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Impact of Crop Residue Burning on Climate Change: A Scenario of Madhya Pradesh, India

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Abstract

Crop residues are generated after harvesting the crops. The main reason behind burning of crop residues is due to difficulty in collection of crop residue. If collected, these residues then may be use in different forms like industrial/domestic fuel, fodder, packaging, bedding, wall construction, and green manuring etc. Burning of crop residues emitted many of the gases (SO_2, NO_2 and CO etc) other than green house gases also. This paper is focussed on impact of crop residue burning on the green house gases and climate change in Madhya Pradesh. Green house gases (GHGs) emitted from agricultural / crop residue burning such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O). The total green house gases emitted due to crop residue burning from Madhya Pradesh is around 5676.46 kg/year out of which carbon dioxide released is approx. 5666.1 kg/year, methane approx. 10.10 kg/year and about 0.26 kg/year of nitrous oxide. It is also compared that the impacts of these green house gases over a 20 year time horizon. These gases are responsible for the green house effect or global warming which may cause climate change.

Keywords: Crop residue burning, GHGs, climate change.

Introduction

India is an agriculture based country. Agricultural crop residue is plant material which remains after harvesting and processing of crop. There are two types of agricultural crop residues such as field residues and process residues. In India usually three agricultural crops are taken. Between two crops, very less time or no time are available to the farmers for preparation of their field for next crop. Moreover no economical technologies are available for collecting of left over agricultural residues from the field. Thus farmers adopt the easiest way i.e. burning of the crop residues in the open field. Major crops of Madhya Pradesh are cereals (83.18 lakh hectares area), pulses (51.79 lakh hectares area), oilseeds (72.02 lakh hectares area) and commercial crops (7.17 lakh hectares area)[1]. The major crop grown in Madhya Pradesh includes paddy, wheat, maize and jowar, moong, gram, tur, urad, mustard, soybean and groundnut. Some commercial crops like sugarcane and cotton is also grown in central India. Generally wheat crop residues are burn in the field (figure-1).

Madhya Pradesh itself generates approx. 33.18 Mt/year crop residues among that 2.0 to 3.86 Mt crop residues are burnt every year[2]. Burning of crop residue emitted gases like SO_2, NO_2[3-4] and CO_2, N_2O and CH_4[5-9]. Excess amount of carbon dioxide (CO_2), methane (CH_4) etc gases are emitted in the atmosphere due to crop residue burning. These gases increase the atmospheric temperature which, affect to the worldwide environment[4].

The aim of this research paper is to quantify the green house gases emitted from crop residue burning and their impact on climate change. Effort was also made to see the impacts of these green house gases over a 20 year time horizon.

Figure-1
Wheat crop residue burning

Material and Methods

To calculate the amount of GHGs emissions like carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) following formula was used[10].
E = M x EF

Where: E= Total emission of the gaseous species considered (kg/year). M= mass of dry matter burned (kg) and EF= Emission Factor (g/kg).

The emission factors of GHGs are mentioned in table-1.

Table-1
Emission factors

Name of the Gas	Emission factors of crop residues (g/kg)
Carbon dioxide (CO_2)	1515
Methane (CH_4)	2.7
Nitrous Oxide (N_2O)	0.07

The data such as mass of dry matter burned was given in table 2[11]. These values of emission factor (table-1) of crop residues were taken from Table-2[12]. On the basis of above formula total emission of the gaseous species was calculated.

Table-2
Generation and burning of crop residues in Madhya Pradesh

State	Crop residues generation (Mt/year)[11]	Crop residues burnt (Based on IPCC Coefficient) Mt/year[11]
Madhya Pradesh	33.18	3.74

Formula for calculation and compare the impact of crop residue burning of GHGs over 20 Year time horizon:
CO_2: Global warming potential (GWP) x emissions, The 20-year GWP times emission rate product for methane is
CH_4: Global warming potential (GWP_{20}) x emissions
and, for N_2O the 20-year impact will be
N_2O: Global warming potential (GWP_{20}) x emissions

Results and Discussion

Burning of crop residue releases the GHGs (table-3) in the atmosphere. Emissions of GHGs was determined on basis of product of emission factors (table-1) and crop residues burnt (Based on IPCC Coefficient) (table-2).The quantity of GHGs (CO_2, CH_4, N_2O) emitted by crop residue burning from Madhya Pradesh itself is about 5676.46 kg/year. In which contribution of CO_2; CH_4 and N_2O is about 5666.1 kg/year, CH_4 is about 10.10 kg/year and about 0.26 kg/year respectively. Critical analysis of table-3 indicates that, carbon dioxide is the most dominant among three gases.

Table-3
Emissions of green house gases from crop residue burning

Name of the Gas	Emissions
Carbon dioxide (CO_2), kg/year	5666.1
Methane (CH_4), kg/year	10.10
Nitrous Oxide (N_2O), kg/year	0.26
Grand Total	5676.46

Impact of GHGs emitted by crop residue burning over a 20 Year time horizon was also compared. The comparison was done based on the products of emission rates and global warming potential (GWP) (table-3 and 4).

Table-4
Global Warming Potential[13]

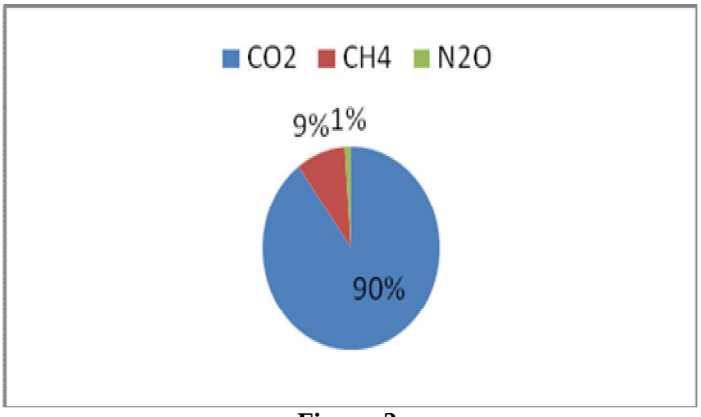
Name of the Gas	Global Warming Potential (GWP) 20 Year time horizon
Carbon dioxide (CO_2)	1
Methane (CH_4)	56
Nitrous Oxide (N_2O)	280

Since the GWP of carbon dioxide (CO_2) is constant i.e. 1 with respect to other gases, so its product with any other value will remain unchanged. The product of each GHGs was calculated (kg CO_2) on the basis of GWP and emissions rate of gases (table-5). Analysis of table-5 shows that the warming impact over the next 20 years from today's emissions of CH_4 would be only 10 times less impact than CO_2; however its generation is about 560 times less than CO_2. Likewise emissions of N_2O are about 21792 times less than that of CO_2 emission, although it warming impact is about 81 times less than that of CO_2 emission.

Table-5
Impact of crop residue burning of GHGs over a 20 Year time horizon

S.No.	GHGs	Emissions (kg/year)	Time Period (year)	GWP	Product (10^3 kg CO_2)	Percent of Total
1	Carbon dioxide (CO_2)	5666.1	20	1	5.67	89.92 %
2	Methane (CH_4)	10.10	20	56	0.565	8.96 %
3	Nitrous Oxide (N_2O)	0.26	20	280	0.07	1.11%

Considering the overall impact of GHGs in the next 20 year time horizon, it may be safely concluded that CO_2 would be dominant because CO_2 contribution is about 90%. Similarly, CH_4, N_2O contributes about 9% and 1% respectively (figure-2). These gases are responsible for the green house effect and ultimately increase the global temperature phenomenon called global warming. The increase in temperature of globe may also responsible for climate change.



Figuge-2
Relative influence of green house gases over 20 year time horizon based on the products of GWP time one year's emission

Conclusion

Results obtained from this study shows that crop residue burning increases the concentration of green house gases (carbon dioxide, methane and nitrous oxide). These green house gases releases from burning of crop residues, trapped the heat which is responsible for global warming and rise in temperature and ultimately may cause the climate change. Analysis of results shows that the warming impact over the next 20 years from current emissions of methane would be 10 times less impact than carbon dioxide; however its generation is about 560 times less than carbon dioxide. Similarly emissions of nitrous oxide are about 21792 times less than that of carbon dioxide emission, although it warming impact is about 81 times less than that of carbon dioxide emission. Considering the total impact of these three green house gases in the next 20 year time horizon, it may be concluded that carbon dioxide would be dominant because carbon dioxide contribute is approx 90% in warming due to crop residue burning. Similarly, methane, nitrous oxide contributes approx. 9% and 1% respectively. On the basis of this study it may be concluded that burning practice of crop residue is not good because it will not only increase the global temperature but it may be responsible for climate change also.

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