"Effect Of Biofuel Upon Global Warming, Climate And Production Of Crops" A Case Study Of Eastern Uttar Pradesh (India)

Devendra Pratap Singh[1], Ms. Anamika Singh[2], Dr. Rakesh Kumar Trivedi[3]

[1]Department of Applied Chemistry Dr. Ambedkar Institute of Technology for Handicapped, Kanpur 208024 Research Scholar,

[2]Department of Geography Banaras Hindu University, Varanasi-221005

[3]Professor & Head, Department of Oil and Paint Technology, H.B.T.I., Kanpur Harcourt Butler Technological Institute, Kanpur 208002

Abstract

Now in these days' green house gases is the main cause of global warming and affects the climate in the world. Environmental arguments centre on the need to reduce greenhouse gases (GHGs) emissions for the sake of both the global and local climate, particularly in large cities. Excessive exploitation of natural resources for development has been resulted into many environmental problems like environmental pollution and degradation, more emissions of greenhouse gases, extinction of many rare species, global warming and many more The consequences of global warming are multidimensional and can leave unpredictable deviation resulting in various weather conditions and calamities, including erratic monsoon behavior, water scarity and higher evapo-transpiration, resulting frequent floods and droughts.

In this respect, the replacement of fossil fuels by biofuels in the transportation sector is necessary to help the reduction of GHGs. Climate change impacts have spurred researchers and industry to look at alternate clean energy options. The high concentration of GHGs in the atmosphere interrupts long wave terrestrial radiation responsible for warming the lower atmospheric air. The variability in surface temperature affects the magnitude of evapotranspiration, atmospheric moisture and precipitation consequently all these may affects the intensity of rainfall and long break spells of rainfall during monsoon season.

In this paper we studied the effect of global warming on about the climate change, activities of southwest monsoon and its impact on Kharif Crop (as a major source of agro residue)and potential of biofuel production as an alternative of fossile fuel in Eastern Uttar Pradesh in India. In this contact second generation biofuels from lignocellulosic agro residues play an important role to improve the environment.

Keywords: Bioethanol, Biomass, Pretreatment, fermentation, hydrolysis, sugar, South west monsoon, atmospheric humidity, kharif crops.

I. Introduction

In Eastern Uttar Pradesh, kharif crops are usually grown in rain feed and irrigated condition during south west monsoon season. The region suffers from delay in monsoon with high rainfall variability in reference to space and times both mainly responsible for decrease in kharif crop. In this paper an attempt has also been made to analyse and find out the importance and relationship between the southwest monsoon rainfall and production of Kharif crops in Eastern Uttar Pradesh. Overall the analysis shows a high positive correlation(+0.78) between south-west monsoon and Kharif crop in study region. So good monsoon can reduces the risk of kharif crop felure. Thus healthy agro residue by kharif crops have great potential of biofuels production.

Production of biofuels from lignocelluloses is one of the ways, which is helpful to reduce GHGs as well as global warming. Biofuels are renewable, meaning their sources can be regrown. Advanced biofuels can offer environmental benefits such as lower carbon emissions and lower sulphur compared with first-generation biofuels are made largely from edible sugars and starches and conventional petroleum-based fuels. Others argue that biofuel production will compete with land needed for food production. To produce ethanol from biomass feedstock's, a pre-treatment process is used to reduce the feedstock size, break down the hemicellulose to sugars, and open up the structure of the cellulose component. The cellulose portion is broken down (hydrolyzed) by enzymes into glucose sugar that is fermented to ethanol. The sugars from the hemicellulose are also fermented to ethanol. The lignin is burned as fuel to power the process.

Many recent studies shows that global warming is one of the major causes of climate change which certainly influence major climatic elements like temperature and rainfall. Excessive exploitation of natural resources for development has been resulted into many environmental problems like environmental pollution and degradation, more emissions of greenhouse gases, extinction of many rare species, global warming and many more [15]. The high concentration of GHGs in the atmosphere interrupts long wave terrestrial radiation responsible for warming the lower atmospheric air. The consequences of global warming are multidimensional and can leave unpredictable deviation resulting in various weather conditions and calamities, including erratic monsoon behavior, water scarity and higher evapo-transpiration, resulting frequent floods and droughts [16].

In recent the monsoon activity certainly affected by climate change. The variability in surface temperature affects the magnitude of evapotranspiration, atmospheric moisture and precipitation consequently all these may affects the intensity of rainfall and long break spells of rainfall during monsoon season. The monsoon plays an important role in production of agricultural crops especially in Indian sub-continent and Southeast Asia. In an agrarian economy like India the monsoon rainfall significantly provides water supply for growing crops in forms of soil moisture, irrigation potential and atmospheric humidity. The Study area received more than 89 percent of annual totals of rainfall in southwest monsoon season which is highly variable with respect to time and scale. Rainfall usually starts abruptly in the first week of July with sudden fall in temperature and a marked rise in relative humidity which makes a favorable condition for *Kharif* crops. Normally the month of July and August receives adequate rain in presence of low pressure trough created over Gangetic plain. The year to year variability in monsoon rainfall leads to extreme hydrological events (large scale droughts and floods) resulting into serious reduction in agriculture output and affecting the vast population and national economy [5]. The abnormal monsoon either in the form of excess or deficient rainfall may cause damage to the crops costing in millions. The southwest monsoon of the Indian area represents the most developed monsoon attitudinally and vertically on the earth [9]. Eastern Uttar Pradesh situated in the middle Ganga plain lies within one of the most active southwest monsoon dominated region of the world [1].

In the study area, kharif crops are usually grown in rain feed and irrigated condition during south west monsoon season. The present study deals with the analysis of impact of southwest monsoon rainfall on Kharif crops with special reference to Eastern Utter Pradesh. Although, the expansion in irrigation facilities and adoption of new agricultural technologies has brought major change in agricultural practices, still farmers are dependent on their Kharif crop production on SW monsoon. With provision of artificial means of irrigation farmers are in a position to save their crops in this season only to a limited extent specifically in the case of low rainfall. The main kharif crops are paddy, maize, sugarcane, pea etc. These all have great potential of biomass production along with food grain.

Therefore, as an alternative, production of biofuel from agro-residue (biomass) can give pollution free fuel for vehicles. The term biomass encompasses a wide spectrum of plant materials that range from agricultural and forestry wastes to municipal wastes to crops grown specifically to make biofuels, such as bioethanol and biodiesel. Lignocellulosic biomass is a complex mixture of carbohydrate polymers from plant cell walls known as cellulose and hemicellulose, lignin and a smaller amount of other compounds generally known as extractives. The technologies used to convert these biomass feedstock's vary, and the alternative fuels produce similarly low amounts of greenhouse gas when combusted. But by using alternative fuels we can offset the use of petroleum products. So if we use, for example, ethanol produced from plant material (which is made from atmospheric carbon) we are not putting carbon in the air that has been trapped as oil for millions of years. Considering fossil fuels are finite, with uncertain supply, and emit GHGs, there is a need to procure further renewable energy resources. Biofuel production has been advocated by many experts as a solution to meeting the energy needs of African countries while reducing greenhouse gas (GHG) emissions.

Engines running on biofuels emit carbon dioxide (CO_2), the primary source of greenhouse gas emissions, just like those running on gasoline. However, because plants and trees are the raw material for biofuels, and, because they need carbon dioxide to grow, the use of biofuels does not add CO_2 to the atmosphere, it just recycles what was already there. The use of fossil fuels, on the other hand, releases carbon that has been stored underground for millions of years, and those emissions represent a net addition of CO_2 to the atmosphere. Because it takes fossil fuels such as natural gas and coal to make biofuels, they are not quite "carbon neutral."

Argonne National Laboratory has carried out detailed analyses of the "well-to-wheels" greenhouse gas emissions of many different engine and fuel combinations. The chart at right shows a few selected examples [7]. Argonne's latest analysis shows reductions in global warming emissions of 20% from corn ethanol and 85% from cellulosic ethanol

Thus, greenhouse gas emissions in an E85 blend using corn ethanol would be 17% lower than gasoline, and using cellulosic ethanol would be

Table 1. Gasoline and Ethanol Greenhouse Gas (GHG) Emissions (not considering land use changes) (grams of GHGs CO_2 eq. per MJ of energy in fuel)

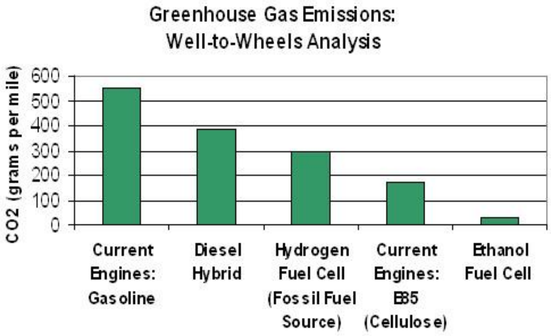
64% lower. A separate analysis found that biodiesel reduces greenhouse gas emissions by 41% [4]. Thus, a B20 blend would achieve a reduction of about 8%. Cellulosic ethanol achieves such high reductions for several reasons:

1. Virtually no fossil fuel is used in the conversion process, because waste biomass material, in the form of lignin, makes an excellent boiler fuel and can be substituted for coal or natural gas to provide the heat needed for the ethanol process.
2. Farming of cellulosic biomass is much less chemical and energy intensive than farming of corn.
3. Perennial crops store carbon in the soil through their roots, acting as a carbon "sink" and replenishing carbon in the soil.

Fuel Source	Making Feedstock	Refining Fuel	Vehicle Operation	Feedstock Uptake	Land Use Change	Total GHGs	Perce Change
Gasoline	+4	+15	+72	0	--	+92	--
Corn Ethanol	+24	+40	+71	-62	--	+74	-20%
Biomass Ethanol	+10	+9	+71	-62	--	+27	-70%

Biofuel helpful to reduce global warming: - The emergence of bio-fuels such as ethanol has been touted as the answer to our energy problems and a boon for the agriculture sector. By defining the energy problem as the danger of relying on foreign sources of oil, domestically produced renewable fuels provide a logical solution. So, the question facing domestically produced renewable fuels is not "if it provides a solution" but "how much of a Solute: on does it provide."

Net Greenhouse Gas Emissions: Another dimension of the energy problem has emerged. Scientific investigation has confirmed the dangers of global warming from greenhouse gas (GHG) emissions. Our reliance on energy from fossil fuels contributes to GHG emissions. Early analysis determined that bio-fuels, while not exempt from carbon emissions, emit less (GHG) emissions than gasoline. As shown in Table 1, corn ethanol results in a 20 percent reduction in emissions versus gasoline. Biomass ethanol shows a 70 percent reduction. Other studies provide similar results.



Source: Use of U.S. Cropland for Biofuels Increases Greenhouse Gases through Emissions from Land Use Change, Feb. 2008.

Although growing corn and biomass and refining them into ethanol produces as much or more emissions than pumping, transporting and refining crude oil into gasoline, the source and amount of carbon contained in the feedstock is the most important component. The carbon in crude oil has been sequestered from the atmosphere and now is being released into the atmosphere during consumption. So, it adds to the amount of atmospheric carbon. Conversely, the carbon contained in corn and biomass that is released during consumption was recently pulled out of the atmosphere during photosynthesis. So this carbon is part of the natural carbon cycle and does not increase the level of atmospheric carbon.

Need of Biofuels: Biofuels plant-derived fuels such as biodiesel and bio ethanol have been promoted as the environmentally friendly way to replace the traditional crude oil products which have driven our cars and airplanes not to mention our economy for so long. The key advantage lies in the widely known fact that petroleum fuels release fossil CO_2 whereas biofuels only return the carbon to the atmosphere that the plants they were made from took in while they were growing, making them carbon-neutral. As a result biofuels would seem to be ideally placed to help in addressing one of the central issues of climate change. In future, however, changes to the way biodiesel is made so-called "second-generation biofuels" will use non-food plants as the starting point may help these fuels reach their full potential for combating climate change. To be made from plant material such as grass, straw and forestry wastes which can be grown on land not required for agriculture when the promised "Sun Diesel" does eventually become commercially available, it will represent a truly sustainable approach to fuel. So, although biofuels may not yet hold all the answers to transport in a world facing climate change, it would seem they could offer plenty of hope for the future.

Biodiesel is the most popular form of biofuel, principally because it can be used in unmodified conventional diesel engines and has been approved by the majority of their manufacturers world-wide. Although it offers very slightly lower fuel efficiency than conventional diesel, it is a clean burning fuel with no sulphur or aromatics, has better lubricant properties and is significantly more biodegradable. This all adds up to a powerful green image and unsurprisingly, a number of celebrities and many eco-conscious travelers have started using it in their vehicles.

Emissions characteristics of E85: Actual emissions will vary with engine design; these numbers reflect the potential reductions offered by ethanol (E85), relative to conventional gasoline.

a) Fewer total toxics are produced.
b) Reductions in ozone-forming volatile organic compounds of 15%.
c) Reductions in carbon monoxide of 40%.
d) Reductions in particulate emissions of 20%.
e) Reductions in nitrogen oxide emissions of 10%.
f) Reductions in sulphate emissions of 80%.
g) Lower reactivity of hydrocarbon emissions.
h) Higher ethanol and acetaldehyde emissions.

However, ethanol blends can be found in other areas of the country as well, and have been used for many years to boost gasoline's octane. (The addition of 10% ethanol to make "gasohol," can boost fuel octane by 3 points.) E85 and E95 (blends containing 85% and 95% ethanol) are being tested in North America in government fleet vehicles, flexible-fuel passenger vehicles, and urban transit buses. (National Renewable Energy Laboratory, U.S. Department of Energy).

Material, Methods and Discussion: The lignocellulosic biomass sample such as wheat straw, rice straw, bagasse, rape straw were collected from rural areas and from local market, after milling they were treated with 3% H_2SO_4 at 121°C for 30 min in auto clave. After washing with water these biomasses were chosen for further evaluation, with enzymatic hydrolysis using cellulase (15 FPU/g cellulose) and β-glycosidase (50 CBU/ g cellulose) without addition of the hemicellulose complex in order to compare with the control.

Fermentation Medium:- One litre of production medium was prepared according to the requirement of S. cerevisiae, containing 50.0 gL^{-1}glucose, 1.0 gL^{-1}yeast extract, 5.0 gL^{-1} KH_2PO_4, 2.0 $gL^{-1}(NH_4)_2SO_4$ and 0.4 $gL^{-1}MgSO_4.7H_2O$. The medium was sterilized and the pH was adjusted to 5.0.

The Preparation of Inoculums: - The micro-organism was cultured in 250 mL Erlenmeyer flasks, containing 100 mL of the medium, which has the same composition as the fermentation medium. The Erlenmeyer flask was incubated at 28^0C for 6 hours on a rotary shaker at 200 rpm.

Fermentation Conditions for Batch Culture: - The fermentation was carried out in a 2 litre stirred tank fermentor, with a working volume of 1.5 litres. The 900 mL fermentation medium was inoculated with 100 mL inoculums and the pH was adjusted to 5.0. It was carried out at 250 rpm and temperature of 30^0C, with an air flow rate of 1vvm. Samples were taken every 2 hours for the entire fermentation cycle, which was terminated after 42 hours.

S N	Agricult-ural Residue	Agricultural area (In Thousand Hect.)	Biomass (dry ton/acre/year)	EtOH Yield (liter/dry ton)	EtOH Yield (liter/acre/year)
1.	Wheat Straw	9485	1-3	333	666
2.	Rice Straw	4372	3-4	335	1173
3.	Barley Straw	58	3-5	345	1380
4.	Sugar cane Bagasse	1970	5-6	360	1980
5.	Maize Straw	274	3-4	345	1208
6.	Rape (Sarson) Straw	622	3-5	355	1180

(Biomass data Source: U.P. all agricultural sankhyikiya spatrika)

Table 2: Total Biomass (Agricultural Residue) and projected biofuel (Ethanol) production upon total Area (In thousand hect.) of main crops in Utter Pradesh (2011-12).

The Analytical Techniques: - Fermentation broth was removed from the fermentor and analyzed at a predetermined time interval. Yeast growth was evaluated by spectrophotometric measurements at 260 nm in a spectrophotometer and calibrated against cell dry weight measurements. The concentration of glucose was determined using the 3, 5 dinitrosalicylic acid (DNS) method [8]. Table 2 represents the total biomass yield and total production of ethanol in a year.

Database and Methodology for climate and crops: The required data of rainfall and temperature were obtained from the director, IMD, Pune for the period of 1994 -2003. The dataset of Kharif production were collected from Krishi Bhawan, Lucknow for the same period. Firstly, the both parameters have been analyzed and discussed separately then to know the extent to which both are related, a co-efficient of co-relation between them has been worked out and its interpretation was presented. Besides many published literatures related to southwest monsoon and Eastern Uttar Pradesh were also consulted and relevant information's were extracted and used in support of our analysis.

The study area: Eastern Uttar Pradesh is situated in a sub-tropical interior of well defined geographical region of the Middle Ganga Plain. It is one of the largest stretches of alluvial deposits of northern India. Eastern Utter Pradesh occupies somewhat continental location and lies between 28^0 30' N. to $33^0$45' N. latitude and 80^0 45' E. to $84^0$46' E. longitude spreading over the total geographical area of 85845. According to 2001 census, the total population of the study region is 66610755 (40% of the state's population). Kharif crops are grown on more than 49.7 percent area of the total Gross cropped area in Eastern Uttar Pradesh. The total kharif cropped area was about 4256732 ha in 2008.

II. Effective parameters of south-west Monsoon

Temperature: Due to global warming there is rising temperature affected the climate changed in all over world. Temperature is one of the major controlling factors amongst all the climatic elements which influence all the crops at the stages of its growth, development and reproductive phase [14]. The mean temperature and rainfall total for SW monsoon are given in table-2. Looking carefully this table it seems very clear that mean temperature for the season ranges between 29.2^0C in the year 2001 to 30.9^0C in years 1995 and 1998 ([10], [11].) The yearly temperature variation shows that sufficient heat energy in the form of solar radiation is available throughout the monsoon for luxuriant growth of crops. Only the restrictive climatic element with reference to crop production in the study area is availability of moisture content in the soil for which the major source is rainfall.

	South-West Monsoon Season	
Year	**Mean Temperature in ^{0}C**	**Total Rainfall in cm**
1994	29.5	84.2
1995	30.9	79.4
1996	30.0	86.7
1997	29.9	94.4
1998	30.9	101.3
1999	29.6	106.0
2000	29.3	109.8
2001	29.2	108.3
2002	30.5	*67.9*
2003	29.9	104.8
Mean	**29.98**	**94.3**

***Source**: Compiled from data obtained from IMD, Pune*

Table.3 Mean Temperature and Rainfall Total of Eastern Uttar Pradesh (1994-2003)

Rainfall: Rainfall regarded as the essence of Indian climate and inter-annual variability is its intrinsic feature. [15]. Although the amount of rainfall of monsoon season is significant, but the onset date of monsoon plays an important role for the beginning of Kharif cultivation. Fig.1 represents the yearly onset dates of SW monsoon during 1994-2003 in Eastern Uttar Pradesh.

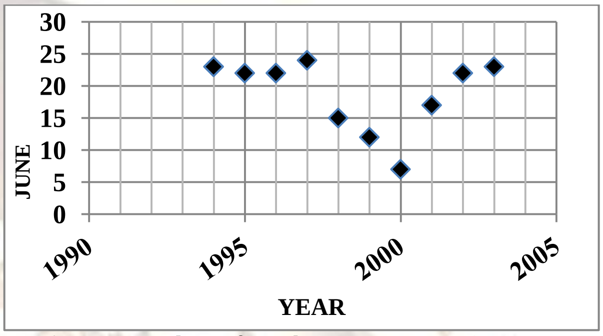


Fig-1 Onset date of southwest monsoon (1994-2003)

From the fig-1 it is clear that onset of monsoon in Eastern Uttar Pradesh is highly variable ranging from first week of June in the year 2000 to end of the third week in many of the years. It can also be noticed by observing the fig 1 and table 1 that year like 1998, 1999, 2000 and 2001 when there were early arrivals of monsoon, the same years were also of sufficient recipient years of rainfall. Table 1 and Fig 2 represent the rainfall characteristics of Eastern Uttar Pradesh during 1994-2003. The mean seasonal rainfall is 94.3 cm. for the area. The highest rainfall during SW monsoon is received in the year 2000 amounting to 109.8cm during last decade followed by 108.3, 106, 104.8 and 101.3 cm in 2001, 1999, 2003 and 1998 respectively. While the years 1994, 95, 96, , and 2002 are characterized by low rainfall years (table.1).Out of total duration under consideration 5 years have been identified as excess rainfall than normal while 3 years comes in deficient rainfall years. The year 2002 has been witnessed as one of the least minimum recipient year with only 67.9 cm.

Kharif Crops: The green revolution introduced the improved techniques in agricultural activities like expansion in modern irrigation facilities, HYVs seeds, farm mechanization, chemical fertilizers, pesticides etc. These new techniques require crop security in terms of sufficient supply of water. The monsoon uncertainty increases the chances of crop failure at large scale.

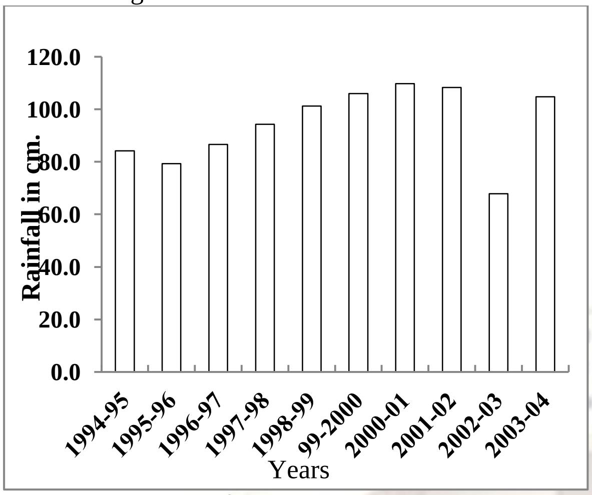


Fig.2 Total rainfall in Southwest monsoon

Years	Kharif Crops production in 000 mT
1994-95	5864
1995-96	5602
1996-97	6692
1997-98	6674
1998-99	5966
99-2000	7382
2000-01	6862
2001-02	7438
2002-03	*5774*
2003-04	7545

Table.2 Kharif Crops Production in Eastern Uttar Pradesh (1994-2003)

Table.2 shows the total Kharif crop production in Eastern Uttar Pradesh. Although the production has been gradually increasing from year to year due to the expansion of improved agricultural practices but deficient monsoon rainfall years have experienced a decrease in total food grain production. Because the drought years are accompanied with high rates of evapotranspiration; causing a marked depletion of water in water bodies, a lowering of ground water table and a concurrent dehydration of the root zone of soil, thus limiting potential moisture supply to crop plants [2].

In the year 2002 the rainfall during southwest monsoon season over the country as a whole was deficient by -19% and the July rainfall was the lowest (-51%) during the past 100 years [17]. In the year 2002 identified as least rain recipient year, the total production is much less than normal even the average value. The similar situation can be observed in the year 1995 also. In the year 1998, though the rainfall was slightly more than the normal even low production is found in this year is attributed to the loss of standing crops due to the occurrence of the flood. Fig-3 shows graphical representation of the average Kharif food grain production during 1994-2003 of Eastern Uttar Pradesh. This graph closely corresponds with the figure-2.

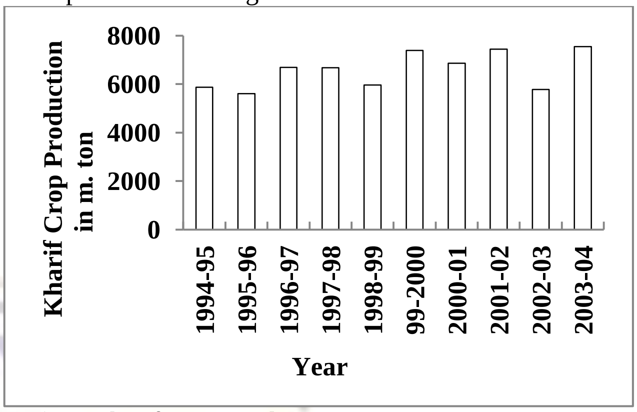


Fig-3 Kharif Crop production in 000 metric Ton

III. Conclusion

With proper kharif crop management, production of ethanol from biomass feedstock's can reduce net greenhouse gases from automobile emissions. This is because plants require carbon dioxide (CO_2) for growth. Energy-crop production creates a "carbon cycle" when biomass derived fuels are burned in vehicle engines the CO_2 released in combustion is taken up by plants during the growth process. Ethanol can also help a lower mobile-source carbon monoxide emission, which helps to improve the climate for rainfall and helps to improve the production of crops. The importance of rainfall study for an area lies in the fact that it controls humidity and aridity of the region and consequently determines the nature of agricultural crops to be grown most effectively and suitably for development of the region [12]. The timely arrivals of the monsoon and regular rains during the season are thus key for India's economic growth because farmer's success depends heavily on the monsoon rains. The monsoon plays a critical role in the production of agricultural crops in the region. June month rain, the initial source of supply of moisture for soils is necessary for planting and growing Kharif crops along with regularity in monsoon in (July, August and September) months. In this regards it is being important to provide accurate information of monsoon arrival and its further behavior in remaining Kharif season so that farmers may take precautionary measures to save their standing crops and make a better strategy for crop management, this is possible if climate improves.

Biofuel from agro residues like ethanol is relatively low in toxicity, water soluble, and biodegradable, making the consequences of large fuel spills less environmentally threatening. Ethanol contains only about two-thirds the energy per volume (or travel range per gallon) of an equal amount of gasoline, but efficiently designed engines could increase the travel range of pure ethanol to about 80% that of gasoline. Nonetheless, slightly larger fuel tanks would be needed if vehicles are to travel equal distances to gasoline on one fill-up of pure ethanol. (The range of vehicles fueled with ethanol blends such as gasohol is statistically indistinguishable from that of vehicles running on regular gasoline.) Pure ethanol's low volatility is beneficial in reducing some emissions but can cause starting problems in cold weather. Researchers are working on ways to overcome this difficulty as well. Overall, the environmental benefits, domestic producibility, and economic boost that ethanol from biomass could provide make it a very attractive transportation alternative.

The concentration of CO_2 in the earth's atmosphere was about 280 parts per million by volume (ppmv) in 1750, before the Industrial Revolution began. By 1994 it was 358 ppmv and rising by about 1.5 ppmv per year. If emissions continue at the 1994 rate, the concentration will be around 500 ppmv, nearly double the preindustrial level, by the end of the 21st century. Hence biofuel technologies must be a one of the way and more efficient in terms of net lifecycle greenhouse gas (GHG) emission reductions while at the same time are socially and environmentally sustainable.

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