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«Development of milk data control system for reducing the bias of genomic evaluation for the Russian Holstein breed»

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Introduction

Project: national GEBV evaluation system
Performers: Moscow State University, All-Russian Scientific Research Institute of Breeding and I Gene company

Model: ***MT ssGBLUP AM***

Traits: Milk production traits - Milk (kg), fat and protein(%, kg)
Breed: Holstein (75% and more by pedigree and genome)

Extremely important factors:

1. High-quality milk records data;
2. General pedigree information;
3. Presence of genomic information.

Introduction

Not all herds in Russia use ICAR certified methods
of milk records collection.
It’s necessary to **control TD milk data.**

<u>Milk data control system:</u>

1. Outlier control;
2. Gestation length control;
3. Herd data variability control;
4. Amount of TD per lactation control;
5. Herd reliability control;
6. Lactation reliability control.

Raw data	
Category	**Number**
Animals	**2 438 733**
Lactations	**6 517 123**
Herds	**1 057**
Regions	**44**
TD milk yield	**74 738 833**
TD milk fat	**68 545 716**
TD milk protein	**49 023 002**

1. Outlier control

Remove rough errors
(incorrected records, rough errors during data transfer etc.)

Trait	Confidence interval
TD milk yield, L	From 1 to 50
TD milk fat, %	From 2,5 to 6
TD milk protein, %	From 2,5 to 6
Lactation number	From 1 to 10

Results (milk protein as example)

Trait	Before control	Deleted data	Deleted data, %
TD milk protein	49 023 002	428 031	**0,87**

2. Gestation length control

Control of calving date

For each lactation:

1. Gestation length (GL) count (calving date – mating date)
2. GL analysis (remove lactation data if GL != 280±20 days)

Results (milk protein as example)

Trait	Before control	Deleted data	Deleted data, %
Lactation, number	6 503 012	190 934	**2,93**
TD milk protein	48 594 971	1 276 168	**2,62**

3. Herd data variability control

Excluding herds, which "copy-past" data

For each herd and each trait (3174 groups):

1. Data grouping (N subgroups:

same TD date, same TD week, same TD month)

2. Variability analysis in each subgroup:

if var(subgroup) for >50% data = 0 - remove all **herd** data

If var(subgroup) for >40% data = 0 - remove all **trait** data

Results (milk protein as example)

Trait	Before control	Deleted data	Deleted data, %
Herd	1 058	54	**5,1**
Herd (only protein)	1 004	22	**2**
TD milk protein	48 594 971	1 961 036	**4,14**

4. Amount of TD per lactation control

Exclude lactations, that have not enough information

For each lactation:

1. DIM amount analyzing:

If amount of DIM (milk yield) < 5 – remove all data

If amount of DIM (fat or protein) < 5 - remove trait data

Results (milk protein as example)

Trait	Before control	Deleted data	Deleted data, %
Lactation, number	6 127 678	678 064	**11,06**
TD milk protein	45 357 767	1 315 697	**2,9**

5. Herd reliability control

Two-step approach with in-lactation and in-herd analysis

Mean absolute error (MAE) calculation for each lactation
Traits: milk yield, milk fat, milk protein

↓

MAE distribution analysis for each herd
Traits: milk fat, milk protein

5.1 MAE calculation

<u>Good example (on one lactation, protein, %):</u>

1. 9 DIM in lactation;
2. 305d lactation curve calculation (Wilmink et al.);
3. Mean absolute error (M) calculation:

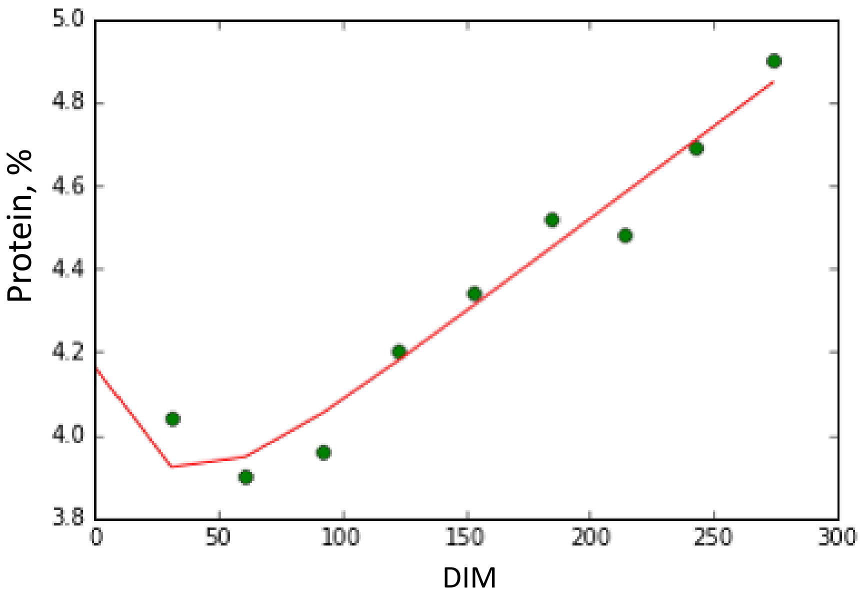
Count the $\mathrm{M} = \sum_{t=1}^{9} \left| \frac{A(t) - F(t)}{A(t)} \right|$, where:

$A(t)$ – actual DIM;

$F(t)$ – forecast DIM.

M = **0,025**

Normal lactation (protein, %)



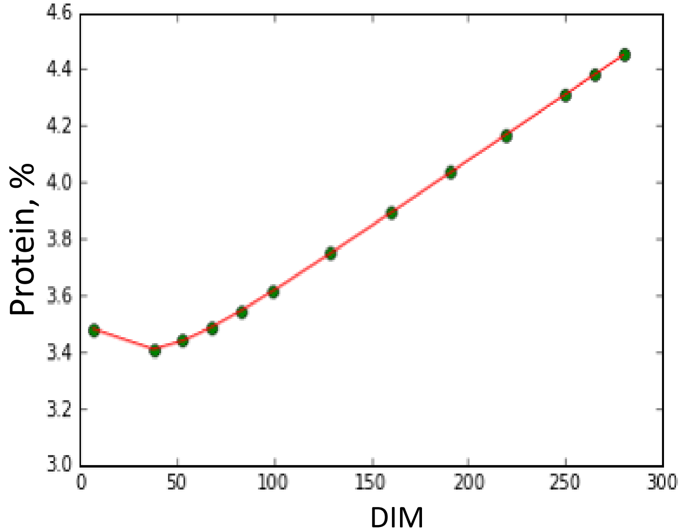
5.1 MAE calculation

Bad example №1:

$\mathrm{M} = \mathbf{0}$

Possible reasons:

DIM records were **generated artificially**, same $\boldsymbol{M}$ for **copy-past** of one value for all DIM in lactation

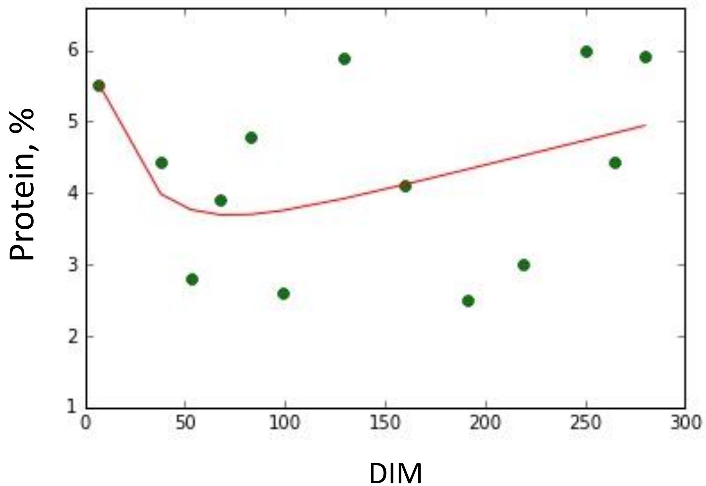


Bad example №2:

$\mathrm{M} = \mathbf{0{,}248}$

Possible reasons:

Errors in data transfer, when TD data go from milk lab to farmer and than to N-GES center



5.2 MAE distribution analysis

For each lactation: M(MAE) calculation

MAE distribution analysis in each herd

Theory: Lactations mean absolute error distribution for each herd must have properties of normal distribution.

Aim: Compare the mean M-values distribution of each herd with reference normal distribution

Method: **2-sample Kolmogorov–Smirnov test (K-S test)** (scipy.stats.ks_2samp)

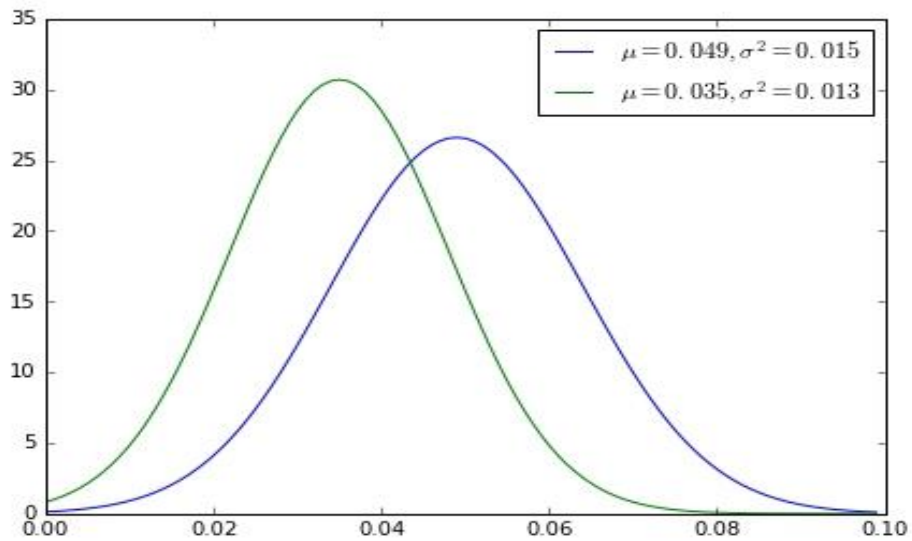
5.2 Reference normal distribution

Data: high-quality TD records from Leningrad region, Russia

Herds: **59** Lactations: **349 931**

Traits: milk fat, % and milk protein,%

Trait	Reference normal distribution
Milk fat, %	$\boldsymbol{N(0,049;\ 0,000225)}$
Milk protein, %	$\boldsymbol{N(0,035;\ 0,000169)}$



5.2 MAE distribution analysis

Exclude herds, which copy-past data in one lactation

For each herd and 2 traits (1964 groups):

1. MAE calculation for each lactation in herd;
2. K-S test for all lactations MAE distribution in herd:

   count D for each herd

   ($0 \leq D \leq 1$, where:

   0 – distribution is fully coincides with reference

   1 – distribution is fully not coincides with reference)

If D for milk fat is >0,91 – remove all milk fat data of herd

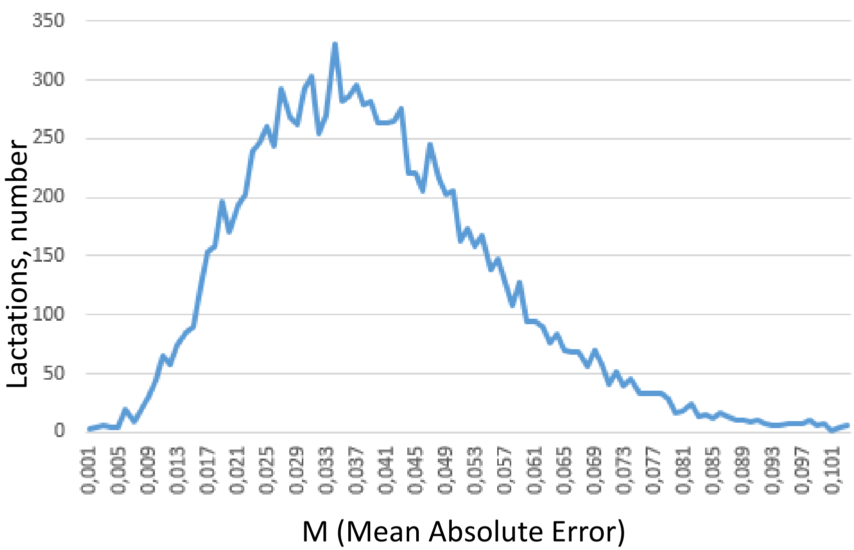
If D for milk protein is >0,8 – remove all milk protein data of herd

5.2 MAE distribution analysis

Results (milk protein)

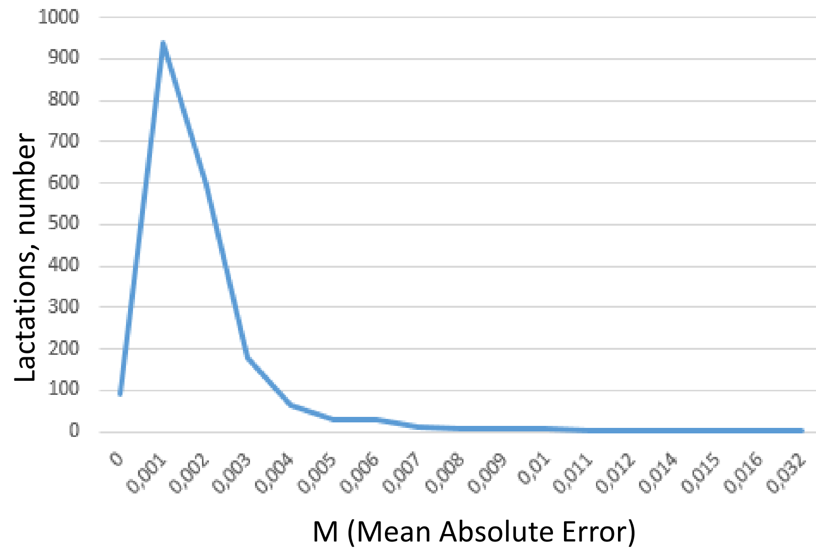
Herd 1 (**D = 0,01**)

Protein data didn't remove



Herd 2 (**D = 0,96**)

All protein data removed



Trait	Before analyze	Deleted data	Deleted data, %
TD protein	44 042 070	3 748 279	**8,51**

6. Lactation reliability control

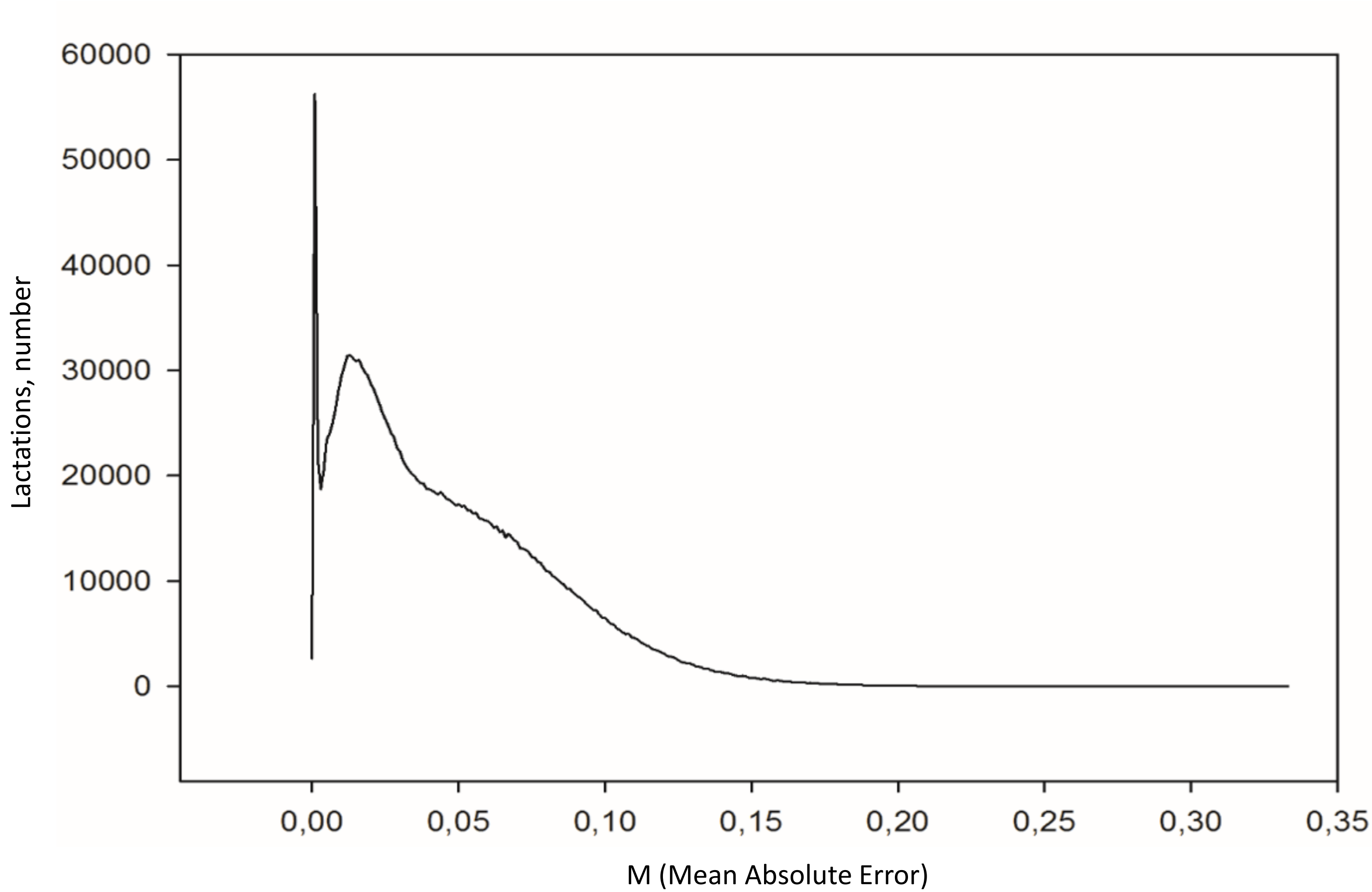
For each lactation: $\mathrm{M(MAE)}$ calculation. **DONE!**

For each lactation after control №5:
remove all outliers according to M-value

M-value for trait	Confidence interval
305d milk yield, L	From 0,011 to 2,19
305d milk fat, %	From 0,004 to 0,17
305d milk protein, %	От 0,004 до 0,17

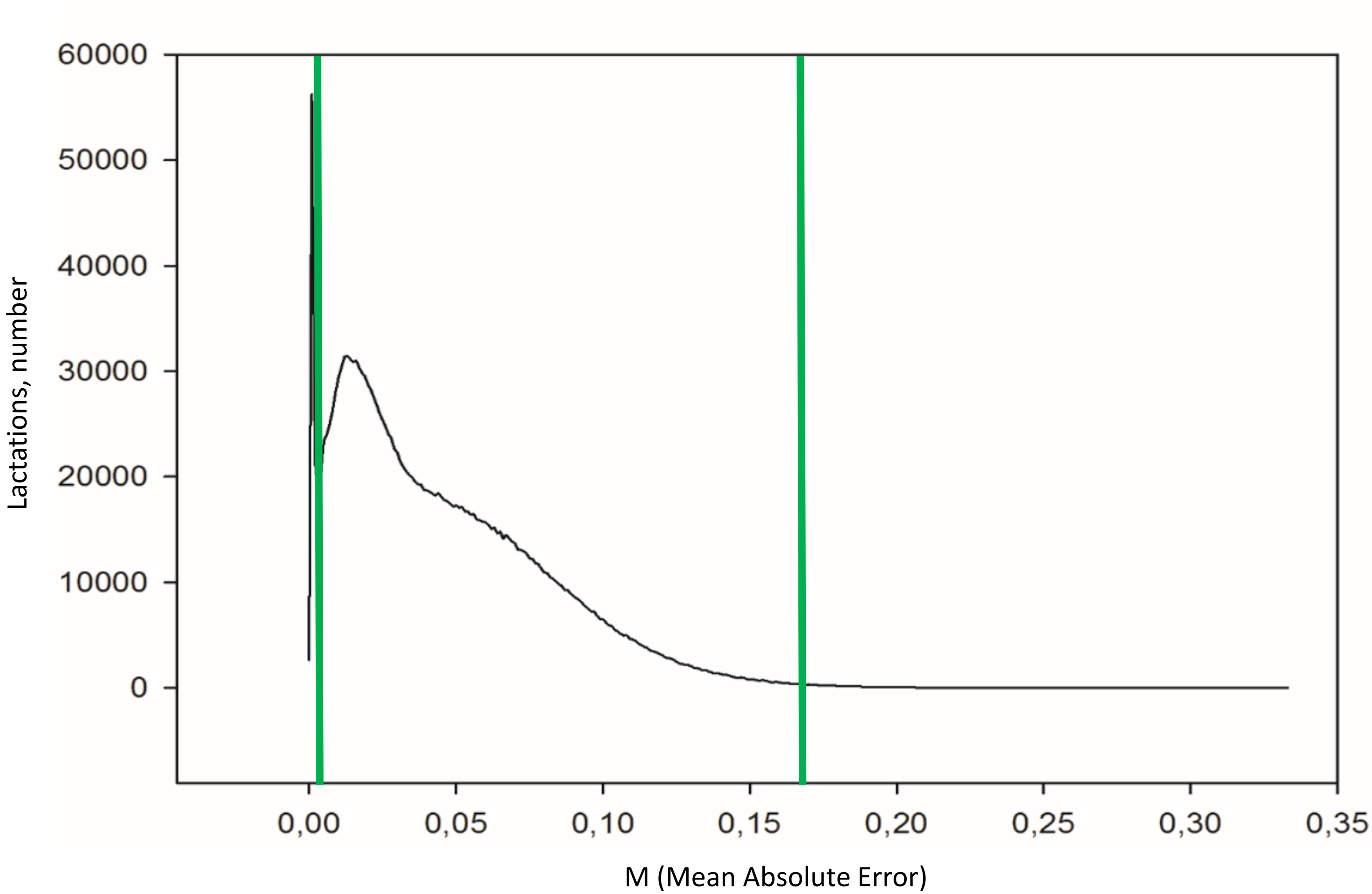
6. Lactation reliability control

Lactations M-distribution before control (protein,%)



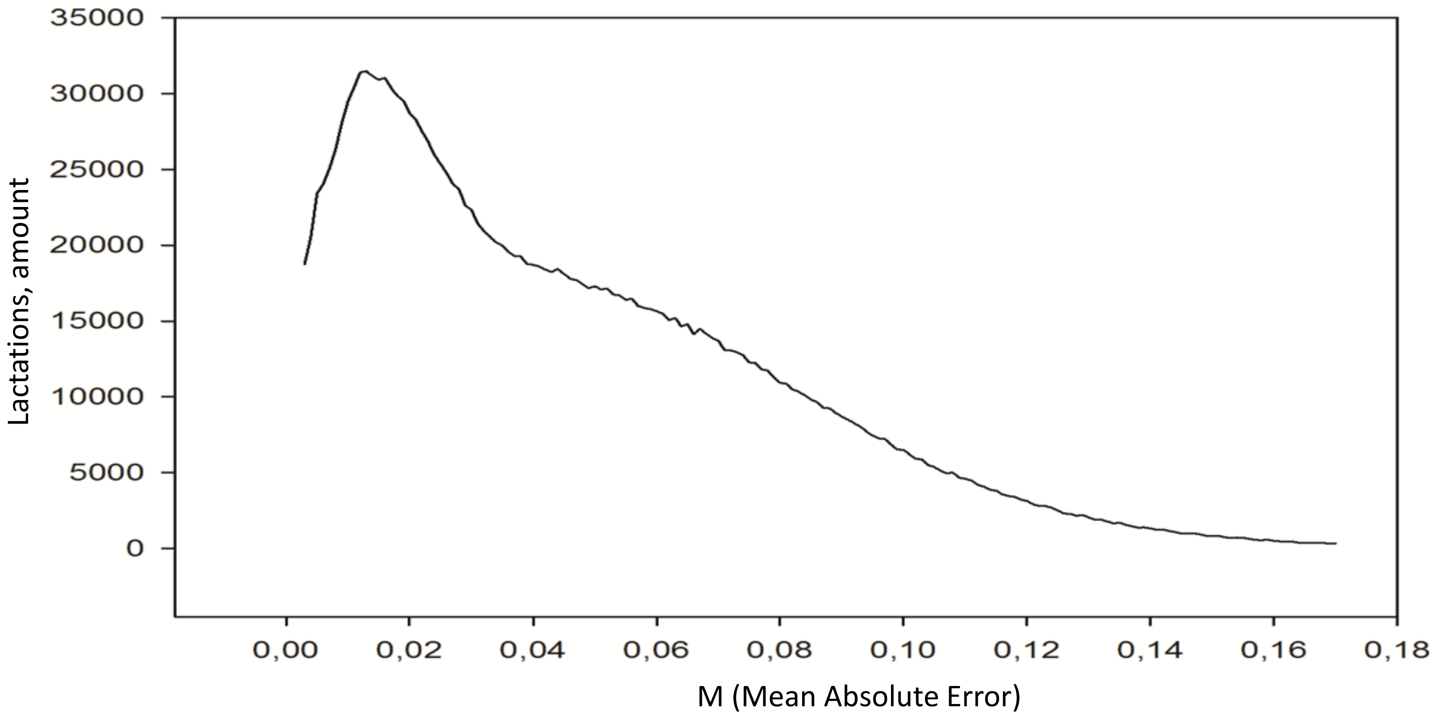
6. Lactation reliability control

Lactations M-distribution before control (protein,%)



6. Lactation reliability control

Lactations M-distribution after control (protein,%)



Trait	Before 6 control	Deleted data	Deleted data, %
TD protein	40 293 791	1 721 507	**4,27**

Results

In average, **20,37% of milk data** was removed.
High-quality milk production database from 44 regions was created for estimation of breeding values.

Results for each control step, in %

Category	Raw data	№1	№2	№3	№4	№5	№6	Total remove, %	Final data
Animals	**2 438 733**	**0,22**	**2,94**	**2,92**	**11,07**	**5,88**	**0,63**	**19,20**	**2 001 385**
Lactations	**6 517 123**	**0,22**	**2,94**	**2,92**	**11,07**	**7,76**	**1,07**	**25,97**	**5 021 595**
Herds	**1 057**	**-**	**-**	**5,1**	**-**	**-**	**-**	**5,1**	**1 003**
TD milk yield	74 738 833	0,49	2,11	2,79	1,67	-	**14,42**	21,48	**59 532 813**
TD milk fat	68 545 716	**0,88**	2,17	4,00	2,00	3,87	3,40	16,32	**58 067 441**
TD milk protein	49 023 002	0,87	**2,63**	**4,14**	**2,90**	**8,51**	4,27	**23,33**	**38 572 284**

Glad to answer any questions

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Thank you for attention