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Vinita Parte
College of Agriculture, Ganjbasoda, Vidisha, JNKVV, Jabalpur, Madhya Pradesh, India

Vishnu K Solanki
College of Agriculture, Ganjbasoda, Vidisha, JNKVV, Jabalpur, Madhya Pradesh, India

Anjana Kujur
RVSKVV, Gwalior, Madhya Pradesh, India

JS Ranawat
College of Horticulture & Forestry, Jhalawar, AUK, Kota, Madhya Pradesh, India

Correspondence
Vinita Parte
College of Agriculture, Ganjbasoda, Vidisha, JNKVV, Jabalpur, Madhya Pradesh, India

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Agriculture importance in global climate change

Vinita Parte, Vishnu K Solanki, Anjana Kujur and JS Ranawat

Abstract
Agriculture plays a very important role in climate change due to a number of reasons. Currently, about 13-15% of greenhouse gas emissions accounted by the agriculture. Fertilizer and energy use in agriculture and some from livestock are sources of some of these emissions. The main source of methane emission is global warming which occurs due to agriculture. Nitrous oxide (N2O) emissions from agriculture are projected to increase by 35-60% up to 2030 because of increased animal manure production and increased use of nitrogen fertilizer. And also the major cause of deforestation is the conversion of forested land to agriculture. To enhance productivity and store large quantities of carbon by adding biochar partly burned biomass to soils. A very positive role played by the agriculture. Particularly in organic agriculture some agricultural practices effectively act as the storage of carbon in soils. Biofuels combustible materials act as a substitute for fossil fuels which are derived from plants, animals, micro-organisms and organic wastes.

Keywords: Climate change, Biochar, Agriculture, fossil fuels, Forests, Organic agriculture

Introduction
Climate is one of the main determinants of agricultural production. Throughout the world there is significant concern about the effects of climate change and its variability on agricultural production. Researchers and administrators are concerned with the potential damages that may arise in future from climate change impacts on agriculture, since these will affect variability on agricultural production. The Climate change is any change in climate over time that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere in addition to natural climate variability observed over comparable time periods (IPCC, 2007). The main source of methane emission is global warming which occurs due to agriculture. Nitrous oxide (N2O) emissions from agriculture are projected to increase by 35-60% up to 2030 because of increased animal manure production and increased use of nitrogen fertilizer (FAO, 2003) [3]. And also the major cause of deforestation is the conversion of forested land to agriculture. To enhance productivity and store large quantities of carbon by adding biochar partly burned biomass to soils (Scher and Sthapit, 2009) [12].

Table 1: From agriculture global greenhouse gas emissions (WRI, 2011) [3].

S. No.	Global GHG emissions	Percentage
1	**Agriculture**	15 %
1a	**Subsector like**	
	▪ Soil (N_2O)	40 %
	▪ Enteric fermentation (CH_4)	27 %
	▪ Rice (CH_4)	10 %
	▪ Energy-related (CO_2)	9 %
	▪ Manure Mgmt (CH_4)	7 %
	▪ Other (CH_4, N_2O)	6 %
1b	**Gas**	
	▪ N_2O	46 %
	▪ CH_4	45 %
	▪ CO_2	9 %
2	Rest of Global GHGs	85 %

Potential for greenhouse gas mitigation in agriculture

According the 4th assessment report of IPCC's (Metz *et al*., 2007) [9] the mitigation opportunities of GHGs in agriculture.

- By the management of carbon and nitrogen flows in agricultural ecosystems emission can be reduced in agriculture ecosystem.
- Removal can be enhanced by the carbon sequestration in plant materials or in soils.
- Replacing fossil fuels – The use of agricultural land's crops and residues can be use as a fuel source either after conversion to fuels like ethanol or diesel or directly. These bio-energy feed stocks still release CO2 upon combustion but now the carbon is of recent atmospheric origin (Metz *et al*., 2007) [9].

Table 2: Global GHG mitigation from different source of agriculture (Metz *et al*., 2007; Smith *et al*., 2008) [9, 16].

S. No.	Different sources of agriculture
1	GHG mitigation from cropland Management
2	GHG mitigation from grazing land management
3	GHG mitigation from restore cultivated organic soils
4	GHG mitigation from restore degraded lands
5	GHG mitigation from rice management
6	GHG mitigation from livestock
7	GHG mitigation from bio-energy (soils component)
8	GHG mitigation from water management
9	GHG mitigation from set aside, LUC and agroforestry
10	GHG mitigation from manure management

The impact of biofuels

Biofuels combustible materials act as a substitute for fossil fuels which are derived from plants, animals, micro-organisms and organic wastes.

This substitution helps in the reduction of emissions of carbon if the burning carbon in biofuels is newly removed from the atmosphere and so does not constitute a net addition to atmospheric carbon. But to biofuels there are some potential drawbacks.

To large energy inputs some biofuels requires to produce meaning that the net carbon reduction may be small or even negative. For scarce land and water resources possibly increasing deforestation biofuels can also compete. There are also some social negative impacts since additional demand can be created by biofuels either for food crops such as for land used to produce food crops or ethanol produced from corn. In either case tend to drive up food prices for expansion of biofuel production. To carefully weighed against the possible negative consequences of the biofuels use and particularly their subsidization by governments. The main types of three biofuels are as follows-

- A sugar, starch, vegetable oil or animal fats are used for making first generation biofuels by using conventional technology.
- The second generation biofuels are made from a variety of non-food crops, including waste biomass, the stalks of wheat, corn, wood and special energy or biomass crops using biomass to liquid technology.
- Algae, sometimes known as oilgae11 are used for making third generation biofuels.

Biofuels, food supply and forests

Some biofuels are also food crops. Therefore increment in demand for biofuels make competition with food crops for land taking hike food prices. For fuel crops currently global land use is about 2% of global cropland (UNEP, 2009). The conflict with expanding global food needs will intensify if with the increase of demand of the biofuels. Forests as agricultural production is displaced from current croplands to forested areas this can also be indirect effects. Clearly biofuels have many impacts. The types of biofuel and production methods are responsible for their effectiveness and they can be act as an additional tool to reduce emissions of carbon. Uncontrolled expansion of biofuels is likely to do more harm than good. But discriminating use of biofuels can result without social impacts destructive ecological in net greenhouse gas reduction.

In the coming decades, large impacts on biological diversity to increased biofuel production is expected which is mostly results due to increased invasive species, habitat loss and nutrient pollution. Cropland expansion mainly results in habitat loss. Species and grasses genotypes act as future feed stocks of biofuels may become critical as invaders. Intensive fuel cropping causes nutrient emissions to water and air and it will also impact species composition in aquatic and terrestrial systems.

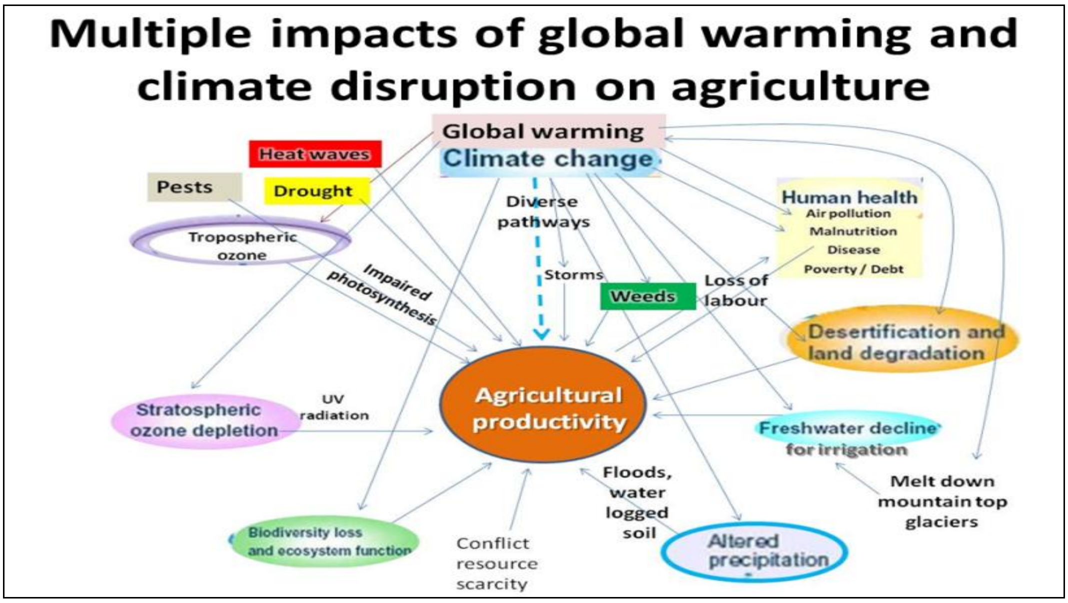

Fig 1: Weyant C *et al*. (2018) [20].

Consequences of global warming

In latest human history, the climate of the world is continuously changing at rates which are unprecedented projected. Disruption of ecosystem, polar and glacial ice melting, coastal areas inundation are the projected impacts of global warming caused by sea level rise, increase in floods and precipitation and severe and frequent storms. Consequently economy, ecology and society of human suffer. The third report was given by the IPCC's in which they have reported that during the 21st century the world average surface temperature can rise by 1.4ºC to 5.8ºC with the sea level rise and extreme weather consequences (Kauppi *et al*., 2001) [6]. The attributable part of global warming is droughts, floods and storms which are already happening around the world with greater frequency and intensity. The rise of sea level will be expected having a number of impacts especially on coastal systems which covers increased erosion of coastal region, higher storm surge flooding, primary processes of production inhibition, severe extensive coastal inundation, changes in quality of surface water and characteristics of groundwater, increased property loss and coastal habitats, increased flood risk and loss in potential of life, losses of nonmonetary cultural resources and values, agriculture impacts and aquaculture through decline in quality of soil and water and tourism loss, transportation and recreation functions. Further, in the 4th report of the IPCC cautioned that at this century end, world sea level will rise from 0.18 to 0.59 m and will be endanger human populations, ecosystem, ports, cities and low lying coastal areas of wetlands. Stern, 2009 emphasized the fast action importance otherwise in near future many low lying areas around the world will be underneath of water. Impact of global warming in terms of elevate the costs all around is becoming evident. Most of the time poor people suffer (Simms *et al*., 2004) [15]. In fact, no country is free from suffering and the effects of climate change may cause a greater impact on few nations than others and distribution will vary across the people, places and times. For example, in 2003 summer the heat wave across Europe is estimated to have caused approximate deaths of 30,000 premature. Greater than 90 percent probability global warming has been linked (Scott *et al*., 2003) [13]. Climate change having a broad range and also have severe impacts on health of human with noticeable life loss. The geographical distribution (altitude and latitude) of the infectious diseases vector organisms relevant with the net climate change. e.g. schistosome spreading snails, malarial mosquitoes and changes in the dynamic life cycle of both vector and infective parasites will be in aggregate, increase the potential changes of many vector-borne diseases and also hike in non vector-borne infectious diseases such as cholera, salmonellas and other food and water related infections also could occur particularly in tropical and subtropical regions because of climatic impacts on water distribution, temperature and microorganism proliferation (Shaffer *et al*., 2009) [14]. The main influenced sector to climate change is agriculture sector. The multiple impacts of agriculture production and productivity are -

1. Plant health affects by higher temperature, the occurrences of pests and lower availability of water increases.
2. Water availability reduces by the modified rainfall patterns and moving the rainy seasons with effects both for rainfed and irrigated agriculture and also for farming systems.
3. Enhanced weather extremes frequency and increase variability supply.
4. In some cases carbon dioxide (CO_2) concentration increases in the atmosphere which may improve the crop yield and crop productivity.

The sea level rise and frequent flooding interrupt the world production patterns of agriculture and causes some farmers loss and countries.

Table 3: Impact of climate change on rainfed agriculture in India (Asha latha *et al*, 2012) [2].

Crops	Per cent loss of normal yield
Sorghum	43.03
Maize	14.09
Tur	28.23
Groundnut	34.09
Wheat	48.68
Onion	29.56
Cotton	59.96

Importance of agriculture in global climate change

Conservation agriculture

Conservation agriculture practices such as reduced tillage, retention of crop residues on the surface, application of optimum quantum of nutrients and suitable crop rotation contributes to reduction of CO_2 emissions and contributes towards carbon sequestration. Application of organic manures, fertilizers and integrated nutrient management practices improves the crop growth and also sequesters substantial quantities of soil carbon. The potential of carbon sequestration due to adoption of recommended package of practices on agricultural soils is about 6 to7 Tg C/y. In addition, the potential of soil inorganic carbon sequestration estimated at 21.8 to 25.6 Tg C/y (Lal, 2004) [7].

In paddy field

In irrigated rice cultivation, management practices such as water management, nutrient management, selection of suitable variety, spacing, stand establishment, crop sequence were found to reduce methane emissions by 7 to 68%. Mid season drainage also found to reduce the emissions of methane substantially in lowland paddy. Application of nitrification inhibitors, matching nitrogen supply with crop demand, tighten N flow cycles, use advanced fertilization techniques, optimum tillage, irrigation and drainage, etc. found to reduce the N2O losses up to 80% (Adhya, 2008) [1].

Agrochemicals

Use of synthetic nitrogen fertilizers has increased globally by more than 8-fold from 1961 to 2006, while grain yields increased globally by 1.5-fold in the same period (FAO stats, 2009). Use of chemical insecticide increased in the United States by 10-fold between 1945 and 2000, while there was a doubling of crop losses from insect damage. The cost of this chemical intensity is an estimated 1 million to 5 million cases of pesticide poisonings per year (UNEP 2004). The worsening of most insect pest problems, and thus dependence on chemical inputs, is increasingly linked to the expansion of crop monocultures and losses in crop diversity (Letourneau and Bothwell, 2008) [8]. Groundwater contamination, fishery losses, loss of natural enemies and increases in pesticide resistance are only a few of the problems arising from agriculture's addiction to pesticides. Pesticides have also been linked to global biodiversity loss and amphibian decline (Rohr *et al*., 2008) [11].

There is an urgent need to develop more ecological agricultural practices which will able to preserve soil fertility, reduce the consumption of non-renewable natural resources and integrated with local biodiversity and landscape. In the last decades, a number of alternate agricultural production systems such as ecological farming, organic farming, Permaculture, etc. have been proposed and implemented in order to meet for a more sustainable agriculture.

Ecological farming both relies on and protects nature by taking advantage of nature's goods and services, such as biodiversity, nutrient cycling, soil regeneration and natural enemies of pests, and integrating these natural goods into agro ecological systems that ensure food for all today and tomorrow.

Organic farming/agriculture is one among the broad spectrum of production methods that are supportive of the clean environment. Organic production systems are based on specific standards precisely formulated for food production and aim at achieving agro ecosystems, which are socially and ecologically sustainable. It is based on minimizing the use of external inputs through the use of on-farm resources efficiently compared to intensive agriculture involving the use of synthetic fertilizers and pesticides.

Permaculture puts the emphasis on management design and on the integration of the elements in a landscape, considering the evolution of landscape over time. The goal of permaculture is to produce an efficient, low-input integrated culture of plants, animals, people and structure and integration that is applied at all scales from home garden to large farm.

The benefits of ecological farming

- Ecological farming provides the ability of communities to feed themselves and ensures a future of healthy farming and healthy food to all people.
- Ecological farming protects soils from erosion and degradation, increases soil fertility, conserves water and natural habitats and reduces emission of greenhouse gases.
- Ecological farming is both a climate change mitigation and adaptation strategy. Ecological farming can provide large-scale carbon sinks and offer many other options for mitigation of climate change. In addition, farming with biodiversity is the most effective strategy to adapt agriculture to future climatic conditions. A mix of different crops and varieties in one field is a proven and highly reliable farming method to increase resilience to erratic weather changes.
- Ecological farming both relies on and protects nature by taking advantage of natural goods and services, such as biodiversity, nutrient cycling, soil regeneration and natural enemies of pests, and integrating these natural goods into agro ecological systems that ensure food for all today and tomorrow.

Nutrient management

Fertilizer recommendations in rainfed crop production have been made primarily for NPK along with the conjunctive use of chemical, organic and bio-fertilizer (Rao and Das, 1982) [10]. Inclusion of legumes in cropping systems can supplement fertilizer N to the extent of about 20 kg N per ha. Conjunctive use of fertilizer N with FYM, croppings of luecaena and gliricidia help in reducing the requirement of fertilizer by 50 percent (Reddy *et al*., 1996).

Ecological farming can help to fight against climate change

Modern intensive agriculture model is one of the largest sources of global greenhouse gas emissions. Ecological farming is both a climate change mitigation and adaptation strategy:

- Efficient ecological farming practices that reduce synthetic fertilizer use and promote fertile soils rich in carbon could mitigate up to 70 percent of global agriculture emissions.
- Key to ecological farming for climate change mitigation is to build up a healthy, carbon-rich soil. This will provide a major carbon sink and at the same time will be the basis for a non-chemical, biodiverse and healthy agriculture.
- Significant emission reductions can be achieved by eliminating fertilizer overuse, which is a triple win: farmers save money by using only the amount of fertilizer used by the plant, emissions are significantly reduced, and nitrate contamination of lakes, rivers, oceans and groundwater is reduced. Growing legumes and/or adding compost, animal dung or green manures, natural nutrient cycling and nitrogen fixation can provide fertility without synthetic fertilizers, and at the same time cut farmers' expenses on artificial inputs and provide a healthier soil, rich in organic matter, better able to hold water and less prone to erosion.

Conclusion

Changing climatic scenario calls for effective contingency planning, Ecological farming, proper nutrient management, preventive and corrective measures and a bottom–up approach with scientific blending. There is a need to work in a consortium mode as extreme weather events are going to be more and time for responding will be short. There is a need of proactive approach rather than reactive approach.

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