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RESEARCH ARTICLE

BALANCE BETWEEN THE RUMINAL METHANE EMITTED AND THAT PRODUCED BY THE MANURE OF ANIMALS BRED

***Roberto De Vivo**

Dipartimento di Biotecnologie ambientali, Istituto di Istruzione Superiore "F Corni", Largo A Moro 25, Modena

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ABSTRACT

All the ruminal methane (CH_4) emitted by ruminants (cattle, buffalo, sheep, camel goats and minor camelids) was calculated all over the world, standardized according to the size and therefore the quantity of methane emitted and was compared with the methane that could potentially be produced if the dejections were treated in anaerobic plants. Obviously we took into account the fact that not all types of breeding allow the recovery of dejections, for example grazing. This calculation was also made for other non-ruminant animals of zootechnical interest. The conversion of methane potentially used by anaerobic plants into electrical energy has also been calculated, considering both the various quantities of manure for each species and for each type of breeding and the yield in biogas and then in methane according to the various chemical composition. This calculation was also extended and separated also for non-ruminant species reared. To make the conclusions pragmatic, electrical energy and potentially powered homes were quantified.

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INTRODUCTION

Among the pollution that can come from man's activity are without doubt to be considered the greenhouse gases, the ones transparent to sun radiation, but which retain the infrared (IR) radiations emitted from the earth's surface: main greenhouse gases (GHG) of agricultural origin, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).Methane is produced when the organic substance is decomposed into a low-oxygen environment, ie in ruminalfermentations and in the large intestine and in the storage of rearing effluents. Nitrous oxide is essentially produced by the microbial transformation of nitrogen in soils and manure left to pasture. Ruminal methane emissions are very important in the case of ruminants, which host large populations of bacteria and protozoa in the rumen. CH_4 originates from the fermentation processes of the organic substance ingested into the rumen from which it is directly ejected into the environment by eructation. The entity of me than production of inversely proportional to its digestibility. The temperature significantly influences the production of methane from dejections; emissions are practically below 10 ° C, while when this value is exeded, methane production grows exponentially.

***Corresponding author: Roberto De Vivo,**
Dipartimento di Biotecnologie ambientali, Istituto di Istruzione Superiore "F Corni", Largo A Moro 25, Modena
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Addressing every form of agro-zoo technical production towards an eco-sustainable system is currently considered as an important requirement from which no production chain should deviate.

MATERIALS AND METHODS

The varoius numerical data of quantity of animals, emissions, dejections and various theoretical yields from official and very reliable sources (FAO, 2018) were found and processed using a Microsoft Excel. After quantifying the number of heads of cattle bred all over the world for the year 2016 (Table 1) it has been calculated all the ruminal methane (CH_4) emitted by ruminants through reared belches (cattle, buffaloes, sheep, camel goats and minor camelids) all over the world, standardized according to the size and therefore the quantity of enteric methane issued (Table 2). The standardization was accomplished taking an adult bovine calculated as a unit, equivalent to an adult buffalo, equal to 8 goats, equal to 8 sheep, equal to 5 minor camelids and equal to an adult camel.

RESULTS

The amount of CH_4 issued has been plotted with reference to the various species and the total number of ruminants bred in the world in the 2016 calendar year (Figure 1, Figure 2);

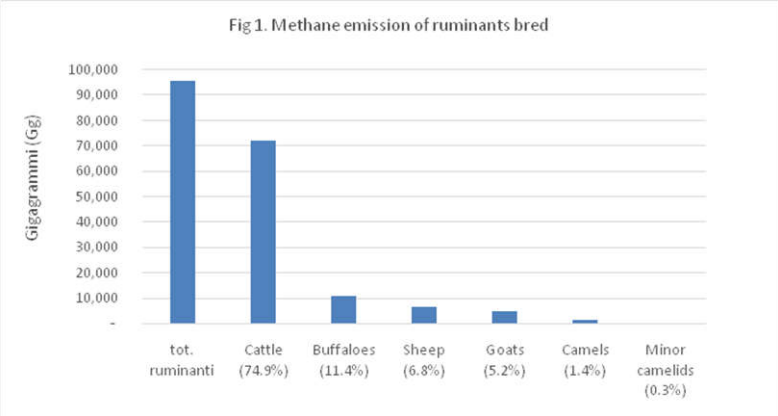


Fig 1. Methane emission of ruminants bred
Gigagrammi (Gg)
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
tot. ruminanti
Cattle (74.9%)
Buffaloes (11.4%)
Sheep (6.8%)
Goats (5.2%)
Camels (1.4%)
Minor camelids (0.3%)

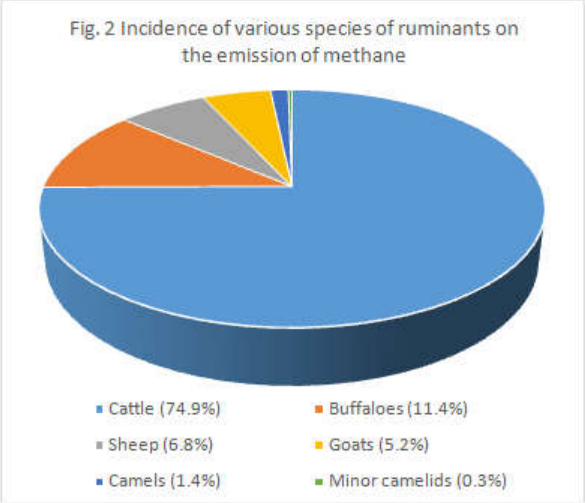


Fig. 2 Incidence of various species of ruminants on the emission of methane
Cattle (74.9%)
Buffaloes (11.4%)
Sheep (6.8%)
Goats (5.2%)
Camels (1.4%)
Minor camelids (0.3%)

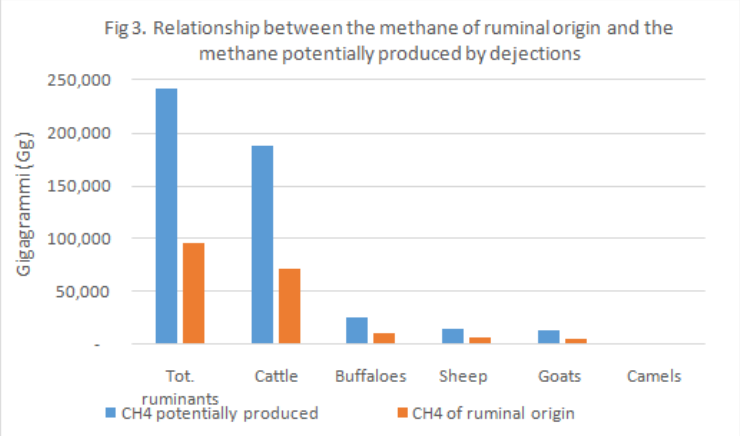


Fig 3. Relationship between the methane of ruminal origin and the methane potentially produced by dejections
Gigagrammi (Gg)
250,000
200,000
150,000
100,000
50,000
-
Tot. ruminants
Cattle
Buffaloes
Sheep
Goats
Camels
CH4 potentially produced
CH4 of ruminal origin

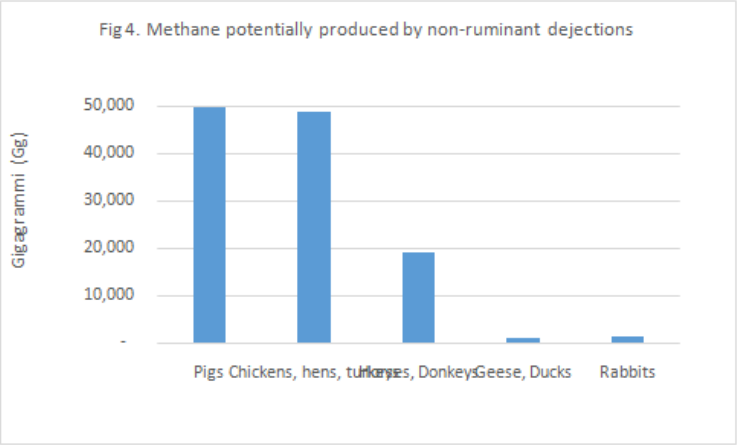
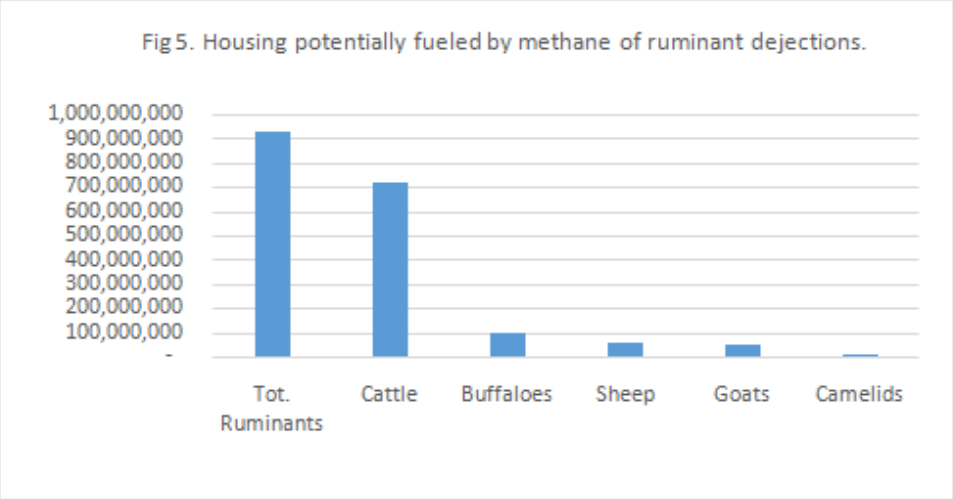
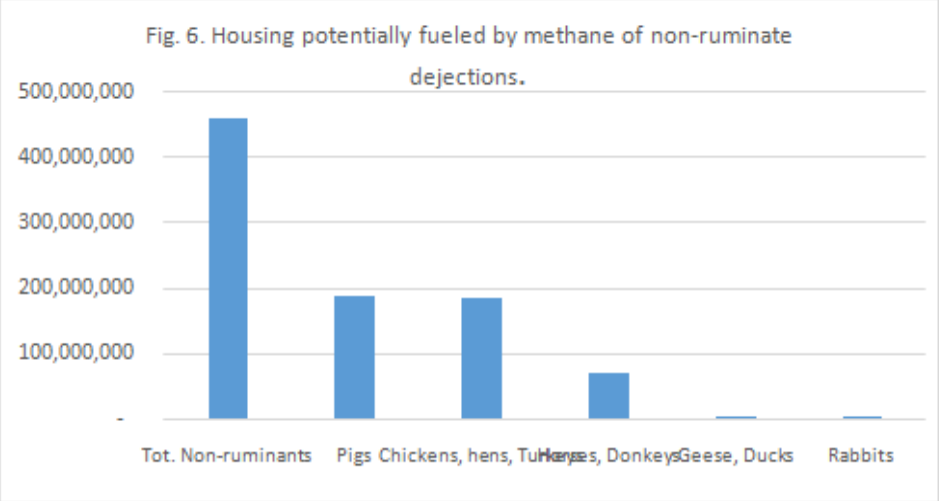


Fig 4. Methane potentially produced by non-ruminant dejections
Gigagrammi (Gg)
50,000
40,000
30,000
20,000
10,000
-
Pigs
Chickens, hens, turkeys
Horses, Donkeys
Geese, Ducks
Rabbits





Tab. 1. Heads bred in the world in 2016

Cattle	**1.475.000.000**
Buffaloes	199.000.000
Sheep	1.173.000.000
Goats	1.002.000.000
Minor camelids	9.000.000
Camels	28.000.000
Pigs	982.000.000
Chickens, hens	22.700.000.000
Turkeys	470.000.000
Geese, Ducks	1.124.000.000
Rabbits	316.000.000
Donkeys	43.500.000
Horses	59.000.000

Tab 2. Ruminal methane emissions related to the year 2016 of the various ruminants.

Species	CH_4 (Gg)
Tot. Ruminants	96.025
Cattle	71.910
Buffaloes	10.960
Sheep	6.564
Goats	5.014
Camels	1.309
Minor camelids	268

Tab. 3. Production of various species and category dejections

	(t/head/year)
Milk cows	18
Adult cattle	18
Big Calves	6,5
Calves	3
MEDIA cattle	11
Sows	3
Fattening pigs	2
MEDIA pigs	2,5
Laying hens	0,072
Meat chickens	0,036
MEDIA avicultures	0,054
Sheep- Goats	1,5
Rabbits	0,12
Equines	15

Tab 4. Biogas yield and% CH_4 of the dejections of the various species treated in anaerobic plants

Species	Biogas (m^3/t)	% CH_4/Biogas
Beef liquid	34	55
Cattle manure	90	50
Pigslurry	20	60
Pig manure	74	60
Sheep - Caprini	108	55
Chickens - Hens	90	60
Equines	63	55

Tab. 5. Productions of dejections, of produced biogas, of methane contained in the biogas by volume and converted into mass (under standard conditions) of the various species of bred.

Species	Dejections (t/year)	Biogas (m^3/anno)	CH_4 (m^3/year)	CH_4 (Gg/year)
Cattle	8.389.062.500	520.121.875.000	260.060.937.500	187.244
Buffaloes	1.131.812.500	70.172.375.000	35.086.187.500	25.262
Sheep	351.900.000	38.005.200.000	20.902.860.000	15.050
Goats	300.600.000	32.464.800.000	17.855.640.000	12.856
Camels	63.700.000	3.949.400.000	1.974.700.000	1.422
Minor camelids	2.700.000	291.600.000	160.380.000	115

Tab. 6. Ruminal emissions of CH_4, potential production from dejections in anaerobic plants and percentage of CH4 emitted on CH4 potentially produced by the various species

	CH_4erupted (Gg)	CH_4product (Gg)	%
Tot. Ruminants	95.757	241.949	39,6
Cattle	71.910	187.244	38,4
Buffaloes	10.960	25.262	43,4
Sheep	6.564	15.050	43,6
Goats	5.014	12.856	39,0

Table 7. Production of dejections, biogas produced, methane contained in the biogas in volume and converted into mass (under standard conditions) of the various species of non-ruminants bred

Species	Dejections(t/anno)	Biogas (m^3/anno)	CH_4 (m^3/year)	CH_4 (Gg/year)
Pigs	2.455.000.000	115.385.000.000	69.231.000.000	49.846
Chickens, hens, turkeys	1.225.800.000	110.322.000.000	66.193.200.000	48.646
Geese, Ducks	30.348.000	2.731.320.000	1.638.792.000	1.180
Rabbits	37.920.000	3.792.000.000	2.085.600.000	1.502
Horses, Donkeys	326.250.000	20.553.750.000	11.304.562.500	19.178

obviously the cattle breeding has the highest incidence (74.9%), followed by buffaloes (11.4%) sheep (6.8%), goats (5.2%), camels (1.4%) and minor camelids (0.3%). Furthermore, the biogas and therefore, the methane potentially produced in anaerobic digestion plants of the manure were calculated. The amount of manure produced within a year by all ruminants bred has been estimated, obviously it has been taken into account that not all ruminants are reared in order to manage the dejections. Grazing animals have been excluded from the count and therefore the amount of dejections produced is not usable and cannot be found.

Obviously the first calculation was to quantify the production of dejections depending on the species, the number of the population bred and obviously the size of the animal. Within the same species, significant differences are related to the various production categories (Table 3). Reflecting on the continuous and unjust faults attributed to the ruminants related to the emission of GHG it was considered appropriate to chart and compare the CH_4 emitted by means of belching and therefore polluting against what could be potentially produced by anaerobic digesters if the same animals were released into the plants of anaerobic digestion for biogas (Figure 3).

Tab 8. Electricity produced by the natural gas produced and number of medium-sized houses supplied by ruminants

Species	Electricity(kWh)	Houses
Tot. Ruminants	3.713.249.790.250	928.312.448
Cattle	2.873.673.359.375	718.418.340
Buffaloes	387.702.371.875	96.925.593
Sheep	230.976.603.000	57.744.151
Goats	197.304.822.000	49.326.206
Camels	21.820.435.000	5.455.109

Tab. 9. Electricity produced by the natural gas produced and number of medium-sized houses supplied bymonogastric

Species	Electricity (kWh)	Houses
Tot. monogastric	1.847.077.109.475	461.769.277
Pigs	765.002.550.000	191.250.638
Chickens - Layers	731.434.860.000	182.858.715
Horses	169.425.506.250	42.356.377
Donkeys	124.915.415.625	31.228.854
Geese - Ducks	18.108.651.600	4.527.163
Rabbits	23.045.880.000	5.761.470
Turkeys	15.144.246.000	3.786.062

Depending on the species, the dejections have a different chemical and microbiological composition, consequently they have a different yield in biogas and consequently in methane. On average, the biogas produced contains about 50% of methane (Table 4).In addition to the bred species another factor to recall is the type of breeding and therefore the type of manure: for example if you use litter, cracked floor or the washing and collection of sewage. The mass of manure produced in a year has been measured, always considering the various species; of the various types of breeding and housing the quantity of biogas produced was calculated, obviously according to the various yields, as well as the quantity of CH_4 contained in the biogas, then the volume of gas produced was converted into mass through the density under standard conditions of pressure and temperature (Table 5). Knowing that among the various species bred, and the various breeding techniques are not always recoverable dejections, the situation in which the dejections can not be recovered is grazing.In order to standardize the calculations and make them truthful, this situation has been considered and so when it comes to the amount of manure it is taken into account that about 50% of the cattle bred in the world is grazing, 50% of the buffaloes are grazing, 80% of sheep, 80% of goats, and 80% of camels and minor camelids. These estimates were made regarding the global situation on average. The dejections left to pasture are not taken into account in this calculation because under aerobic conditions they do not contribute to the emission of CH_4.In total, all ruminants of potentially recoverable ruminants that could be used in bioreactors would have produced about 241,000 Gg of CH_4 and the same ruminants through ruminal fermentations have emitted about 96,000 days in the atmosphere, that is 39.8%. Obviously, cattle are the ones that could potentially produce more methane from the anaerobic digestion of their dejections compared to other ruminants bred, about 187,000 Gg compared to about 71,000 that emit through ruminal fermentations, 39.7% compared to that potentially usable. The buffaloes emit about 11,000 days and could produce about 25,000, 43.4%. The sheep emit 6,500 Gg of methane and could produce 15,000, 43%. The goats emit 5,000 days and could produce 12,000, 39% (Table 6). In addition to the ruminant population, the same calculation was made for the quantification of the faeces produced, the use of these residues in anaerobic digestion plants for the production of biogas, for all other non-ruminant animals of zoo technical interest (Figure 4). The dejections of pigs reared could produce about 50,000 days, the dejections of flocks of laying hens, chickens and turkeys about 48,000 days, horses about 11,000 days, donkeys 8,000 Gg, geese and ducks about 2,000 days, rabbits about 1,500 (Table 7, Figure 4).The conversion of methane potentially used by anaerobic plants into electricity has also been calculated, considering both the various quantities of dejection for each species and for each type of breeding, and the yield in biogas and then in methane according to the chemical composition. All calculations refer to global and annual data referring to 2016.This calculation was also extended and separated also for non-ruminant species reared. The production of electricity has been estimated taking the average yield of CH_4 combustion in electricity 11.05 kWh / m3 (Biteco).The electric energy that can potentially be produced by all ruminants raised was therefore calculated, obviously starting from the previous calculations and then the various percentages that could be used for the type of breeding debris. To make this data pragmatic, the electrical energy potentially produced by the combustion of the methane produced was quantified and divided by the average amount of consumption of a dwelling, about 4,000 kWh (Casaecologica), reaching the number of average houses that can be fed. Potentially the number of houses that can be powered by the electricity produced by ruminants is about 900,000,000, more than 700,000,000 from cattle, about 90,000,000 from buffalo, about 57,000,000 from sheep, about 49,000,000 from goats and about 5,000 ,000 from camels, minor camelids are negligible (Table 8, Figure 5).Farms of other non-ruminant animals in total, carrying out the calculations with the same procedures could feed in total about more than 450,000,000 homes. The breeding of pigs approximately 190,000,000, hens, chickens and turkeys about 185,000,000, donkeys and horses about 70,000,000, geese, ducks and rabbits about 9,000,000 (Table 9, Figure 6).

DISCUSSION

From the results obtained it is evident that the ruminants bred do not pollute so much as some animalist or environmentalist sources want to make believe in order to hide more or less questionable reasons.

Conclusion

A clear and very important conclusion that emerged from this data processing is that if properly exploited, the dejections would produce more than double the methane that physiologically the ruminants emit into the atmosphere. A further conclusion that should be taken into consideration is that if manures of bread animals were all treated in anaerobic plants they should produce so much electricity to satisfy about 900 million homes, as for non-ruminant rearing animals could feed about 450 million homes. So in total all the animals bred in the world, which are often seen only as a source of pollution, could produce clean energy to feed about 1 billion and 350 million homes.

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