Scientific report: Short-Term Scientific Mission

COST Action: FA1302
Title action: Methagene – Large-scale methane measurements on individual ruminants for genetic evaluations.

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Scotland's Rural College (SRUC)

Host: Prof . Eileen Wall

Period of STSM:

20th to 28th November 2017

STSM title:

Methagene STSM to work on breeding goals to consider environmental issues (Methane emissions in dairy cattle).

Purpose of the STSM:

To work with the team in the SRUC on breeding goals, the incorporation of methane (CH_4) , and methodology of estimating methane economic value in dairy cattle.

Description of the work carried out during the STSM

The main work carried out during the STSM can be split into two parts:

1. Estimation of methane economic weight (EW) based on the shadow price of CO_2, and in relation to energy loss due to emissions.
2. Inclusion of CH_4 in the breeding goal in the selection index for Spain, and estimate the correlated response for three scenarios :
   - Current : without regard to CH_4 emissions
   - CH_4 without an economic weight

- CH_4 with an economic weight based on the shadow price of CO_2
- CH_4 with an economic weight in relation to energy loss

The STSM was also an opportunity to attend seminars related to genetics, sustainability and efficiency in livestock production systems.

1. Estimation of CH_4 emission cost

Two methods of estimation were used to estimate the EW of CH_4. The first method was based on the shadow price of CO_2. To estimate the economic value, short-term traded carbon values (Departemet for Business Energy & Industrial Strategy, 2017) were used. The EW of CH_4 is thus:

EW (CH_4) = -1*(shadow price of CO_2*28/1,000,000)*305

For the shadow price of CO_2, a much higher[1] shadow price was used, which is 32.38 £/tCO_2e, or 36.19 €/tCO_2e and giving that CH_4 has a global warming potential 28 times higher than CO_2 (Myhre et al., 2013), The EW of CH_4 was estimated to be -0.31 € per kg of CH_4 emitted.

In the second method, we estimated the EW of CH_4 in relation to energy loss (energy obtained from food but not utilised for production). Actually, cows lose from 2% to 12% of their net energy as enteric eructated CH_4 (Johnson and Johnson, 1995; Lassey et al., 1997; de Haas et al., 2011).

Thus, we estimated the total net energy required per lactation for an animal model (Table 1). To do that, we calculated the total energy requirement per lactation based on the equations of National Research Council, (2001). 6% (average of net energy lost) of total net energy required per lactation, is the estimation of the cost of CH_4 emissions, which leads to an EW of -0.54 €/kg CH_4 emitted, considering an average emission of 122 kg of CH_4 /cow/lactation.

[1] The updated short-term carbon values were estimated for three scenarios in the Updated short-term traded carbon values used for modelling purposes by the Departemet for Business Energy & Industrial Strategy, (2017) : low scenario, central scenario and high scenario. We have used the high scenario for 2025.

EW (CH_4) = (Total net energy required per lactation*6%*cost (€/calorie))/122

Table 1 : Animal model production data for estimating total net energy required (lactating cow; 305 days)[2]

milk (kg)	9542
Fat (kg)	348
Protein (kg)	305
Fat%	3,65
Crude Prot%	3,20
Cow weight (kg)	600
Calf birth weight (kg)	45

2. Inclusion of CH_4 in the selection index of Spain

After including the genetic parameters and economic values in the selection index theory "multitrait desired gains 20 traits" Excel spreadsheet by J. v/d Werf, we have obtained the results as follow for the 4 scenarios:

Table 1: Index values and genetic response per scenario

Trait	Unit	Scenario 1 : Current (without CH_4)		Scenario 2 : with CH_4 & no EW		Scenario 3 : with CH_4 & EW= -0.31 €/kg		Scenario 4 : with CH_4 & EW= -0.54 €/kg	
		EW	Response /yr	EW	Response /yr	EW	Response /yr	EW	Response /yr
Milk	kg	0.01	228.64	0.01	218.50	0.01	218.44	0.01	217.87
Fat	kg	1.94	4.90	1.94	4.78	1.94	4.85	1.94	4.89
Protein	kg	4.84	9.55	4.84	10.25	4.84	10.22	4.84	10.17
UCI[1]	-	0.00	0.27	0.00	0.24	0.00	0.25	0.00	0.26
LFI[2]	-	0.00	1.25	0.00	1.12	0.00	1.18	0.00	1.23
Longevity	day	0.17	-6.43	0.17	-6.07	0.17	-6.33	0.17	-6.53
SCC[3]	log(SCC)	2.06	0.03	2.06	0.03	2.06	0.03	2.06	0.03
Days Open	day	-1.89	-0.17	-1.89	0.14	-1.89	0.17	-1.89	0.19
LWT[4]	kg	0.00	0.51	0.00	1.01	0.00	-0.12	0.00	-1.04
Methane	kg	-	-	0.00	10.07	-0.31	9.47	-0.54	8.95
Index value (€)		**57.34**		**59.83**		**56.81**		**54.68**	

[1]Udder Composite Index
[2]Legs and Feet Index
[3]Somatic Cell Count
[4]Lactating cow live weight

[2] Means of production calculated on lactations completed in 2013 by the National Confederation of Spanish Friesian Holstein (CONAFE)

The results showed that including CH_4 in the breeding goal without putting an economic value on it increases the value of the index by 4%, and while putting an economic value on CH_4 (-0.31 and -0.54) the index value decreases by 1% and 5% respectively. The index value and the response in CH_4 is high when no economic value was put on CH_4 emissions. Moreover, when an economic value is put on CH_4, the response decreases by 6% for scenario3 and 11% for scenario 4. We can infer from this that putting an economic value on CH_4 emissions decreases CH_4 produced, but also decreases index value (1%-5%).

The biggest change in the index value is observed in functional traits (days open), Udder composite index [3] (*Indice compuesto de ubre*), legs and feet index (*Indice de patas y pies*) and live weight. Indeed, selecting for lower emitting cows causes live weight to decrease.

References

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[3] From genetic evaluations of linear characters (conformation characters) recommended by the World Federation of Holstein-Frisian, and evaluated by INTERBUL, synthetic indexes are calculated, such as the Feet and Leg Index (FLI) and the Udder Composite Index (UCI).

Werf, J. Van der. MTINDEX20T Multiple-trait desired gains selection index.

Benefits from the STSM to the METHAGENE network

In order to include CH_4 emission as a breeding goal, one of the first tasks is to define the economic importance of each trait included in the aggregate genotype and his economic weighting in the current and planned situation. Thus, economic value of CH_4 emissions, which represents a loss of dietary energy in ruminants and is an important contributor to global warming, needs to be estimated.

In this STSM, the economic value of CH_4 was estimated from the perspective of the shadow price of CO_2, and the energy loss by CH_4 emissions. Its inclusion in selection index, will allow to select for low emitting and more efficient cows.

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Confirmation by the host institution of the successful execution of the STSM

See attached document