**Application**

Mitigation of methane emissions will improve the sustainability of the dairy sheep sector.

**Introduction** Ewe milk is the leading dairy product of the Greek livestock sector. About 6 million dairy ewes are kept and their milk is used for the production of various types of cheeses, 21 of which retain a Protected Designation of Origin status. Among them, Feta is the most renowned, with 70% of its production being exported. Sheep milk production, while still retaining a rather natural profile, is not exempt from current public trends regarding greenhouse gas emissions and pressure is expected to increase in the future. Considering the significance of the dairy ewe sector, the aim of the present study was to identify factors and management practices that could potentially mitigate methane emissions.

**Materials and Methods**

A simulation study was designed to test the following hypotheses: i) Ewes with higher annual milk production emit lower amounts of methane per kg of milk produced. Recorded data regarding the dairy ewe breeds kept (Chios, Lacaune, Assaf-E) and their actual milk production (adjusted for fat and protein content) across Greece were used. ii) Rations with a restricted forage inclusion rate reduce methane emissions per kg of milk produced. iii) Use of forages with higher energy content result in rations with lower methane emissions per kg of milk produced. iv) Precision feeding resulting from feeding more homogenous groups results in lower methane emissions per kg of milk produced. Therefore, factors considered in this simulation study were: a) Milk yield type, five levels [based on bodyweight (kg) and annual milk production (kg), respectively]: 70/600, 65/500, 60/400, 55/300, 50/200. b) Forage inclusion in the ration: two levels, standard (mean 67%) and restricted (mean 44%). c) Forage energy concentration: three levels [low (alfalfa hay and wheat straw), intermediate (maize silage, alfalfa hay and wheat straw), high (maize silage and alfalfa hay). d) Grouping strategy: two levels (single group and high/low milk production groups). In total, a 5 x 2 x 3 x 2 factorial arrangement of effects was considered, yielding 60 different scenarios. For each scenario, 52 (weekly) rations were formulated, according to INRAe requirements (Hassoun et al. 2018) and the corresponding Feed Tables, for the lactating as well as the dry period, spanning a period of one year. Methane emissions were calculated using the following equations: (a) CH4/DOM = 45.42 - 6.6 x FL + 0.75 x FL2 + 19.65 x PCO - 35 x PCO2 - 2.69 x FL x PCO and (b) CH4 = DMI x 0.001 x DOM x CH4/DOM where CH4/DOM is methane production per kg of digested organic matter, FL is the feeding level (dry matter intake as % of bodyweight), PCO is proportion of concentrate in the ration (0≤PCO≤1), CH4 is methane production (g/day), DMI is dry matter intake (kg/day) and DOM is the digested organic matter (g/kg of dry matter) (Sauvant et al. 2018). From equation (b), yearly methane production was calculated; for those scenarios that included two groups of ewes, yearly emissions were weighted for the production of each group. Finally, emissions per kg of milk produced were calculated by diving total annual emissions by annual milk yield for each scenario. A general linear model was developed in order to study the effect of the above factors (included as fixed ones) on methane emissions (g/kg of ewe milk).

**Results**

All factors considered in the study had a statistically significant effect regarding methane emissions (Table 1). However, milk yield per ewe and amount of forage in the diet accounted for 82.1% and 15.3% of the effect, respectively. Mean emissions from the five ewe types (50/200, 55/300, 60/400, 65/500 and 70/600) were 48.10, 36.46, 30.34, 26.71 and 23.52 g/kg of milk, respectively. Compared to 50/200 ewes, those of the 60/400 and 70/600 types emitted almost 37% and 51% less methane, respectively.

Table 1. Factors affecting methane emitted per kg of ewe milk and corresponding adjusted Wald statistic (F). Adjusted R2 = 0.985

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| --- | --- | --- |
| Factor | F | P |
| Milk yield | 911.801 | <0.001 |
| Amount of forage in the diet | 170.379 | <0.001 |
| Type of forage in the diet | 3.512 | 0.037 |
| Grouping | 24.737 | <0.001 |

**Conclusions**

Increased milk production per ewe will result in reduced methane emissions per kg of milk, thus improving the sustainability of the sector.Genetic selection and management practices aiming to enhance ewe health, improve housing conditions and meet nutritional requirements while not overfeeding forages, should be the focus of sheep farmers and their consultants, alike.

**References**

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