Focus India Publications

June, 2015

Climate Change and The Agriculture Crisis

Agroecology as a Solution





Supported by
Rosa Luxemburg Stiftung, South Asia

Climate Change and The Agriculture Crisis

Agroecology as a Solution

Focus on the Global South

Climate Change and The Agriculture Crisis : Agroecology as a Solution

Author : **Parul Laxmi Thapa**

Published in : **June 2015**

Published by *:* **Focus on the Global South, India**
To request copies contact
33-D, 3rd Floor, Vijay Mandal Enclave,
DDA SFS Flats, Kalu Sarai, Hauz Khas,
New Delhi – 110016. India
Tel: +91-11-26563588; 41049021
www.focusweb.org

Supported by : **Rosa Luxemburg Stiftung, South Asia**
Centre for International Co-operation
C-15, 2nd Floor, Safdarjung Development Area Market,
New Delhi - 110016
www.rosalux-southasia.org

Images by : Author (unless stated otherwise)

Design & Printed by : **Pullshoppe,** 9810213737

The contents of this booklet can be freely reproduced and quoted on the condition that the source be mentioned. Focus would appreciate receiving a copy of the text in which the report is mentioned or cited.

This is a campaign publication and for private circulation!

Contents

Foreword

Farmers across north India faced an extremely hard time in early 2015 when unseasonal rain and hailstorm lashed through several states causing huge loss of *rabi* crops (mainly wheat, barley, maize, pulses, oilseeds, cumin) that were ready for harvest. Usually the month of February, March and April rarely receive rains but this year heavy rainfall and hails damaged more than 182 lakh (18.2 million) hectares of harvest, leading to suicide attempts by several farmers across India.

However small and marginal farmers in India have adapted their way of living and farming in order to withstand these changes. For example, they have chosen local indigenous seed varieties that grow more quickly, resist dryness or survive in excessive waters, they have developed water management systems to deal with floods and to keep soils humid during the dry season. Most of the time, they have done it so successfully that it has gone unnoticed. But unusually this year local farmers and media reported several such cases where there was zero or minimal damage owning to sustainable agriculture practices and use of local indigenous varieties of seeds. In the desert state of Rajasthan, unseasonal rain and hailstorm destroyed crops in 26 out of 33 districts, but still several farmers living in Ranisar village (Phalodi Tehsil) in Jodhpur district, despite facing adverse climatic conditions, saved their cumin crops because they followed agroecological methods of farming by adopting organic system, indigenous varieties of seeds and agro-diversity in their farms, as reported by local media. Similarly a local Basmati rice variety developed by farmer, Anil Sawhney in Tigra village in Bareilly (Uttar Pradesh) withstood the heavy rains in March because he has been cultivating this native variety using the traditional method of farming without any chemical fertilizer and pesticides. Several organic farmers in Punjab saved their wheat crops by practicing sustainable agriculture because it can stand stress better than crops grown through conventional/ green revolution techniques, which requires heavy chemical inputs. While climate change is leading to high losses of agriculture production, farmers like these are cleverly adapting to the scenario by reviving traditional practices of non-chemical use, mulching and multi-cropping, conserving indigenous seeds and adopting agro-diversity in their farms.

Today there is enough research data and evidence that indicates that sustainable agriculture approaches have immense mitigation and adaptation potential in the context of climate change and it can make significant contribution in reduction of greenhouse gas (GhGs) emissions. Sustainable agriculture uses extremely low fossil fuel based inputs and has a better carbon footprint than green revolution based agricultural practices. This is because conventional agriculture production utilises more energy than organic systems due to heavy reliance on energy-intensive fertilisers, chemicals, and concentrated feed, which organic farmers forgo. Sustainable agriculture therefore leads to better carbon sequestration in the soil

and can immensely contribute in minimizing the climate-related risks being faced by Indian farmers through its approaches which focus on multi-cropping, knowledge-intensive processes which are farmer-centric and stabilize soils. Soil stability will be an important part of coping with droughts and heavy rains. Sustainable farms are also known to be more resilient to different kinds of stresses, including pest and disease incidences. Changes in farming models and practices towards sustainable agriculture offer a significant opportunity at reducing GHG emissions. There are many forms of sustainable agricultural, such as agroecology, organic agriculture, natural farming, biodynamic farming, zero budget farming, ecological agriculture, biological agriculture, etc. All these approaches demonstrate the best use of nature's goods and services by integrating natural, regenerative processes e.g. nutrient recycling, nitrogen fixation, soil regeneration, using natural enemies of pests, water conservation, soil conservation, restoration of soil fertility, maintenance of agricultural biodiversity and minimise non-renewable inputs (pesticides and fertilisers) that damage the environment or harm human health. The Indian government has no reason to shy away from understanding and stating the negative impacts of GHG-inducing intensive models that have been promoted so far and instead promote sustainable agriculture.

But today we are witnessing promotion and propagation of high carbon intensive agriculture technologies in India. This agriculture system does not have the potential to change from being one of the largest GHG emitters to a net carbon sink. It is the energy intensive industrial agriculture system which requires excessive chemicals, pesticides, herbicides, fertilisers, intensive water use and large-scale transport, storage and distribution, thus contributing significantly to climate change. The industrial agriculture and food system destroys biodiversity, soils, nutrition and local food systems, and it is also responsible for at least 40% of global greenhouse gas emissions, which trigger climate change. There are numerous examples of advancement of these false solutions promoted by corporate interest based on risky technologies being proposed to deal with climate change and food insecurity, for instance crops genetically engineered for drought resistance, industrial agrofuels, large scale geo engineering projects, synthetic biology, nanotechnology etc. And all these are based on large-scale mono cropping, hi-tech investment and chemical input systems which require capital and centralised control. But none of these 'solutions' can work because they all work against the only effective solution: a shift from a globalised, industrial food system governed by corporations to local food systems in the hands of small farmers.

Globally these false solutions are being pushed through the Climate Smart Agriculture (CSA) paradigm which is being promoted as a magic wand to deal with all climate related issues in agriculture. Climate smart agriculture is nothing new but it is essentially just a rebranding and continuation of the Green Revolution practices. The same actors who promoted Green Revolution, for example the World Bank, are also behind the imposition of climate smart agriculture as a solution to climate change and to increase income of the rural poor using the

same failed thesis that to increase incomes one must increase productivity. Climate smart agriculture begins with deception by not making a differentiation between the negative effects of industrialized agriculture and the real solutions offered by traditional sustainable peasant agriculture which has contributed to alleviating poverty, hunger and remediation of climate change. Climate smart agriculture will create dependency on so-called new technologies through their complete packages that include prescriptions of "climate smart varieties", inputs, and credit, while ignoring traditional and true adaptive farming techniques and stewardship of indigenous seed varieties in practice by farmers. As Green Revolution meant the imposition of synthetic fertilizers and pesticides as a requirement to access loans and technical support, now it is the imposition of transgenic and biotechnology for the same requirements, and all under the name of productivity. The international peasant movement, La Via Campesina believes that "under climate smart agriculture framework, there is little hope of reducing and removing greenhouse gases, trying to solve food insecurity or any significant rural economic and social development. The problems of poverty, food insecurity and climate change are not market failures, but rather structural flaws that will persist and worsen with its implementation".

Despite India's rich tradition of agroecological practices, we witnessed a reflection of climate smart agricultural approach in the National Mission for Sustainable Agriculture (NMSA). It's key objective is to enhance agricultural productivity through customised interventions such as use of bio-technology to develop improved varieties of crops and livestock. NMSA is one of the eight technology missions under the National Action Plan on Climate Change (NAPCC) launched by the Government of India in 2008 to address climate change-related issues. It is this misplaced notion of Climate Smart agriculture which got further transmitted through the NMSA in the State Action Plan on Climate change of different states which really force us to suspect the real intent to promote low carbon agriculture pathways. For example, Manipur Plan talks about "modern scientific agriculture", Madhya Pradesh proposes "modernization of agriculture, increased use of biotechnology", West Bengal and Rajasthan both proposes "zero tillage agriculture", while Rajasthan talks about "exploring carbon sequestration potential of carbon deficient soil' and 'increased use of biotechnology". Many state climate action plans also talk about agro fuel plantations.

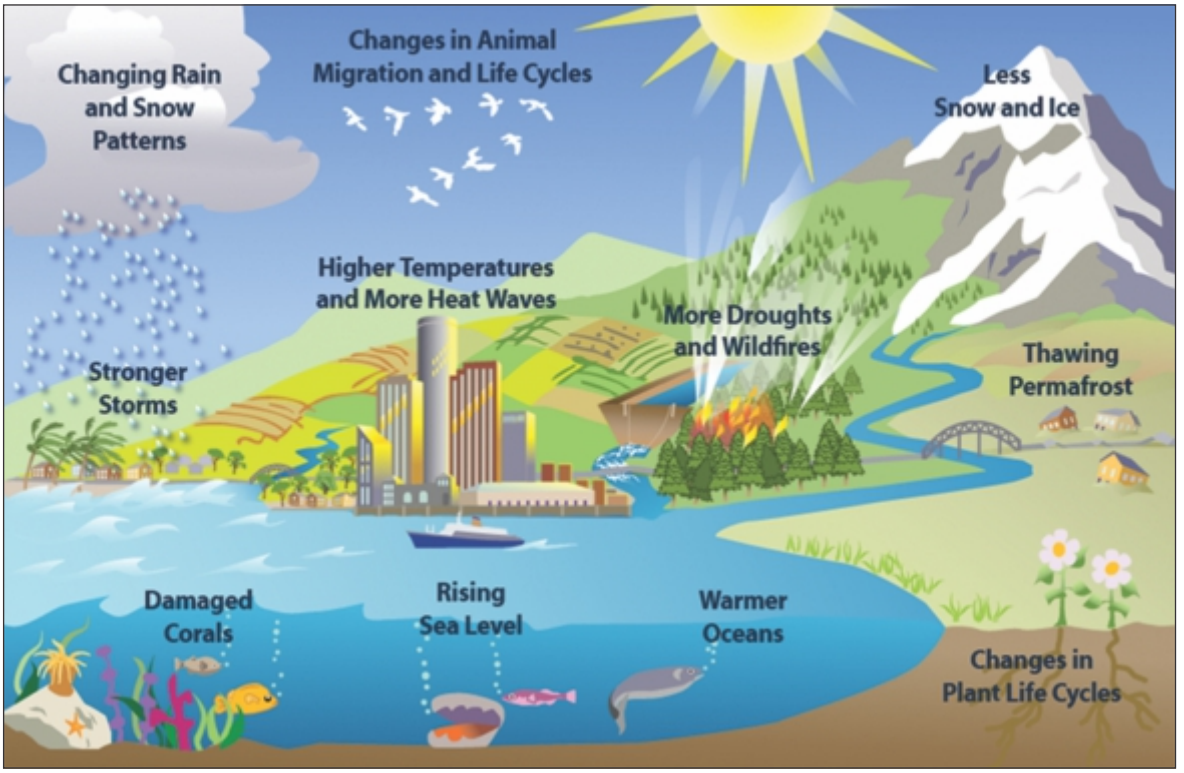
We believe that these are the false solution for making agriculture climate resilient even though each of these states have witnessed deep agrarian crisis induced by input intensive green revolution. The NAPCC must conduct a proper assessment of Green Revolution-induced climate change in order to avoid promotion of these false solutions in India where the majority comprises of small and marginal farmers practicing sustenance farming. Shying away from stating the issues with the current model of agriculture will not create the imperative for a shift to sustainable agriculture, which is a requirement both for mitigation as well as adaptation. The Indian government must clearly specify incentives to farmers for shifting to sustainable farming and other agroecological practices. While the government of India provides enough subsidies

for inorganic fertilizers and pesticides, not much effort is being given to encourage environmentally sound farming practices. There should be a mechanism of direct subsidies to farmers, who are practicing environmental friendly agriculture. The government should realize that the imperative to shift to sustainable agriculture is larger than climate change.

The need of the hour is not to wait for global agreements on mitigating climate change but to act locally, intelligently and consistently. Indian farmers must adapt their practices to deal with changing temperatures and more frequent extreme weather events. These adaptations must first and foremost build resilience within the agroecosystem, increasing its ability to continue functioning when faced with unexpected events. With this objective, Focus on the Global South has come out with this publication to inform our peasants, especially the small and marginal farmers, about the problem of climate change, its impact on agriculture and how agroecology can be a better solution to deal with the climate crisis. Prior to this publication, Focus has also published a series of three booklets dealing with different aspects of agroecology, to highlight the alternative technologies, mechanisms and practices based on sustainable and agro-ecological principles, which could be helpful to make these small farms not only viable and self-reliant but also profitable economic units. The current booklet 'Climate Change and The Agriculture Crisis : Agroecology as a Solution' will add another important dimension to our small-holder agroecology series of publications, and bring to light how agroecological farming holds immense mitigation and adaptation potential and therefore are better suited to deal with the climate crisis.

Afsar Jafri
Coordinator
Focus on the Global South

Understanding Climate Change



Source : http://www.epa.gov/climatechange/kids/ scientists/clues.html

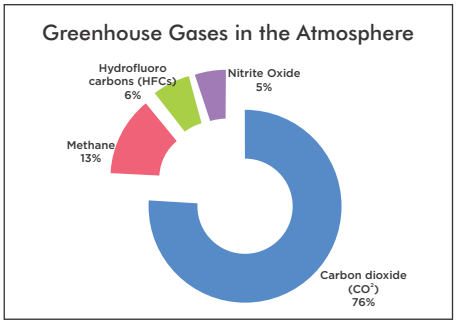
What is climate change ?

Climate change refers to long-term shifts in weather patterns in a specific region or globally affecting all that it is made of and is surrounded by. According to the United Nations Framework Convention on Climate Change (UNFCCC), climate change refers to change of climate which is linked directly or indirectly to human activity that alters the composition of the global atmosphere and in addition to natural climate variability, is comparable overtime periods.

How does Climate Change happen?

It is crucial to understand how and what causes climate change before analysing its effects over different spheres of human lives. Our planet is surrounded by a blanket of gases, knowns as the greenhouse gases (GHGs). These keep our planet warm so that life can be sustained on it. This blanket traps heat from the sun and radiates it to our planet. This process is called the greenhouse effect. This is very crucial as without this process our planet would be too hot in the

day or too cold in the night to support any life form. These gases are increasing due to more and more burning of fossil fuels for energy (electricity and power), transport, industrial consumption and agriculture. Increase in greenhouse gases leads to more heat being trapped in the atmosphere. These gases include carbon dioxide, water vapor, methane, ozone, and nitrous oxide. This leads to rise in temperatures and impacts the ecosystem severely.



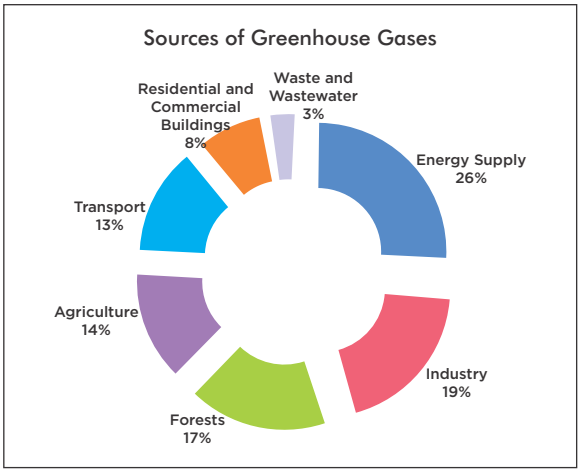
These are the main greenhouse gases that are present in our atmosphere. Carbon dioxide (CO_2) is the most significant and produced abundantly.[1]

Greenhouse Gases

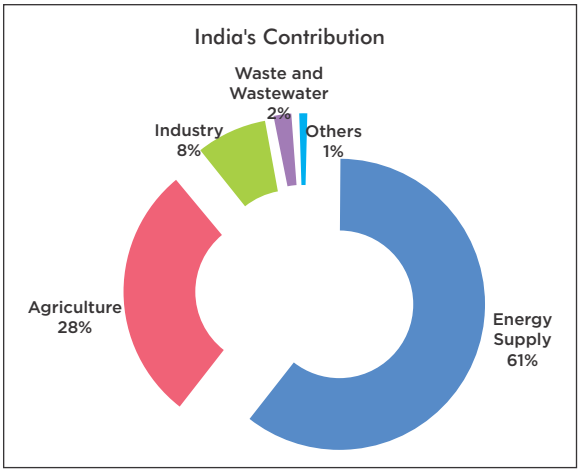
Greenhouse gases play the lead role in affecting the climate on earth. And their concentration is rapidly increasing every year due to human activities and natural causes. Where do these greenhouse gases come from and how are they affecting our planet. Let us briefly examine this.

Greenhouse Gas (GHGs)	Sources
Carbon dioxide (CO_2) *It is produced abundantly and has a longer impact on climate as it remains in the atmosphere for a longer time*	Deforestation, change in land use pattern, burning of agricultural waste, urbanisation, industrialisation, usage of fossil fuels
Methane *It has more global warming potential than carbon dioxide*	Chewing food by animals, standing water in farm lands, garbage dumps, coal mines, leakage in gas pipes
Nitrite oxide *An important gas that is chiefly produced through agriculture*	Chemical pesticides and fertilizers that are used in farming, sewage waste
Fluorocarbons and Hydrofluorocarbons *It affects the ozone layer directly*	Airconditioners and refrigerators

[1] *Data on GHGs taken from "Contribution of Working Group I to the Fourth Assessment Report of Intergovernmental Panel on Climate Change", 2007*
http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml



Global GHG emissions can be broken down by economic activities that lead to their production.[2]



Greenhouse Gases caused due to economic activities.[3]

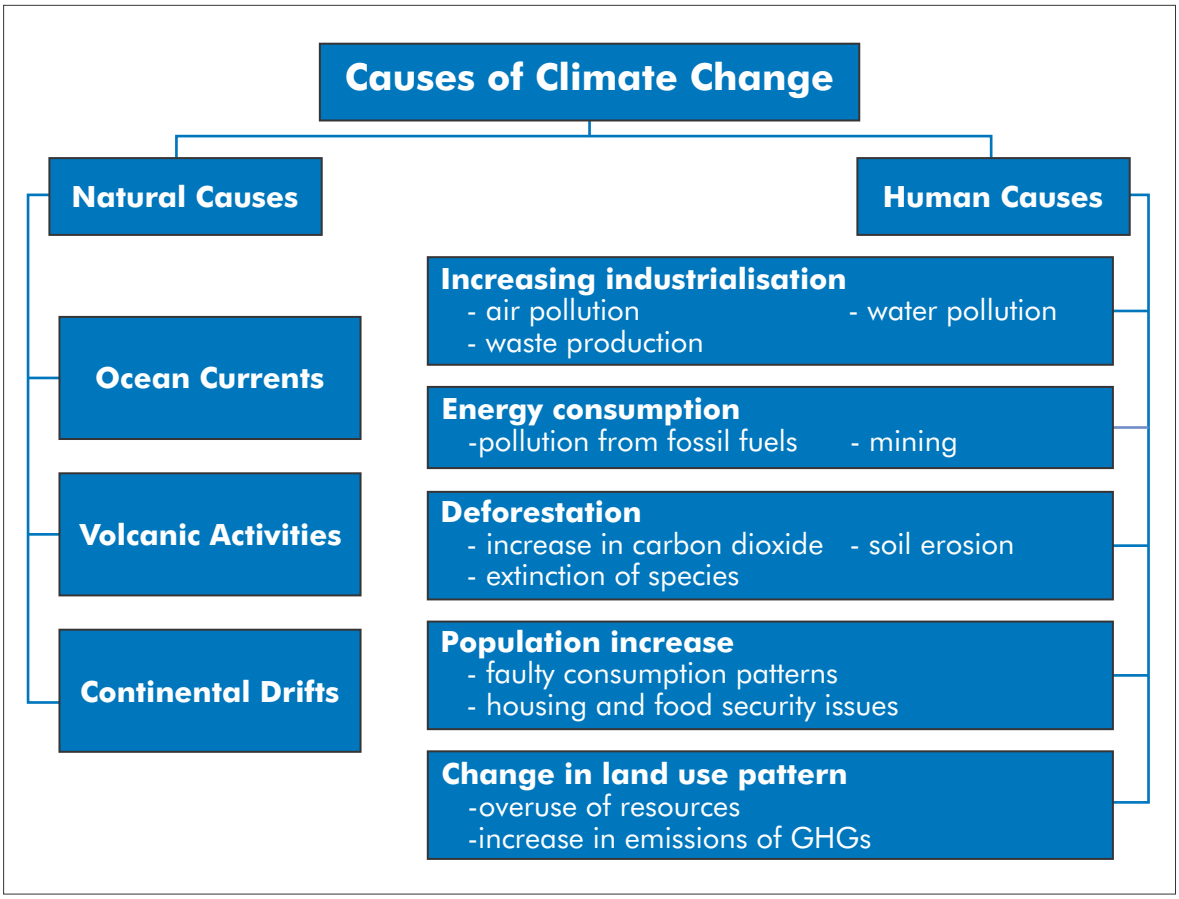
What causes climate change ?

Our planet is dynamic and keeps changing naturally. There are both natural and manmade factors that affect climate change. Since the last 100 years or so, the climate has been rapidly changing and due to this there has been consistent rise and fall in patterns related to temperature and rainfall. According to scientists this rapid change is caused by human activities and has resulted in increasing the concentration of greenhouse gases in our atmosphere. Mainly, there are two reasons for climate change- natural and manmade (anthropogenic activities).

Natural Causes : There are several natural factors that affect climate change. The Earth's climate can be affected by natural factors that are external to the climate system, such as changes in volcanic activity, solar output, the Earth's orbit around the Sun, continental drifts and ocean currents. Of these, the two factors relevant on timescales of contemporary climate change are changes in volcanic activity and changes in solar radiation. In terms of the Earth's energy balance, these factors primarily influence the amount of incoming energy. Volcanic eruptions are episodic and have relatively short-term effects on climate. Changes in solar radiation have contributed to climate trends over the past century but since the Industrial Revolution, the effect of additions of greenhouse gases to the atmosphere has been about ten times more.

Human Causes : Human causes are seen as the main reason behind climate change and its extreme effects such as droughts, untimely or delayed rains and floods. This is caused by the burning of fossil fuels and the conversion of land from forestry and agriculture for industrial

purposes. Since the beginning of the Industrial Revolution, these human influences on the climate system have increased substantially. In addition to other environmental impacts, these activities change the land surface and emit various substances into the atmosphere. These in turn can influence both the amount of incoming and outgoing energy and can have both warming and cooling effects on the climate. The dominant product of fossil fuel combustion is carbon dioxide, a harmful greenhouse gas. The overall effect of human activities since the Industrial Revolution has been a warming effect, driven primarily by emissions of carbon dioxide and enhanced by emissions of other greenhouse gases. The build-up of greenhouse gases in the atmosphere leads to an increase of the natural greenhouse effect. It is this human-induced enhancement of the greenhouse effect that is of grave concern because ongoing emissions of greenhouse gases have the potential to warm the planet to levels that have never been experienced in the history of human civilization. Such climate change could have far-reaching and/or unpredictable environmental, social, and economic consequences.



How are we contributing to climate change through our daily activities?

- **Electricity** is the main source of power in urban areas. All our gadgets run on electricity generated mainly from thermal power plants. These thermal power plants are run on fossil fuels (mostly coal) and are responsible for the emission of huge amounts of greenhouse gases and other pollutants.

- **Cars, buses, and trucks** are the principal ways by which goods and people are transported in most of our cities. These are run mainly on petrol or diesel, both of which are dangerous and dwindling fossil fuels.

- We generate **large quantities of waste** in the form of plastics that remain in the environment for many years and causes damage in emitting GHGs. They are often consumed by birds and fish which is extremely unhealthy.

- **Timber** is used in large quantities for construction of houses, which means that large areas of forest have to be cut down. In addition, we use huge quantity of paper in our daily work in schools and offices which results in more cutting of trees.

- A **growing population** has meant more and more mouths to feed. As the **land area available for agriculture is limited**, high-yielding varieties of crop are being grown to increase the agricultural output from a given area of land. However, such high-yielding varieties of crops require large quantities of fertilizers; and more fertilizer means more emissions of nitrous oxide, both from the field into which it is put and the fertilizer industry that makes it. These then also require huge amount of water for irrigation. Pollution also results from the runoff of fertilizer into water bodies.

How does climate change affect us ?

The effects of climate change are not similar across the globe. It is already known now that developing countries will face harsher challenges of climate change. Scientists believe that climate change on this scale is already causing and could produce results such as the following:

- Increase in surface temperatures
- Rise in sea levels
- Drops and changes agricultural yields
- Retreat of glaciers and melting of sea ice (leading to less availability of fresh water)
- Changes in rainfall (quantity and pattern)
- Increase in intensity of extreme weather events such as heat waves, tornadoes, hurricanes, and heavy rainfall
- Longer, recurring and more severe droughts
- Expansion of subtropical deserts
- Species endangerment and extinction and loss of biodiversity
- Spread of diseases due to the increased range of insects
- Acidification of oceans creating drops in fishing yields and death of coral reefs

These factors are a serious threat to food security especially to small scale farmers and their livelihoods

How is climate change affecting India ?

Affect	Present	Future
Rise in temperature/ Heat Waves	The year 2015 has already witnessed the 2nd strongest heat wave in the country. As of the beginning of June, it has already claimed 2000 death in multiple locations across the country.	Unusual and unprecedented spells of hot weather are expected to occur far more frequently and cover much larger areas. Under 4 degree celsius warming, the west coast and southern India are projected to shift to new, high-temperature climatic regimes with significant impacts on agriculture.
Changing rainfall patterns	Monsoon has shown heavy decline in the five decades. Frequency of heavy rainfall events has also increased.	An abrupt change in the monsoon could precipitate a major crisis, triggering more frequent droughts as well as greater flooding in large parts of India. India's northwest coast to the south-eastern coastal region could see higher than average rainfall. Dry years are expected to be drier and wet years, much more wet than ever before.
Droughts	Evidence indicates that parts of South Asia have become drier since 1970 as droughts have increased. Droughts affects more than half of India's agriculture leading to a huge fall in production and affects the economy adversely.	Droughts are expected to be more frequent in some areas, especially in north-western India, Jharkhand, Orissa and Chhattisgarh. Crop yields are expected to fall significantly because of extreme heat each year.

Ground water	More than 60% of Indian agriculture is rainfed. This leads to heavy dependency on groundwater. This source is already over exploited by industries and the urban sector.	Falling water tablesare expected to reduce further on account of increasing demand for water from a growing population, growing industries, more affluent life styles, deforestation, soil erosion and change in land use pattern.
Glacier Melt	Glaciers in the north-western Himalayas and in the Karakoram range - where westerly winter winds are the major source of moisture - have remained stable or even advanced. On the other hand, most Himalayan glaciers - where a substantial part of the moisture is supplied by the summer monsoon - have been retreating over the past century.	The Indus and Brahmaputra are expected to see increased flows in spring when the snow melts, with flows reducing subsequently in late spring and summer. Alterations in the flows of the Indus, Ganges, and Brahmaputra rivers could significantly impact irrigation, affecting the amount of food that can be produced in their basins as well as the livelihoods of millions of people.
Sea Level Rise	Mumbai has the world's largest population exposed to coastal flooding, with large parts of the city built on reclaimed land, below the high-tide mark. Rapid and unplanned urbanization further increases the risks of sea water intrusion.	With India close to the equator, the sub-continent would see much higher rises in sea levels than higher latitudes. Sea-level rise and storm surges would lead to saltwater intrusion in the coastal areas, impacting agriculture, degrading groundwater quality and contaminating drinking water. Kolkata and Mumbai, both densely populated cities, are particularly vulnerable to the impacts of sea-level rise, tropical cyclones, and riverine flooding.

Agriculture and Food Security	Rice : While overall rice yields have increased, rising temperatures with lower rainfall at the end of the growing season have caused a significant loss in India's rice production. Without climate change, average rice yields could have been almost 6% higher (75 million tons in absolute terms). Wheat : Recent studies show that wheat yields peaked in India and Bangladesh around 2001 and have not increased since despite increasing fertilizer applications. Observations show that extremely high temperatures in northern India - above 34degree celsius - have had a substantial negative effect on wheat yields, and rising temperatures can only aggravate the situation. Traditional food items (millets and other local vegetables/fruits) are still not given the space in the markets that they deserve. With a deep focus on cash crops, these staple food items are suffering.	Seasonal water scarcity, rising temperatures, and intrusion of sea water would threaten crop yields, jeopardizing the country's food security. Should current trends persist, substantial yield reductions in both rice and wheat can be expected in the near and medium term. Under 2 degree celsius warming by the 2050s, the country may need to import more than twice the amount of food-grain than would be required without climate change.
Water Security	Many parts of India are already experiencing water stress. Even without climate change, satisfying future demand for water will be a major challenge based on the increasing population and consumption patterns.	An increase in variability of monsoon rainfall is expected to increase water shortages in some areas. Studies have found that the threat to water security is very high over central India, along

	Urbanization, population growth, economic development, and increasing demand for water from agriculture and industry are likely to aggravate the situation further.	the mountain ranges of the Western Ghats, and in India's north-eastern states.
Health	Increasing malnutrition and related health disorders such as child stunting - with the poor likely to be affected most severely. Heat waves are likely to result in a very substantial rise in mortality and death, and injuries from extreme weather events are likely to increase.	Malaria and other vector-borne diseases, along with diarrheal infections which are a major cause of child mortality, are likely to spread into areas where colder temperatures had previously limited transmission.
Migration	South Asia is a hotspot for migration of people from disaster-affected or degraded areas to other national and international regions. The Indus and the Ganges-Brahmaputra-Meghna Basins are major transboundary rivers, and increasing demand for water is already leading to tensions among countries over water sharing.	Climate change impacts on agriculture and livelihoods can increase the number of climate refugees.

Source : "Turn the Heat Down-Climate Extremes, Regional Impacts and Cases for Resilience", World Bank study, June 2013

Negotiating Climate Change : The World Politics

As climate change is a complicated and challenging issue, it needs to be objectively understood with scientific, political and social information about its causes, its potential environmental and socio-economic impacts and possible response options. In order to understand climate change better, the International Panel of Climate Change (IPCC) was created in 1988 by United Nations Environment Program (UNEP) and World Meteorological Organisation (WMO)[2]. It created knowledge base on the social and economic impact of climate change, its reasons of occurence and the possible ways of responding to it. Since then the IPCC has regulaly delivered comprehensive scientific reports about climate change, the Assessment Reports. It has also responded to the need for information on scientific and technical matters from the United Nations Framework Convention on Climate Change treaty or the UNFCCC, through Methodology and Special Reports, and from governments and international organizations through Special Reports and Technical Papers. The IPCC aims to assess and responds to information that is relevant on human-induced climate change, the impacts of human-induced climate change and the options for adaptation and mitigation.

UNFCC Treaty : Hollow Commitments ?

For more than two decades now, the world has placed its faith in international agreements to address the threat of climate change. A binding global treaty is seen as the best way to ensure that greenhouse gas emissions are capped at a level low enough to prevent dangerous climate change. The effort to set emissions limits got off to a good start in 1992, when the UNFCCC was first signed. It has become about as universal as a treaty can be, with over 190 signatories. But momentum towards an agreement that set binding emissions limits for individual countries soon became discouraging over the argument put forward by most developing countries: that rich countries should shoulder the entire burden of reducing emissions. In the late 1990s, this divide prevented the United States from ratifying the Kyoto Protocol, the main mechanism for reducing global emissions. The United States Senate reasoned that unless China and other large developing countries agreed to limit their emissions, an international agreement would be meaningless.

This divide was finally bridged in a big way during President Obama's visit to China in early November last year, when the world's two largest emitters, the United States and China,

[2] "*Contribution of Working Group I to the Fourth Assessment Report of Intergovernmental Panel on Climate Change*", *2007*
http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml

announced a bilateral agreement.[3] The Sino-American agreement comes at a critical time for the global climate negotiations: the Kyoto Protocol, despite America's refusal to ratify it, remains the world's only binding international agreement to reduce emissions. And it is scheduled to expire in 2020. Most climate experts believe that a replacement agreement must be formulated by the end of 2015 to allow enough time for it to come into force before 2020. The European Union has launched its own attempt to jump-start climate negotiations, announcing it will pursue emissions reductions of 40% below 1990 levels by 2040.[4] Among the world's large economies – and big emitters – India is seen as the biggest wildcard going into the negotiations with the 2015 climate conference, scheduled to be held in France.

India's Perspective: Economic Development Vs Cutting Emissions

So far, India's stance on climate change has blended genuine concern with a resolute refusal to consider limiting its own emissions. It began formulating policies to support renewable energy in 2008 under the National Action Plan on Climate Change (NAPCC). India's current Prime Minister, Narendra Modi, has been outspoken in calling attention to the challenge of climate change. His personal progressive stance on climate change contrasts sharply with New Delhi's long-standing refusal to consider limiting emissions while India's per-capita emissions, at 1.7 metric tons in 2010, remains below the global average of about 5 metric tons. Successive Indian governments have maintained that poverty reduction and expanding access to energy, not reducing emissions, must be the country's chief priorities. At the UN Climate Summit in September last year, India's Environment Minister repeated this stance, implying that India would not limit its emissions for at least thirty years. India's sees its best way forward in rapidly and dramatically expanding partnerships in the field of clean energy. The Indian government has stated its desire to expand production of hydropower, solar and nuclear energy.

India's policy on agriculture in the context of climate change, is foregrounded by the need to produce enough grain to meet the food requirements of the country. To promote sustainable agriculture, policy makers and leaders have indicated the direction of the policy by repeating the old argument that the Green Revolution helped the country achieve self-sufficiency in food grain production. A Second Green Revolution is already on its way. With factory produced chemical fertilizers, pesticides, genetically modified seeds (GMOs) and export crops as its main features, it is already on field trials in research institutions in India.[5] There is more focus on

[3] *https://www.whitehouse.gov/the-press-office/2014/11/11/fact-sheet-us-china-joint-announcement-climate-change-and-clean-energy-c*

[4] *For more information check http://www.teriuniversity.ac.in/mct/pdf/new/environment/India_position_in_the_Climate_Change_negotiations.pdf*

[5] *http://in.reuters.com/article/2015/02/22/india-gmo-modi-idINKBN0LQ01P20150222*

food grain production - rice and wheat, the most vulnerable to climate change, as they are being mono-cropped with heavy use of chemical inputs. Dr. Vandana Shiva of Navdanya, says that the mission on sustainable agriculture under the NAPCC is based on the false assumption that genetic engineering will create climate resilience to climate change. She stresses that, "Genetic engineering will not create drought resistant or flood resistance. Genetic Modification is the latest form of biopiracy, which will rob vulnerable communities of their adaptation capacity to climate change." [6]

Domestic Policies and Actions

Under the NAPCC, State Action Plans on Climate Change (SAPCC) were formulated. A common framework was designed by the Ministry of Environment and Forest (MoEF) to guide these. However, all states have not submitted them and there are multiple challenges with its planning, funding and implementation.

Several programmes, activities and projects such as crop insurance and weather advisory systems that can address existing climate variability in agriculture sector have been attempted by the government. There is much desired to deal with the impacts of climate variability on sectors like forestry, fishery and energy. In the recent years, cyclone prediction and preparedness has improved considerably, reducing loss of lives. However, the same can not be said for extreme rainfall events. Predictions related to extreme rainfall, droughts and flooding remain inadequate, affecting the agriculture sector in terms of production.

The Indian Council for Agricultural Research (ICAR) launched the National Initiative on Climate Resilient Agriculture (NICRA) in 2011 in the 100 most climate vulnerable districts of India. These districts were mapped on the basis of drought to extreme rainfall, cyclones and other factors. Central Research Institute of Dryland Agriculture (CRIDA) carried out research and has implemented some initiatives that focus on technology, demonstration and capacity building. Interventions at local level have been designed around crop-production mechanism, livestock management, natural resource management etc. These are in early stages of implementation to assess their impacts. However, initiative like these will make a calculated response to mitigation.

Climate Smart Agriculture : Smart for whom?

The Food and Agriculture Organisation of the United Nations (FAO) is another significant agency that leads the way in dealing with the world's hunger. The FAO is the only global intergovernmental organization with a broad mandate in governing the world's food and agricultural system with the help of local and regional participants.

[6] *http://base.d-p-h.info/fr/fiches/dph/fiche-dph-8762.html*

According to the FAO, "The concept of Climate-Smart Agriculture (CSA) was originally developed by FAO and officially presented at the Hague Conference on Agriculture, Food Security and Climate Change in 2010 … CSA is an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. The magnitude, immediacy and broad scope of the effects of climate change on agricultural systems create a compelling need to ensure comprehensive integration of these effects into national agricultural planning, investments and programs."

In September 2014 the FAO launched the Global Alliance for Climate-Smart Agriculture. It describes itself as "a voluntary alliance of partners, dedicated to addressing the challenges facing food security and agriculture under a changing climate." Its members include environmental groups, the World Resources Institute- an influential US-based natural resources think tank; European corporate food giant Danone; the World Business Council for Sustainable Development, global flagship of corporate environmentalism; Ecoagriculture Partners, a private outfit that advocates a corporate-friendly form of 'sustainable agriculture'; the World Bank; and over 20 governments, including those of the United States of America, United Kingdom, Mexico, Costa Rica and France. Also on board is the Consultative Group on International Agricultural Research (CGIAR), the green revolution's global research consortium. The International Fertilizer Industry Association, the Fertilizer Institute- the industry's research and development arm- and Yara and Mosaic, two of the world's top fertilizer corporations are also members

The focus of climate-smart agriculture has been on promoting sustainable agricultural productivity, improving farmer livelihoods and developing more resilient food systems in the face of climate change. It talks about reducing greenhouse gas emissions caused by agriculture through practical techniques, such as mulching, inter-cropping, conservation agriculture, crop rotation, integrated crop-livestock management, agro-forestry, improved grazing, and improved water management, together with innovative practices, such as better weather forecasting, drought- and flood-tolerant crops, and crop and livestock insurance.

Climate-smart farming has been condemned as "a deceptive and deeply contradictory initiative". It is seen as a dangerous platform for corporations. By endorsing activities of the planet's worst climate offenders in agribusiness and industrial agriculture, the Alliance seems to be contradictory in nature. It has been touted to serve big business interests, not to address the climate crisis. Companies with activities resulting in dire social impacts on farmers and communities, such as those driving land grabbing or promoting (genetically modified) GM seeds, already claim that they are 'climate-smart'. Yara (the world's largest fertilizer manufacturer), Syngenta (GM seeds), McDonald's, and Walmart are all at the 'climate-smart' table. Climate-smart agriculture will serve as a new promotional space for the planet's worst

social and environmental offenders in agriculture. The proposed Global Alliance on Climate-Smart Agriculture seems to be yet another strategy by powerful players to prop up industrial agriculture, just like Green Revolution.

Another issue is that the Alliance's projects are to be funded by carbon offset schemes. Carbon offsetting is the use of carbon credits to enable businesses to compensate for their emissions, meet their carbon reduction goals and support the move to a low carbon economy. Businesses compensate for their environmental impact in order to meet increasing stakeholder pressure. This will enable developed nations to buy carbon credits in the global south and still continue their emissions. In this process, small farmers will be badly affected. They will face the burden of mitigation, even though they are the minimal contributors and the most vulnerable to climate crisis. Thus CSA is seen as a design to expand carbon markets and serve the interests of agribusiness and the financial industry. These were never designed to address the real cause of climate crisis but only to be a lucrative market for polluters.

Alternatives to green revolution industrial farming and 'climate-smart' agriculture are being developed and put in practice by small scale producers all over the world. The real climate solutions are based on agroecological practices and the re-localisation of food systems to effectively fight hunger. Governments, funding agencies, and international organizations are refusing to move towards committing to shift resources away from climate-damaging practices of chemical-intensive industrial agriculture and meat production, towards investment in and commitment to agroecology, food sovereignty, and support to small-scale food producers.

The International Forum for Agroecology stated that, "The real solutions to the crises of the climate, malnutrition, etc., will not come from conforming to the industrial model. We must transform it and build our own local food systems that create new rural-urban links, based on truly agroecological food production by peasants, fishers, pastoralists, indigenous peoples, urban farmers, etc. We can not allow agroecology to be a tool of the industrial food production model: we see it as the essential alternative to that model, and as the means of transforming how we produce and consume food into something better for humanity and our Mother Earth."[7]

[7] *http://www.foodsovereignty.org/forum-agroecology-nyeleni-2015/*

Last kharif season we lost rice because of the drought. This time the wheat was almost ready to harvest when the rain came lashing. There is only chaff left now. We lost about 70% of the wheat. My father walked to the field and fell down of shock and died. We have to pay 10 lakh loan in total to the bank and moneylenders.

*– **Rajesh Singh**, 27, farmer, Mathura, Uttar Pradesh*

About 10 years back, we managed 5000 boxes of apples. The snowfall declined over the years. Then it was delayed and then it snowed for only a few weeks. We are able to produce only 1200 boxes now. If it does not snow at the right time, the apples will not germinate. We don't have money to buy more land in upper areas of Spiti like some others did. It is impossible to make any livelihood from apples now.

*– **Sumiran Singh Verma**, 53, farmer, Shoghi, Shimla, Himachal Pradesh*

I was growing Bt cotton (BG -II or Bollgard 2) and used chemical fertilizers and pesticides on my field. I took loans from our local lenders also. There was no rain for 3 years. The soil became hard and cracked. Forget the investment, I became debt-ridden.Last summer, the drought broke me mentally. My land is parched and unfit for growing anything now.

*– **D Nayanappa**, farmer, 40, Kurnool, Andhra Pradesh*

When I was younger, floods were useful to cultivate three crops. Land was fertile to sow four crops also sometimes. That has changed now.We keep adding urea and other packets so that insects stop attacking our crops. But that also does not help because there are so many new small insects now. Rain has also changed in the last 10 years. Everything gets affected.

*– **Sabana Amin**, farmer, 58, Sitamarhi, Bihar*

Why does agriculture stand to loose the maximum from Climate Change ?

600 million people are dependent on the agricultural sector in India and most of them are small farmers, holding upto 2 hectares of land or usually lesser. Two thirds of the net sown area, is rainfed. About two-thirds of this is drought-prone with about 40 million hectares of land being flood-prone.[8] The poorest people tend to be located geographically in more exposed or marginal areas, such as flood plains or on nutrient-poor soils. The poor also are less able to respond due to limited human, institutional and financial capacity and have very limited ability to cope with climate impacts, and to adapt to a changing hazard burden. Climate change

[8] *http://www.dieselhal.com/blog/uncategorized/climate-change-consequences-indian-farmers/*

stands as a serious threat to agriculture as it is directly linked to availability of water (rainfall and groundwater),air, soil and biodiversity. Any change in any of these can change the face of Indian agriculture drastically. Variation in climate will have a direct impact on the livelihood of people and affect migration patterns. Food production in India is sensitive to the changing climate with variations in temperature and monsoon rainfall. Rise in temperature has a direct impact on the *rabi* crop and every 1 degree celsius rise will reduce wheat production by 4 to 5 Million Tonnes. Every small change in temperature and rainfall has significant effect on the quality and quantity of fruits, vegetables, tea, coffee, basmati rice and aromatic and medicinal plants.[9]

We are a big country that witnesses huge variations in climate conditions. This leads to different kinds of challenges to tackle climate change. In addition, agriculture becomes more vulnerable for small farmers who are directly dependent on monsoons. With limited means of sharing traditional knowledge, knowledge sharing through exchanges and trainings, farmers are stuck in an unfamiliar terrain. Changing seasonal patterns, increase in temperatures and erratic rainfall is already impacting the ecosystem with changes in crop, livestock, pests and pathogens. The rains in April this year have already created havoc in the country by destroying wheat crop by either flattening or submerging them in rainwater. This also leads to increase in debts for farmers as they loose crop production due to erratic rainfall.[10]

It is not just climate change that is affecting agriculture, but also the other way round. Agriculture and its practices are also affecting climate change. Agriculture is the second biggest contributor to greenhouse gases after the energy sector in India. Most dangerous gases like methane and nitrite oxide are produced by farming practices such as industrial agriculture. The biggest contribution is made due to the use of chemical fertilizers and pesticides that are put in the soil. The practice of burning crop residue is another big emitter of greenhouse gases. Besides these, animals produce methane during chewing process, use of machinery (mainly diesel) on the field and burning of biomass also contribute to climate change.

Effects of Climate Change

India is a vast country with different climatic zones that are determined by the soil, water presence and climate conditions. There are six different climate zones based on these. We have listed the effects and changes that climate change is expected to cause in the coming times. These are not caused by changes in the climate alone, but also due to prevalent agricultural

[9] *"Statistics Related to Climate Change in India", Ministry of Statistics and Programme Implementation, November 2013*

[10] *http://www.aljazeera.com/news/2015/04/unseasonal-rain-destroys-india-ripened-crops-150415094557312.html*

practices. In addition we should also understand the effects on some important crops and other significant factors that are crucial to agriculture.[11]

Indo Gangetic Plains

With the most fertile soil in the country this region is full of rivers and tributaries. With rice, wheat, oilseeds, legumes and vegetables, the Gangetic plains form one of the most well irrigated areas through surface and groundwater sources. However, with decades of overuse of chemical fertilizers and pesticides, the soil has degraded and groundwater levels are plummeting deeper and deeper. With glaciers shrinking, the water flow is also set to fall down. Climate change will lead to lower yield and will require changes in sowing patterns. This region is set to become heat-stressed with short-seasons by 2050.

Himalayan Belt

This region holds glaciers that provide water to the rivers that flow through north India. With rising temperature, the glaciers are shrinking at a faster pace than before. Due to this there is flooding in the rivers for a short period of time. However, in the long run, the availability of freshwater will be affected deeply due to this. This will have a direct impact in reduction of crop yield.

Hot and Humid Zone

This zone comprising of Odisha, Chattisgarh, parts of West Bengal, Madhya Pradesh and Maharashtra is heavily dependent on rainfall. While rice, pulses and groundnuts along with millets are grown in this area, cash crop of cotton may also be found with small farmers. High temperatures and droughts can damage crops in this zone. As the soil is dry and lifeless, inundation can also cause issues. Climate change is all set to reduce rainfall in some areas and create droughts in some. Extreme weather events are likely in this zone.

Tropical Wet Region

This forms the southern part of the peninsula of the country where it is usually hot and winters are also warm. With plantation crops that grow in the tropical rainforest here, marine fisheries also face the threat of climate change. Coconuts, areca nuts, spices and pulses are grown in abundance. Climate change is all set to raise the seawater level which would lead to salinizing both soil and freshwater. Thus the area will be affected heavily with fisheries and cultivated land produce.

---

[11] *"Rising to the Call: Good Practices of Climate Change Adaptation in India", Centre for Science and Environment, 2014*

Arid and Semi Arid Zone

This zone comprises of the Thar desert, Gujarat and the Deccan plateau. These regions practice rain-fed agriculture. Acute water shortages with high temperatures have already led to reduced yield. The Barmer flood in 2006 left several diseases after the widespread destruction. The search for groundwater has resulted in salinization in several parts of Rajasthan. Climate change will result in excessive or acute rainfall in the region affecting yield and causing damage in all possible ways.

Delta and Coastal Areas

The delta region of West Bengal stands to face threat by being submerged completely. Some islands in Sunderbans have already been submerged and migration of the local people has been going on for sometime now. 7000 people have already been displaced and by 2030, this number is set to rise to 70,000.[12] Sea-level rise has eaten habitats affecting the biodiversity adversely. Floods and saline water fill up this low lying area making agriculture impossible in West Bengal and Odisha. The primary crop of rice and sea fishery has been deeply affected. Freshwater availability stands as the biggest threat besides the increasing frequency and intensity of cyclone and tidal waves in this region.

Crops and other Variables

According to Intergovernmental Panel on Climate Change (IPCC) Report, Climate Change 2014 – Impacts, Adaptation and Vulnerability, rise of global temperature and increasing food demand would pose large risk to food security globally and regionally. It finds that even at just 1 degree Celsius of warming, a negative impact for major crops like wheat, rice and corn would be seen. For India, the prediction is that the stress on staple crops would increase negatively, affecting the overall food security. Post 2030, the overall food production will decrease.[13] While *kharif* crops will be impacted more by rainfall variability, *rabi* crops by are set to be affected by temperature variability. Wheat is likely to be negatively impacted due to terminal heat stress. Though the nature of changes may be uncertain, however, it is certain that the changing environmental parameters are affecting cultivation of crop and the ecosystem.

Let us examine some significant effects on some specific commercial crops, other important factors for agriculture and how their yield will be impacted by climate change and how in turn this will impact our food security.

---

[12] *"Suffering The Science: Climate Change, People and Policy", Oxfam International, 2009*

[13] *"Climate Change : IPCC Report Warns of Looming Food Crisis", Down to Earth, 31 March, 2014*

Wheat	It is predicted that with only 1 degree celsius rise in temperature, annual wheat production could go down by 6 million tonnes.[14] North Indian states like Haryana, Uttar Pradesh and Punjab would face profound impacts of climate change in the coming times. During February-March 2003-04, night temperature was recorded 3 degree celsius above normal in Haryana. Subsequently, wheat production declined from 4106 kg/ha to 3,937 kg/ha at this time.[15]
Rice	If temperature increases by 1 to 4 degree celsius, the grain yield of rice is going to reduce by 10% for each degree. Basmati varieties, a very important cash crop, has already shown vulnerability to temperature induced pollen sterility leading to lower grain formation.[16] Rainfall pattern is another impacting factor for rice. With drought like situation and uneven rainfall during the productive stages will lead to an impact on production. The eastern and north-eastern regions of the country are set to see increase in temperature and uneven rainfall. This will lead to a shortfall in production impacting the huge number of rice eaters in the country thus creating a hunger like situation.
Maize	Maize is a very important cereal for states in mountain and desert regions of the country for food security. It is particularly affected by rainfall in these areas. Thus with uneven rainfall this is set to decline the production. Higher temperatures also play a significant role. During monsoon, the yield could go down by 35% in the Southern Plateau region and upto 55% in the Indo-Gangetic plains in the coming decades.[17]
Fishery (Marine and Fresh water)	The geographical distribution and mortality of all marine life is to be affected by climate change. For both marine and freshwater fish, the area they occupy is going to shift, expand or shrink from its current locations. Since, all species are interlinked, any variation in the distribution of one set of organism can affect the functioning of the entire ecosystem with large economic and environmental results. With increasing temperatures on sea

[14] *Aggarwal, PK and Swaroop Rani, DN., "Assessment of Climate Change Impacts on Wheat Production in India", Indian Council of Agricultural Research, New Delhi*

[15] *Ibid*

[16] *Singh, SD., Chakrabarti, B and Aggarwal, PK., "Impact of Elevated Temperature on Growth and yield of some Field Crops, Global Climate Change and Indian Agriculture," ICAR Network Project, Indian Council for Agricultural Research, New Delhi*

[17] *Ibid*

	surface, there has been a decrease in spawning. There is already a shift in the breeding pattern to more suitable temperatures. This could affect the availability of commercial fish and impact the livelihood of fisherfolks in summer months especially April-September.
Soil	Changes in temperature and precipitation influence water runoff and erosion. This affects the organic carbon, nitrogen content and salinity of the soil. This impacts the biodiversity of soil micro-organisms which is very important for soil fertility. In addition, due to excessive use of chemical inputs such as fertilizers and pesticides, the soil is being robbed of its nutrients. It has contaminated groundwater and has reduced soil fertility in the long run. They destroy living processes of the soil and at the same time produce nitrous oxide, a potent greenhouse gas.
Water	By the year 2050, South Asia is likely to become a water stressed area with about 2.5 billion people affected by scarcity.[18] The delayed monsoons, recurring droughts, untimely rains and hailstorms and flooding cause a very difficult situation for Indian agriculture. Rising temperatures and extreme weather events will lead to water scarcity as it would increase evaporation rate. It can also lead to flooding in several areas. Indian agriculture heavily depends on rainfall and requires irrigated water if there is any irregularity. However, the industrial and urban sector also demand water in huge quantities and this could escalate the issue further.
Livestock and poultry	Disruptions in the seasonal pattern are known to affect biological rhythms of organisms. Ambient temperature plays a significant role whereas increased temperature and humidity levels are known to increase body temperatures leading to decline in feed intake, disturbed reproductive functions and low milk yield. Limited availability of water also impacts the reproductive functions and milk production. North India is likely to experience greater climate related reduction in milk production of cows and buffaloes as compared to other areas.[19] Due to heat waves, poultry animals will also be negatively impacted as it raises the chances of health issues.
Pests and Diseases	The number of diseases and pests is likely to go up with the increase in temperatures. The migratory insects are going to arrive sooner to the fields and this will affect the yield from the fields.

[18] *"Beyond Scarcity: Power, Poverty and Global Water Crisis," Human Development Report, UNDP, 2006*

[19] *Upadhyay, RC., Sirohi S., Ashutosh, Singh, SV., Kumar A., and Gupta, SK., "Global Climate Change and Indian Agriculture, Case Studies from the ICAR Network Project," Indian Council of Agricultural Research, New Delhi*

Adaptation and Mitigation

The adverse effects of climate change are and will continue to affect every sphere of human life. For small farmers especially, the threat is increasing everyday in poor countries like India. Right to food, nutrition, food security and food sovereignty are under severe threat. In order to reduce or eliminate these changes, so that human beings can survive, certain shifts in current practices is required. There is a wide range of adaptation and mitigation practices that can help in fighting climate change. These practices are systemic in nature, that is, that they challenge the current dominant practices that are guided by markets and corporations. It is essential to challenge them in order to survive these odd changes. According to Intergovernmental Panel on Climate Change (IPCC) mitigation, is defined as 'an anthropogenic intervention to reduce the sources of greenhouse gases'. On other hand climate adaptation refers to the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities or to cope with the consequences.[20] Thus, while adaptation reduces vulnerability of people and ecosystems, mitigation, attempts to reduce the magnitude of climate change impacts. However, neither adaptation nor mitigation alone can offset all climate change impacts. To respond to this threat it will be necessary to focus 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.

The assessment of climate change impacts, the vulnerability and adaptation to climate change require a wide range of physical, biological, and socio-economic models, methods, tools, and systematic assessment of data. Assessment of the implementation of the current climate commitments has confirmed non-attainment of greenhouse gas (GHG) reduction targets, and therefore, adaptation has become inevitable. There is now a strong belief that enhancing of society's response capacity through the pursuit of sustainable development pathways is one of the most significant ways of mitigating the likely impacts of climate change. According to the IPCC, a number of agricultural mitigation options which have limited potential now, will likely have increased potential in the long-term. Current initiatives suggest that identifying synergies between climate change policies, sustainable development, and improvement of environmental quality will likely lead the way forward to realization of mitigation potential in agriculture sector.[21]

Studies have shown that mitigation strategies are one of the best way to avoid damage to crops and reduce the effects of climate change. Agroecological farming practices focus on increasing organic matter in soil which leads to carbon sequestration. This is possible through

[20] *Intergovernmental Panel on Climate Change(IPCC) www.ipcc.ch*

[21] *https://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch8.html*

adding manure and plant residue to the field, mixed and legume based cropping, crop rotation and minimum tillage.[22] Agroecological agriculture practices also cut emissions of CO_2 , methane and nitrous oxide as there is no use of chemical inputs and no burning of crop residue.

Adaptation strategies for farmers will have to be based on sustainable agricultural practices especially leaning on local ones. Strategies used by farming communities to cope with climate crises in the past will be instrumental in finding solutions to address the future uncertainties of climate change.[23] These are suited for local climate variability and thus stand a better chance of surviving and adapting well to the local soil, water, air, rainfall and gene pool than any other. Chemical inputs of any kind or hybrid and genetically modified seeds contribute to the global climate change as they increase emissions, degrade the soil by killing microorganisms and thus affecting the biodiversity and ecosystem negatively. On the other hand, ecosystem-based adaptation (EbA) integrates ecosystem and biodiversity to create practices that help people adapt and cope with the adverse effects of climate change. In addition, organisations working with farmers strongly feel that it is crucial to help small farmers move towards diversity. Diversification of land use, a mixture of annual crops, perennial crops, fruit trees, fodder trees, timber trees would help in paving the way. They must provide subsistence and food, as well as cash and also provide for other habitat needs. Agriculture itself should provide additional environmental services, rather than consume or pollute them.[24]

Let us examine the mitigation and adaptation strategies based on agroecological techniques that can be helpful for farmers to improve agricultural practices, increase yield and contribute towards cutting climate change's adverse effects.[25]

Soil

Moisture conservation can be practiced by mulching to increasing organic matter in the soil. Scientists have found that mulching with plant biomass can reduce temperature of the soil by as much as 2 degree celsius as it helps in cutting out evaporation. This helps in reducing water need for certain crops (like millets and chillies). Preventing soil-erosion by building gully plugs, terrace farming layouts, bunding and contour ploughing, conservation tillage (leaving crop residue in the field) and through strategic vegetation of shrubs and trees along the edges of a

[22] *For more information, please check http://kotschi.eu/en/agriculture-climate/*

[23] *National Conference on Ensuring Food Security in a Changing Climate, Gene Campaign and ActionAid, April 2010, New Delhi*

[24] *http://base.d-p-h.info/fr/fiches/dph/fiche-dph-8762.html*

[25] *For more information and copies in hindi and english, please check http://focusweb.org/content/handbook-agroecology-farmers-manual-sustainable-practices-0*

field is another method for adaptation. With intense and erratic rainfalls, conservation of water and soil erosion are both important. The ridges slow down the water runoff and absorb it making the soil more porous with less hard clods, less water logging and cracking, thus making the soil better even in extreme climate conditions. Studies have shown that these can increase crop production significantly in hilly and uneven areas. By enhancing organic matter through vermicomposting, residue and kitchen waste compost, mixed and inter cropping of nitrogen fixing plants can provide nutrients to the soil more naturally that chemical fertilizers. Inputs can be made from naturally available ingredients such as animal dung. This also helps in retaining moisture and reduces farm waste by re-using it. It completely eliminates the need for expensive, fossil-fuel based fertilizers that degrade the soil and is one of the leading cause of loan-taking and farmer-suicides,as it is rich in nitrogen, phosphorus and potassium it helps in reducing the metals in the soil along with other pathogens.

Gauri Mandal's village is in the Sunderbans of West Bengal. She own four bighas (1.3 acres). Mostly, she cultivated paddy with some vegetables for her family's consumption. Due to the cyclone Aila in 2008, her field was filled up with saline water. Following this and due to the erratic climate, the rains have been untimely. Earlier, Mandal was also using chemical fetilisers. This, she saw, was leading to deterioration of the soil. Applying more chemical inputs was difficult as they were to be bought each time and were not performing as desired. The output decreased with every season. The soil became hard and cracked up.

In 2009, she built a vermicompost pit in her kitchen garden. She selected a top covered but side open space so that there would be no direct sunlight on the compost. A handful of earthworms were set free in a mixture of moist loamy soil and another layer of broken bricks with coarse sand. It is highly recommended that local earthworms must be used for best results. She bought the earthworms- eisenia fetida from a local organisation. These were kept in a ring of 2m X 1m X 0.75m layout that was built with brick and mortar. Dry leaves, fresh cattle dung and other organic waste from the kitchen was also added. She says that moisture is very important in the compost and to ensure that, water must be sprayed on the mixture at regular intervals. It takes about 60-90 days for the mixture to be ready. It has to be kept turning every 5-7 days as well. She has been using the vermicompost on her field since then. Mandal says that she

could see the change within a few months. The soil on her land became softer and porous. It required less water than before. Currently she produces about 5-6 quintals per year and sells it to other farmers too. She has started growing different types of vegetables (mixed and inter cropping)throughout the year since then. She is able to consume fresh, chemical free vegetables and also sells the excess at the local market. After consuming she sells paddy as well (roughly 4 bags of paddy in one season).

She is not dependent on the market for any kind of farming supply now. She also saves vegetable seeds for sowing. Her farming is dependent on the biodiversity of the area and not any manufactured inputs.

Water

Harvesting and storage of water can be done through digging small pits and ponds in and around the field to catch rainwater and trap runoffs. These include traditional rainwater harvesting structures and are found throughout India. Furrow beds can be created by digging narrow trenches through the field and the crop is grown on the ridges between them. When water collects in the furrows, it is absorbed instead of flowing away. Traditional Drip Irrigation practices are found throughout the country. Bamboo drip irrigation from the North-East and earthen pots from the Central and Western Indian regions are very well known. These ensure that the water is carefully used in the initial stages and reaches the roots when required. These are not just effective but also very cheap to build and maintain by farmers.

Trenches help in absorbing rainwater and aid in raising groundwater level

Contours and Bunds: These help the water to percolate instead of running off and recharges groundwater. These practices are the most effective ways to combat water shortage in a water scarce country like India that is dependent on rainfall very heavily for farming. Due to unreliable rainfall pattern, these practices help in dealing with climate change very positively.

Flood Protection: In some areas raised farm beds are being successfully practiced by farmers throughout Assam and West Bengal to deal with flooding in the fields caused due to heavy rainfall, sea-water flooding and river overflowing. Check dams and dykes can also aid in low-

lying areas by holding back water at a certain level. Besides this strengthening mangroves along coast lines is very important for shoreline protection as they absorb and disperse tidal wave surges to a very good extent.

Cattle Management

Growing high quality fodder : By growing native grasses and rotating grazing systems and promoting traditional and local breeds as they are not just resilient to change, they adapt better to conditions of their particular region and require less fodder and water while producing more milk. Thus, it is extremely beneficial to use local breed and not the non-native ones.

Native to Southern India, the Hallikar is known for its draught power and racing abilities

The link between agriculture and livestock has not received the much needed and important attention in recent years. It took a beating down with the introduction of hybrid varities of cattle through government intervention. This has affected the manure availability and quality, especially for small farmers, and has in turn affected farming practices and crop productivity. Pastoralists have selectively bred cattle and sheep over generations to produce unique combinations of hardy and highly adapted animals (based on gene pool) that can withstand biodiversity. The *Halikar* breed, indigenous to Karnataka and penninsular India, are tall and strong with slender limbs. They are known for their swift movements and racing abilities. They consume less water and fodder than hybrid cattle and perform better. They are known for their dairy and draught power and can be extremely beneficial to small farmers.

Seed Banks

Creating seed banks at the household and also the community level has various advantages Seed banks are a form of storage and diversification, and they enhance farmers' ability to buffer environmental and economic stress by planting several crop varieties adapted to a range of environmental conditions. At the same time, seed banks facilitate farmers' access to markets and give farmers more choice over what they grow. Seed banks enable rural tribal villages to become less dependent on engineered high-yield varieties and on expensive inputs such as fertilizers and pesticides. These varieties that are stored by farmers are inherently more compatible with local farming conditions, economically practical and environmentally

sustainable than the high yielding varieties being used today. They are also more resistant to pests, diseases, droughts and floods.

Seed and Grain Bank, Kashipur, Rayagada
Credits : Agragamee, Odisha

The availability of the appropriate kind of seed is highly significant for agriculture because without viable seed, the survival of rural households is endangered. The ways that farmers obtain seeds are as old as agriculture, and most small-scale farmers routinely save their seed from one harvest to the next. At one time, India had 200,000 varieties of paddy (rice grown in fields submerged in water), ranging from wetland to dry land to deep water and scented millets were once a popular crop because they are drought-resistant, highly nutritious, and capable of cultivation in poor soil.[26] These have been rapidly diminishing due to the introduction of hybrid seeds. While hybrid seeds require chemical fertilizers, pesticides and alot of water, local seeds require farm-available inputs that usually comprises of farm-animal waste or is naturally available in the habitat. The emission of greenhouse gases can be significantly cut off by stopping the use of these fertilisers that are necessary for these hybrid seeds. These seeds are the most farmer friendly and can resist climate change effects as they grow well in extreme or marginal environmental conditions such as shifting rainfall patterns and extreme temperatures.

Seed conservation
Credits : Agragamee, Odisha

Traditionally, seed preservation has been women's role, and their knowledge of seeds has been extensive. Therefore, women play a major role in the conservation of diversity at the farm level. It is women who decide on the amount of seed and selections of varieties to be stored and the various ways of storing them.

Much of the seed stored in community seed banks is generative, but vegetative seed such as potato tubers, sweet potato vines, yam stets and cassava stakes are

[26] *Interview with Dr. Debal Deb, Scientist, Centre for Interdisciplinary Studies*

also found. Transferring seed between individuals, households and the seed bank entails a variety of exchange mechanisms. These are mainly informal mechanisms such as seed fairs, in-kind seed loans, barter and transfers based on social obligations

Some seed banks also double up as grain banks and acts as an emergency supply unit in extreme times of damage or starvation.

Crop Selection and Growing Practices

Certain crops such as millets are more beneficial than the conventional rice- wheat farming. Shifting to low-input crops eases the pressure on limited water supply and is healthier for the soil as it replenishes it with nutrients immediately, thus reducing the need to keep land fallow (which leads to soil erosion) after harvesting. Andhra Pradesh, Odisha, Rajasthan and Karnataka among other states are growing millets to be more food secure. Cultivation and growing practices such as crop rotation, mixed and inter cropping, delaying sowing time, using local and traditional seeds, SRI (System of Rice Intensification), natural farming, no- input farming, on-farm conservation, organic farming, agroecological farming and others help in combining practices that aid in mitigation and adaptation both. These practices increase soil's resilience to the fluctuations that climate change causes, reduces the growth of pests and reuses farm waste to reduce the pressure on climate change.

Cultivation Practice : System of Rice Intensification(SRI)

Chamaru Ram is nearly 70 years old. He own about two acre (20 karnal and 1 karnal is 400 sqm) land in his village in Kangra, Himachal Pradesh. His total grain output was 90kg/karnal(9q/acre). He started practicing SRI in 2006 on 0.05 acre of his land. Over the years, he increased this to 0.08 acre of his land. He was interested in SRI technique as it focussed on improving soil fertility and use less water for irrigation. He followed SRI practice and his grain output doubled in to 180kg/karnal(18q/acre).

Plants should be spaced optimally widely to permit more growth of roots

The simple steps of SRI as compared to conventional farming are listed below :

Particulars	Conventional method	SRI method
Nursery	At the field-level	Raised nursery
Preparation of field	Marker not used	Marker used
Transplantation	No fixed-spacing	10" x 10" planting of single seedlings 8-12 days old seedlings transplanted
Weeding	Manual	Bigger weeder required according to the filed size for frequent weeding. This keeps the soil aerated as well
Management of water	Rain fed or flooded with irrigated water	Application of 1" inch water, rest drained. Soil has to be kept moist so that aerobic soil conditions prevail
Fertilizers/Manure	Urea & FYM	Naturally prepared: *panchgavya, amaritjal, matka khad,* vermicompost

Chamaru Ram used lesser seeds (around 250g/karnal) and used lesser water in the process. He found that the crop is less prone to damage by wind as well. He says that it is important to transplant the seedling after exactly10-12 days. In addition, as he used naturally prepared manure, the rice tasted better, the soil became softer and fodder also turned out to be greener. He is a big follower of SRI now and urges other farmers in his village to do the same.

Pest Management

Bio-pesticides and enhancers are very important for the agriculture sector in order to reduce the effects of climate change drastically as they stop the use of fossil fuels to a large extent. Chemical fertilizers produce dangerous greenhouse gases. Bio-pesticide inputs are made from locally available materials. The most important and common ones include neem, cow dung, cow urine, red-chillies, garlic, mustard and water to kill pests. Bio-enhancers are made from dung, urine, jaggery, curd, legumes and other material. Trap crops (such as marigold) can also be used to combat pests so that no chemically made pesticides are used.

Kitchen Garden

These form a very crucial part in dealing with climate change and its effects on food security. Farmers should maintain a kitchen garden to produce food for their own consumption of vegetables, pulses, fruits and grains. Diverse gardening on a small scale is much less prone to risks. With climate risks and cash crop's prices, families can have a steady supply of food and not go hungry.

Agroecology : The Sustainable Alternative to Climate Change Crisis

The challenges and issues we face today- energy, food security, environment, financial security and climate change, can not be understood in isolation. Climate change is a non-linear phenomenon, and it is better to see it as climate chaos than climate change or global warming alone.[27] The solution to the crises of climate is to promote biodiverse, ecological, organic farming, which produces more food at lower cost, while reducing greenhouse gas emissions and increasing the resilience of farming systems to climate chaos, and enhance the capacity of agriculture communities to adapt to climate change.[28]

Agroecological farming combines all these practices by cutting down the effect of climate change through sustainable agriculture. It can be seen as a suitable tool to deal with climate change for agriculture. It consists of a variety of agricultural techniques, based on traditional practices and have greatly expanded over the last two decades. With these techniques, healthy and naturally produced food is grown in decentralised, community-oriented, energy-efficient, and sustainable ways. In agroecological farming, farmers use technologies based on ecological knowledge rather than chemistry or genetic engineering to increase yields, control pests, and build soil fertility. They plant a variety of crops, rotating them so that insects that are attracted to one crop will disappear with the next. They know that it is unwise to eradicate pests completely, because this would also eliminate the natural predators that keep pests in balance in a healthy ecosystem. Instead of chemical fertilizers, these farmers enrich their fields with manure and re-use crop residue, thus returning organic matter to the soil to balance the biological cycle.

A key principle of agroecology is the diversification of farming systems. Mixtures of crop varieties are grown through intercropping (growing two or more crops in proximity), agroforestry (combining trees and shrubs with crops), working along with biodiversity and other ecologically sustainable techniques. Indigenous and local livestock is integrated into farms to support the ecosystems above the ground and in the soil. All these practices are labor-intensive and community-oriented, reducing poverty and social exclusion. In other words, agroecology is able to raise agricultural productivity in ways that are economically viable, environmentally benign, and socially uplifting.

From a systems point of view, agroecology is a systemic solution par excellence. If we shift from our chemical, large-scale industrial agriculture to agroecological, community-oriented,

[27] *http://base.d-p-h.info/fr/fiches/dph/fiche-dph-8762.html*

[28] *Ibid*

sustainable farming, this would contribute significantly to solving three big problems. It would greatly reduce energy dependence (as we use fossil fuels extensively to grow, transport and process food). The healthy, naturally grown food would have a huge positive effect on public health, because many chronic diseases — heart disease, stroke, diabetes, and so on — are linked to our diet. And finally, agroecology contributes significantly to fighting climate change by drawing CO_2 from the atmosphere and locking it up in organic matter.[29]

There are several communities, movements and organizations around the world that are facilitating this shift from industrial/conventional agriculture to agroecology, that is not only urgently needed, but is also practical and can be achieved without new technologies or expensive investments. There are several examples from around the world that illustrate the economic, environmental and social justice and profitability, especially for small farmers. There is of course the need to scale it up at the local, global and political level before it is too late.

[29] *TJ., LaSalle and P., Hepperly, "Regenerative Organic Farming: A Solution to Global Warming," Rodale Institute Report, 2008.*


Shortage
Diseases
Migration
Agroecology
Page
Word
Pests
Cloud
Increased
Loss
Biodiversity
Debts
Suicides
LowFarmer
KnowledgeDry
Waves
Sharing
Burst
Moneylenders
Rainfall
Unseasonal
Pattern
Fertilizers
Snowfall
Hailstorms
Food
Temperatures
Cattle
Water
Seed
Floods
Mitigation
Productivity
Farming-Water
use
Degraded
Biodiversity
Vermicompost
Ecological
Erratic
Spells
Harvesting
Loans
Drought
Banks
and
Climate
Sowing
Sovereignty
Heat
Practices
Seeds
Reduction
Local
Soil
Rising
Changes
Farming
Pesticides
Adaptation

Focus on the Global South

Focus on the Global South is a policy research organisation based in Asia (Thailand, Philippines and India). Focus provides support to social movements and communities in India and the Global South by providing research and analysis on the political economy of globalisation and on the key institutions underlying this process. Focus' goals are the dismantling of oppressive economic and political structures and institutions, the creation of liberating structures and institutions, demilitarization, and the promotion of peace.

Rosa Luxemburg Stiftung (RLS)

The Rosa Luxemburg Stiftung (RLS) is a Germany-based foundation working in South Asia as in other parts of the world on the subjects of critical social analysis and civic education. It promotes a sovereign, socialist, secular and democratic social order, and aims to present alternative approaches to society and decision-makers. Research organisations, groups for self-emancipation and social activists are supported in their initiatives to develop models which have the potential to deliver greater social and economic justice.