SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

Action number: FA1308
STSM title:
Statistical modelling for estimation of methane emission on dairy cattle farms
STSM start and end date: 08/02/2018 to 26/02/2018
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PURPOSE OF THE STSM/

(max.500 words)

In the last decades we have witnessed increasingly pronounced climate change worldwide. Climate change is transforming the environmental conditions in various regions by making them not convenient for living and agricultural and livestock production in particular. FAO experts (FAO, 2013) stated that with purpose to hold the increase in global temperature below 2°C and to avoid dangerous climate change, global GHG emissions need to be significantly decreased worldwide.

The livestock sector, within the agriculture, has come into focus because of its significant impact on the environment. The global livestock sector significantly contributes to an anthropogenic GHG emissions, but at the other hand, it can also deliver a significant share of the necessary mitigation effort. Total GHG emissions from livestock supply chains are estimated at 7.1 gigatonnes of CO_2-eq/year (year 2005) which represent 14.5% of all anthropogenic emissions from which 44% is methane (IPCC, 2007). Regarding the species, cattle are the main contributor to the sector's emissions with about 4.6 gigatonnes CO_2-eq, representing 65% of sector emissions. Methane represents one of the most important greenhouse gasses. Also, it is highly correlated with global warming. Ruminants, with daily methane production in amount of 250 – 500 l, in the next 50 – 100 years will contribute to the global worming for 8-10%.

On the other hand, livestock sector is a 'victim' of climate change, due to heat stress condition caused by changes in climate. Heat stress effect dairy cattle breeding by decreasing the milk production, feed efficiency, and also by inducing various reproductive and health disorders. In the end this results in decrease of farms profitability and significant increase of greenhouse gasses emission by kg of milk produced. FAO (2011) forecasts significant increase of human population till year 2050 (7.2 to 9.6 billion) meaning necessity of significant increase of livestock production with especial emphasis on sustainable production systems. Therefore, reduction of greenhouse gasses need to be treated as common good and imperative of every production.

Methane reduction methods could be classified as short-term and long-term. Short-term methods imply increase of production per animal and feeding optimisation. Long-term method imply genetic evaluation and selection based on methane emission variation. Precondition for genetic evaluation for methane emission is

selection of optimal indicators and models for methane emission estimation that are highly accurate and easy applicable in routine animal recording.

Therefore, the purpose of this STSM were to define:

- Indicator for methane emission prediction,
- Optimal prediction model based on regular animal recording data from dairy farms.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

(max.500 words)

For statistical analysis two different datasets were used. First dataset contained individual Test-day records of dairy Simmental cows collected in regular milk recording performed by alternative milk recording method (AT4/BT4) from January 2007 to December 2017. Second dataset contained Linear scoring records of first parity dairy Simmentals. Both datasets were provided by the Croatian Agricultural Agency (CAA) which is a Croatian national agency for the implementation of animal recording.

Logical control of test-day and linear scoring records of dairy Simmental cows in both datasets was performed in accordance to the ICAR standards (2003). After the basic statistical analysis (basic statistics, distribution frequency) necessary new variables were created. Records with missing or nonsense region, calving, control and scoring date, age at calving, with lactation stage in (> 5 days and < 305 days) were deleted from datasets.

As indicators for methane emission prediction following variables were used:

- Body weight (BW)
- Fat corrected milk (FCM)
- Dry matter intake (DMI)

Furthermore, for estimation of methane emission of dairy Simmental cows based on regular animal recording following models were used:

- CH_4 (MJ/d) = 75.42 + 94.28 x DMI (kg/d) × 0.05524 (MJ/g of CH_4) (Kriss, 1930)
- CH_4 (MJ/d) = −2.07 + 2.636 × DMI (kg/d) − 0.105 × DMI (kg/d)^2 (Axelsson, 1949)
- Linear 1: CH_4 (MJ/d) = 5.93 + 0.92 × DMI (kg/d) (Mills et al., 2003)
- Nonlinear 1: CH_4 (MJ/d) = 56.27 − (56.27 + 0) × $e^{[-0.028 \times DMI(kg/d)]}$ (Mills et al., 2003)
- CH_4 (MJ/d) = 3.23 (± 1.12) + 0.809 (± 0.0862) × DMI (kg/d) Ellis et al. (2010)

The significance of the differences between the estimated methane emission using defined models were tested by Scheffe's method of multiple comparisons using the MIXED procedure of SAS (SAS Institute Inc., 2000).

DESCRIPTION OF THE MAIN RESULTS OBTAINED

(max. 500 words)

The purpose of this STSM were to define: indicator for methane emission prediction, as well as optimal prediction model based on regular animal recording data from dairy cattle farms since these are the main preconditions for genetic evaluation of dairy cattle for methane emission.

Indicators and models for genetic evaluation have to be highly accurate and easily applicable in routine animal recording. After detailed literature review and analysis of available animal recording data as indicators following traits were defined:

- Body weight (BW)
  - Estimated from linear scoring records (rump length, back length, heart girth)
- Fat corrected milk (FCM)
  - Estimated from test-day records
- Dry matter intake (DMI)
  - Estimated from BW and FCM.

After that, for estimation of methane emission of dairy Simmental cows based on regular animal recording data five different models (described previously) were used. Obtained results indicate that data from regular animal recording (milk recording and linear scoring) could be used in estimation of methane emission of dairy Simmental cows. Hence, it is possible to set the genetic evaluation for methane emission of dairy Simmentals.

The research result obtained during this STSM will be presented as follows:

1. The Fifth and Final DairyCare Conference, Thessaloniki, Greece. March 19th and 20th 2018
   Form: Poster, Abstract
2. 11th International Scientific/Professional Conference Agriculture in Nature and Environment Protection, Vukovar, Croatia, May 28th – 30th 2018
   Form: Invited Plenary; Full Paper
3. 26th Animal Science Days (ASD), Smolenice, Slovakia 26th - 28th September 2018.
   Form: Oral Presentation, Full Paper

FUTURE COLLABORATIONS (if applicable)

(max.500 words)

The research results point out that data from regular animal recording (milk recording and linear scoring) could be used in estimation of methane emission of dairy Simmental cows. This means that the genetic evaluation for methane emission of dairy Simmentals could be incorporated in Simmental breeding programme. Furthermore, adequate indicators and models should also be defined for Holstein cows. Respecting stated, further scientific cooperation regarding the above mentioned issues is necessary and planned during this year.

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13.03.2018.