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METHANE EMISSION VIS-A-VIS LIVESTOCK AND MITIGATION STRATEGIES- A REVIEW

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It has been noted thta livestock sector is growing faster than any other agricultural sub-sector and it contributes about 40% to global agriculral output. Livestock has made an important contribution to the food supplies globally through various products like milk, meat eggs, etc. The production of livestock products over the pas two decades (FAO, 2006) is increasing fastly, particularly in developing countries; reported an increase of 78%, 127% and 331% in cereal, meat and egg production, respectively.

According to report of Indian Network of Climate Change Assessment (INCCA) GHG emissions during the year 2007 was observed from Industry (Electricity, Transport and Cement etc.) 79.5%, Agricultural 17.5% and Waste 3.0% that includes carbon di-oxide (CO_2-1221.76), Methane (CH_4-20.56) and Nitrous oxide (N_2O-0.24) million tons. Among the different green house gas after carbon di-oxide and it is 20 times more potent than carbon dooxide. The net Greenhouse Gas (GHG) emissions from India i.e. emissions with land Use, Land Use Change & Forestry (LULUCF), in 2007 were 1727.71 million tons of CO_2 equivalent (eq).

Livestock has been the mainstay of Indian agriculture sector and also a major source of GHGs emissions from the world's largest livest population. The milching livestock (including lactating dairy cattle, buffalo and goat) constitutes 21.3% of the country's livestock. The total CH_4 emission from enteric fermentation and manure management was estimated at 3.16 Tg/yr for the year 2003. Enteric fermentation contributes 91.3% of total CH_4 emissions as compared to only 8.7% by manure management. The CH_4 emission in terms of milk production is less in exotic cows (23.8 gm CH_4/kg milk) as compared to indigenous cows (44.6) gm CH4/Kg milk). The projected estimates of livestock population indicates that lactating dairy cattle and buffalo are expected to increase to increase by 3.5 and 5.6 million resulting to an expected increase of ~36% and 17% methane emissions, respectively by the year 2021. These estimates are important indicators for stuying the future impacts of livestock to climate change and their role in food security, and may also serve as an important pathway for formulating policy measures for sustainable livestock production.

Species	Developing Country	Developed Country	Total
Cattle	22.8	31.8	54.6
Buffalo	---	---	6.2
Sheep	3.7	3.2	6.9
Goat	---	---	2.4
Subtotal	**26.5**	**35**	**70.1**
Pig	0.4	0.5	0.9
Horse, Mules	---	---	1.7
Camel	---	---	1.0
WR, Herb	---	---	2.6
Human	---	---	0.3
Subtotal			**6-10**
G.Total			**76-80**

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Table 1. CH_4 Emission from Livestock, Tg (Terragram) per year(Khan, et al. 2001; Singh, 1997)

Table-1 Indicate that Emission of Methane gas from different kind of Lvestock (Ruminants) is more in developed countries (35.00) than developing countries (26.5) and remaining 6-10 Tg from other animals etc. The greenhouse gas (GHG) emissions from the agricultural sector account for about 25.5% of total global anthropogenic emission. While CO_2 receives the most attention as a factor relative to global warming. CH_4, N_2O and chlorofluorocarbons (CFCs) also cause significant radiative forcing. With the relative global warming potential of 25 compared with CO_2, methane is one of the most important GHGs. The estimated CH_4 emission rate per cattle, buffaloes, sheep and goat in developed countries are 15.7, 137, 21.9 and 13.7 (g/animal/day) respectively. However, the estimated rates in developing countries are significantly lower at 95.9 and 13.7 (g/animal/day) per cattle and sheep, respectively. There exists a strong interest in developing new and improving the existing CH4 prediction models to identify mitigation strategies for reducing the overall CH_4 emission.

A synthesis of the available literature suggestes that the mechanistic models are superior to empirical models in accurately predicting the CH_4 emission from dairy farms. The lastest development in prediction model is the intergrated farming system model which is a process-based whole-farm simulation technique. Several techniques are used to quantify enteric CH_4 emissions starting from whole animal chambers to sulfur hexafluoride (SF6) tracer techniques. The latest technology developed to estimate CH_4 more accurately is the micrometeorological mass difference technique. Because the conditions under which animals are managed vary greatly from country to country. CH_4 emission reduction strategies must be tailored to country-specific circumstances. Strategies that are cost effective, improve productvity, and have limited potential negative effects on livestock production hold a greater chance of being adopted by producers. It is also important to evaluate CH_4 mitigation startegies in terms of the total GHG budget and to consider the economics of various strategies. Although reductions in GHG emissions from livestock are seen as high priorities, strategies for reducing emissions should not reduce the economic viability of enterprises.Before going for the mitigration strategies of methane gas from livestocks we should know about the livestock status in India. India has 226.1 million cattle, 96.9 million buffaloes, 59 million sheep and 124.5 million goats, 18.5 million pigs, 0.9 million each of camels and donkeys, 0.8 million horses/ponies and small a number of yak, mithun and mules (1) (FAO Production Year Book, Vol, 57:2003). These animals produce 13.46 Tg methane/year (includingemissions from animal wastes). The methane emission factors (kg/head/year) for different categories of animals in India are lower than in Europe and North America. based on the studies conducted at Indian Veterinary Research Institute, methane emission factors for cattle, buffalo, sheep and goat varied from 25.6 to 57.6, 28.9 to 52.7, 2.6 to 4.1 and 3.3 to 4.3 respectively. These variations are mainly due to differences in body weight, type of feed (high vs. low fibre) and individual behavior (high or low methane producers) of the animals.

As developing countries are now responsible for almost three-quarters of such emissions, this has important implications in terms of mitigation strategies, because these countries are presently outside the remit of the Kyoto Protocol. This paper therefore reviews certain areas of CH_4 emissions from ruminants, highlights on how some novel feed additives can decrease CH_4 emissions from ruminants, and how some plants seconday metabolites might act as a selective inhibitor of methanogens. An enteric methane emission (which is one of the greenhouse gases) represents an economic loss to the farmer where feed in converted to CH_4 rather than to productoutput. Finally concluded that the mitigation of methane emission is essential to protect the environment from the greenhouse effect and at the same time improve feed conversion efficiency.

The development of management strategies to mitigate methane emissions from cattle are possible and desirable. Not only will enhanced utilization of dietary carbon improve feed efficiency and animal productivity, but a decrease in methane emissions will reduce the contribution of ruminant livestock to the global methane inventory. Now here following strategies are being described to mitigate methanogenesis on the dairy farms;

i) Non-productive or low productive animals should be replaced with either high producing indigenous cattle/buffalo or high producing crossbred cattle.

ii) Any effort made to chance degradability of poor quality feeds results in an improvement in nutrient availibity accompanied with a decrease on methanogenesis. For example, urea ammoniation of straw may serve three purposes, firstly it enhances degradability of straw, secondly the supplemented non-protein nitrogen source stimulates microbial protein synthesis in the rumen and lastly it reduces methanogenesis.

iii) Plant secondary metabolites (saponins, tannnins, lignins, essential oils etc.) have antimicrobial activities to protect the plants against invasion by microbes. This plant property can be exploited for control of undesirable microbes in the rumen. The initial screening experiments have indicated that the extracts of plants containing secondary metabolites are effective against methanogenesis and ciliate protozoa, and some have an adverse effect on degradability of feed in the rumen (reticulum & omasum). Based on the results of in vitro screening experiments, a few plants and some mixtures of plants have been selected fro inclusion in the diet of ruminants to study their effect on in vivo methane emission as estimated by open circuit respiration calorimeter.

Mixture improveddry matter digestibility of feed by 10.6 to 11.3% in (Table-2). In another experiment, a mixture of 3 plants fed to cattle calves at 2% of DM intake on alternate days inhibited methane production by 9.4% and the body weight gain was 8.7% (448 vs. 412 g/d) higher as compared to control, with no adverse effect on digestibility of different nutrients.

Table2. Effect of plant secondary metablolites on in vivo methane emission and digestibility of feed dry matter:

Plant	Methane inhibition (%)	Digestibility of dry matter (%)	Animal Species
Terminalia Chebula (1% of dry matter intake)	24	11.3(+)	Sheep
Allium sativum (1% of DM intake)	11.9	11.1(+)	Sheep
Terminalia chebula & Allium sativum	23.5	10.6(+)	Sheep
Mixture of three plants (2% of Dm intake on alternate days)	12.0	No effect	Cattles & Calves

iv) The results of the vivo experiments conducted so far indicate that planbts containing secondary metabolites, showing promising results in in vitro experiments, do have a potential to be used rumen modulators for controlling methane emission in ruminants. The levels used in in vitro experiments are usually very high and may not be usable in vivo expriments. Therefor, the level of feeding of plants additives ahs to be standardizeidn for practical application to get inhibition in methanogenesis without any adverse effect on nu7trient utilization.

v) Plant extracts (saponins and tannins) used as novel feed additives are able to decrease the number of hydrogen procuders such as protozoa in the rumen. This is a promising way for the future. Fumarate and malate (dicarboxylic acids) stimulate hydrogen use for propionate synthesis at the expense of methane in the rumen. These products natuarlly found in plants open promising perspective. Dieatary encapsulated fumaric acid decrease methane formation by 76% in the trial with grwoing lambs. This is also are very promising findings that should be explored by feed manufactures and livestock farmers.

CONCLUSION

Livestock production system that meets the goals of social responsibility in terms of animal welfare or other societal concerns may also have some negative impacts on the environment that must be recognized in order to be addressed. The manipulation of the ruminal fermentation has tremendous potential for improving animal physiology, nutrition and subsequently production. It is important to reduce the enteric methane emissions from ruminants, because methanogenesis corresponds to dietary energy loss as well as contributes to global warming. Therefore, in considering ethical animal production practices, special consideration needs to be given to the impacts of the system on the environment.

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