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CLIMATE CHANGE AND WAY FORWARD TO CLEAN COW TECHNOLOGY

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Abstract: The world is riding on crest of enthusiasm of clean technology having minimum damage to natural resources to preserve and protect environment as a convenient action against inconvenient truth of climate change. Term 'clean technology' implies to any product or service that improves operational performance, productivity, or efficiency while reducing costs, inputs, energy consumption, waste, or environmental pollution. It is nothing but sensible and wise response of world community to crisis of climate change and global warming. The animal husbandry and dairy sectors have also started paving new avenues like 'clean cow technology' to meet the pace of clean technology in livestock sector and to contribute to global environment welfare by innovating and inventing ways of reducing methane emission from ruminants, considered responsible for climate changes and global warming.

Keywords: Climate Change, Green House Gases, Clean cow technology.

INTRODUCTION

The most serious environmental problem faced today, by humanity, on planet is climate change and its socio-economic consequences. Emission of green house gases *viz.* methane, carbon dioxide and many other polluting gases due to anthropogenic activities is major factor responsible for climate change. Agricultural practices, including dairy and beef production, are one of the largest anthropogenic sources of greenhouse gases (GHGs). The environmental performance of livestock sector in term of GHG emission is major challenging issues globally. Now-a-day, the issue of environmental performance of livestock industry is gaining momentum because of increased awareness towards climate change. These concerns have resulted in a widespread interest from governments, consumers and industry in the assessment of the environmental performance of livestock production. Thus, global livestock sector is faced with a three-fold challenge: the need to increase production to meet demand,

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adapt to a changing and increasingly variable economic and natural environment and, at the same time, improve its environmental performance (Opio *et al*., 2013).

GRAVITY AND RELEVANCE OF LIVESTOCK SECTOR TO CLIMATE CHANGE

Due to ever expanding population of dairy animals, emission levels of GHGs are increasing day by day. The environmental performance of livestock sector in term of GHGs emission is major challenging issues globally. Now a day, the issues of environmental performance of livestock industry is gaining momentum because of increased awareness towards climate change. These concerns have resulted in a widespread interest from governments, consumers and industry in the assessment of the environmental performance of livestock production. The significant contribution of the livestock sector to total anthropogenic emissions responsible needs urgent attentions and action to better understand the sources of the livestock sector's GHGs emission and related mitigation options for climate change. The scientific community in the world is continuously thriving best to undertake comprehensive assessment of livestock-related GHGS emission and identification of low-emission development pathways for the livestock sector. The major objectives include quantifying the estimates of livestock sector's overall emissions and identification of the major available mitigation strategies over a diversified area of planet.

Dairy animal sector comprises of rising population of cattle, sheep and goat, and buffalo. The global ruminant population in 2010 was estimated to be 3,612 million with cattle making up nearly 40 percent, sheep and goat 55 percent, and buffalo the remaining 5 percent (Opio *et al*., 2013). Livestock sector contributes to 14.5 percent (7.1 gigatonnes CO_2 eq per annum) of total anthropogenic GHG emissions and thus plays a crucial role in climate change. Beef, milk, pork and poultry productions account for 41, 20, 9 and 8 percent of emissions, respectively contributing of the livestock sector's emissions (Gerber *et al*., 2013).

As per the EPA, "enteric fermentation" in cows and other ruminant animals, like sheep and goats, contributed major part of the world's total emissions of methane, a hard-hitting greenhouse gas with much greater short term warming consequences than carbon dioxide does. Agriculture sector represent around 10–12% (5.0–5.8 gigatonnes CO_2 eq per annum) of global total anthropogenic GHGs emission. Livestock contribution to the global anthropogenic GHG emissions was estimated at 6.3%, with GHG emissions from enteric fermentation accounting for 2.1 gigatonnes CO_2 eq per annum and manure management accounting for 0.99 gigatonnes CO_2 eq per annum (IPCC, 2014). The relative contribution of emissions from enteric fermentation to the total agricultural GHG emissions will vary by

region depending on the structure of agricultural production and type of livestock production systems. Accepted global greenhouse gas (GHG) emissions estimates from 17 billion domestic food-producing animals vary from 8 to 18% of global anthropogenic emissions (Herrero *et al*., 2015). In another report, it was estimated that between 1995 and 2005, the livestock sector was responsible for greenhouse gas emissions of 5.6–7.5 gigatonnes CO_2 eq per annum and livestock may contribute to half of the technical mitigation potential of the agriculture, forestry and land-use sectors, in this relation through better management options (Herrero *et al*., 2016).

The Indian scenario is not quite different. As per study conducted by space application center, ISRO, the total methane emission from Indian livestock, which includes enteric fermentation and manure management, was 11.75 Tg for 2003. Enteric fermentation accounts for 10.65 Tg (~91%) compared to 1.09 Tg (~9%) by manure management. Dairy buffalo and indigenous dairy cattle together contribute 60% of the total methane emission. The three high methane emitter states are Uttar Pradesh (14.9%), Rajasthan (9.1%) and Madhya Pradesh (8.5%). The detailed district-level spatial analysis in GIS environment resulted in the identification of clusters of districts with high emissions. Among these, Mednipur District (West Bengal) reported the highest total methane emission of 0.12 Tg. Using the remote sensing-derived livestock available feed/fodder area, the average methane flux from Indian livestock was computed as 74.4 kg/ha (Chhabra *et al*., 2009).

MITIGATION STRATEGIES: A WAY FORWARD TO CLEAN COW TECHNOLOGY

The amplitude of problem is so high that collaborative efforts and action from all sector stakeholders is urgently required to ensure implementation of existing mitigation strategies and development of clean technology for livestock sectors. The complexity of problem involves many challenging task. GHGs emission intensities vary greatly between production units, even within similar production systems. Emissions per unit of animal product will be different under different farming practices and supply chain management. Thus, mitigation prospects of clean cow technologies can greatly utilize the gap between the production units with the lowest emission intensities and those with the highest emission intensities. It is suggested that 30% reduction in GHGs emission would be possible, for example, if producers in a given system, region and climate adopted the technologies and practice currently used by the 10 percent of producers with the lowest emission intensity (Gerber *et al*., 2013). Producers can increase the profitability of their operation by incorporating carbohydrates in a

cattle diet, increasing feed intake, processing forages and offering a diet that includes unsaturated fat. Each of these factors has been shown to improve feed efficiency and reduce methane production. The major objectives include quantifying the estimates of livestock sector's overall emissions and identification of the major available mitigation strategies over a diversified area of planet.

For livestock production systems, nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO) emissions, the three main GHG emitted, are losses of nitrogen, energy and organic matter that undermine efficiency and productivity. Possible interventions to reduce emissions are thus, to a large extent, based on technologies and practices that improve production efficiency at animal and herd levels. They include the use of better quality feed and feed balancing to lower enteric and manure emissions. Improved breeding and animal health help to shrink the herd overhead (i.e. unproductive part of the herd) and related emissions. Manure management practices that ensure the recovery and recycling of nutrients and energy contained in manure and improvements in energy use efficiency along supply chains can further contribute to mitigation. Sourcing low emission intensity inputs (feed and energy in particular) is a further option.

RUMEN FERMENTATION MODIFIERS

Many factors influence ruminant methane production, including level of intake, type and quality of feeds and environmental temperature. Many research trials have been conducted to identify the factors affecting methane production in ruminants, to examine technologies for the mitigation of methane emissions from ruminants, and to identify areas requiring future research. Earlier approach to improve feed efficiency with ionophores antibiotic has no values in today's' residue consciousness world of consumers and environmentalists. The regulatory authority of many countries has banned the use of antibiotics in production of foods of animal origin. As an alternative, research on newer approach involving herbal supplements or photochemical or methane production inhibitors to modulate the rumen fermentation have been employed as a mitigation strategies. The use of garlic oil, cinnamaldehyde (the main active component of cinnamon oil), eugenol (the main active component of the clove bud), capsaicin (the active component of hot peppers), and anise oil has shown encouraging results in reducing methane production. The research on associated factors like diet composition, production system and specific conditions needs to be elaborated to understand exact mechanism (Calsamiglia *et al*., 2007). In one trial conducted in Angus cattle, it was found that canola oil can be used to reduce methane losses from cattle.

Adding canola oil to the diet decreased total daily methane emissions by 32% and tended to decrease methane emissions as a percentage of gross energy intake by 21%. However, much of the reduction in methane emissions was due to decreased feed intake and lower total tract digestibility of DM and fiber (Beauchemin and McGinn, 2006).

DUNG BEETLES

Recent biotic mitigation approach using dung beetles may affect fluxes of GHGs from cattle farming. In one study conducted at three different levels i.e. the dung pat, pasture ecosystem, and whole lifecycle of milk or beef production, dung beetles reduced GHGs emission by up to 7% and 12% respectively, mainly through large reductions in methane (CH_4) emissions. However, at the lifecycle level, dung beetles accounted for only a 0.05-0.13% reduction of overall GHG emissions. This study suggests that the effects of dung beetles may be accentuated in tropical countries, where more manure is left on pastures, and dung beetles remove and aerate dung faster, and that this is thus a key area for future research (Slade *et a*l., 2016).

METHANE INHIBITORS

Methane inhibitors are chemical compounds with inhibitory effects on rumen archaea. Many trials of methane inhibitors involving bromochloromethane, 2-bromoethane sulfonate, chloroform, and cyclodextrin demonstrated ~ 60 % reduction in methane production. Due to concerns of animal health, food safety and environmental impact, their use as methane inhibitors are under debate. However, recently identified methane inhibitors 3-nitrooxypropanol (3-NOP) has proved to be effective methane inhibitors. It is recently known that 3-NOP specifically targets methyl-coenzyme M reductase (MCR) which catalyzes the methane-forming step in the rumen fermentation (Duin *et al*., 2016). The study in lactating cows to investigate the effects of 3-NOP demonstrated that the compound effectively decreases methane emission in lactating cow without affecting milk yield and milk fat concentration. 3-NOP is effective in reducing 30% GHG emissions without affecting milk production. In beef cattle, up to a 5.8% reduction in *ad libitum* DMI was observed when 2.5 mg/kg BW of 3-NOP was fed. Increasing level of 3-NOP linearly reduced methane (CH_4), with 33% less CH_4 at the highest level of supplementation compared with the control. The use of 4.5 mg/kg BW of 3-NOP in beef cattle consuming a back-grounding diet was effective in reducing enteric CH_4 emissions without negatively affecting diet digestibility (Haisan *et al*., 2014; Reynolds *et al*., 2014; Romero-Perez *et al*., 2014; Hristov *et al*., 2015).

McLANAHAN NUTRIENT SEPARATION SYSTEM

Several other interventions using oil seed cake, herbal additives, tannins etc. are being extensively researched and many of them have come out with successful results in reducing methane emission. The use of cow dung for biogas fuel through farm based biogas generation unit would also reduce emission of methane from dung left indisposed. The breakthrough technology in reducing methane emission through separation of useful nutrients and water from cow dung is under innovation at Michigan State University. The technology is named as McLanahan Nutrient Separation System. It uses anaerobic digesters, ultra filtration, air stripping and a reverse osmosis system. The system under trials produces 50 gallons of waters from 100 gallons of manure. It also extracts nutrients from the manure that can be harmful to the environment and can be reused as fertilizers. The nutrients available from manure after separation includes cconcentrated organic nitrogen and phosphorus fertilizer (slurry or stackable form); concentrated nitrogen fertilizer (liquid), concentrated potassium fertilizer (liquid) and clean water. Still scientists are working to improve throughput and sustainability of system (Oswald *et al*., 2014).

In conclusion, the significant contribution of the livestock sector to total anthropogenic emissions responsible needs urgent attentions and action to better understand the sources of the livestock sector's greenhouse gases (GHGs) emission and related mitigation options for climate change. The scientific community in the world is continuously thriving best to undertake comprehensive assessment of livestock-related GHGs emissions and identification of low-emission development pathways for the livestock sector.

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