Methane production by Indian ruminant livestock

G. P. Singh and Madhu Mohini

National Dairy Research Institute, Karnal 132 001, India

Methane production estimates for Indian ruminants by various outside agencies were much higher[1,2] because the estimates were based on theoretical calculation without any actual experimentation on Indian ruminant livestock. The total methane contribution to greenhouse pool by Indian ruminants was 9.02 Tg/year based on methane production per kg digestible dry matter of feed available in different parts of the country and determined at National Dairy Research Institute, Karnal. Similarly, the methane production per kg milk produced in India was also much lower than reported earlier[3].

CARBON DIOXIDE, methane, chlorofluorocarbons (CFCs), nitrous oxide and other gases like sulphur hexafluoride etc. are the main greenhouse gases accumulating in the atmosphere due to the process of industrialization. This is causing depletion of ozone layer and global warming. It has been projected that if the present state of industrialization, dairy farming, growing of paddy, etc. continue, the concentration of carbon dioxide in atmosphere will double[4] by 2055 AD and concentration of greenhouse gases from all sources (carbon dioxide, methane, nitrous oxide, CFC, etc.) will double[5] by 2035 AD. Methane emission in atmosphere as a greenhouse gas has been estimated to be 255 million tonnes per year[2], although, Reid[6] estimated 423 million tonnes per year. Methane contribution to greenhouse gas pool is only 18%, however, its production by ruminants is one of the major global issues because of its relative effectiveness in terms of global warming potential and life in atmosphere. One kg methane's relative effectiveness in terms of global warming potential is equal to 40 kg carbon dioxide. According to an estimate[2], Indian contribution of methane from all sources is 12.1% of total world methane production and out of that rice field and ruminants contribute 27.3 and 13.2%, respectively, of total Indian methane production. Various methods are suggested for reducing the methane production by ruminants, however, control of methanogenesis by manipulation of rumen fermentation through feed additive and feeds is the only feasible and attractive solution at present[7,8]. Acetate and butyrate are methanogenic and spare hydrogen during their formation, while propionate being the glucogenic VFA utilizes hydrogen. Therefore, molar percentage of acetate, propionate and butyrate in TVFA play an important role

Table 1. Methane production by Indian ruminant livestock (cattle, buffalo, sheep and goat)

		Methane production		
Species	Number ($\times 10^3$)	l/day ($\times 10^8$)	mole/day ($\times 10^8$)	Tg/year
Cattle crossbred				
Male	4278	5.00	0.26	0.154
Female	8513	12.48	0.56	0.322
Cattle indigenous				
Male	94407	112.60	5.00	2.934
Female	88512	87.50	3.90	2.280
Total	195867	218.50	9.72	5.690
Buffalo				
Male	16706	19.10	0.85	0.498
Female	60054	85.80	3.83	2.237
Total	76760	108.90	4.86	2.735
Sheep	44,837	8.00	0.36	0.388
Goat	99405	14.90	0.66	0.388
Total				9.023

Based on:
Animal no.: Tech. Committee Report, Govt. of India, 1993.
Body weight of animal.
Type of feed and intake.
Digestibility of feed.
Methane per kg DDM determined.

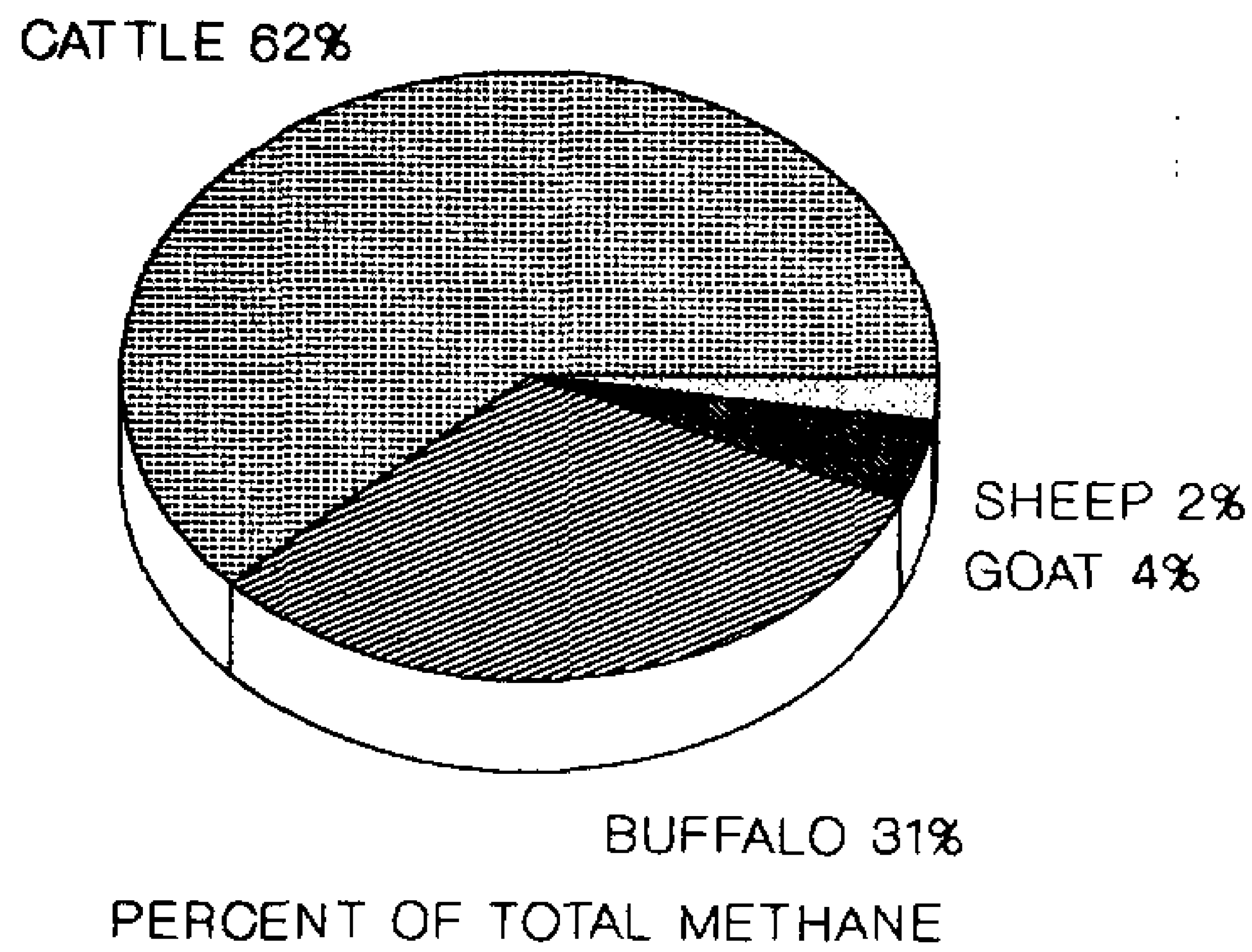

Figure 1. Contribution of methane by different ruminant livestocks.

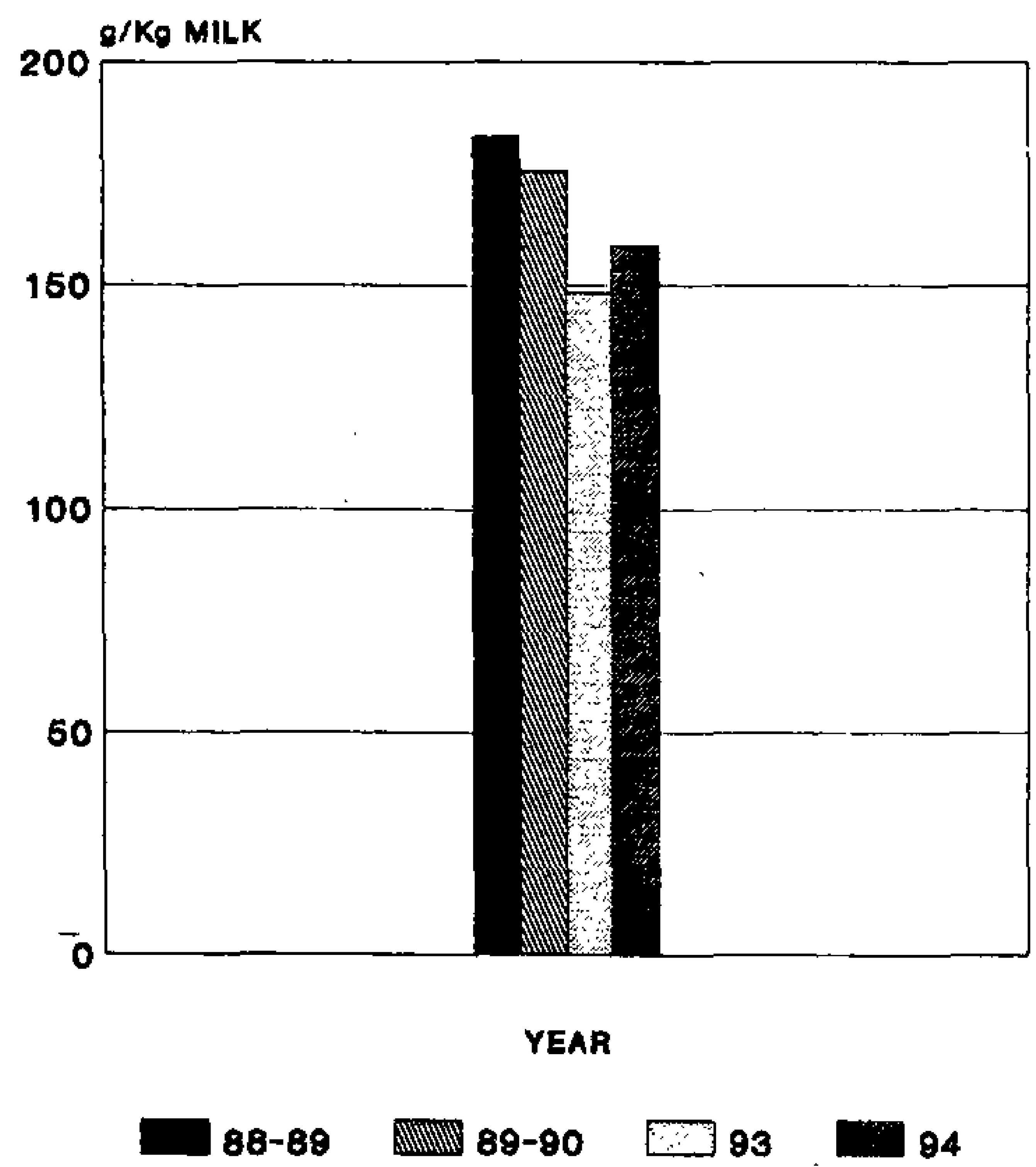

Figure 2. Methane production by Indian ruminant per kg milk produced based on total milk production and population.

in methane production by ruminants and proportion of these in rumen needs to be manipulated.

Total gas production was measured as proposed[9]. At the same time, *in vitro* dry matter digestibility (IVDMD) (single stage) of the samples of feed and fodders along with their combinations as practised in various parts of the country were also estimated for calculating the gas and methane production per unit of digestible dry matter (DDM). Percentage of methane in gas was estimated by absorbing carbon dioxide in 1 N sodium hydroxide, and making necessary correction for some other minor gases present in ruminal gas pool. Methane production per kg digestible dry matter was estimated for different types of ration based on IVDMD and methane produced on fermentation of feed. Thus, methane production based on per unit feed fermented is comparatively a better method of assessment of methane production. On the basis of methane produced per kg DDM, methane production per day for different categories of animals was calculated taking into account the intake and digestibility of feed by the animals. Total methane production by Indian ruminant livestock has also been calculated.

In rural areas of India, animals are not fed in keeping with their requirements. Most of the animals are underfed during scarcity period of the year. Feeding practices and type of feed differ from region to region. Even the body weight of animals is not the same and varies. Taking into account all these factors total emission of methane from ruminant livestock has been calculated (Table 1). Total emission of methane by cattle is 5.690 Tg/year, with the male contributing 3.088 Tg/year, and female 2.602 Tg/year. Buffaloes contribution of methane to atmosphere is estimated to be 2.735 Tg/year, with male buffaloes contributing only about 18%. Sheep and goat's contribution to total methane pool is 0.210 and 0.388 Tg/year. The per cent share of total methane production was much higher in cattle than the total of buffalo, goat and sheep (Figure 1) because of their numbers, body weight and amount of feed consumed.

Contrary to the amount of methane emission by Indian ruminant livestock observed on the basis of experimental data by the authors, higher amount of methane emission (10.0 and 10.4 Tg) was reported[1,2] in 1990 on the basis of theoretical calculation. On the other hand, much lower amount of methane emission has been reported[10] which was based on the prediction equation developed in Western countries, feeding grain and high quality hay diet[11]. This is not applicable to Indian animals because Indian ruminant animals are fed on crop residues-based diets and that too is not enough to meet the nutrient requirement of more than 90% of animals.

In India, the average milk production is not more than three kg per animal per day and despite large numbers of animals majority of them are either non-producers or very low producers. Methane production per kg milk produced in India (total methane produced/total milk production), reported and discussed in many National and International fora, seems to be higher than what is actually produced, (240 g methane per kg milk)[3]. Methane production per kg milk varies between 148 and 183 g/kg milk (Figure 2) based on milk production and methane production estimates of last 6–7 years. However, it is far less than the reported figure of 240 g/kg.

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Mutants resistant to foliar diseases in groundnut (*Arachis hypogaea* L.)

B. N. Motagi, M. V. C. Gowda and R. Sheshagiri

Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad 580 005, India

Foliar diseases particularly leafspots and rust are the major factors limiting yield and quality in groundnut. Most of the groundnut cultivars in India are highly susceptible to foliar diseases. Fungicidal sprays are effective in controlling these diseases, but the use of disease-resistant cultivars is a better approach. A number of resistant germplasm lines are available but many other undesirable attributes limit their utility as cultivars. Attempts have been made to produce high yielding disease resistant cultivars through hybridization, but the lines developed either had only moderate resistance or retained one or more undesirable features. Mutagenic treatment of Valencia 1 with EMS, resulted in isolation of a large number of foliar disease-resistant mutants. Three mutants, viz. 28-2, 45 and 110 combined high yield potential and early maturity, besides multiple disease resistance and desirable pod and kernel features. These mutants can be widely tested for their commercial release and/or profitably utilized in future breeding programmes.

THE cultivated groundnut (*Arachis hypogaea* L.) is an important oilseed crop and is presently cultivated in an area of 21.17 m ha with a total production of 25.89 m t. In India groundnut occupies 31.3 per cent of the total cropped area under oilseeds (8.35 m ha) and accounts for 36.1 per cent of total oilseed production (8.85 m t). Like in other developing countries, the average yield in India is around 1000 kg per ha as against the average of 2995 kg per ha realized in USA[1]. Many reasons are ascribed to the low productivity in developing countries. Foliar diseases particularly early leafspot (*Cercospora arachidicola* Hori.), late leafspot (*Phaeoisariopsis personata* (Berk and Curt) V. Arx) and rust (*Puccinia arachidis* Speg.) are the major factors limiting yield and quality in groundnut. Each of these diseases is individually capable of causing substantial yield loss, and when leafspots and rust occur together yield losses can go up to 70 per cent[2]. These diseases have an adverse influence on the recovery of pods at harvest, quality of seeds, and haulms. Fowler[3] estimated that defoliation of leaflets may begin when six per cent of their leaf area is diseased. Severe infections may cause complete defoliation. However, lesions are not confined to the leaves but may occur also on the stems and pegs, leading to direct deterioration of the developing pods[4]. Because of prolonged wet periods, late leafspot is more predominant in the transitional belt of Karnataka, which accounts for over 50 per cent pod and fodder yield loss[5]. Spanish cultivars are the most popular cultivars in this regions as they mature early and facilitate double cropping under rainfed conditions. But all of them are highly susceptible to the foliar diseases. Though several effective chemicals are available to control these diseases, fungicidal control is not preferred due to the escalation of production cost, especially in the rainfed condition[6]. Cultivation of the resistant/tolerant varieties is the best approach under these circumstances.

Several genotypes resistant to late leafspot and rust have been identified. But most of them belong to the Valencia group and are landraces with a number of undesirable attributes like thick shell, low productivity, late maturity and poor adaptation, making them unsuitable for direct utilization[7,8]. A number of attempts have been made to produce disease-resistant, productive cultivars through hybridization, but the lines developed either possessed only a moderate level of resistance or retained one or more undesirable features[9]. A number of wild *Arachis* species have shown either highly resistant or immune reaction to these pathogens[10]. *A. cardenasii*, a diploid species, was identified to be an excellent source of resistance to late leafspot[9]. Stable interspecific hybrid derivatives belonging to *Virginia* group with high yield and high level of resistance have been developed but they were all late maturing and had low shelling percentages[11]. Recently two moderately resistant hybrid derivatives, viz. ICGV 86590 and ICGV 87160 were released for commercial cultivation in southern peninsular region of India. They are comparable to popular susceptible cultivar JL 24 in productivity, but suffer from