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Animal Husbandry Sector and Global Climate Change

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Abstract—*There is a growing problem of global environmental change and which is a world issue affecting one and all. Because of greenhouse effect, it is possible that average air temperature of the earth is increased by 0.5~2.0ºC, change takes place in the pattern of rain and snow, rainfall and evaporation as well. According to data concerned, carbon dioxide, methane and nitrogen oxide are major gases resulting in greenhouse effect. 15%~20% climate warming is due to methane, which is the second major greenhouse gas next to carbon dioxide and whose influence is 21 times that of carbon dioxide , so the problem of emission of methane is concerned by all professionals. The output of methane emitted from ruminants accounts for 1/5th of that in atmosphere. In particular, cattle produce the greatest amount of methane, being 2~3 times that of other ruminants. Other livestock are also major resources creating greenhouse effect in the globe, they also release large amount of gases, such as carbon dioxide and ammonia making air pollution heavier. Consequently, it is very important to control harmful gases of animal husbandry production.*

1. INTRODUCTION

There have been various deliberations from time to time regarding the status of climate change and the impact of current human lifestyle on our environment. The impact of human activities viz. deforestation, mining, burning of fossil fuels, use of chemicals and gases, increased use of automobiles and pollutions of other kinds as well affect all the realms of environment and contribute in one way or other to adverse climatic changes. The reports of Intergovernmental Panel on Climate Change (IPCC, 2007) leaves no doubt that climate change is real, that it will become worse, that the poorest and most vulnerable people will be the worst affected. The International Fund for Agricultural Development (IFAD) acknowledges climate change as one of the factors affecting rural poverty and as one of the challenges which needs to addressed. Rural poor communities rely greatly for their survival on agriculture and livestock that are amongst the most climate-sensitive economic sectors. Because of greenhouse effect, it is possible that average air temperature of the earth is increased, change takes place in the pattern of rain and snow, rainfall and evaporation as well. The IPCC predicts that by 2100 the increase in global average surface temperature may be between 1.8° C and 4.0° C. With increases of 1.5° C to 2.5° C, approximately 20 to 30 per cent of plant and animal species are expected to be at risk of extinction as per Food and Agriculture Organization with severe consequences for food security in developing countries.

One of the sector which has not been accessed properly earlier and only recent studies have been made into is that of animal husbandry sector. One of the major sources of climate change is the green house gases (GHGs) which comprise of CO_2, CH_4, N_2O, fluorinated gases and some other gases. Out of these methane is the third highest contributor to global warming as per human emissions but if we look at the total methane emission from all sources, animal husbandry sector particularly ruminants are major contributor to it. In most of the studies the contribution of methane emission by livestock and its impact is not properly accessed.

At present, very few development strategies promoting sustainable agriculture and livestock related practices have explicitly included measures to support local communities in adapting to or mitigating the effects of climate change. Activities aimed at increasing the resilience of rural communities will be needed to raise their capacity to adapt and to respond to new hazards. At the same time, while small scale agricultural producers and livestock keepers, especially poor farmers, are relatively small contributors to greenhouse gas (GHG) emissions, they have a key role to play in promoting and sustaining a low-carbon rural path through proper agricultural technology and management systems.

2. GLOBAL TRENDS IN GREEN HOUSE GAS EMISSIONS

2.1. Global Emissions by Gas

At the global scale, the key greenhouse gases emitted by human activities are:

(a) Carbon dioxide (CO_2) - Fossil fuel use is the primary source of CO_2. The way in which people use land is also an important source of CO_2, especially when it involves deforestation. Land can also remove CO_2 from the atmosphere through reforestation, improvement of soils, and other activities.

(b) Methane (CH_4) - Agricultural activities, waste management, and energy use all contribute to CH_4emissions.

(c) Nitrous oxide (N_2O) - Agricultural activities, such as fertilizer use, are the primary source of N_2O emissions.

(d) Fluorinated gases (F-gases) - Industrial processes, refrigeration, and the use of a variety of consumer products contribute to emissions of F-gases, which include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).Black carbon (BC) is a solid particle or aerosol, not a gas, but it also contributes to warming of the atmosphere.

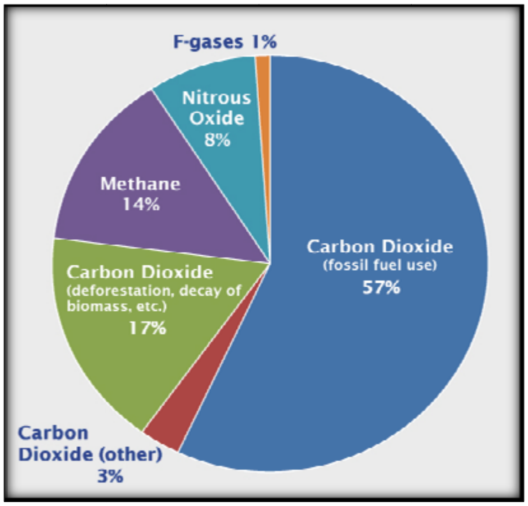

Fig. . 1: Global greenhouse gas emissions by gas

Source: IPCC (2007)

2.2. Global Emissions by Source

Global greenhouse gas emissions can also be broken down by the economic activities that lead to their production.

(a) Energy Supply (26% of 2004 global greenhouse gas emissions) - The burning of coal, natural gas, and oil for electricity and heat is the largest single source of global greenhouse gas emissions.

(b) Industry (19% of 2004 global greenhouse gas emissions) - Greenhouse gas emissions from industry primarily involve fossil fuels burned on-site at facilities for energy. This sector also includes emissions from chemical, metallurgical, and mineral transformation processes not associated with energy consumption. (Note: Emissions from electricity use are excluded and are instead covered in the Energy Supply sector.)

(c) Land Use, Land-Use Change, and Forestry (17% of 2004 global greenhouse gas emissions) - Greenhouse gas emissions from this sector primarily include carbon dioxide (CO_2) emissions from deforestation, land clearing for agriculture, and fires or decay of peat soils. This estimate does not include the CO_2 that ecosystems remove from the atmosphere. The amount of CO_2 that is removed is subject to large uncertainty, although recent estimates indicate that on a global scale, ecosystems on land remove about twice as much CO_2 as is lost by deforestation.

(d) Agriculture (14% of 2004 GHG emissions) - global greenhouse gas emissions) - Greenhouse gas emissions from agriculture mostly come from the management of agricultural soils, livestock, rice production, and biomass burning.

(e) Transportation (13% of 2004 global greenhouse gas emissions) - Greenhouse gas emissions from this sector primarily involve fossil fuels burned for road, rail, air, and marine transportation. Almost all (95%) of the world's transportation energy comes from petroleum-based fuels, largely gasoline and diesel.

(f) Commercial and Residential Buildings (8% of 2004 global greenhouse gas emissions) - Greenhouse gas emissions from this sector arise from on-site energy generation and burning fuels for heat in buildings or cooking in homes. (Note: Emissions from electricity use are excluded and are instead covered in the Energy Supply sector.)

(g) Waste and Wastewater (3% of 2004 global greenhouse gas emissions) - The largest source of greenhouse gas emissions in this sector is landfill methane (CH_4), followed by wastewater methane (CH_4) and nitrous oxide (N_2O). Incineration of some waste products that were made with fossil fuels, such as plastics and synthetic textiles, also results in minor emissions of CO_2.

3. NEW TOOLS FOR MEASURING CLIMATE CHANGE PARAMETERS

3.1. Global warming potential

Global warming potential or GWP is a tool that compares the direct climate forcing of different greenhouse gases relative to that of CO_2. The GWP combines the capacity of a gas to absorb infrared radiation, its lifetime in the atmosphere , and the length of time over which its effects on the earth's climate need to be quantified (the time horizon). In the case of CH_4, it is also adjusted to take account of indirect effects via the enhancement of tropospheric ozone, stratospheric water vapor and production of CO_2 resulting from its destruction in the atmosphere. So, as CH_4 has an effective climate-forcing lifetime in the atmosphere of only 12 years, CH_4 has a GWP of 72 over a 20- years time horizon, but a GWP of 25 over a 100-year time horizon and 7.6 over a 500-year time horizon.

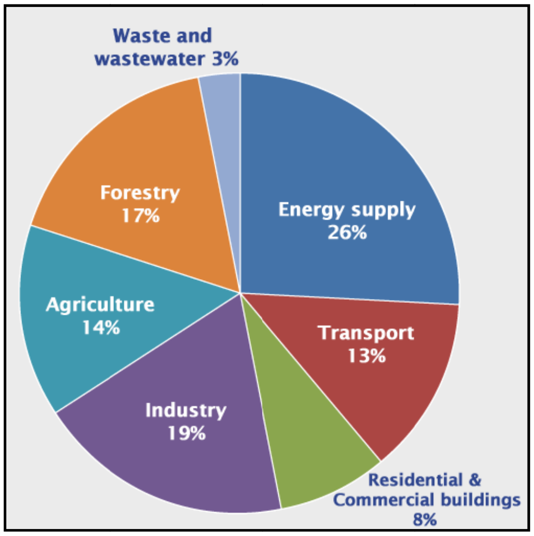

Fig. 2: Global greenhouse gas emissions by source
Source: IPCC (2007)

3.2. Carbon dioxide equivalents

When attempting to access the relative importance of CH_4 fluxes and mitigation strategies the concept of carbon dioxide equivalents (CO_2-eq) is often employed to convert CH_4 fluxes into units directly comparable with CO_2. This is done simply by multiplying the mass of CH_4 by its GWP to give the mass in CO_2-eq. Usually the 100-year time horizon GWP value is used, so a reduction of 1 tonne CH_4 would be a reduction of 21 or 25 tonnes CO_2-eq respectively. However, where a shorter time horizon is considered, the GWP increases substantially, a reduction of 1 tonne of CH_4 using a 20-year GWP time horizon yielding a cut of 72 tonnes of CO_2-eq. A 100- year time horizon has become the commonly used benchmark for national greenhouse gas emissions budgets and trading.

4. IMPORTANCE OF GREEN HOUSE GASES

Total Green House Gases contribute less than 1 percent of the total quantity of gases in the atmosphere but they have a very significant role to play. Due to the property of green house effect i.e. ability to trap the thermal radiation from a planetary surface and re-radiation in all directions by green house gases like CO_2,CH_4 etc. Since part of this re-radiation is back towards the surface and the lower atmosphere, it results in an elevation of the average surface temperature above what it would be in the absence of the gases. In the absence of green house gases the earth's temperature would have been not suitable enough for all the life to sustain and survive. But, at the same time the excess of GHGs may result in such increased elevation of temperature which may again be unsuitable for life or may lead to such catastrophic changes such as significant rise in the level of sea water which will wipe of many forms of life completely. That is why, a proper balance of the amount of green house gases has to maintained in the atmosphere.

5. CLIMATE CHANGE AND LIVESTOCK

5.1. The effects of climate change on livestock

In most of the developing and least developed countries still the majority of the population is associated with agriculture systems where livestock is a key asset. Livestock has multiple roles to play in such economies where it is an economic asset and has social as well as cultural importance. Poor people are so much dependent on livestock that losing the same may result in difficulty to survive even. Climate change as is well established has adverse impact on the life and health of humans as well as animals. It can affect livestock directly as well as indirectly.

5.1.1. Direct effects

(a) Variable rainfalls or temperature patterns which can result into spread of vector borne disease as well as emergence of new diseases.

(b) Generation of new disease transmission models.

5.1.2.Indirect effects

(a) Change in the feed resources owing to change in patterns of climatic conditions for crops.
(b) Increased competition for feed, water and space.

5.2. Role of livestock in climate change

The GHG emission from the agriculture sector account for about 25.5% of total global radiative forcing and over 60% of anthropogenic sources (FAO, 2009). Animal husbandry accounts for 18% of GHG emissions that cause global warming. Emission of CH_4 is responsible for nearly as much radiative forcing as all other non-CO_2 GHG gases combined. While atmospheric concentrations of GHGs have risen by about 39% since pre-industrial era, CH_4 concentration has more than doubled during this period (WHO, 2009). Reducing the increase of GHG emissions from agriculture, especially livestock production should therefore be a top priority, because it could curb warming fairly rapidly. The major GWP of livestock production worldwide comes from the natural life processes of the animals.

5.3.Sources of GHGs from livestock:

Livestock produce Green House Gases in mainly two ways:

(a) Digestive process: Methane is produced in herbivores as a by-product of 'enteric fermentation,' a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream.
(b) Animal wastes: Animal wastes contain organic compounds such as carbohydrates and proteins. During the decomposition of livestock wastes under moist, oxygen free (anaerobic) environments, the anaerobic bacteria transform the carbon to methane. Animal wastes also contain nitrogen in the form of various complex compounds. The microbial processes of nitrification and de-nitrification forms nitrous oxide, which is emitted to the atmosphere.

5.3.1. Enteric emissions

The global annual emission of methane from all sources has been estimated as 500– 600 Tg/year of which over 300 Tg/year comes from anthropogenic activities (IPCC 2001).Livestock farming has been found to be the most important anthropogenic activity that results in methane emissions.

India emerged as the largest contributor to the livestock methane budget, simply because of its enormous livestock population, although the emission rate per animal in the country was much lower than in the developed countries. For instance, the annual methane production per animal was estimated to be 95 kg for the dairy cows in Germany, nearly threefold higher than 35 kg for the Indian cattle. The default enteric fermentation emission factors for cattle recommended by Inter-Governmental Panel on Climate Change (IPCC) for national GHG inventories are also much higher for the developed countries compared to the Indian sub-continent (Table 1).

Table 1: Enteric fermentation emission factors

Region	Annual methane emission (kg/head)	
	Dairy cattle	Non-dairy cattle
North America	118	47
Western Europe	100	48
Eastern Europe	81	56
Oceania	68	53
Latin America	57	49
Africa and Middle East	36	32
Indian Subcontinent	46	25

Source: IPCC(1996)

The differences in per head emissions are due to lower level and poor quality of feed intake in India. Methane production in livestock is related to the level of intake and digestibility of feed. The livestock characteristics (age, weight and species), health and living conditions influence the energy requirement. Higher methane production results from higher energy requirement and feed intake. The energy requirement of Asian cattle species *Bos indicus* is about 10% lower than European and North American cattle species *Bos taurus* . In Indian conditions the animals are mostly fed on poor quality roughages of low digestibility and emit less methane than exotic cattle of developed countries fed with highly digestible good quality feed.

5.3.2. Emissions from manure management

The total global methane emissions from livestock manure management have been estimated as 9.3 Tg/year of which the developed countries contribute about 52%. The sharply different manure management practices in India, as compared to the western countries, lead to much lower methane emissions from manure. Cattle and buffalo manure is extensively used in the country as fuel and is largely managed in dry systems. India's contribution to nitrous oxide emissions from manure management in 1990 is estimated to be 0.017 Tg/year, which is projected to increase to 0.022 Tg by 2020 .

6. MITIGATION STRATEGIES OF LIVESTOCK EMISSION

Several methods have been proposed for mitigation of emissions of GHGs from livestock. Technologies that can reduce the amount of methane production in rumen or total release of methane into atmosphere are useful for efficient use of feed and making the environment more favorable.

All approaches points towards either reduction of methane production per animals or reduction per unit of animal product. These depend on some important factors to be considered for selection of best options for methane emission reduction: climate, economic, technical and material resources, existing manure management practices, regulatory requirements etc. Methane has relatively short life (10-12 years) in the atmosphere as compared to other GHGs, for example CO2 has 120 years and therefore strategies to reduce the methane in atmosphere offer effective and practical means to slow global warming. Decreased emission rate of only 10% will stabilize methane concentration in atmosphere at present level. Mitigation of GHG emissions in the livestock sector can be achieved through various activities, including:

(a) Different animal feeding management.
(b) Manure management (collection, storage, spreading).
(c) Management of feed crop production.

7. CONCLUSION

We can conclude that livestock sector is an important contributor to the phenomenon of climate change as well as is sensitive to the phenomenon itself. Such approach needs to be devised which not only leads to curbing of the production of the GHGs but also at the same time keeps in mind the optimum production levels from the livestock sector. The projected trend of population growth indicates that livestock population will increase tremendously over the next few years and hence creating a database for GHG inventory are important indicators for studying the future impacts of livestock to climate change. There is urgent need to understand the various factors affecting variability in enteric CH_4 production to decrease the uncertainty in GHG emission inventories and to identify viable GHG reduction strategies. Although the reduction in GHG emissions from livestock industries are seen as high priorities, strategies for reducing emissions should not reduce the economic viability of enterprises if they are to find industry acceptability.

To solve the problem of global warming as such and associated climate change, animal husbandry professionals need to delve further in the studies relating to impact of livestock sector on climate change as it can be a major finding to curb the problem of climate change at a global level. Such an approach has to be devised which focuses both on mitigation, to reduce the level of emission of gases contributing to global warming, and on adaptation, to support local communities in dealing with the impacts. Further we need to understand the global trends in greenhouse gas emissions to understand the role of animal sector in particular.

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