UNIVERSITY OF AGRICULTURE IN KRAKOW

PFHBiPM

Novel model of monitoring of subclinical ketosis in dairy herds in Poland based on monthly milk recording and estimation of ketone bodies in milk by FTIR spectroscopy

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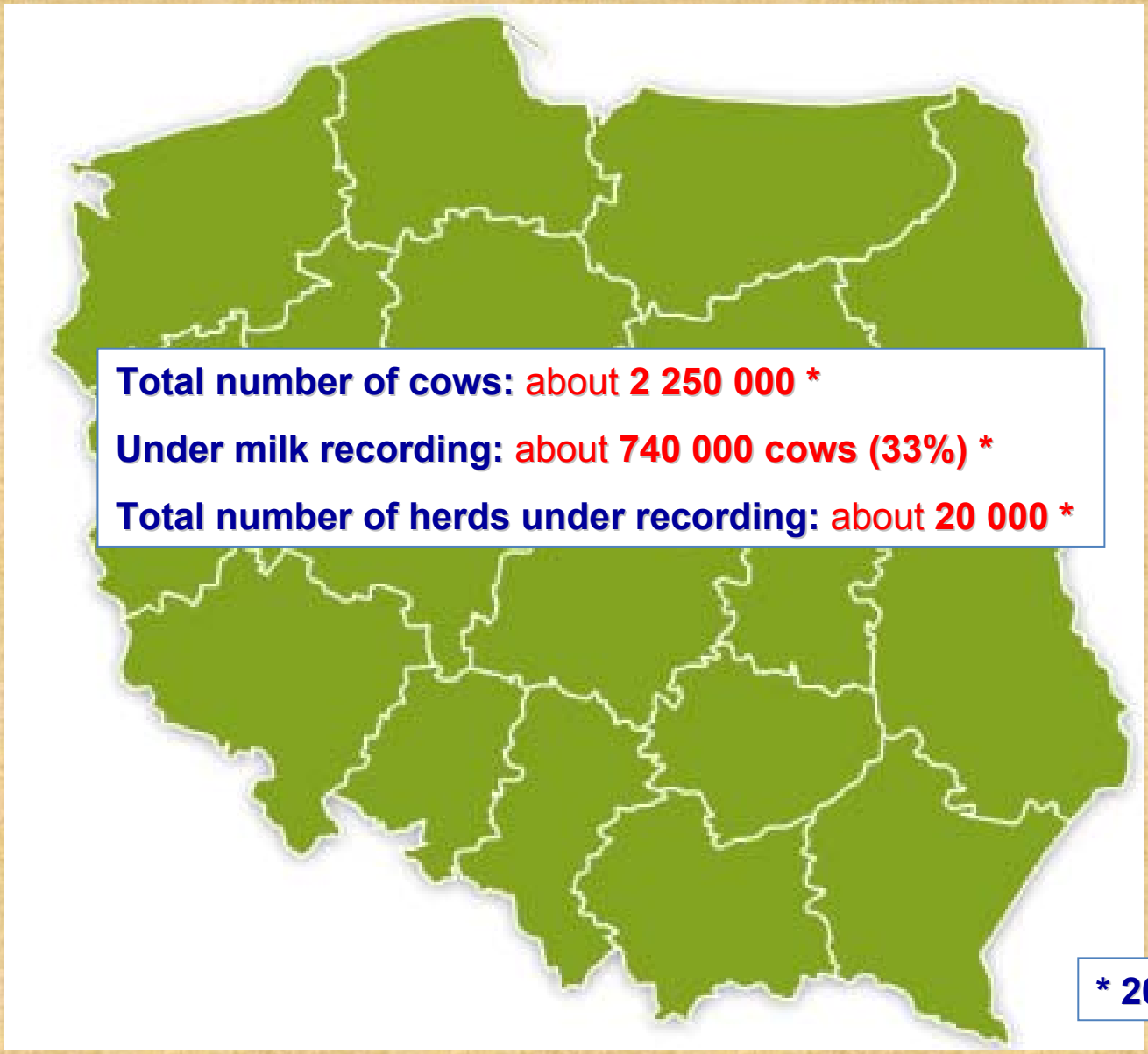
ICAR 2015 TECHNICAL WORKSHOP

10-12 June, 2015, Krakow, Poland

Important facts…….



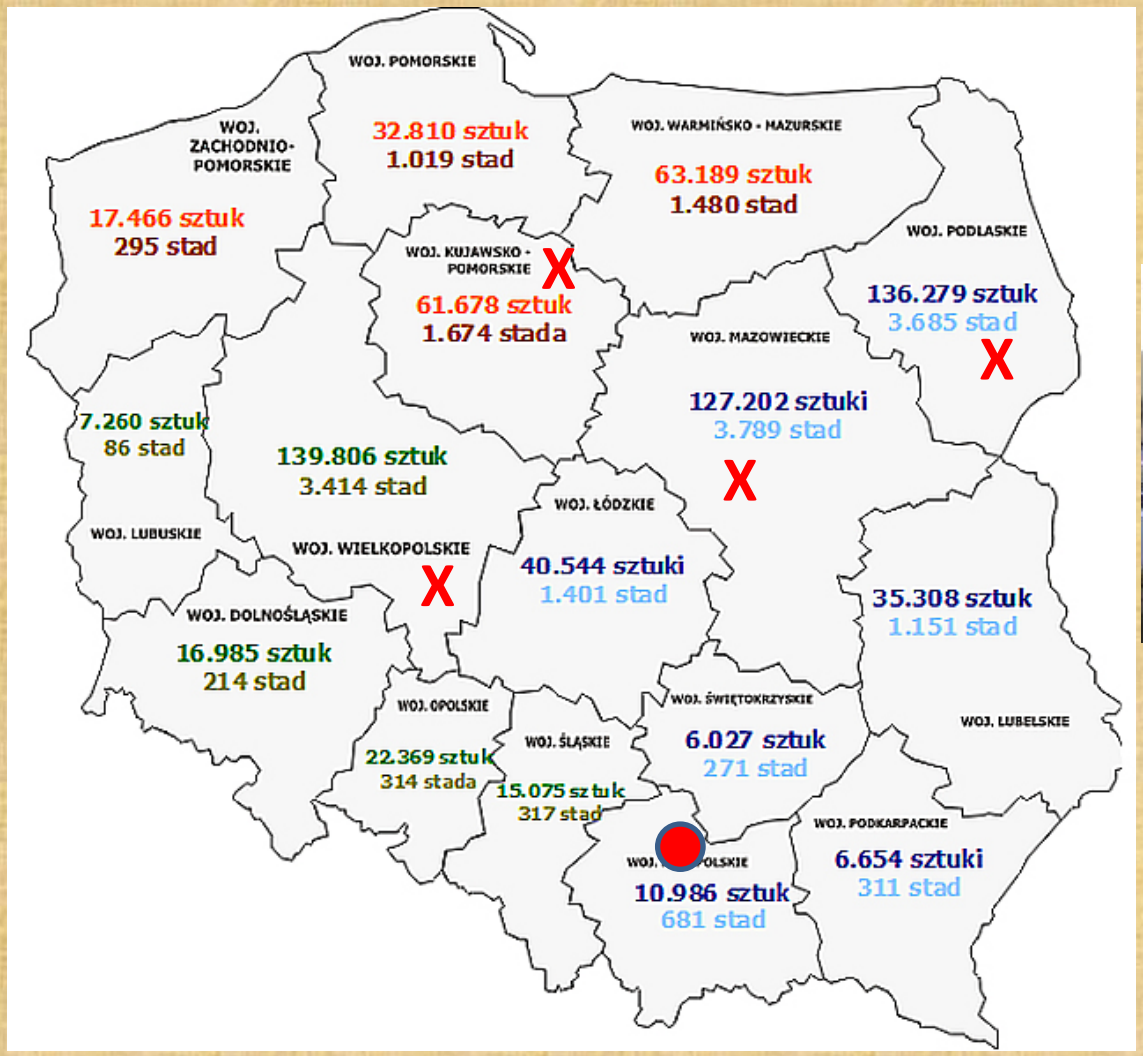
Total number of cows: about **2 250 000** *

Under milk recording: about **740 000 cows (33%)** *

Total number of herds under recording: about **20 000** *

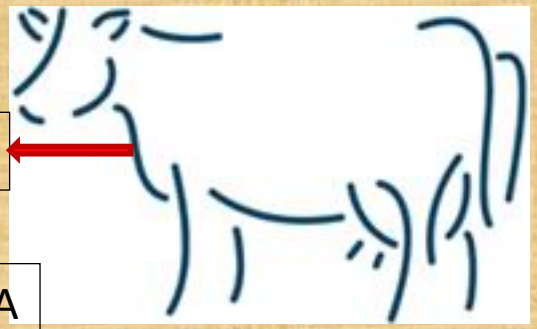
* 2014-12-31

Important facts…….



„X” – 4 laboratories with new CombiFoss FT+ using FTIR

Diagnosis of subclinical ketosis (SCK)



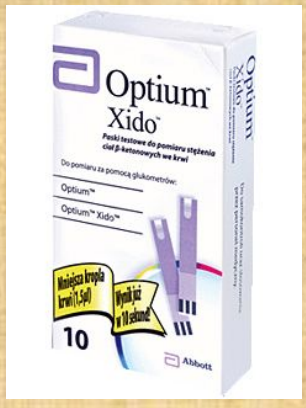
Blood sample

Determination of BHBA

DIAGNOSIS

ill
(BHBA>1,4*)

healthy
(BHBA<1,4)



*mM/L

Working together….

Our aim was

to create a cheap, easy and massive monitoring method of dairy herds for SCK

To give the information on:

- risks of individual cows
- risk of herds,
- reasons and risk factors for SCK

General points

Monthly milk recording (A4, AT4 and A8 methods)

Identification of risky cows at a day when milk control was performed – within 5-60 days in milk

Identification of risky herds

~~Diagnosis~~ Estimation of subclinical ketosis (SCK)

Blood sample

Determination of BHBA

DIAGNOSIS

ill
(BHBA>1,4*)

healthy
(BHBA<1,4)

Milk sample

Parameters determined:
Fat [%]
Protein [%]
BHBA [mM/L]
Acetone [mM/L]
……..

ESTIMATION

ill
(assumption)

healthy
(assumption)

**mM/L*

Developing of the model

- BHBA in the blood was a dependent variable; milk composition parameters, including $BHBA_M$ and acetone (ACE_M) were independent variables – ~1100 cows

Item	Mean	SD	Min	Max
N cows		1091		
N cows with ketosis[1]		153		
Milk, kg/d	30,9	8,9	5,2	63,0
Fat, %	4,64	1,03	2,00	8,99
Protein, %	3,29	0,36	2,33	5,87
Lactose, %	4,79	0,25	3,04	5,35
Urea, mg/L	195	74	0	439
Log SCC[2]	2,30	0,67	0,90	4,36
Milk fat-to-protein ratio (F/P)	1,42	0,31	0,62	2,86
$BHBA_M$[3], mM/L	0,10	0,14	0,00	2,84
ACE[4], mM/L	0,14	0,19	0,00	3,23
$BHBA_B$[5], mM/L	0,81	0,64	0,18	4,15

[1] Cows having $BHBA_B$ concentration more than 1,4 mmol/L.
[2] Logarithm of somatic cell count.
[3] Milk concentration of β-hydroxybutyrate acid.
[4] Milk concentration of acetone.
[5] Blood concentration of ß-hydroxybutyrate acid.

Developing of the model

- Analysis of logistic regression with the option of backward elimination
- It was assumed that a cow was ketotic (depended variable) when BHBA in the blood was > 1.2 or 1.4 mM/L.

Table x. Characteristics of the models: r^2 and model fit statistics when SCK was diagnosed at $BHBA_B$ > 1.2 mmol/L or 1.4 mmol/L ($BHBA_B$ – blood β-hydroxybutyrate concentration)

Model	$BHBA_B$ > 1.4 mmol/L				$BHBM_B$ > 1.2 mmol/L			
	r^2	Model Fit Statistics			r^2	Model Fit Statistics		
		Criterion	Intercept only [1]	Intercept and covariates [2]		Criterion	Intercept only	Intercept and covariates
BHBA	0,218	AIC [3]	693,7	483,7	0,2291	AIC	795,3	573,3
		SC [4]	698,5	493,2		SC	800,1	582,9
ACE	0,2205	AIC	693,7	481,3	0,2332	AIC	795,3	568,7
		SC	698,5	490,8		SC	800,1	578,2
F/P	0,0958	AIC	693,7	609,1	0,111	AIC	795,3	695,7
		SC	698,5	618,6		SC	800,1	705,2
BHBA, ACE	0,2540	IC	693,7	445,3	0,2674	AIC	795,3	531,5
		SC	698,5	459,5		SC	800,1	545,7
BHBA, ACE, F/P	0,2542	AIC	693,7	447,2	0,2677	AIC	795,3	533,0
		SC	698,5	466,3		SC	800,1	552,0

[1] Intercept only refers to the respective criterion statistics with no predictors in the model (the response variable).
[2] Intercept and Covariates corresponds to the respective criterion statistics for the fitted model which includes all independent variables and the intercept.
[3] AIC = -2 Log L + 2((k-1) + s) Akaike Information Criterion; ultimately, the model with the smallest AIC is considered the best.
[4] SC =2 Log L + ((k-1) + s)*log(Σ fi),Schwarz Criterion; SC penalizes for the number of predictors in the model and the smallest SC is most desirable.

Developing of the model

- Analysis of logistic regression with the option of backward elimination
- It was assumed that a cow was ketotic (depended variable) when BHBA in the blood was > 1.2 or 1.4 mM/L.

Sensitivity and specificity at optimal cut off probability

Model	$BHBA_B$ > 1.4 mmol/L							$BHBA_B$ > 1.2 mmol/L						
	Cut off probability	No of observations				Sensivity, %	Specificity, %	Cut off probability	No of observations				Sensivity, %	Specificity, %
		positive	negative	false positive	false negative				positive	negative	false positive	false negative		
BHBA	0,08	105	510	233	13	88,98	68,64	0,10	126	506	206	23	84.56	71.07
ACE	0,08	106	505	237	13	89,08	68,06	0,10	125	512	200	24	83.89	71.91
F/P	0,11	92	479	263	27	77,31	64,56	0,16	114	597	115	35	76,51	83,85
BHBA, ACE	0,07	107	529	213	12	89,92	71,29	0,09	129	473	239	20	86.58	66.43
BHBA, ACE, F/P	0,07	107	527	215	12	89,92	71,02	0,09	129	473	239	20	86.58	66.43

Developing of the model

- By elimination the following parameters were included in the model:

variable	regression coefficient	P-value
Intercept	-3.6336	<0.001
ACE_M [mM/L]	6.3874	<0.001
$BHBA_M$ [mM/L]	10.9514	<0.001
F/P ratio	0.4507	0.035

- The model uses data from cows in 5-60 days in milk (two first test days)

Identification of cows at risk of SCK

Blood sample

Determination of BHBA

Milk sample

Parameters determined:
Fat [%]
Protein [%]
BHBA [mM/L]
Acetone [mM/L]
……..

DIAGNOSIS

ill
(BHBA>1,4*)

healthy
(BHBA<1,4)

≠

ESTIMATION

„ K! ”
She was ill

„ not K! ”
She was healthy

**mM/L*

Identification of cows at risk of SCK

Cows considered as in SCK are marked as **K!**

=

„There is a cosiderable (> 70%) probability, that in the milk sampling day this cow suffered from subclinical ketosis"

Estimation of **K!** is not equal with the diagnosis of ketosis !

Identification of cows at risk of SCK – shown in the monthly milk recording reports (RW-2)

Data 13-08-21 | WYNIKI UŻYTKOWOŚCI MLECZNEJ KRÓW | POLSKA FEDERACJA HODOWCÓW
RW-2 | **WYNIKI PRÓBNYCH UDOJÓW** | BYDŁA I PRODUCENTÓW MLEKA
Str 1 | Numer obory **99-9999-9** | metoda oceny **AT-4** | data próby **08-08-21**

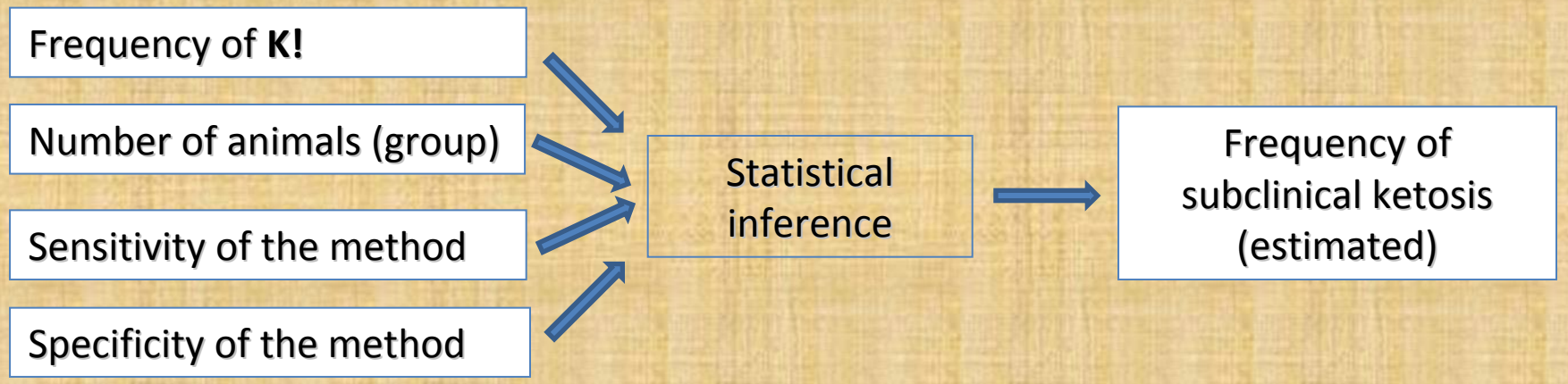
Lp.	Krowa / Ojciec	Urodzona / Wycielona	Wyniki próbnych udojów	12/06	01/04	02/08	03/06	02/04	02/05	06/06	07/05	08/01	09/03	10/03	11/05	Wydajność			Zdarzenia
1.	PL-005015897184	Ur. 07-03-05	ml	23,0	22.4	20.6	15.4	18.8	12.2	18.0	CH	ZAS	ZAS	ZAS	26.8	dd	8		W. 04 13-10-28
	MECKA2		%tł	5.24	3.87	4.61	4.98	4.88	5.11	4.74					7.98	kg ml	214		
K!	nr. oborowy **1111**		%bi	3.89	3.49	4.35	4.33	4,00	4.28	4.28					3.15	kg tł	17		
	ks.GŁÓWNA	W 13-08-08	%lak	4.37	4.84	4.68	4.52	4.67	4.59	5.06					4.42	%tł	7.98		
		nr laktacji 4	%sm	14.24	12.86	14.5	14.69	14.43	14.94	14.55					16.33	kg bi	9		
	PL-005074178587		mocz	165	198	239	179	153	145	53					129	%bi	4.42		
	DOLBY	okmw. 510	ks	159	468	946	284	2914	415	1207					261	kg sm	35		
			tł/bi	1.35	1.11	1.12	1.15	1.22	1.19	1.11					**K!**	% sm	16.33		
2.	PL-005015897254	Ur. 09-12-05	ml	40.2	24	34.2	21.4	22.2	21.4	ZAS	ZAS	31	26.6	32	21.8	dd	115		
	nr. oborowy **1112**		%tł	3.68	3.41	3.27	3.83	3.15	3.59			3.2	3.25	3.13	3.28	kg ml	3306		
	CIERWONA2		%bi	2.94	3.09	3.2	3.12	3.33	3.7			2.71	2.7	2.8	2.89	kg tł	106		
		W.13-07-13	%lak	4.56	4.58	4.57	4.75	4.70	3.74			4.19	4.41	4.58	4.44	%tł	3.2		
		nr laktacji 2	%sm	12.00	11.81	11.91	12.52	11.99	12.10			11.01	11.13	11.27	11.35	kg bi	91		
	PL-005038951539		mocz	206	317	245	166	85	130			132	287	208	611	% bi	2.75		
	FLAKON		ks	269	383	308	468	696	8755			3079	777	357	3.39	kg sm	369		
			tł/bi	1.25	1.10	1.02	1.23	0.95	0.97			1.18	1.20	1.12	1.13	% sm	11.16		
3.	PL-005015897313	Ur. 08-03-04	ml	25.4	20.0	28.2	20.2	24.6	ZAS	ZAS	30.4	15.8	34.8	41.6	35.6	dd	132		
	BYSTRA 3		%tł	3.40	3.54	3.61	3.96	4.10			5.6	4.36	3.61	2.72	3.25	kg ml	4152		
	nr. oborowy **1113**		%bi	3.51	3.51	3.48	3.95	3.89			3.78	2.66	2.98	3.20	3.31	kg tł	153		
	ks.GŁÓWNA	W.13-06-26	%lak	4.90	4.86	5.04	4.95	4.86			4.64	4.66	4.98	5.07	5.09	%tł	3.69		
		nr laktacji 3	%sm	12.53	12.64	12.91	13.73	13.80			14.62	12.51	12.30	11.60	12.34	kg bi	132		
	PL-000609028241		mocz	155	266	200	126	170			187	151	317	175	41	% bi	3.19		
	SUREN		ks	38	44	80	94	73			116	41	91	14	27	kg sm	519		
			tł/bi	0.97	1.01	1.04	1.00	1.05			**K!**	**K!**	1.21	0.85	0.98	% sm	12.49		
4.	PL-005015897324	Ur. 11-02-03	ml								25.2	35.0	30.4	37.2	19.4	dd	129	**100**	
	DIKSA 20		%tł								4.16	3.41	4.57	2.89	4.83	kg ml	4054	**3204**	
	nr. oborowy **1114**		%bi								3.72	2.85	3.19	3.27	3.54	kg tł	151	**121**	
		W.13-06-29	%lak								4.66	4.95	4.80	4.81	4.82	%tł	3,73	**3,78**	
		nr laktacji 1	%sm								13.28	11.87	13.21	11.7	13.88	kg bi	130	**102**	
	PL-000607074648		mocz								112	200	305	100	308	% bi	3,22	**3,18**	
	CAPO		ks								572	215	596	170	315	kg sm	505	**400**	
			tł/bi								1.12	1.20	1.43	0.88	1.36	% sm	12,46	**12,48**	ks. WSTĘPNA
5.	PL-005015897335	Ur. 10-03-13	ml	22,2	20,1	21,7	17,4	22,4	12,7	16,2	13	16,8	9,6	15,7	ZAS	dd	**439**	305	ZAS 13-10-21
	BYSTRA4		%tł	2,07	2,45	2,64	2,04	2,55	3,53	3,61	3,66	3,83	3,88	3,6		kg ml	**15283**	11524	
	nr. oborowy **1115**		%bi	3,05	3,13	3,29	3,39	3,25	3,29	3,43	3,07	3,22	3,83	4,42		kg tł	**446**	306	
	ks.GŁÓWNA	W.12-08-09	%lak	4,88	4,85	5,29	5,16	5,05	5,09	4,91	5,04	4,94	5,12	5		%tł	**2,92**	2,66	
		nr laktacji 1	%sm	10,6	11	11,7	11	11,4	12,6	12,6	12,3	12,6	13,3	13,5		kg bi	**505**	368	
	PL-005053032480		mocz	285	356	359	20,3	320	357	169	318	97	161	28		% bi	**3,3**	3,19	
	GRANT		ks	88	50	38	190	28	39	67	176	126	153	411		kg sm	**1801**	1317	
			tł/bi	0,68	0,78	0,8	0,60	0,78	1,07	1,05	1,19	1,19	1,01	0,81		% sm	**11,79**	11,42	

okmw-okres międzyw ycieleniow y/**w1w**-w iek pierw szego w ycielenia; **dd**-dni doju; *-w ynik w ątpliw y; **-w ynik nieoznaczony; **tł/bi**-stosunek %tłuszczu do %białka; NLAK - okres nielaktacyjny
rc-rama ciała **sm**-siła mleczności **kp**-kaliber i pojemność **ka**-kaliber **tb**-typ i budow a **nr**-nogi i racice **wy**-w ymię **um**-umięśnienie **og**-ogółem

Identification of herd at risk of SCK

The degree of SCK risk in the herd is determined by:

- frequency of ill cows in the group of cows 5-60 DIM
- number of cows
- sensivity and specificity of the method



Identification of herd at risk of SCK

Information about the risk for herd in the main raport RW-1:

„**Attention**: a herd at risk of subclinical ketosis!”

=

There is a considerable (>90%) probablity, that
prevalence of subclinical ketosis was > 10%

or

„**Attention**: a herd at high risk of subclinical ketosis!”

=

There is a considerable (>90%) probablity, that
prevalence of subclinical ketosis was > 20%

Identification of herd at risk of SCK – shown in the monthly milk recording reports (RW-1)

ZETO Olsztyn
Data 13-11-14
RW-1

WYNIKI UŻYTKOWOŚCI MLECZNEJ KRÓW
WYNIKI STADA – SPRAWOZDANIE OKRESOWE

POLSKA FEDERACJA
HODOWCÓW BYDŁA
I PRODUCENTÓW MLEKA

Numer obory **99-99999** metoda oceny **AT4** data próby **12-10-12**

HODOWCA BYDŁA MLECZNEGO UL. KUKURYDZIANA 3 KOWALE 99-999 KOWALE

INFORMACJE O PRODUKCJI MLEKA

	w ost. miesiącu	narastająco*
mleko kg	276025	1780215
białko kg	9301	58594
tłuszcz kg	11133	72200

od początku roku kwotowego*

* przy pierwszej próbie w roku kwotowym, wartości narastające dotyczą poprzedniego roku kwotowego

WYNIKI PRÓBNYCH DOJÓW

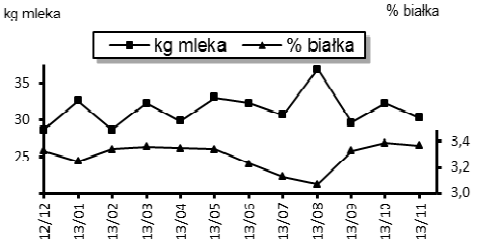
	12/12/05	13/01/04	13/02/06	13/03/07	13/04/10	13/05/14	13/06/08	13/07/09	13/08/10	13/09/08	13/10/10	13/11/12
lkd	276	271	284	283	278	306	309	304	306	309	291	286
dl	213	189	201	192	189	194	185	178	182	180	175	169
ml	28,6	32,6	28,6	32,2	29,8	33	32,2	30,6	36,8	29,6	32,2	30,2
% tł	4,51	4,51	4,46	4,27	4,37	4,31	4,12	3,99	3,56	3,66	4,01	4,28
% bi	3,33	3,25	3,34	3,36	3,35	3,34	3,23	3,13	3,07	3,33	3,39	3,37
wks	191	357	275	246	226	299	169	189	113	194	219	195

WYNIKI W TRZECH OSTATNICH PRÓBACH

mc	Liczba krów						
	doj	zas	ch	W przedziałach kom. somat.			
				<=300	>300 <=400	>400 <=1000	>1000
10	286	64	0	237	13	18	14
09	291	62	1	231	16	25	14
08	309	54	5	247	11	26	16

PRZECIĘTNE WYDAJNOŚCI

Wyniki za	Liczba krów		Ogólna wydajn w stadzie / przec I krów				
	ogółem	przec.	kg ml.	% tł	kg tł	% bi	kg bi
ost. miesiąc	362	354,7	778	4,03	31	3,36	26
bieżący rok	439	348	7376	4,16	307	3,31	244
ost. 12 m-cy		343,3	9629	4,23	407	3,30	318



WYDAJNOŚCI LAKTACYJNE W ROKU 2012

		Średnie wydajności 305 – dniowe dla stada						
		l. krów	dni / lata	kg ml	%tl	kg tł	% bi	kg bi
	Stado	229	297	9972	4.37	430	3.24	319
	Średnia	69440	299	6306	4.13	260	3.25	205
Średnie wydajności w grupach laktacyjnych								
100	pierwiastki	107	100	3227	4.11	133	3.17	102
305 dni	pierwiastki	94	297	9440	4.36	412	3.27	308
	w II laktacji	61	293	9714	4.36	424	3.25	316
	w III laktacji	46	299	10543	4.26	449	3.19	337
	>III laktacji	28	297	10134	4.67	473	3.27	331
PRZECIĘTNA WYDAJNOŚĆ ŻYCIOWA KRÓW UBYŁYCH w ost. 365 dniach								
ubyłe		62	2,6	24636	3,85	950	3,36	829

UWAGA: stado zagrożone subkliniczną ketozą!
Więcej informacji w „Hodowca on line" (www.pfhb.pl) i w raporcie RW-11

SKŁAD MLEKA (z ostatniego doju)

Grupa laktacyjna	Liczba krów	Mleko Kg	Tłuszcz* %	Białko* %	Stosunek tł/bi	Mocznik mg/l	L.krów moczn<100
1-40 dni	31	38,6	4,58	3,24	1.41	166	3
41-100 dni	50	38	4.11	3,13	1.31	185	2
101-200 dni	103	30	4.26	3,43	1.24	184	4
pow.200 dni	98	23.4	4.34	3,65	1.19	178	8
Razem	282	30.1	4.3	3,44	1.25	180	17

* wyliczane jako proste średnie arytm. nie uwzględniające kg mleka od poszczeg. krów

HODOWCA BYDŁA MLECZNEGO
KUKURYDZIANA 3
99-999 KOWALE

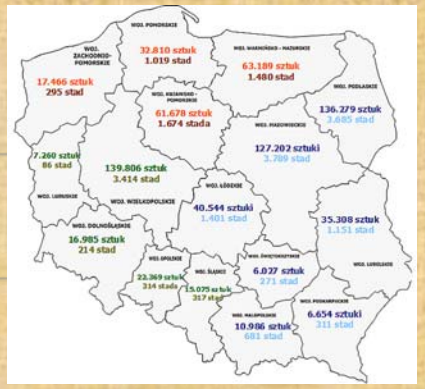
RESULTS of monitoring of SCK in Poland – 2 years

What have we learnt about ketosis in Poland ?

Period: from 2013-04-01 to 2015-03-31
Milk samples: 1 846 876

RESULTS of monitoring of SCK in Poland – 2 years

Cows at risk of SCK (K!), %

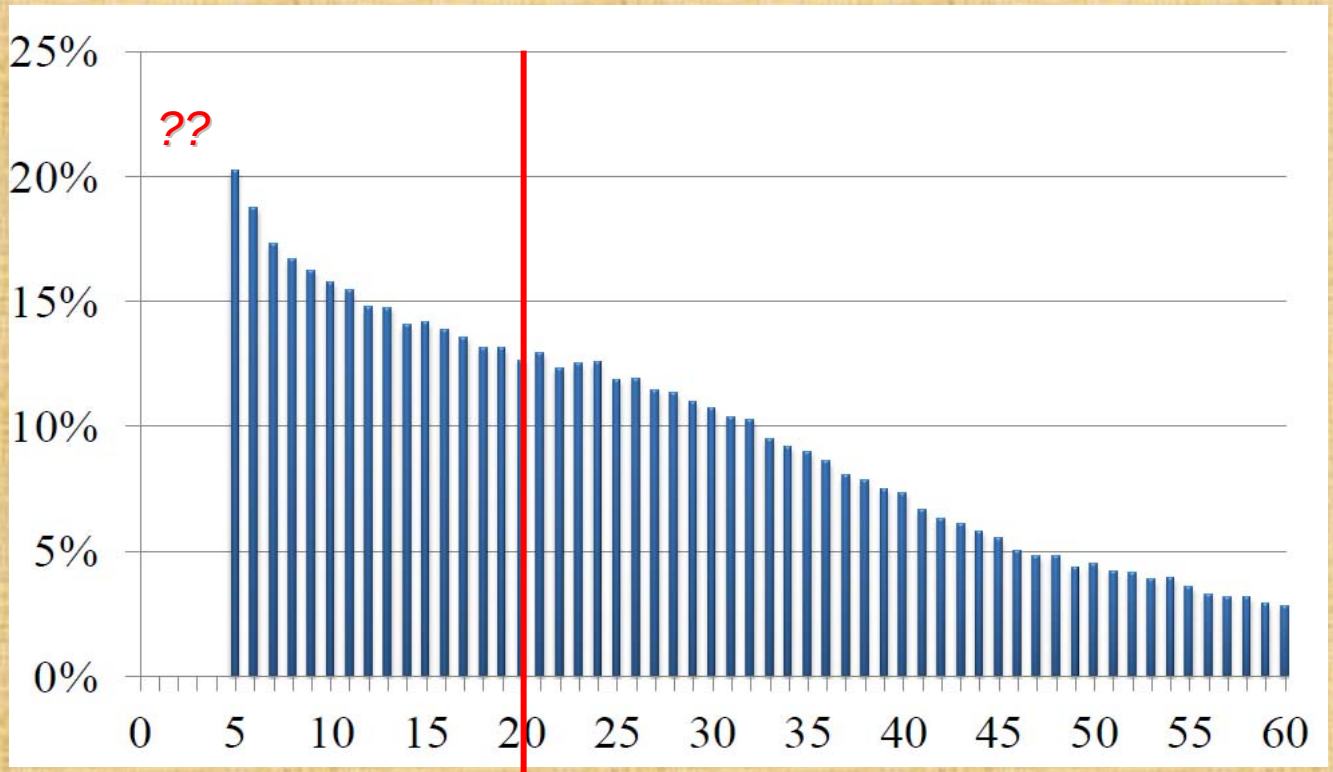


	Parzniew	Jeżewo	Minikowo	Krotoszyn	Poland
2013/2014	9,60%	9,95%	10,50%	7,88%	9,42%
2014/2015	10,29%	10,40%	11,07%	8,61%	10,03%
2 years	9,94%	10,19%	10,80%	8,26%	9,73%
N of milk samples	548283	343228	448171	507194	1846876

RESULTS of monitoring of SCK in Poland – 2 years

Types of ketosis depending on days in milk (Oetzel, 2006)

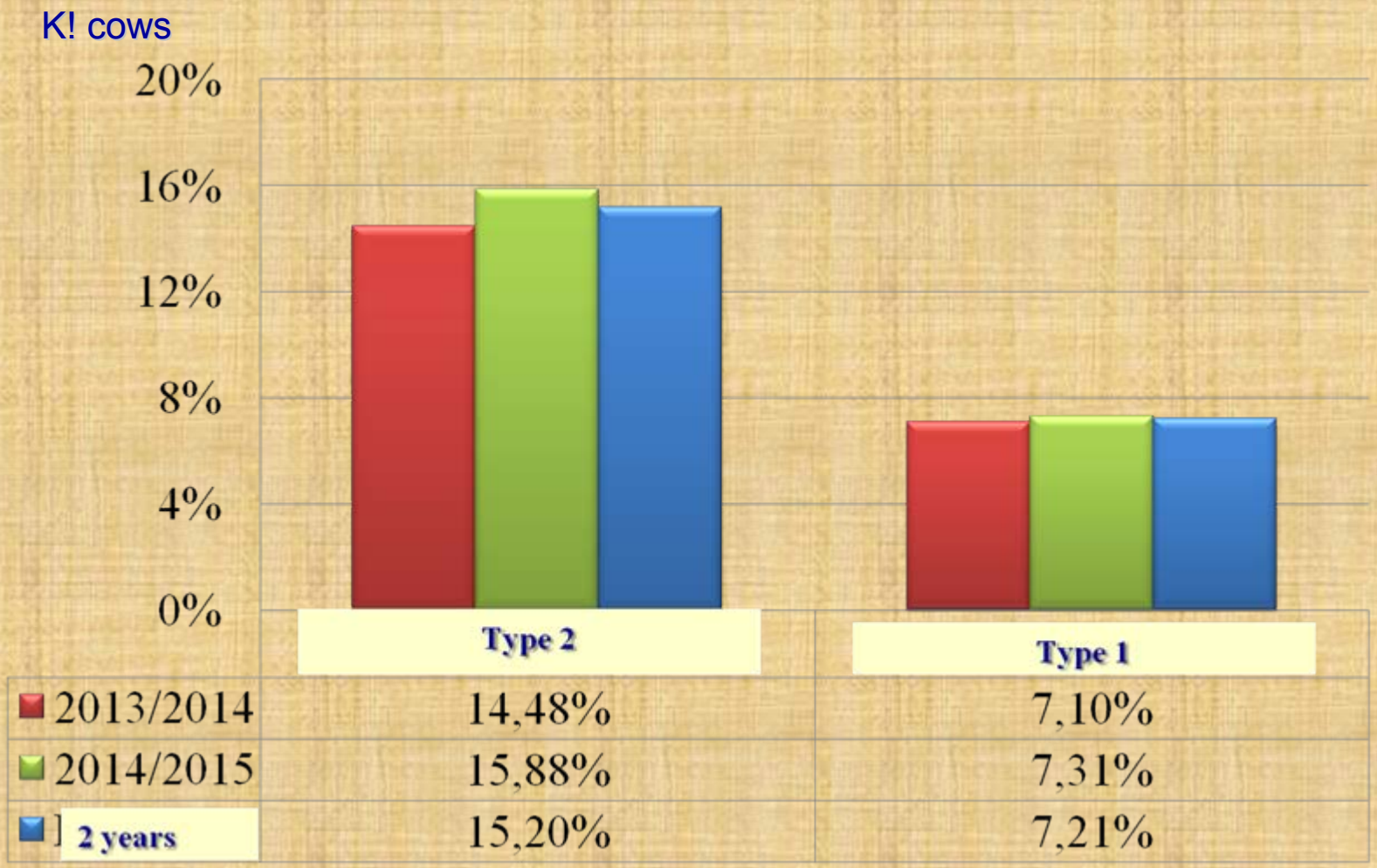
K! cows



2 years

RESULTS of monitoring of SCK in Poland – 2 years

Cows at risk of SCK (K!) of type 1 or type 2, %

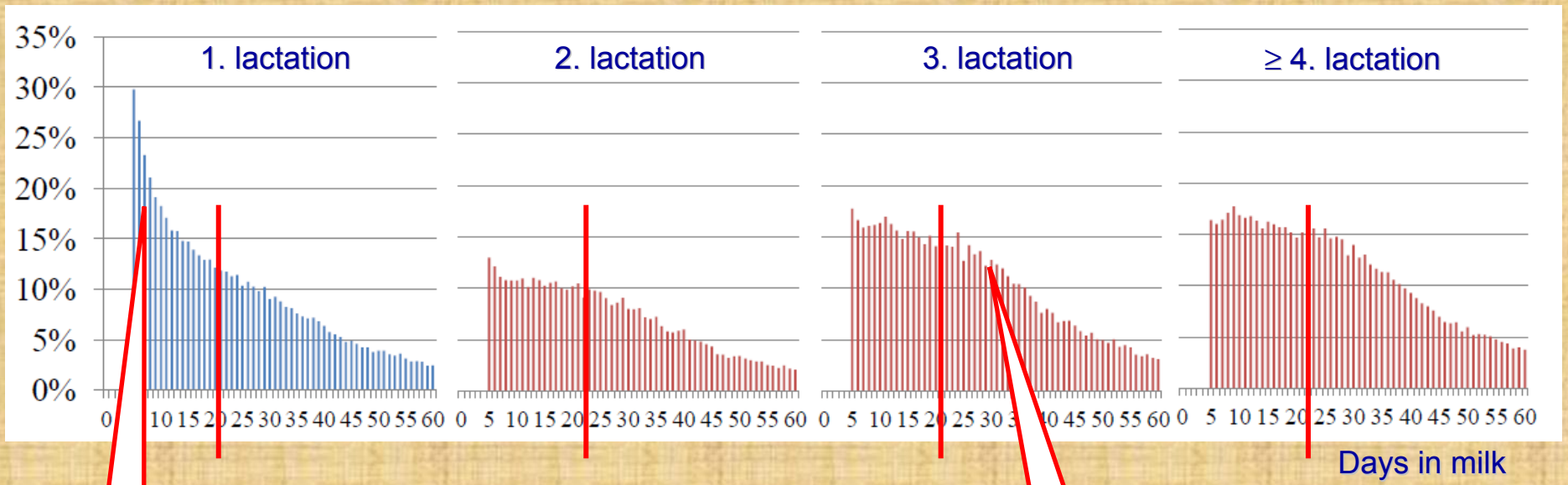


	Type 2	Type 1
2013/2014	14,48%	7,10%
2014/2015	15,88%	7,31%
2 years	15,20%	7,21%

RESULTS of monitoring of SCK in Poland – 2 years

Cows at risk of SCK (K!) depending on parity, %

K! cows

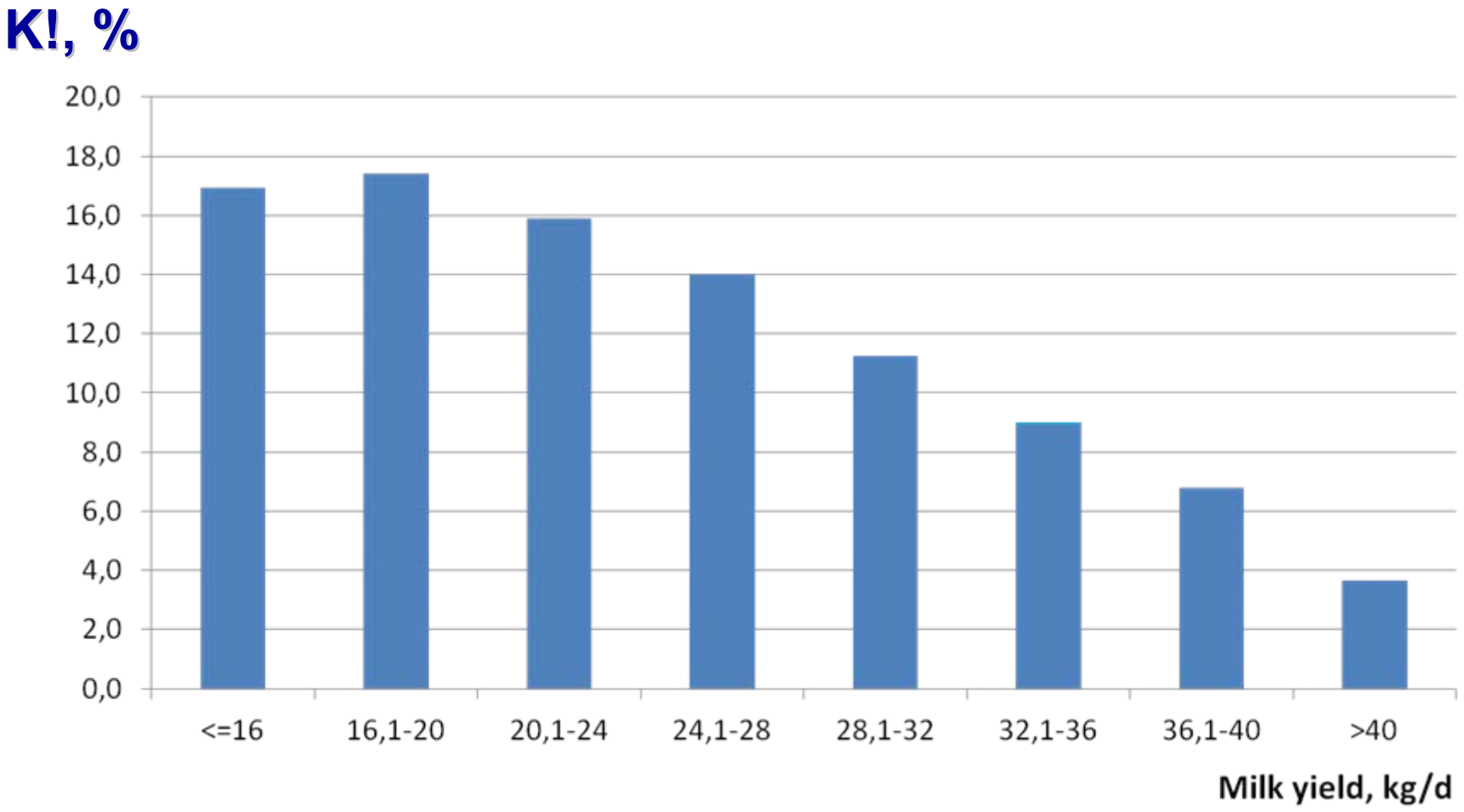


Overfattening

A lack of „fuel”

RESULTS of monitoring of SCK in Poland – 2 years

Cows at risk of SCK (K!, %) – relationship with milk yield



Is the SCK a disease of high yielding cows …. ?

RESULTS of monitoring of SCK in Poland – 1. year

Herd size, N of cows	N of herds	Problematic herds, % with PFSK	
		>10%	>20%
< 20	4 611	9,0	13,2
21 – 50	9 723	7,7	14,4
51 – 100	4 480	6,6	6,8
➢100	1 557	2,0	1,2
Total	20 371	7,3	11,4

Future

- Validation of the method – especially for smaller farms
- New parameters in the model – fatty acids in milk
- Analysis of FTIR spectra – cooperation of Norway and Poland
- Detection of **risk factors** in different types of farms
- Education of farmers

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Conclusions

- System has been quite well-accepted by the practitioners
- A lot of data provided to the farmer will improve an efficiency of milk production – prevention !!!
- A target group – small holders

Thank you for your attention !