PMN as a result of infection

a, b: indicate significant differences (P < 0.05)

DSCC – NEW DEVELOPMENTS

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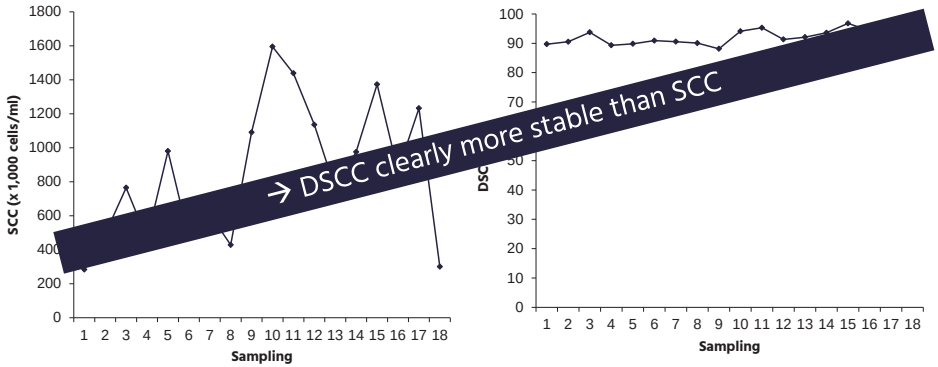
- Development of SCC and DSCC over a period of nine days, example of one *S. aureus* infected cow (not published)



→ DSCC clearly more stable than SCC

OVERVIEW – CURRENT ACTIVITIES AND APPLICATIONS

CANADA

PROJECT DESCRIPTION

- Project partners:

Université de Montréal

valacta

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- Objective: Evalutation of DSCC for mastitis management in the frame of DHI testing/milk recording

DATA SET

- 11 dairy farms, tie stalls
- 969 cows
- 4 monthly testings
- Samples:
  - DHI morning milking
  - DHI evening milking
  - DHI 50% morning, 50% evening
  - Sterile handstrip foremilk samples (1 per cow, evening and morning milking each)

RESULTS – ANOVA

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SCC

Factor	p-value
IMI status	***
Parity	***
DIM	***
Milk weight	***

DSCC

Factor	p-value
IMI status	***
Parity	***
DIM	NS
Milk weight	NS

Random effects in LME: cow within herd and repeated sampling per cow

SCC – IMI STATUS

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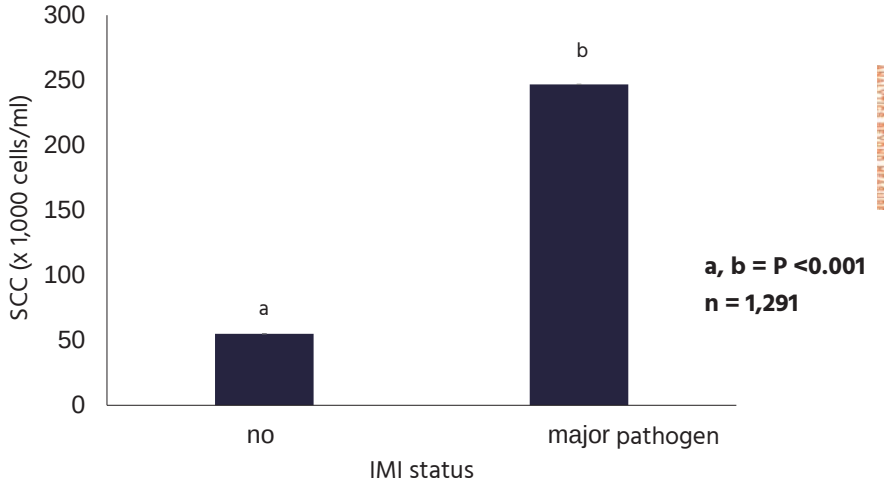

DSCC – IMI STATUS

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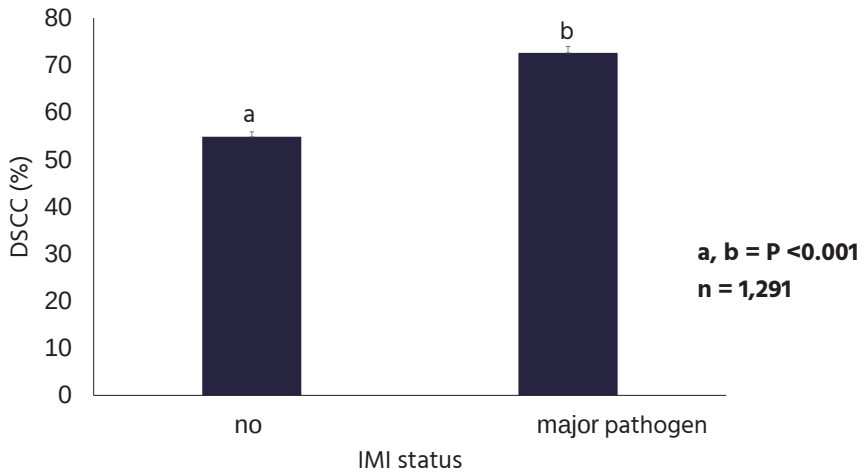

SCC VS DSCC DEPENDING ON IMI STATUS

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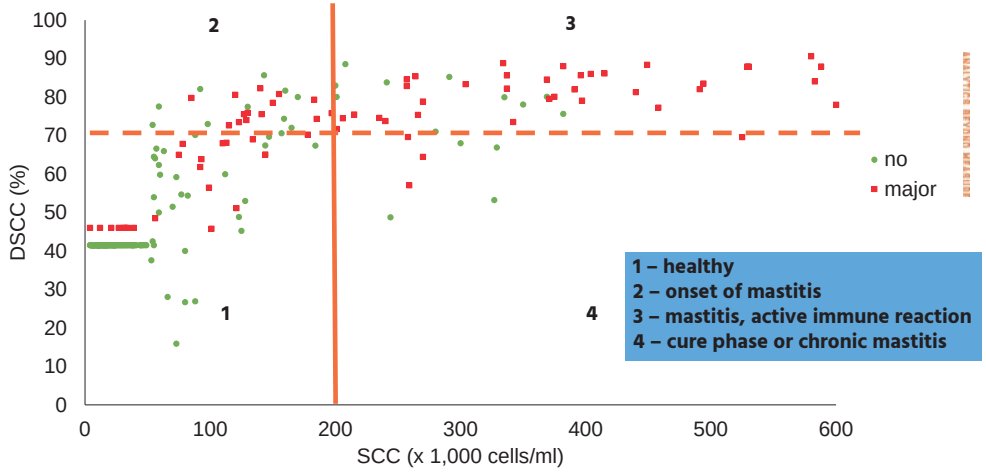

TEST PERFORMANCE – SENSITIVITY AND SPECIFICITY

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No and minor vs. major and other

n = 1,105; Major pathogens (n = 150), other pathogens (n = 37)

	Cut point(s)	Se	Sp
SCC	100,000	65[a]	75[a]
	200,000	52[y]	88[y]
DSCC	70	58	76
	75	50	82
SCC and DSCC*	100,000 and 70%	67[a]	68[b]
	200,000 and 70%	63[z]	73[z]

a,b and y,z = statistically significant (*P <0.01*) difference

Preliminary results, further statistical investigations on-going

*=only cows with SCC and DSCC below optimal cut points considered healthy

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DENMARK

PROJECT DESCRIPTION

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- Project partners:

KØBENHAVNS UNIVERSITET · SEGES · FOSS

- Objective: Investigation of new parameter for mastitis management and development of guidelines on applying such

- Work packages:
  1) Generation of data set
  2) Data analysis
  3) Development of guidelines

DATA SET

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- 2 herds with 180 and 360 cows each
- Monthly collection of samples over a period of one year
- Samples:
  - Quarter foremilk samples (in total around 22,500)
  - DHI samples (in total around 5,500)
- Parameters:
  - SCC and DSCC: all samples
  - Bacteriological culture: all quarter foremilk samples
  - Mastitis PCR: all DHI samples
- All DHI data available

RESULTS

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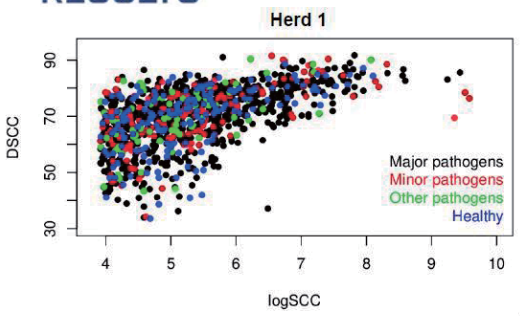
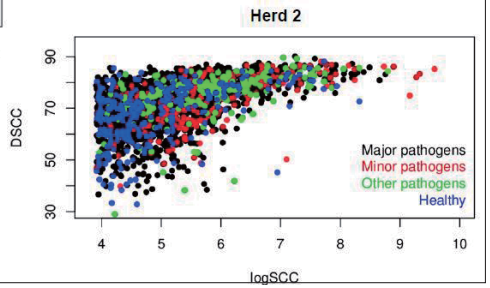


Predominantly IMI by *S. aureus*

Predominantly IMI by *NAS*



OUTLOOK

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- DSCC improves detection of IMI using DHI samples (even when SCC is known)
- More detailed investigation of dynamics of IMI and DSCC as well as SCC
- Evaluation of DSCC and SCC for mastitis management based on bio-economic models

ITALY

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NEW UDDER HEALTH REPORT

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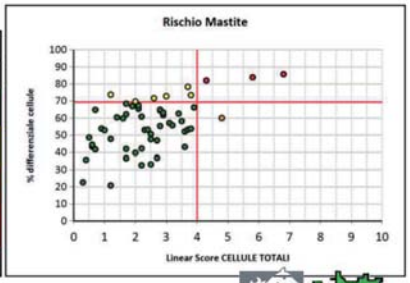
VACCHE STANCHE (> 200 gg Lattazione)

CELLULE TOTALI			CELLULE DIFFERENZIALI		
	Nº Vacche	%		Nº Vacche	%
Sane	51	93	Sane	45	82
			A Rischio	6	11
A Rischio	4	7	Subcliniche a rischio cronicità	1	2
			Con mastite subclinica/clinica	3	5
TOTALE	55	100		55	100

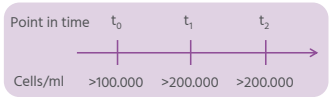


IDF Mastitis Conference 14-16 May 2019 Copenhagen

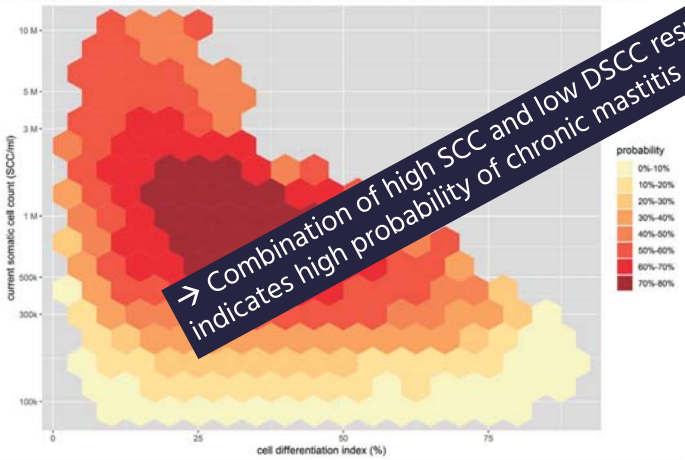
GERMANY

ZELLDIX PROJECT

- Project partners:
- Objective: development of new udder health report including outlook on future udder health
- Data set: approximately 10 million regular milk recording test days
- Approach:



RESULTS – PROBABILITY FOR CHRONIC MASTITIS



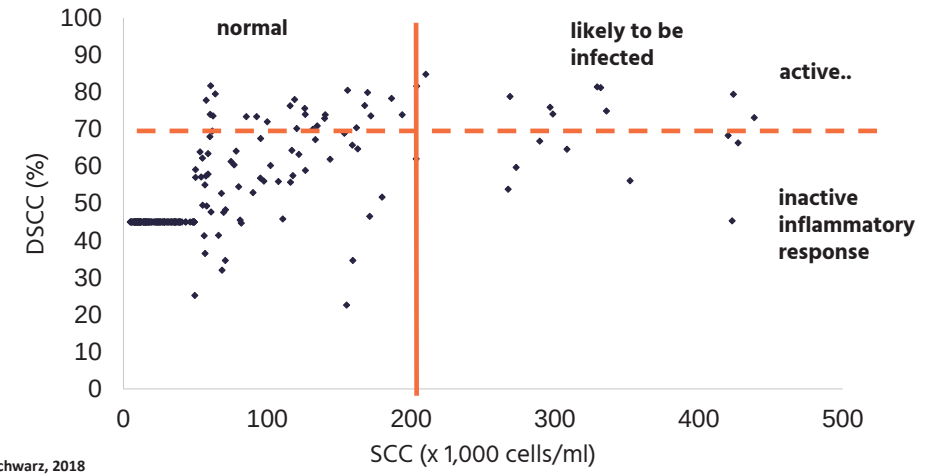
CDI = 100 - DSCC

OUTLOOK

- Models combining DHI results from multiple test days to generate risk lists developed and currently tested in pilot farms
- Evaluation of results from study with accurate IMI status (i.e. bacteriological culture) – focus on DSCC

SUMMARY

SCC AND DSCC DATA



Schwarz, 2018

POSSIBLE PRACTICAL APPLICATIONS

- Improved mastitis screening and management (e.g. early detection, identification of chronic cases)
- Optimisation of selective dry cow therapy
- Targeted selection of milk samples for bacteriological analysis (e.g. mastitis PCR)

A MESSAGE TO TAKE HOME – DSCC

Solid concept (well-founded in scientific literature)

From Science to Practise

Possible practical applications to be investigated and developed further in field trials

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MILK FATTY ACID ANALYSIS AND DAIRY COW NUTRITION

ANALYTICS BEYOND MEASURE

EVOLUTION OF UNDERSTANDING OF MILK FATTY ACIDS

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ANALYTICS BEYOND MEASURE

- **1897** • Question of the origins of milk fat (wholly from diet or synthesised by animal)? (Jordan and Jenter, 1897)
- **1947** • Leading theory: Short-chain fatty acids arise from degradation of oleic acid (Hilditch, 1947)
- **1951** • De novo synthesis of short-chain fatty acids proven (Popjak et al., 1951)
- **1990** • Detailed determination of origin of fatty acids completed (e.g., Palmquist, 2006)
- **2000s** • Fatty acid profiling (chain length, degree of saturation, major fatty acids) using FTIR technology (FOSS) → Practical applications: Focus on milk processing/dairy product aspects
- **2010s** • Practical applications: Fatty acid profiling with focus on dairy cow nutrition (Visiolait project)

FATTY ACID CALIBRATIONS

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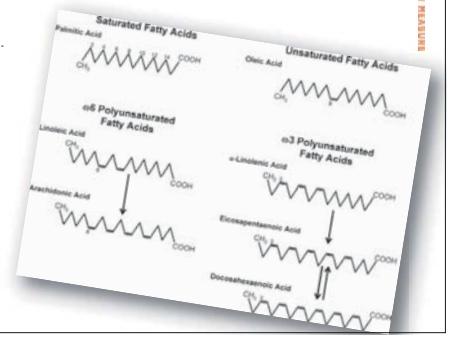
ANALYTICS BEYOND MEASURE

Package I

- Degree of unsaturation
  - Saturated Fatty Acids (SFA)
  - Mono Unsaturated Fatty Acids (MUFA)
  - Poly Unsaturated Fatty Acids (PUFA)
  - Trans FA

Package II

- Chain length
  - Short Chain Fatty Acids (SCFA): $C_{4:0}$, $C_{6:0}$, $C_{8:0}$, $C_{10:0}$
  - Medium Chain Fatty Acids (MCFA): $C_{12:0}$, $C_{14:0}$, $C_{16:0}$
  - Long Chain Fatty Acids (LCFA): $C_{18:0}$, $C_{18:1}$, $C_{18:2}$
- Major fatty acids
  - $C_{14:0}$
  - $C_{16:0}$
  - $C_{18:0}$
  - $C_{18:1}$



NEW 2019: FATTY ACID ORIGIN PACKAGE

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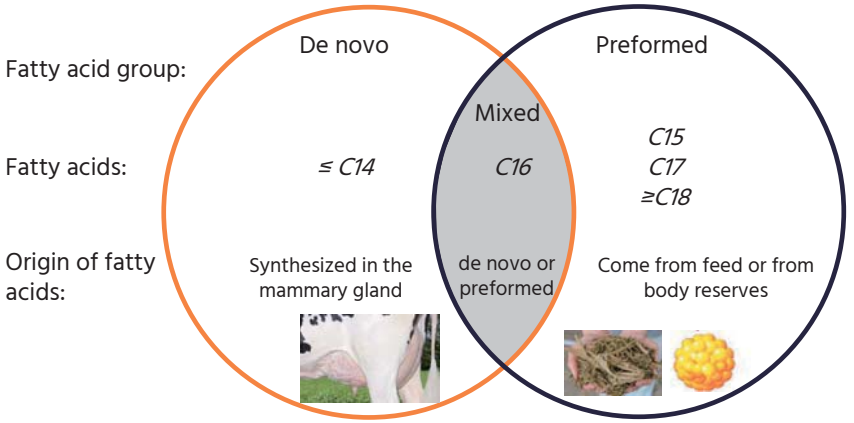
ANALYTICS BEYOND MEASURE



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POTENTIAL PRACTICAL APPLICATIONS

REAL LIFE EXAMPLES

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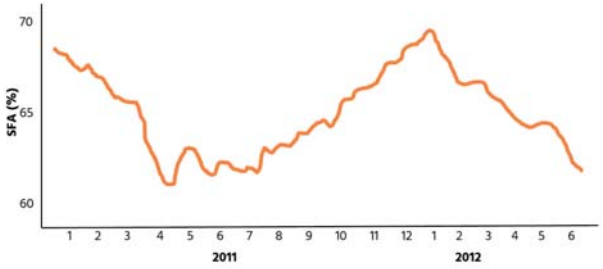
- Visiolait – optimisation of feeding:
  - Energy and protein efficiency
  - Rumen activity
  - Health and fertility

→ Used successfully in France and Germany

- National milk laboratories, UK:
  - Fatty acid profiling as basis for production of value-added dairy products



REAL LIFE EXAMPLE
FAT AND PROTEIN VS DE NOVO FA

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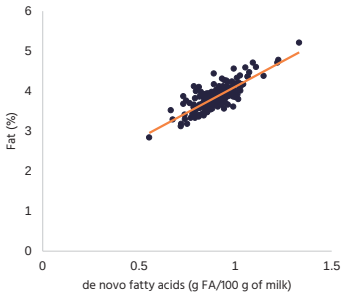

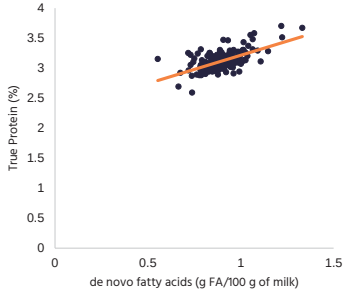

→ 200 dairy farms, 1 test per farm

High **fat %** associated with high de novo contents
→ increased function of rumen as well as production of volatile fatty acids

High **protein %** associated with high de novo contents
→ Increased microbial fermentation as well as microbial protein synthesis

→ Opportunity for dairy farmers to increase revenue and profit

FAT AND FATTY ACID PROFILE

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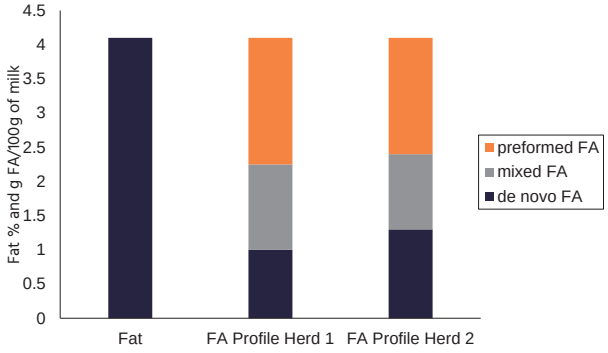
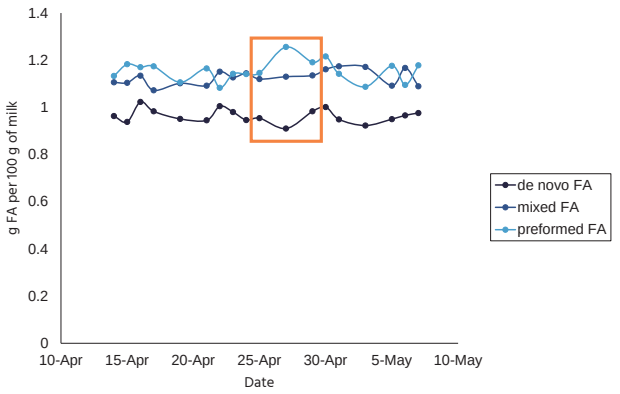
- Example: Herd level



WHAT IMPACT DOES THIS HAVE ON DAIRY HERD MANAGEMENT?



What happened?
- Cows started mobilizing
- De novo synthesis went down

Reason?
Change in silage quality (more fibre/less digestible)

Idea:
Changes in fatty acid profile can be noticed a few days before milk or fat yield start to decrease

→ Dairy farmer can react EARLIER and save $$$

By courtesy of Debora Santschi

MISCELLANEOUS

ICAR 2019 CONFERENCE – FOCUS ON NEW TOOLS

Hall Panorama

8:30-10:30	**Technical Session 7** **Challenges in Creating Additional Value from Milk Analysis** **Chairpersons: Silvia Orlandini and Jere High**
8:30-8:50	S07(T)-OP-1 **Additional value of cell differentiation in the course of DHI testing** Folkert Onken
8:50-9:10	S07(T)-OP-2 **Pregnancy testing in dairy cows using a PAG test in milk samples: Different thresholds for different stages of the pregnancy** Daniel M. Lefebvre
9:10-9:30	S07(T)-OP-3 **New quality assurance challenges with recent mid-infrared models** Frédéric Dehareng
9:30-9:50	S07(T)-OP-4 **Implementation of a routine Fourier-transform infrared procedure for fatty acid analysis in milk** Daniel M. Lefebvre
9:50-10:10	S07(T)-OP-5 **Routine infrared phosphorous determination in ex-farm milk giving better insight in the phosphorous cycle on dairy farms** Harrie van den Bijgaart
10:10-10:30	Question and Discussion

A MESSAGE TO TAKE HOME

- Raw milk samples hold a wealth of information – milk quality and dairy herd management
- Focus on new innovative solutions (e.g. DSCC) and the implementation of those
- Provide dairy farmers with better information for decision making as basis for production of milk of high quality

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Dedicated Analytical Solutions

MILK TESTING IN EUROPE: PAYMENT SYSTEMS

Dr. Daniel Schwarz, FOSS, Denmark

Tainan, 02 August 2019

Dedicated Analytical Solutions

FAO RECOMMENDATIONS

Table 7: examples of rejection and deduction levels for cow milk:

	Rejection level	Deduction level	Unit
Fat	<3.0	3.0 - 3.2	%
SNF	<8.2	8.2 - 8.5	%
Total Solids	>12.0	10.0 - 12.0	%
Water	<1.027	1.027 - 1.028	Density at 15 C
or	>1.036	1.035 - 1.036	Density
or	>-0.520	-0.520 to -0.525	°C freezing point
or	>10	5 - 10	% excessive water
Preservatives	none	none	
Antibiotics	0.0006		i.u. / ml
Temperature			°C
pH	<6.4	6.4 - 6.5	
Clot on boiling	Positive test	-	
Alcohol test	Positive test	-	
Titratable acidity	0.20	0.18	% lactic acid
10 min Resazurin	0 and 1	2 and 3	Disc numbers
Methylene blue	<30	30 - 60	Minutes
Bacterial count	>750	500 - 750	(x1,000 CFU/ml)
Somatic cell count	>1,000	750 - 1,000	(x1,000 CFU/ml)

Note: these are examples only and should be adjusted to your local situation!

Milk Testing and Payment Systems

Resource Book

a practical guide to assist milk producer groups

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EU REGULATIONS

REGULATION (EC) No 853/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 29 April 2004

laying down specific hygiene rules for on the hygiene of foodstuffs

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION

3. (a) Food business operators must initiate procedures to ensure that raw milk meets the following criteria:

(i) for raw cows' milk:

Plate count at 30 °C (per ml)	≤ 100 000 (*)
Somatic cell count (per ml)	≤ 400 000 (**)

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ARLA, EUROPE

Parameter	Frequency	Class	Class limit	Premium/deduction % of raw milk value
Fat and protein	Each collection day			
Somatic cell count (SCC)[1] (1000 cells/ml)	Each collection day	1S 1E 1B 2 3	- 200 201 - 300 301 - 400 401 - 500 501 -	+ 2 % + 1 % 0 % - 4 % - 10 %
Total bacterial count (TBC)[1] (1000 bacteria/ml)	4-5 times a month	1E 1B 2 3	- 30 31 - 50 51 - 100 101 -	+ 1 % 0 % - 4 % - 10 %
Spores Spores/litre	2 times a month	1E 1B 2	- 400 401 - 4000 4001 -	+ 1 % 0 % - 4 %[2]
Antibiotics	Five times a month	Negative 3		[3]
Visibly abnormal milk	Each collection day	Negative 3		0 % - 10 %[4]
Smell and taste	(See Section 75)	Negative 3		0 % - 10 %[5]
Freezing point	Every fourth week		(None – only informative)	
Urea	Each collection day		(None – only informative)	

Arla

Arlagården® Quality Assurance Programme

FOSS

ARLA MILK PRICE

Arlapris december 2016

4,2% fedt og 3,4% protein. DKK øre/kg mælk.

	Konventionel	Øko
Fedtpris (DKK/kg fedt)	25,03	25,03
Proteinpris (DKK/kg protein)	40,04	40,04
Kg-afhængige omkostninger (DKK øre/kg mælk)	– 10,00	– 10,00
Råvareværdi	231,2	231,2
Bedste kvalitet (4 %)	+ 9,3	9,3
Økotillæg	+	112,8
Non GM foder	+ 7,5	
Acontopris	248,0	353,3
Forventet gns logistiktillæg	+ 0,8	0,8
Forventet gns øvrige tillæg og fradrag*	+ 0,2	0,2
Forventet gns efterbetaling og rente	+ 7,6	7,6
Forventet gns konsolidering	+ 9,6	9,6
Arlapris	266,2	371,5

*Gennemsnit af andre tillæg og fradrag som basisomkostninger, markedstillæg og transportrelaterede tillæg.

Price calculator

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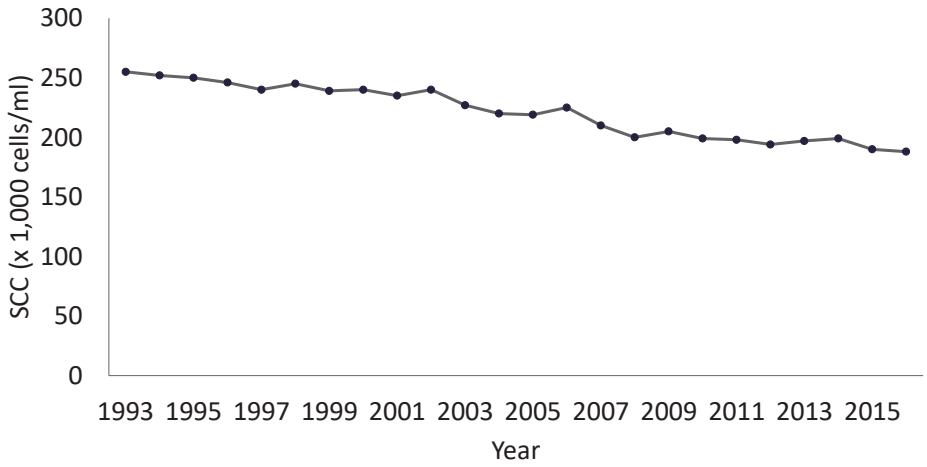
BULK TANK MILK QUALITY IN GERMANY



Data from federal state Hesse only – 160,000 cows, 2,000 dairy farms, 8,500 kg/cow and year

FOSS

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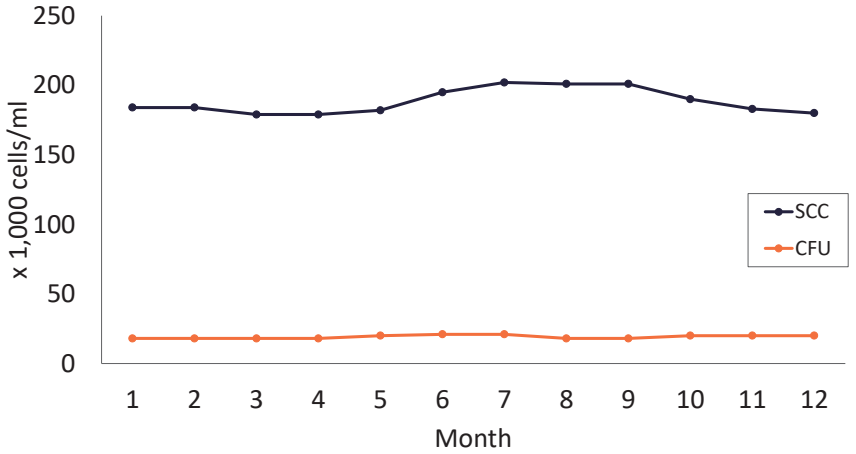

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