Horizon 2020 Programme

INFRAIA-02-2017
Integrating Activities for Starting Communities

SmartCow: an integrated infrastructure for increased research capability and innovation in the European cattle sector

SmartCow
an integrated infrastructure for increased research capability and innovation in the European cattle sector

Project ID: 730924

Deliverable number: D11.1

Deliverable title : Access provision to the SRUC beef installations

EC version : V1

Due date of Deliverable	**30/04/2022 (M51)**
Actual submission date	**04/05/2022 (M52)**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°730924

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2. Revision history

Version	Date	Modified by	Comments

3. Dissemination level

PU	Public	X
CO	Confidential , only for members of the consortium (including the Commission Services)	☐

SmartCow

an integrated infrastructure for increased research capability and innovation in the European cattle sector

[redacted]

Background	In the frame of SmartCow project, SRUC has provided access it Research Installation “SRUC Beef centre” through Trans National Access (TNA).
Objectives	This Deliverable aims at describing the TNA provided by SRUC during the SmartCow project.
Methods	The Deliverable is composed of a table summarising the TNA provided by the Research Installation (RI) and by the reports of activities provided by the TNA users who accessed this RI.

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1 TNA provided

Name of the TNA project	Name of TNA user	Organisation of TNA user	Country of TNA user	Installation from the RI	Start date	End date	Number of units of access provided
Agolin Ruminant effects on beef cattle methane emissions	Beatrice Zwifel	Agolin	Switzerland	Respiration chambers	07/07/2020	06/01/2022	48 cow.weeks
Agolin Ruminant effects on beef cattle methane emissions	Beatrice Zwifel	Agolin	Switzerland	Feed efficiency	07/07/2020	06/01/2022	720 cow.weeks

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2 Final reports of the each TNA provided

There is a combined report for both TNA 1 and TNA 2 as both were for the same applicant and formed one larger trial.

2.1 TNA 1 and 2 combined report

Objective: The objectives of this study were to test the effects of Agolin Ruminant (AR) on 1) enteric methane emissions from, 2) breed of, and 2) feed efficiency of suckler beef steers.

Hypothesis: The hypothesis was that cattle receiving AR will have lower methane yield than control cattle and/or better feed efficiency.

Ethics Statement: This study was conducted at SRUC's Beef and Sheep Research Centre. The experiment was approved by the Animal Experiment Committee of SRUC and was conducted in accordance with the requirements of the UK Animals (Scientific Procedures) Act 1986.

Animals: A total of 70 beef steers aged from 9 to 18 months (44 Aberdeen Angus cross and 26 Limousin cross) were selected for this trial. The steers were paired by breed, sire and liveweight and one of each pair was randomly allocated to either the Control (C) group or the Agolin Ruminant (AR) group (35 replicates per group). At the onset of the treatment phase (e.g. when the AR was introduced to the treatment diet) the average weight of the C group was 480 ± 16.6 kg, and the AR group was 475 ± 15.9 kg.

A sub-set of 18 paired animals (36 in total) were selected for methane measurements in respiration chambers. This subset was chosen to represent the range of animals within the experiment. This number of replicates was deemed sufficient to detect a 20% reduction in methane emissions intensity (g / kg weight gain) at a significance level of 0.05 (2-sided t-test). Animals will have 4 weeks to be trained to use the feed recording equipment (HOKO feeders) and to adapt to the base diet.

Animals were housed in four pens, two for the C group and two for the AR group, and bedded on saw dust to ensure that consumption of bedding did not contribute to nutrient intake.

Diet: All animals were offered a grass silage and concentrate diet (530:460 silage:concentrate on a dry matter basis) at approximately 1.05 times average daily intake. Grab samples of each diet TMR and ingredients were taken weekly and frozen. At the end of the experimental period, samples were then combined into three bulked samples per diet and sent to SRUCs Analytical Services Department for analysis. See Table 1 for ingredient and chemical compositions of the C and AR diets.

The AR diet was prepared by diluting 81 ml of AR solution into 4919 ml of water and was then sprayed evenly on to 50kg of dark grains in a cement mixer (to ensure thorough mixing). The dark grains were then incorporated into a premix which was prepared in a separate mixer wagon to the control diet premix. Similarly, mixing of premix and silage prior to feeding was done in separate wagons for each diet to ensure the control diet was not contaminated with AR.

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Diets were offered to all steers using electronic feeders (HOKO, Insentec, Marknesse, The Netherlands). Daily fresh weight intakes and dry matter intakes (DMI) were recoded for each animal. Fresh water was provided *ad libitum.*

Table 1: Ingredient and chemical compositions of the control (C) and Agolin Ruminant treated (AR) diets.

	C Diet	AR Diet
Ingredient Composition (g / kg DM)		
Grass silage	532	534
Barley	336	335
Dark Grains	84.2	83.4
Molasses	8.8	9.7
Minerals	38.1	37.5
Chemical composition (g / kg DM)		
Dry matter (g / kg)	482	475
Ash	55	54
Crude protein	195	195
Acid detergent fibre	234	235
Neutral detergent fibre	352	354
Starch	201	200
Oil	20.3	19.9*
Gross energy	17.8	17.9

*Prior to AR application

Agolin Ruminant Dosage: The dosage of Agolin Ruminant varied between animals and was dependant on intake. The target average dosage was 0.8 g / head / day and the actual average dosage over the treatment period was 0.82 ± 0.14 ml / day.

Respiration Chambers: Methane measurements were undertaken in six indirect open-circuit respiration chambers and concentrations of CH_4 in air samples exhausted from the respiration chambers were measured by an infra-red absorption spectroscopy sensor (MGA3000; Analytical Development Company Limited). The method of measurement in the respiration chambers is described in detail in Rooke *et al* (2014). Animals were confined in the respiration chambers for 72 hours per measurement period, with the final 48 hours used to calculate the CH_4 emissions (allowing for a 24-hour settling period).

Each of the sub-set of chamber animals were allocated to one of six respiration chambers with three treatment and three control animals measured in each chamber, and paired animals being measured in the same week. There were two methane measurement periods: (i) pre-treatment (baseline) and (ii) 13-18 weeks post AR introduction. Animals were returned to the same chamber at each measurement to account for between chamber effects.

Performance Recording: After a four-week adaptation period to the additive diet, there was a 56-day performance recording period from which residual feed intake (RFI) and feed efficiency were

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calculated. During the performance recording period, steers were maintained under controlled conditions, where group sizes within the pen remained constant. Individual dry matter intake (DMI, kg/day) was recorded for each animal using the electronic feeding equipment. Body weight was measured weekly on a calibrated weigh scale, before fresh feed was offered. For all steers, ultrasonic fat depth was obtained at the 12th/13th rib and 3rd lumbar at the start (12th/13th rib - FD0; 3rd lumbar – FDL0) and end (12th/13th rib – FD1; 3rd lumbar – FDL1) of the 56-day period using industry-standard equipment (Aloka 500; BCF Technology Ltd, Glasgow, UK). Eye muscle depth was also recorded at the start (MD0) and end (MD1) of the recording period. Images were analysed using Matrox Inspector 8 software (Matrox Video and Imaging Technology Europe Ltd, Middlesex, UK).

Main Findings: There was no significant difference in methane yield (g CH_4 / kg DMI), digestibility corrected yield (g CH_4/kg digestible DM), volume (l CH_4/day) or mass (g CH_4/day) between treatment groups at the Baseline methane measurement period (ANOVA, $p > 0.05$, see Table 2 for mean values and SEMs). During the treatment period there was a significant effect of Treatment on methane yield ($p<0.05$), methane volume and mass ($p < 0.01$), with values higher in the AR group. However, there was no significant difference in digestibility corrected CH_4 yield.

Table 2: Effects of treatment and breed on methane volume (litres CH_4/day), mass (g CH_4/day) and yield (g CH_4/kg DMI) on Aberdeen Angus sired and Limousin sired steers. SEM = standard error of the mean. C = Control, AR = treated with Agolin Ruminant.

	Aberdeen Angus X		Limousin X					
	C	AR	C	AR	SEM	Treatment	Breed	Baseline
Baseline								
CH_4 Volume (l/day)	333	340	305	326	13.0	-	-	-
CH_4 Mass (g/day)	218	223	200	214	8.5	-	-	-
CH_4 Yield (g/kg DMI)	25.9	25.1	25.7	27.3	0.89	-	-	-
CH_4 Yield (g/kg Digestible DM)	50.8	47.8	47.7	50.9	1.2	-	-	-
Treatment								
CH_4 Volume (l/day)	267	303	270	276	10.5	$p < 0.01$	ns	$p < 0.01$ *
CH_4 Mass (g/day)	175	199	177	181	6.9	$p < 0.01$	ns	$p < 0.01$ *
CH_4 Yield (g/kg DMI)	21.5	21.7	21.2	24.3	0.77	$P < 0.05$	$P < 0.05$	$p < 0.01$
CH_4 Yield (g/kg Digestible DM)	45.9	46.7	46.4	54.3	1.1	ns	ns	$P < 0.05$

* Significant Treatment x Breed interaction

Table 3 shows the effect of breed and treatment (AR or C) on growth, feed intake and feed efficiency. Although there were breed effects on some of these metrics, there was no significant effect of treatment.

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Table 3: Effect of breed and treatment on growth, feed intake and feed efficiency of Aberdeen Angus-sired and Limousin sired steers. C = Control, AR = treated with Agolin Ruminant.

	Aberdeen Angus X		Limousin X				
	C	AR	C	AR	SEM	Treatment	Breed
Mid-BW (kg)	548	557	514	478	12.9	ns	p < 0.05
Mid-MBW (kg)	113	114	108	102	2.0	ns	p < 0.05
ADG (kg/day)	1.34	1.45	1.21	1.25	0.023	ns	p < 0.01
DMI (kg / day)	9.41	10.1	8.74	8.51	0.147	ns	p < 0.01
DMI/BW (g/kg)	17.5	18.4	17.4	18.3	0.29	ns	ns
DMI/MBW (g/kg)	84.2	88.7	81.8	84.6	1.00	ns	ns
FCR (kg/kg)	7.17	7.00	7.33	6.95	0.149	ns	ns
RFI (kg)	-0.05	0.167	-0.11	-0.10	0.073	ns	ns
FD0 (mm)	4.52	4.80	3.60	3.19	0.211	ns	p < 0.01
FD1 (mm)	5.91	7.25	4.62	4.39	0.291	ns	p < 0.01
FDL0 (mm)	6.25	7.04	5.25	4.41	0.318	ns	p < 0.01
FDL1 (mm)	8.09	9.93	6.79	5.49	0.368	ns	p < 0.01 *
MD0 (mm)	65.9	64.8	68.5	66.8	0.87	ns	ns

Mid-BW = mid-test BW; Mid-MBW = mid-test metabolic BW; ADG = average daily gain at the end of the 56-day test; DMI = dry matter intake; FCR = feed conversion ratio; RFI = residual feed intake; FD0/FD1 = fat depth at the 12th/13th rib at the beginning and end of the 56-day test, respectively; FDL0/FDL1 = fat depth at the 3^{rd} lumbar at the beginning and end of the 56-day test, respectively; MD0 = eye muscle depth at the beginning of the 56-day test.
* Significant Treatment x Breed interaction

It appears that there was no effect of Agolin Ruminant on whether enteric methane emissions or performance of finishing suckler beef cattle in this trial. Absolute methane emissions and methane yield were significantly higher in the AR group. There did, however, appear to be a decrease in the digestibility of the treatment diet. When corrected for diet digestibility there were no significant differences in methane emissions between treatment groups.

There was an effect of breed on methane yield during the treatment measurement period ($p<0.05$), with methane yield higher in the Limousin X AR group, but this difference was not apparent when correcting methane production for diet digestible dry matter intake.

Dissemination Plan

Before publication of these results further investigation to understand the methane emission results and the conditions under which Agolin Ruminant is effective is required.

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