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Trends of Green House Gas Emissions: Inter-Sectoral Analysis

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Abstract

Human activities, though aimed at development have always had significant impact on the environment as the seeds of destruction are present in this growth process itself , some is true for agriculture contributing towards harmful GHG emissions. This secondary data based study is aimed to analyze the trends of GHG emissions in world & India. The energy sector, followed by agriculture and industry are the major contributors towards GHG emission in global scenario with Asia region at the top. Country –wise, India is at third place after China and USA, though per capita emissions here are 60 per cent lesser than the global average. So far agriculture, forestry and other land use (AFLOU) sector is concerned, India has witnessed an increase of 25 percent in GHG emissions between 1990 and 2017, mainly due to enteric fermentation, area under rice cultivation and extensive usage of synthetic fertilizers. At the same time, agriculture being a prominent victim of climate change, needs mitigation strategies like optimization in fertilizer usage, use of fermented manures, rice water management, balancing the farming system to check these increasing GHG emissions.

Keywords : GHG emissions, Agriculture, Energy, Climate change

JEL Classification: Q10, Q54, Q56, O13

Introduction

Human civilization owes its origin and existence to natural resources. The relationship between man and nature has become complex through so called developmental process (Sengupta, 2001) as humans interact with and affect their natural environment through it. Economic activities affect the environment in different ways. In perusal of satisfaction of wants, production and consumption of goods and services lead to draw the sources and energy from environment. The claim process modified it more often in a negative way disturbing the natural balance. By the very nature of this process, the economic growth is not in harmony with equity, stability, environment quality and resource availability. This has tarnished the ecological balance in terms of air and water pollution, desertification, climate change, biodiversity loss etc. Environmental problems have become more acute with population explosion, intensification of agriculture, rapid industrial growth, urbanization and use of modern pollution prone technology (Kaur *et al*, 2014) . This issue has become all the more important in the present context as many natural resources, which were once regarded as free goods, have now become scarce resources. Atmospheric composition of earth regenerates itself , but is effected by current state of atmosphere and the rate at which pollutants are added. Green house gas emissions are the major culprit here.

Agriculture along with livestock was the prime economic activity being undertaken for human survival since ancient times. With the passage of time these have transformed from subsistence to commercial activities. In this process, intensity of input use which includes chemical fertilizers, agro-chemicals, irrigations, machinery etc. has increased tremendously, though leading to all time high production and productivity of various crops. But modern agriculture in this development process has also become a cause of concern for the environment (Jane *et al*, 2020).

Climate change is the real phenomenon, threatening the very survival of human race on planet earth in terms of providing adequate food, water, energy, safe shelter etc (Sharma and Sharma, 2018). The climate has been changing in ways that cannot be taken as natural transition, but human activity is adding in a big way. Transformation of agriculture is one such aspect contributing to the production of greenhouse gas (GHGs), which have increased since the advent of industrial age (Dario *et al*, 2014). Greenhouse gases can be defined as those that absorb infrared radiation in the atmosphere, trapping heat and thus raising the temperature of earth i.e. global warming (Synder *et al*, 2009). This has

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affected socio-economic sectors including agriculture, forestry, fisheries, water resources, human health, settlements etc.

Developing economy like India is a resource scarce country having fewer financial and technical resources and are more vulnerable to climate variations. Biological sectors like agriculture have been mainstay of such countries supporting about 58 per cent of the population and contributing significantly to Gross Domestic Product of the country. So, high dependence on climate sensitive sector like agriculture makes the economic system highly fragile. Human induced climate change and environment problems have led to adverse affect on farm productivity and the food security of the nation.

In the wake of above observations, it becomes imperative to analyse the aspects of climate change. GHGs are the major component of this change. So, the specific objective of this study is to analyse the trends in GHG emissions of India, particularly in agriculture sector.

Data Sources and Methodology

The present study is entirely based on secondary data/ information retreived from published sources like FAOSTAT, Climate Watch, India energy outlook etc. Simple averages have been calculated to examine the magnitude of GHG emissions on various basis such as sectors, sub sectors, country wise and region wise. The selective position of some important variables has been studied with the help of proportions and depicted with pie charts, bar diagrams for better understanding.

Results and Discussion

Green house gas emissions by sectors- Global scenario

The world has witnessed Green House Gas emissions to the extent of 49.44 billion tonnes CO_2eq. in 2016. The sector wise split of these emissions has been presented in Table 1. The largest contribution towards these emissions has been the energy sector with major sources of emissions being industry (24.2%) construction (17.5%) and transport (16.2%) respectively. Further, it can be divided to Iron and Steel industry at 7.2 per cent , chemical and petro-chemicals at 3.6 per cent and other industries at 10.6 per cent. However, share of food and tobacco industries has been only 1 per cent. On the other hand, emissions from energy use in construction of commercial buildings is about 6.6 per cent, while that of residential buildings about 11 per cent. In case of transport sector, major share of emissions have been from road transport (11.9%) and shipping (1.7%) sectors. In all energy sector has been adding 73 percent of total GHG emissions in world.

Agriculture, forestry and land use (AFLOU) has remained the second major contributor of GHG emissions in the global scenario. In this, livestock and manure has been adding 5.8 per cent, agricultural soils 4 per cent, crop/ stubble burning 3.5 percent , deforestation 2.2 per cent and rice cultivation at 1.3 per cent respectively. So, the share of livestock has been the largest in the world.

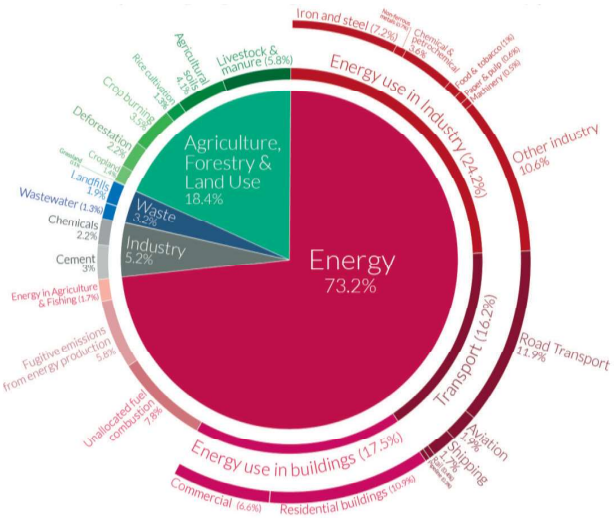

Fig. 1: GHG emissions: Global Scenario
Source: Climate Watch, the World Resources Institute(2020)

In case of industrial sector, cement and chemicals industries are the main contributors, together adding up 5.2 per cent of the total emissions. While the share of waste in the emissions stands at 3.2 per cent, having wastewater at 1.3 per cent and land fills at 1.9 per cent respectively

Fuel combustion and fugitive emissions from energy production have been adding 7.8 per cent and 5.8 per cent of GHG emissions in the energy sector of world. This means world's iron and steel industry is more emission intensive, followed by chemicals as the second largest emitting industrial subsector.

Region wise GHG emissions

Table 1. Region wise GHG emissions

(Emissions in $MtCo_2$ eq.)

Regions	1990	2000	2010	2019
Africa	1062.91	1073.49	1054.76	1308.20
America	1369.72	1384.54	1574.89	752.55
Asia	3157.75	3011.41	1743.53	2285.77
Europe	1593.42	1339.06	1725.92	1402.02
Oceania	143.73	150.82	188.21	90.93

Source: FAOSTAT
Note: Million metric tonnes of CO_2 equivalent

The balancing of economic growth be it agricultural, industrial or any other sector of the economy, the best management could bring growth, equity and sustainability in the economy (Homer, 1989). But the pace and level of development is not at par across the regions of world, as development is historical in nature. Many regions have

attained a higher pace and witnessed huge growth in different sectors of the economy and some lagged behind in the process due to various reasons. So, GHG emissions also vary among the regions depending on various factors. All the regions except African have shown a declining trend in emission of GHGs. Asia being the highest emitter, has shown a decrease of about 28 per cent in 2019 over 1990. In American region these have almost halved and in Europe it is more or less same.

Greenhouse gas emissions: Country-wise scenario

India has emerged as a major energy consumer in the world economy. Experiencing a rapid economic growth, coupled with increasing population its energy consumption has more than doubled since 2000. India is the third largest CO_2 emitter as shown in figure 2, enlisting after China and USA, though its CO_2 emissions are about its one fifth of china and one half of USA. Though per capita emissions in India are still on the lower side by world standards i.e. 60 per cent lesser than the global average (World Energy Outlook, 2021). The power generation, industry and transport have been the major contributors towards carbon dioxide emissions in India.

So, far as AFLOU sector is concerned, trends in CO_2 emissions has not been uniform. The scenario of top ten countries as per their standing in emission from this sector has been given in table 2. In this ranking, India is at fifth position in world over the three decades, though it has managed to cut its emissions to 97.60 from 286.54 million tonnes. Countries like China, Canada, USA, Russia and Japan have also shown a declining trend during the period, but an increase has been witnessed in UK and Iran. On the other hand, France and Germany have remained at same level of emissions.

India being the second most populous country of the world and one of the fastest growing economies is having huge demand for energy by different sectors. This has also caused increased GHG emissions by these sectors, which have been shown in figure 3 . With tremendous demand for energy input by various developmental aspects it is highest contributor towards GHG emissions in 2017 , followed by agriculture , industrial and land use sectors in India.

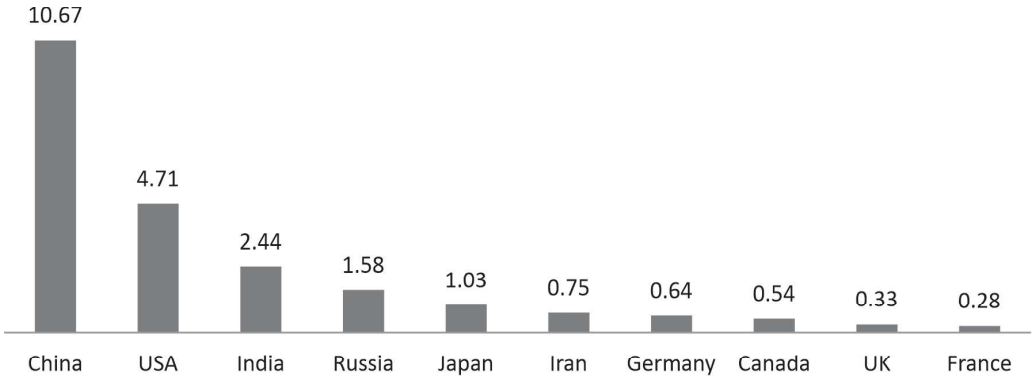

Fig. 2: Top ten GHG emitters in 2020 (Bt CO_2 eq), Source: Climate Watch, 2020

Table 2. Country-wise GHG emissions from AFLOU sector, 1990-2019

(Emission in $MtCO_2$ eq)

Countries	1990	2000	2010	2019
Canada	213.05	216.45	316.62	217.21
China	453.02	458.84	447.85	779.89
France	49.39	50.05	90.06	84.69
Germany	97.87	80.94	47.94	58.10
India	286.54	292.44	106.78	97.60
Iran	33.29	33.21	43.03	19.85
Japan	135.77	116.90	127.09	59.89
Russia	452.49	535.91	844.99	706.52
UK	23.57	21.98	18.92	19.59
USA	681.47	680.59	543.48	487.27

Note: Million metric tonnes of Carbon dioxide equivalent

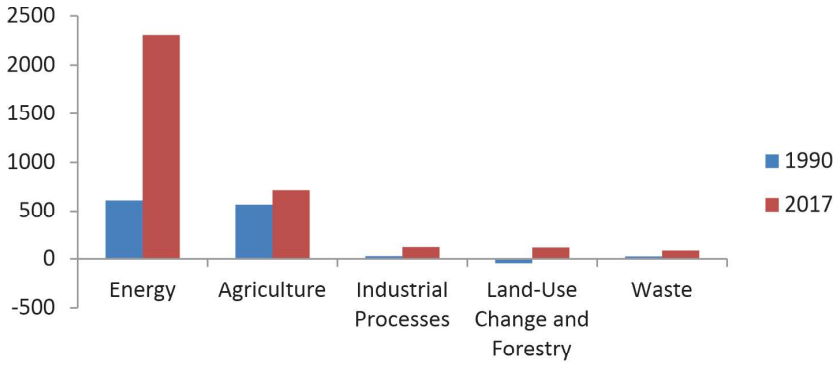

Fig. 3: Sector-wise GHG Emissions in India, 1990 through 2017

Sector-wise GHG Emissions in India

The agriculture sector was found to be emitting 502.44 Mt of GHGs in the year 1990, which has increased to 647.81 Mt tons in 2017; depicting an increase of about 25 per cent. Enteric fermentation was found to be contributing the largest proportion ranging between 45-49 per cent during last three decades. Area under rice cultivation was second largest contributor to GHG emissions emitting 18.7 per cent in 1990 and marginally decreased to 15 per cent in 2017. On the other hand, the proportionate emissions from synthetic fertilizers increased sharply from 9.7 per cent to 17 per cent of total emissions emitted by agriculture sector during the same span of time. Other factors like burning of straw, crop residue, manure left etc, were contributing small proportions to emission of GHGs.

During a span of three decades, livestock population grew from 470.9 million to 535.8 million depicting an increase of 13.7 per cent, whereas emissions from enteric fermentation grew 18.5 per cent. India's GDP increased 265 per cent from 1990 to 2017, while GHG emissions increased by 183 per cent during same period; meaning thereby that increased output has caused lesser damage to environment in wake of government policies initiatives under Sustainable Development Goals. The usage of Nitrogenous based fertilizers to enhance the production of food, fibre and fuel demands of growing population in the country has led to increased emissions from 48.83 $MtCO_2e$ in 1990 to 113.78 in 2017 $MtCO_2e$.

Mitigation of GHG emissions

Increasing concentration of green house gases in the atmosphere is leading to climate change, which has emerged as a serious global environmental issue and poses a threat and challenge to mankind (Verge et al, 2007). The repercussions are ostensible, with glaring impact on agriculture and established farming systems. Due to spatial and temporal variations in level of GHG emissions, it's quantification and delving into effective mitigation strategies is difficult. GHG emissions from agriculture are related to adoption of adequate technologies, status of food and nutritional security, growth rate of human and livestock population, level of socio-economic development, policy initiatives etc. So, mitigation requires active management of agricultural systems. Livestock sector is contributing highest propertionate of methane emission among other subsectors from agriculture. GHG emissions related to animal production are directly emitted from domestic animals and grazing lands. This can be mitigated by reducing the feed input per unit of product output. Similarly, usage of fermented manures can reduce the level of GHG emissions (Jane, 2007). Also optimum fertilization strategies, zero tillage, rice –water management can go a long way in bettering the environmental heath by contracting the harmful emissions. So, the balanced farming systems are needed to check the escalating greenhouse gas emissions.

Table 3. GHG emissions in Agriculture sector in India

(Emissions in $MtCO_2eq$)

Year	Enteric Fermentation	Rice Cultivation	Synthetic Fertilizers	Others	Total Agriculture sector
1990	246.45	94.60	48.83	112.56	502.44
2000	259.32	99.11	70.50	122.48	551.41
2010	284.50	95.01	106.20	136.61	622.32
2017	292.06	98.64	113.78	143.33	647.81

Note: Million metric tons of carbon dioxide equivalent

Conclusion and Policy Implications

With increase in economic growth, the emission intensity i.e. GHGs per unit of GDP tends to decline. This happens on account of declining energy efficiency, increased use of renewable sources of energy, expanding and dependable public transport network etc.

Agriculture is both a contributor as well as a victim of climate change. The agricultural practices like application of chemical fertilizers, pesticides, manures and other livestock waste, add to GHG emissions. With rising population, demand for food including livestock products is bound to grow, would cause intensification of agricultural practices and thus higher level of emissions (Pathak and Wassmann, 2007). On the other hand, these leading to climate change having most profound impact on the present agricultural production systems and their sustainability. So, the mitigation strategies are utmost needed to break this cause and effect phenomenon.

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