Greenhouse gas emission from livestock in Brazil

M. A. Lima & C. Campanhola

Researcher Scientists of the Brazilian Agricultural Research Corporation – Embrapa
Rodovia SP-340, Km 127,5, Jaguariúna, SP, 13820-000, Brazil

Summary

Agribusiness represents more than 32% of the Gross Domestic Product in Brazil, employs more than 40% of the labor force and is responsible for about 38% of the country exports. On the other hand, agriculture activities have released an average amount of 9.9 Tg year^{-1} of CH_4 and 0,5 Tg year^{-1} of N_2O to the atmosphere, in the period 1989-1995. From the total figure of methane emitted, 96% is assigned to livestock, mainly cattle raising in extensive systems, with a cattle herd of about 165 million head. Following are the flooded rice fields and biomass burning with, respectively, 3% and 1% of the total methane emission by agriculture. The N_2O emissions from animal sources are also significant. Emissions from manure applied to the soil correspond to 10.3% of the direct N_2O emissions from agricultural soils in Brazil, and are estimated at 8.24 Gg of N-N_2O, in 1994. N_2O emissions from animal production systems (grazing animals) accounted to 141.8 Gg of N-N_2O in the same year. Indirect N_2O emissions derived from animal sources accounted to 72.3 Gg of N-N_2O, or 87.8% of the total indirect N_2O emissions from agricultural soils. Due to the relevant amounts of methane and nitrous oxide emissions from livestock sources in Brazil, this paper presents estimates of methane and nitrous oxide emissions from livestock and potential measures that could be used for gas emission mitigation.

Keywords: Brazil, livestock, methane, nitrous oxide, mitigation

Introduction

According to official statistics (IBGE, 1998), Brazilian agricultural areas occupy nearly 228 million hectares and pasturelands cover the most part of the agricultural lands compared with the cropped areas. In 1995, 15% of the total cultivated area corresponded to permanent crops and 85% to temporary crops. However, the area occupied with agriculture is very variable from region to region. Only 1.7% of the North region is planted with crops and 6.3% is covered with pastures, whereas in the South, Southeast and Northeast regions the cropped area accounts to 24.5%, 14.0% and 14.8% in each region, respectively. In addition, pasture areas are more significant in the Southeast, Western-Central and South regions, with 40.7%, 38.9% and 35.8% representation in each region, respectively.

Brazil has currently one of the largest extensive domestic ruminant herds in the world, with 159.4 million head of bovines, 22.7 million head of goats and sheep, above 31.3 million head of swine and 3.25 billion head of broiler chicken (FNP, 2001). The main characteristic of the bovine, buffalo, mule, asinine, goat and sheep production systems countrywide is the use of large grazing lands with a low animal load per area unit. Most part of them are characterized by deposition of wastes in the soil or even in water bodies, the latter being very common in most of the swine production systems.

Bovines are the most numerous herd in all the Brazilian regions with beef cattle representing around 87% of the total bovine herd. In this production system, the Zebu cattle represents 80% of breeds raised for slaughter, and predominates in the Southeastern, Western-Central, Northern and Northeastern regions. However, in the South region, European breeds outweigh the others. In average, Brazilian beef cattle average indexes are: birth rates of 60%, death

rates from birth to weaning of 8%, interval between parturitions of 21 months, slaughter age of 48 months and 34 kg of carcass per hectare. The low support capacity of pastures shows a low digestibility rate of the material consumed, which varies from 50% to 55%. Currently, the bovine herd fattening by means of the confinement management corresponds only to 1.2% of the total herd, with the highest concentration in São Paulo State (30% of the total herd confined). In the same way, the pasture-supplemented management represents only 1.4% of the total herd.

The most common variety of dairy cattle in Brazil is a crossbreeding between Zebu and Holstein breeds. These herds are generally not specialized, presenting mixed aptitude (meat and milk). Females present low birth rates (50 to 60%), on average, with intervals of parturition varying from 19 to 24 months. Hay is used mainly for lactating cows during the dry season (Lima, 2000).

This paper presents estimates of methane and nitrous oxide emissions from livestock in Brazil, considering the differences among geographical regions. There is also a brief discussion on the potential measures for gas emission mitigation.

Methodology

Methane and nitrous oxide emissions were estimated using methods described in the IPCC/OECD Guidelines for Greenhouse Gas Emissions (IPCC/OECD, 1996). Regional data were obtained from official production statistics and literature. When the information was not available in these two sources, data were complemented by consultation with institutions, breeders associations and experts. Parallel statistics surveys (Anualpec, 2001) were also accessed to obtain more recent estimates for livestock herds. Step 2 of the calculation of methane emissions proposed by IPCC was used for beef and dairy cattle as well as for swine (Table 1). Data used in the calculation of CH_4 and N_2O emissions for different management systems of animal wastes are shown in Table 2.

Table 1 – Livestock parameters used for estimating methane emission by enteric fermentation.

Technical parameters	*Value range for different regions*
Dairy cattle	
Weight (kg)	*400- 414*
Digestibility rate (%)	*55-60*
Pregnancy index (%)	*55-76*
Food Consumption (kg)	*7.9-8.3*
Milk production (kg)	*1.08-3.3*
Beef cattle	
Weight (kg)	
- Females	*380-400*
- Males	*450*
- Young	*230*
Digestibility rate (%)	*50-56*
Pregnancy index (%)	*58-67*
Food Consumption (kg)	
- Females	*7.6 – 8.0*
- Males	*9.0*
- Young	*5.75*
Milk production (kg)	*1.1*

Table 2 – Fraction of N in each waste management system (AWMS), according to type of animal and region of the country.

Management System	Region	Dairy cattle	Beef cattle	Swine	Sheep	Poultry	Others
		Fraction (AWMS)					
Pasture/Rangeland	South	0.75	0.75	0	1.00	0	0.99
	Others	0.45	0.97	0	1.00	0	0.99
Solid storage/ Dry lot	South	0	0	0	0	0	0
	Others	0.20	0.030	00	0	0.20	0
Liquid / slurry	South	0	0	0	0	0	0
	Others	0.03	0	0	0	0	0
Anaerobic lagoon	South	0	0	0	0	0	0
	Others	0.01	0	0	0	0	0
Daily spread	South, São Paulo State	0.20	0.20	0.10	0	0.80	0
	Southeast, W-Central	0.20	0	0.05	0	0.80	0
	Others	0.20	0	0	0	0.80	0
Other systems	South	0.05	0.05	0.90*	0	0	0.01
	Southeast, W-Central	0.11	0	0.95	0	0	0.01
	Others	0.11	0	100	0	0	0.01

Results and discussion

Brazilian agricultural activities have contributed with significant amounts of greenhouse gas emissions to the atmosphere. In 1994, the contribution was estimated at 10.18 Tg of methane, 0.34 Tg of nitrous oxide, 0.24 Tg of oxides of nitrogen, and 2.79 Tg of carbon monoxide.

Methane emissions by livestock

In 1994, the methane emissions from livestock in Brazil were estimated at 9.77 Tg, being 9.38 Tg caused by enteric fermentation and 0.39 Tg by animal wastes management systems (Table 3). The category of beef cattle was responsible for 80.9% of methane emissions from cattle rising. The dairy cattle category contributed with 13.5% and the remaining livestock categories with 5.6% of emissions.

In the same year, methane emissions from management systems of animal wastes were estimated at 395.2 Gg (average of 396.80 ± 10.34 Gg in the period 1993-1995), being 50% attributed to beef cattle rising, 15.5% to dairy cattle, 15.5% to poultry and 13.3% to swine. The total emissions from livestock represented nearly 95.9% of the total emissions of methane from agricultural activities (flooded rice fields – 2.8%, agricultural residues burning – 2.8%).

Nitrous oxide emissions by livestock

In 1994, direct N_2O emissions from manure applied to the fields (daily spread) were estimated at 8.24 Gg of N-N_2O, which represents 10.3% of the total direct N_2O emissions from agricultural soils (Table 4). N_2O emissions from animal production (grazing animal) were estimated at 141.8 Gg of N-N_2O. Beef cattle and dairy cattle accounted together to emissions of 119.87 Gg (84.5% of the total). Nitrogen leaching and runoff constituted the major sources of indirect N_2O emission in the country, contributing with 72.3 Gg, which is 87.8% of total indirect emissions.

Table 3. Methane an nitrous oxide emissions from livestock in Brazil, 1994 (Embrapa, 1999a,b).

Sources	CH_4 (Tg)	N-N_2O (Tg)
Enteric fermentation	9.38	-
Management Systems of Animal Wastes	0.39	-
Daily spread of animal wastes in cultivated soils	-	0.008
Wastes of grazing animals	-	0.142
Wastes as indirect source (deposition)	-	0.015
Wastes as indirect source (leaching)	-	0.057
Total	9.77	0.222

Considerations on methane and nitrous oxide mitigation measures for Brazilian livestock

These preliminary GHG estimates provide useful data to identify some mitigation measures for the Brazilian livestock sector. The diffusion of technologies for the improvement of production efficiency, the increase of technical and managerial capabilities, and a better adaptation of the animal production systems at the farm level are potential tools for the implementation of these measures. Incentives to the adoption of adequate technologies, supported by a set of policies oriented to improving regional animal production chains, are also important aspects to be considered. Based upon these premises, some feasible opportunities to reduce CH_4 and N_2O emissions from livestock sources are presented below.

Enteric fermentation:
Indications for methane mitigation in the domestic livestock sector are associated to the improvement of animal productivity (U.S.EPA, 1990a, 1990b, 1991). This can be achieved by food supplementation, control of diseases and genetic improvement. In Brazil, the most part of methane emissions come from areas of extensive pastures, and the food supplementation for grazing cattle is often a limited practice. Pasture supplemented systems have been shown a slight increase in the Southeast, South and Western-Central regions and there is a set of products for diet supplementation in local markets, such as corn and sorghum silage, soybean bran, sugar cane bagasse, etc. Recent studies carried out in beef cattle grazing systems with *Brachiaria spp.*, a very frequent forage in Brazil, combined with supplementation along the year have shown very promising results on animal productivity. Moreover, the carrying capacity of forages increases as the animals have diet supplementation, especially during critical periods of the year. Finally, there is a need for more studies on improvement of microbial process efficiency, in order to optimize fibbers digestion in the rumen, on microbial synthesis, and on design of bioengineering strategies.

Animal wastes:
CH_4: The mitigation of methane emissions from animal wastes in confinement systems of bovine and swine can be obtained by energy recuperation processes, using anaerobic digesters. But, in relative terms, this methane source is not critical in Brazil, due to the extensive character of livestock. In the case of swine, efforts have been made in implementing the building of dunghills and bio-dunghills to treat the wastes.
N_2O: In the South region, approximately 80% and 10% of poultry and swine manure, respectively, are applied to the soil as nitrogen source. In these cases, formulation of diets with a better amino acid balance has a good potential to both reduce excretion of urinary nitrogen and promote a better digestion of food. For grazing animals, studies should be carried out to find the best balance of C and N in soils.