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RESEARCH ARTICLE

RELATIONSHIP BETWEEN THE EMISSIONS OF FARMED ANIMALS AND THE CONTRIBUTION OF CULTIVATED PLANTS TO FEED THEM

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ABSTRACT

The purpose of this processing is to compare the emissions of greenhouse gases produced by farmed animals and the carbon dioxide fixed by the crops of the various plants used for their feeding. Starting from the collection of FAO data, the CO_2 fixed by the main crops of zootechnical interest was calculated. The biomass produced and the CO_2 set by them were calculated using the "Calvin-Benson cycle" and then subtracted from the atmosphere. All the emissions related to ruminal fermentations and the management of the dejections in the various types of farms were also calculated. A balance has been made and the ratio between the emissions due to the animals and their dejections and the CO_2 set by the crops destined for their feeding has been calculated. The relationship and the incidence of the various species bred on the emissions related to the dejections have been calculated. The results obtained showed that the contribution of the atmospheric emissions of the farms is compensated by the vegetation used by the animals themselves.

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INTRODUCTION

Carbon fixation, corresponds to that series of enzymatic reactions called "Calvin-Benson cycle" in which the CO_2 molecules are absorbed and the C atoms are attached to carbohydrate molecules increasing their carbon units. In practice, carbon dioxide is transformed into organic compound (carbohydrate). The Calvin-Benson cycle is a cyclical metabolic process and represents the so-called dark phase of Chlorophyll Photosynthesis. It occurs in the chloroplast following the first phase (called light-dependent); the result of this process is the synthesis of a glucose molecule inside the plants. Among the emissions of greenhouse gases due to zootechnical activities there are, in addition to ruminal methane, that is the one emitted during the digestive processes of ruminants, another source of atmospheric pollution represented by the dejection of farmed animals (ruminants and non-ruminants) and their management. The aerobic dejection produces nitrous oxide (N_2O) while during storage in tanks under anaerobic conditions they also produce methane (CH_4). The N_2O emissions deriving from stored dejections depend on the nitrogen and carbon content of the manure, on the storage modalities, on its duration and on the type of treatment preceding storage. The methane emissions from zootechnical manure originate mainly from anaerobic degradation of the organic substance contained in them during the storage that precedes the agronomic use.

The entity of these emissions is proportional to the amount of organic matter contained in the dejections and depends on the climatic conditions. The temperature influences the production of methane from the dejections in a decisive way; emissions are practically nil below 10 °C, while when this value is exceeded, methane production grows exponentially. The type of breeding and therefore, the type of dejections greatly influence; for example, the management of effluents in the form of slurry reduces N_2O emissions, but increases those of CH_4, while for solid dejections the opposite occurs. For example, pig manure removal operations and specific storage conditions can be efficiently treated to further reduce emissions. Instead, different feeding strategies have been tested to reduce GHG emissions but seem to be ineffective in reducing emissions in a meaningful and lasting way (Philippe, 2015). Another very important conclusion that exculpates farms from atmospheric pollution is this conclusion: if properly exploited, the excrements produced by the farmed animals would produce more than double the methane that physiologically ruminants emit into the atmosphere (De Vivo, 2018). According to calculations carried out, if ruminant manure bred worldwide were all treated in anaerobic plants, producing so much electricity to satisfy 900 million medium-sized houses, as for non-ruminant farm animals feed around 450 million homes. So in total all the animals raised 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 medium-sized houses (De Vivo, 2018). After 2002, the increase in methane in the atmosphere was higher than the increase in ruminants. This evidence shows that methane sources are only partially known and that the increase of CH_4 in the atmosphere and the increase in the number of ruminants is a spurious association (Zicarelli, 2018).

MATERIALS AND METHODS

The CO_2 fixed by the main crops of zootechnical interest was calculated for the year 2016 and therefore, the biomass produced, the CO_2 fixed by the "Calvin-Benson cycle" and then subtracted from the atmosphere. Furthermore, all the emissions related to ruminal fermentations and to the dejections released by the farmed animals have been calculated. For the calculation of the biomass of the various crops, the FAO (Food and Agriculture Organization of the United Nations) data were used and it was possible to trace the amount of dry matter. The quantity of carbon physiologically contained is about 50% of the dry substance, from which the amount of CO_2 subtracted from the atmosphere, stoichiometrically equivalent to the carbon content, was calculated, being the only carbon source. In general, the biomass also includes crop residues undergrounded during agricultural processing. Depending on the availability of the data, the quantities have been corrected, taking into account that some products are also used in other areas besides zootechnical ones, for example in those destined for human consumption. In particular, the main plant species were considered to feed the reared animals: maize grains, cultivated up to the state of ripening and seed production; green maize, used for the production of silomais, main food for intensively reared ruminants; oats; sorghum, alfaalpha; soybeans used in the form of various products. As far as pasture is regarded, the estimate of the world area present in some sources is varied and in the present contribution only the FAO data were used.
Furthermore, the emissions from the cultivation of plant species, attributable to the processing of the soil, to the production of fertilizers and pesticides, to electricity, fuels and the operation of the machines have been taken into account.
The calculation of these emissions by the cultivation of plants was made starting from the quantity of dry substance and the coefficients of CO_2eq / S.S. Italians (C.R.P.A., Centro Ricerche Produzioni Animali, 2013).

These coefficients are true in Italy but in other regions of the world they are also five times higher (C.R.P.A.). So to be sure to take into account all the emissions and differences with the various types of agriculture in the various parts of the world, these coefficients have all been fivefold. The greenhouse gases emitted by dejections produced by livestock reared on pasture and in intensive farming have been quantified and converted into equivalent carbon dioxide (CO_2eq) considering the different climate-changing powers of the different greenhouse gases. This was possible using the FAO data, which provide for the various species reared the calculated and hypothesized emissions from the dejections in the different phases of management, storage, spreading and those left by grazing animals. The data used concern both ruminant and non-ruminant species. Methane (CH_4) emitted from ruminants (cattle, buffalo, sheep, goats, camels and minor camelids) was calculated on the planet in 2016, using data and FAO statistics.

RESULTS

The vegetables cultivated for the feeding of ruminant and non-ruminant animals in the world in 2016 have fixed, and therefore removed from the atmosphere, about 23.700.000 gigagrams (Gg) of CO_2 (Table 1).

Table 1. Quantity of dry matter (S.S.), amount of carbon (C) contained and consequently quantity of carbon dioxide (CO2) fixed by the main plant species for animal feed in the world in 2016.

	S.S. (Gg)	C (Gg)	CO_2 (Gg)
Maize grains	1.353.306	676.653	2.435.950
Maize green	5.430	2.715	9.773
Oats	94.331	47.166	169.797
Sorghum	19.179	9.590	34.523
Alfalfa	127.500	63.750	229.500
Soybeans	535.831	267.915	964.495
Pasture	11.050.000	5.525.000	19.890.000
Total			23.734.037

The pasture (Pardini, 2006) is the part of vegetation that manages to absorb more carbon dioxide, it is followed by the maize (the one cultivated for the grains) which represents the part of cultivated vegetation for the animals that subtracts more carbon dioxide. The emissions from fodder productions attributable to the various processing processes (which are precautionally quintupled to take account of the various agronomic technologies of the planet) are shown in Table 2 and have been estimated to be about 1.900.000 Gg of CO_2 eq.
The species that represents the greatest emission is the maize grains, followed by the soybeans which, even in minor production, have a greater impact.

Table 2. Emissions due to land processing, production of fertilizers and pesticides, electricity, fuels and machines

	S.S (Gg)	CO_2eq/S.S. (Gg)	CO_2eq (Gg)
Maize grains	1.353.306	0,70	947.314
Maize green	5.430	0,70	3.801
Oats	94.331	0,75	70.749
Sorghum	19.179	0,90	17.261
Alfalfa	127.500	0,35	44.625
Soybeans	535.831	1,60	857.329
Pasture	11.050.000	-	-
Total			1.941.078

The manure management, the spreading for fertilization and the one left to pasture have produced a quantity of greenhouse gases, in the world in 2016 equal to about 1.400.000Gg of CO_2eq (Table 3).

Table 3. Amounts of greenhouse gases emitted (converted into CO2eq) due to the storage of manure, the spreading on agricultural land and the one left to pasture

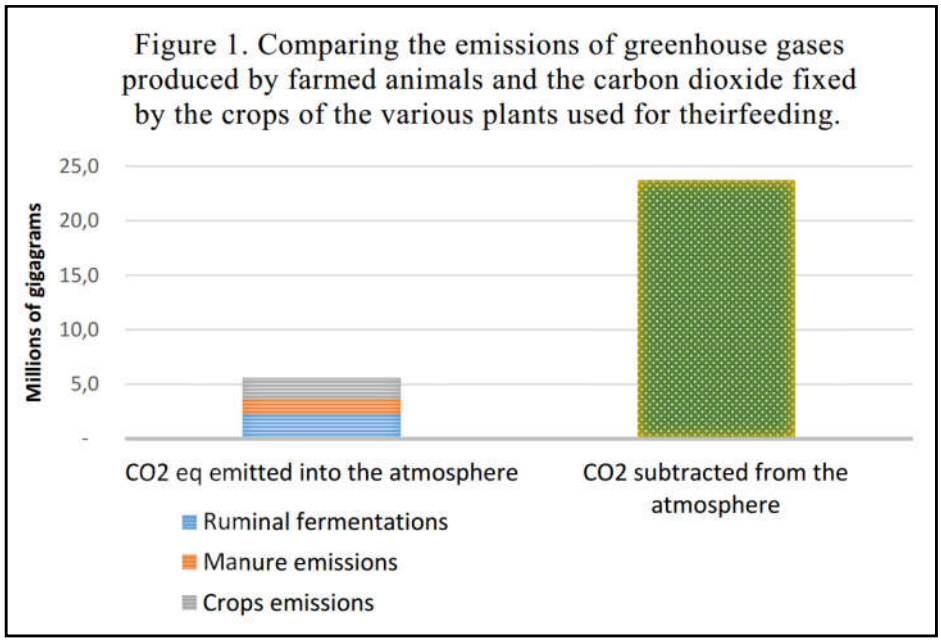
	Storage	Spreading	Pasture	Total
Cattle	156.086	77.256	525.439	758.781
Buffaloes	27.755	12.572	42.474	82.801
Sheep	7.322	8.835	96.975	113.132
Goats	4.747	3.682	101.481	109.910
Minor Camelids	239	12	1.258	1.509
Camels	1.426	156	7.101	8.683
Pigs	115.689	39.465	-	155.154
Chickens, Hens	27.842	39.579	44.955	112.376
Turkeys	2.488	4.980	1.481	8.949
Geese, Ducks	1.776	4.030	4.997	10.803
Horses, Donkeys	3.182	851	23.656	27.689
Total CO_2eq (Gg)				1.389.787

Table 4. Ruminal methane emissions related to the year 2016 of the various ruminants and conversion in CO2 eq

Species	CH_4 (Gg)	CO_2eq (Gg)
Cattle	71.910	1.725.836
Buffaloes	10.960	263.050
Sheep	6.564	157.531
Goats	5.014	120.337
Camels	1.309	31.415
Minor camelids	268	6.437
Total ruminant	96.025	2.304.607

Table 5. Comparing the emissions of greenhouse gases produced by farmed animals and the carbon dioxide fixed by the crops of the various plants used for their feeding

CO_2eq emitted into the atmosphere (Gg)	CO_2 subtracted from the atmosphere (Gg)
5.700.000	23.700.000



Another emissions, almost twice as much as that deriving from the management of the dejections, derives from the physiological ruminal fermentations of ruminants reared. The ruminal methane emissions, converted into CO_2eq, produced by ruminants bred (cattle, buffaloes, sheep, goats, camels, minor camelids) in the world during the year 2016 turn out to be about 2.300.000Gg (Table 4). The species that has the greatest impact is the bovine species (cattle) comprising both those bred for meat and those bred for milk. In order of decreasing impact the pigs follow in which the dejections on the pasture are void because this type of breeding is not widespread, then chickens and hens are almost equal to the impact of sheep and goats. The sum of the worldwide emissions of ruminal processes in 2016 (Table 4), related to the management of the dejections (Table 3) and to the agricultural processes (Table 2) is about 5.700.000Gg of CO_2 eq, released into the atmosphere . The amount of CO_2 subtracted, instead, from the atmosphere by the physiological processes of the plants cultivated to feed the reared animals is equal to about 23.700.000Gg (Table 1). The comparison (Table 5, Figure 1) shows the significant difference and the considerable excess quantity of the CO_2 subtracted in comparison to that emitted into the atmosphere.

Conclusion

From the processed data it emerges that the CO_2 subtracted from the atmosphere by the vegetables cultivated to feed the bred animals is about 4 times higher than the sum of CO_2 eq emitted by agricultural processing, the one emitted from physiological ruminal fermentations and that one due to the management of the dejections. From this elaboration, therefore, it can be said that zootechnical activities generally in the world can be excluded from the human activities responsible for the increase in greenhouse gases.

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