Climate Change and Indian Agriculture

Implications & way Forward

Study conducted by actionaid

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The Heinrich Böll Stiftung / Foundation (HBF) is the Green Political Foundation, affiliated to the "Greens / Alliance '90" political party represented in Germany's federal parliament. Headquartered in Berlin and with about 28 international offices, HBF conducts and supports civic educational activities and projects world-wide.

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About ActionAid

ActionAid works with poor and excluded people in India to end poverty and injustice. Together with the people, we claim legal, constitutional and moral rights to food and livelihood, shelter, education, healthcare, dignity and a voice in decisions that affect their lives.

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Design and Print: Kriti Creative Studio #9873249374

Preface

Agriculture has been the basis of all historical and world civilisations. Our own Indian civilization has through the ages, flourished and evolved on the base of a highly complex, diverse and developed system of agriculture.

Indian agriculture ails today. As against a 7- 8% growth rate of economy in the last few years, agriculture and allied sectors in the last decade and half have registered a much lower growth trajectory and face stagnation. With per capita food availability at a low point and land alienation at a high point, the magnitude of food insecurity manifests itself in varied ways to multiply distress for our poor and excluded people.

Agrarian distress is further aggravated due to extreme climatic conditions, the worst sufferers once again being the marginal and small farmers who constitute 84% of the farming households of India. They are not able to economically cope up with poor crop yields and livestock production. Increased food insecurity is further magnified by lack of access to agricultural subsidies, access to low cost inputs and a lack of remunerative prices for their produce and limited purchasing power.

A recent International Conference on Climate Change and Sustainable Agriculture 2012, organized by the Indian Council of Agriculture Research (ICAR) and National Council for Climate Change, Sustainable Development and Public Leadership observed that "The climate system is extremely complex and poorly understood in terms of extent, timing and impact. Thus, the knowledge and understanding of implications of climate change at the national level is inadequate and fragmentary."

The statement is telling and calls for a serious introspection by policy makers, scientists, CSOs and peasant organizations to lift out agriculture from a crisis and prepare the road map for adaptation and mitigation technology for climate change.

The current study is a small beginning for ActionAid India to understand the climate and agriculture from the perspective of small and marginal farmers. The study was conducted in three drought-prone regions of India- Anantapur of Andhra Pradesh, Balangir of Odisha and Bundelkhand regions of Uttar Pradesh.

Field researchers, using participatory methodologies, interviewed 1000 marginal and small farmers, spent time understanding their perspectives and have then compiled the major findings from the field.

This study has attempted a possible adaptation framework for climate change vis-à-vis agriculture. I would urge peasant leaders, academics, civil society organisations and policy makers to deliberate on the issues obtaining out of this study and suggest a way forward for collective action.

ActionAid India is happy to join hands with all like-minded organizations to bring the issue to the centre stage of national debate, policy reform and action.

Several farmers groups, government officials, media personnel and social organisations contributed to this work. We take the opportunity to thank all participants for their time and the ideas they have shared with us. We acknowledge and thank the main researchers of this study - Dr. Ramanjaneyulu and Dr. Laxmi Tummuru of Centre for Sustainable Agriculture, Dr. Suman Sahai of Gene Campaign, and Shri Amar Jyoti Nayak, Byomkesh Kumar Lall, Debabrat Patra, P Raghu, Bharath, Harjeet Singh and other colleagues of ActionAid India, who contributed in various capacities.

We would like to also gratefully acknowledge Dr. Axel Harneit-Sievers, Director, Heinrich Böll Foundation's India Office and Sanjay Vasistha for their contribution and support to this study. We would also like to thank Shri Sanjay Vijayvargiya, Devendra Gandhi, Siddha Gopal, Ajay Srivastava, G Chandrasekhar and Gaddam Rajashekar who supported field work and contributed ideas to shape this work.

Sandeep Chachra
Executive Director

ActionAid India

From Researchers

In the following report, ActionAid in collaboration with Centre for Sustainable Agriculture (CSA), Hyderabad have undertaken an attempt at documenting and analyzing how farmers are being affected by a changing climate and how farmers are adapting to it by local innovations. The aim is to begin identifying the critical adaptation lacunae that farmers currently face and the areas of policy change that are urgently needed. The report is based on secondary data and a short nine-day field study (three days in each research area) in the states of Andhra Pradesh, Odisha and Uttar Pradesh. The study builds on the vast amount of knowledge across the country that exists on India's agrarian crisis and makes suggestions for the way forward on agriculture adaptation policy.

We deeply appreciate the help extended by various people during the course of our study, especially, the farmers, government officials, NGO staff, journalists who were part of the study and the consultations organized in various states and in Delhi. Their inputs have enriched the report immensely.

We thank HBF for extending support for this preliminary study.

As the study is based on a very small sample, the conclusions from the field study may not be generalized. However, the lessons drawn from the field study are in clear confirmation with the larger literature available on this subject.

We also thank Shefali and Amar for editing the document and enriching the report by sharing the best practices of adaptation by Gene Campaign, *Beej Bachao Andolan,* Centre for Sustainable Agriculture (CSA), *Tarun Bharat Sangh* and Western Odisha Rural Livelihood Project (WORLP).

Ramanjaneyulu

Laxmi Tummuru

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Executive Summary

Indian Farmers are passing through a phase of unprecedented agrarian crisis which is sadly manifested in abandonment of agriculture, distress migration and growing number of farmers' suicides. The worst affected are the small and marginal farmers, landless wage labourers who constitute 95% of the farming communities in India. The conditions of the farming communities have further worsened due to climate variation which is experienced through drought, untimely rain and flash flood. There is now growing evidence that the impacts of climate change are unfolding at a pace that is much quicker than predicted by the IPCC in their Fourth Assessment Report (AR4). One of the critical sectors for human survival is agriculture. It is also one of the sectors that climate change will have the worst impact on. Very high losses of agricultural production – there are estimates ranging from 20% to 40% - including in production of food crops, are expected to occur, especially in Africa and South Asia.

The impact of climate change on agriculture particularly in specific regions is under-researched; while agriculture's contribution to climate change and the solutions proposed for it are controversial. International discussions on agriculture adaptation and mitigation are spread across a few international bodies. And industrialized countries appear more willing to set up mitigation-oriented projects on agriculture in developing countries (for which they hope they earn carbon credits one day) than prioritizing agriculture adaptation. This has implications for how countries like India prioritize and finance agriculture adaptation to climate change.

Yet, climate change is already a reality for Indian farmers. Like the marginalized everywhere, the majority of these farmers are paying a high price for anthropogenic climate change though having contributed little towards causing it. Marginal and small food producers are worst-hit because they already face enormous social and economic disadvantages. Such farmers who also often have to engage in wage labour have meager resources to buffer themselves from the additional risks that climate change poses. Though the government is in the process of evolving plans for agriculture adaptation, Indian farmers largely face the climate threat alone.

Climate change impacts agriculture in several ways. First, climate change has a direct bearing on the biology of plant and animal growth. Second, it impacts farm ecology, for example soil conditions, soil moisture, pests and diseases. Third, the slow on-set of climate change impacts variability in rain patterns and rising temperatures—affecting entire agricultural cycles which are intrinsically linked to cultural traditions and the rhythms of agrarian life. Fourth, the increase in frequency and intensity of extreme weather makes agriculture highly vulnerable to dramatic crop loss. Finally, the severity of the impact depends on the social, ecological and economic vulnerability of the people and agrarian system in which they live. In another words, adaptation to climate is about reducing vulnerability overall and not just in agriculture alone.

Much of the discussion in India on agricultural adaptation is centered on particular technologies that farmers can deploy. However, if Indian policy makers wish to support farmers' adaptation to climate change, they must seriously address the worsening ecological, economic and socio-political problems Indian farmers face today. In order to make sound policy decisions, they must effectively understand how climate change is likely to exacerbate these pre-existing problems for farmers, agrarian livelihoods and food security. Institutional efforts for agricultural adaptation must therefore assess how climate change is likely to impact different sections of the population in each region; tackle the key factors contributing to the agrarian crisis in these regions; and take appropriate measures by learning from farmers themselves and making them critical agents of change. Only then can adaptation measures become and remain effective.

In Chapter 2, we have discussed the findings from our field research from 15 villages spread across three districts- Ananthapur in AP, Lalitpur in UP and Balangir in Odisha. In Part I and II, we have tried to address the issue that how the climate change is affecting agriculture and how the fertiliser, pesticide and water intensive agriculture has contributed to the GHG emission and rendered the farmers more vulnerable to climate change. The Part- III of the chapter shares the field experience of the farmers that how the farmers are affected by the climate change and how they are adapting to the change.

In Part I of Chapter 3, we explore the international politics around climate change and discuss, how rather than meeting their legally mandated emissions reduction targets enshrined in the Kyoto Protocol, the countries such as the United States (which has never been part of the Protocol), Japan and Russia are demanding that the Kyoto Protocol be scrapped so that developed and developing countries alike have binding reduction targets. In Part II we discuss the national policy on Climate Change and the CSOs' critiques of National Climate Action Plan. In Part III, we discuss the state level Action Plans. The policy analysis and the field research have established the gap between intentions and action on the ground.

In Chapter 4 we have discussed the best practices of adaptations, innovated by various organizations like Gene Campaign, Beej Bachao Andolan, Centre for Sustainable Agriculture, Tarun Bharat Sangh, Western Odisha Rural Livelihood Project. These give us the hope that low cost alternatives are possible to adapt to the climate change but strong political will is needed to bring these learning to the policy formulation.

In the last Chapter we have discussed way forward by suggesting actions at local to national level. The suggestions are drawn from our work on the ground with small and marginal farmers and indentifying the gaps in the implementation of well meaning policies.

Chapter 1

Understanding Climate Change Impacts in the larger Indian Context

Though India occupies only 2.4% of Earth's surface area, it is home to 17.5% of the world's population. In the last decade alone, the country added another 181 million people to the world population. By 2025, India will surpass China to become the world's most populous nation (Census 2011). According to India's National Action Plan on Climate Change (NAPCC) 2008, the agriculture sector employs 56.4% of the total workforce and supports 600 million people either directly or indirectly.[1] It therefore remains vital to a staggering number of Indians who otherwise would have no alternative means of livelihood. Furthermore, Indian farmers enable the country to remain food self-sufficient while other countries have to rely on increasingly volatile international markets for food security. This critical function not only adds to food security, but also national security. Yet a large number of people continue to be food insecure in the country. The challenge in the country therefore is not whether enough food is produced, but rather how it is produced and distributed.

Economically, agriculture also contributes to 21% of the country's GDP. Yet access to land and natural resources remains highly unequal and fraught with social conflict. Close to 94% of Indian farmers, considered small and marginal, hold less than 4 hectares (ha) of land according to the most recent agriculture census of the Ministry of Agriculture (2005). This is nearly 63% (~100 million hectares) of total agricultural land in India. 44% of farmers own less than .5 ha of land. A logical place to start agriculture adaptation, therefore, would be by updating the agriculture census and carrying out a climate change and vulnerability risk assessment as part of the census.

Yet, budget allocation to the agriculture sector has been declining. For the 11th five-year plan (2007-2012) of the Planning Commission, it was only 3.7% of the total plan outlay. Yet a large chunk of it was going to harmful input subsidies. The fertilizer subsidy reached an all time high of Rs. 1,19,772 cr in 2008-09[2] which is 650 % rise in the previous four years.

The Indian government's focus in the last two decades has been on increasing and sustaining India's rapid economic growth. In spite of this, from 1995-2010, 256,913 farmers (according to official estimates) have committed suicides due to a number of interrelated causes that have lead to devastating indebtedness.[3] While the average per capita income in the country was Rs. 19,325 in 2004-2005,[4] small land holding farmer families earned only Rs. 5076 and marginal farmer households earned even less at Rs. 3312.[5] Small and marginal farmers and landless food producers are among the most deprived sections of society.

Climate change, therefore, brings major challenges to a deeply troubled sector. It significantly increases risk and vulnerability for farmers who are already facing ever increasing costs of cultivation, decreasing incomes and an agrarian crisis. High chemical input use, degrading soils and receding ground water levels plague many parts of the country. Rising food inflation, increasingly volatile and high global agricultural prices compound the vulnerability and unpredictability climate change creates for farmers and rural workers who have to buy food during lean periods of the year.

Agriculture, apart from being a victim of climate change, is also a sector that is thought to contribute to it. In India according to various estimates, it is suggested that agriculture could contribute around 25% to 30% of national GHG emissions.

The fertilizer, pesticide, water intensive agriculture contributes around 14 % of total global greenhouse gas (GHG) emissions. The two biggest culprits of agriculture related emissions are nitrous oxides and methane. Nitrous oxide's global warming potential is 310 times greater than CO_2; while methane's is 21 times more (Smith *et al*., 2007). The green revolution driven agriculture sector is responsible for 75 percent of the world's total nitrous oxide emissions and 50 percent of the total methane emissions.[6] Synthetic fertilizer production and consumption and manure management from large scale confined animal operations are responsible for nitrous oxide in high input intensive agriculture systems and these large-scale animal operations are also the main sources for the world's methane.

Dr. Suman Sahai of Gene Campaign tells that the high input, mechanized, monoculture promoting, agrochemical based model of agriculture that is being endorsed in most parts of the world, as also in India, marginalises small farmers. It is also unsustainable in the long run, and it is a model with a large carbon footprint that will continue to contribute to GHGs. It is not a model that can help agriculture cope with the emerging challenges and threats from a changing climate. In order to ensure sustainable agriculture productivity and food production, agriculture must effectively adapt to a changing climate in a manner in which production losses can be minimized or eliminated. At the same time, GHG emissions from agriculture must also be minimized or eliminated in order to meet the global target of containing the rise of average temperatures below 2 degrees Celsius.

But these trends impact major strategic decisions for the government's policies not just on climate change, but on what kind of agriculture practice needs to be promoted that would promote sustainable agriculture empowers the small and marginal farmers that would ensure also on food security, economic growth, trade and investment. Policymakers must therefore be clear whether food self-sufficiency and food growers of the country remain a priority for India's (GOI) strategy for economic development and national security in the medium to long term.Government officials must weigh all of these factors in devising a climate adaptation strategy that also ensures food security and livelihoods for food producers and rural workers in the country.

1.1. About the study

This study presents an overview of the impact of climate change on Indian agriculture, analyzes the government's plans for addressing adaptation in agriculture and presents recommendations for the way forward. The report draws on a nine day fieldwork in three districts of states of Andhra Pradesh, Odisha and Uttar Pradesh, respectively. On the basis of the fieldwork, three state consultations and one national consultation were held over the course of four months. The study relies primarily on secondary material, though the field visits and consultations help enrich the content of the report.

Methodology

As already mentioned the primary focus of the study is to understand the impact of climate change on the small and marginal farmers in Andhra Pradesh, Odisha and Uttar Pradesh. The data collection was done in Ananthapur in Andhra Pradesh, Balangir in Odisha and Lalitpur in Uttar Pradesh. The villages included in the study were chosen to capture as much variation both in terms of climatic conditions and coping mechanisms adopted by the farmers under these diverse situations.

Both primary and secondary data was collected for the study. Information related to the state profiles and the statistics for the districts was obtained from the internet. For collecting the primary data from the villages, a check list was prepared, which consisted of different sections like demographic profile of the village – number of households, caste and age composition in the village, size of the land holdings and so on. Another section in the checklist contained questions that elicited subjective responses from the farming community about various issues in agriculture. Majority of these questions were open ended, which was a conscious decision so as to elicit as much information as possible. The identified villages in the three states are mentioned in the table below:

State	District	Names of villages
Andhra Pradesh	Ananthapur	• Battalapalli (Kadiri) • Nangivandlapalli (Talupula) • Bandlavanipalli (Kadiri) • Veeraiahpalli peta (Kadiri) • Pathakotha Cheruvu (Guntakal)
Odisha	Balangir	• Dahimal (Belpara) • Raikhal (Belpara) • Sargimeenda (Belpara) • Bahabal (Patnagarh) • Bhalukhai (Patnagarh)
Uttar Pradesh	Lalitpur	• Sipri • Chautaraghat • Dugria • Dudhai • Bajrandgadh Pali

Techniques of data collection

As already mentioned, both primary and secondary data was collected for the purpose of the current study. While the secondary data was collected through internet and handbooks from the district administration, the primary data was collected via field visits to the villages. The PRA methodology was used for primary data collection and analysis. In this process, the local communities were involved in the sharing and analyzing their experiences regarding the impact of climate change and how they adapt to it and what are the factors that limit their coping capacity.

Chapter 2

Understanding Climate Change and Agriculture

Climate change will have a sharply differentiated effect between agro-ecological regions, farming systems, and social classes and communities within India. Small and marginal farmers will suffer most by the impacts of climate variability and yet they represent the bulk (94%) of the farming population in the country. They largely rely on rainfed agriculture, forests and fisheries, but many are located in more exposed or marginal areas, such as flood plains or nutrient-poor soils. Moreover they, along with the landless and the urban poor, are less able to cope with these changes due to economic, social and institutional discrimination and disempowerment. These limitations will intensify with a rising hazard burden of climate change. Increasing competition for land and water for non-agriculture use is only exacerbating their situation.

This chapter outlines the projections of climate change for the sub-continent and the impact this will have on Indian agriculture. Particular attention is given to the districts of Ananthpur (Andhra Pradesh), Balangir (Western Odisha) and Lalitpur (Uttar Pradesh) highlighting the salient findings from the fieldwork. The chapter is divided into three parts, Part I addresses climatic impacts on agriculture and the Part II shows the main drivers of agriculture emissions, which agriculture practices in India mostly promoted through Green Revolution model agriculture, are contributing to climate change and Chapter III shows how the communities in these three districts are once again experiencing these problems and trying to adapt to the climate change.

Part I: A Changing Climate's Impact on Indian Agriculture

Disaster-risk and extreme weather events due to climate change in India

Droughts, floods, tropical cyclones, heavy rains and extreme heat already impact agriculture production and livelihoods in the country with significant loss of life and to the economy. According to the World Bank, between 1990-2008 in South Asia, "750 million people —50% of the region's population—were affected by at least one weather-related disaster, leaving almost 60,000 dead and resulting in about $45 billion in damages."[7] Some studies predict that cyclone intensity may go down on the eastern side; however storm surges are supposed to increase along the coastline everywhere.

About two-thirds of the sown area in India is drought-prone and around 40 million hectares is flood-prone. The intensity and frequency of rainfall is likely to increase flooding, while hotter temperatures will create more droughts, resulting in higher energy and water use.[8] Rather than relief, the disaster response must focus on adaptation measures that will require significantly improved disaster prevention and preparedness.

Box 1: Projected Climate Change Impacts in India

- Warming at the rate of 0.48 °C over the last 100 years and rise of 2.5°C to 4.9°C over the end of the 21st century.[9] The INCCA 2010 study[10] predicts a 1.7°C to 2.0°C temperature rise in the subcontinent as early as the 2030s.
- A 2-4% of temperature increase in South Asia is predicted to lead to an increase by 7-924 million of the number of poor rural people experiencing water stress in the region (IFAD).
- Government data from the North Indian Ocean shows that sea-level rise has been between 1.06-1.75 mm per year over the last 40 years. A global mean sea level rise of .5 m according to IPCC 2007 projections or higher if the Greenland ice sheet melts faster will inundate significant portions of India's coastline within the next century. Higher water levels imply increased storm surges with higher impacts on coastal communities and breeding grounds for fish.[11]
- The National Mission on Sustainable Agriculture also predicts more frequent and heavy precipitation events snow cover to contract and hot extremes and heat waves as common occurrences.

Slow-onset of climatic changes: devastating for agro-ecosystems and food security

According to the FAO, while much of the attention on adaptation is focused on addressing short-term disasters and extreme events, it is the long term "slow-onset" changes to the climate that will devastate agricultural systems and food production. The FAO, therefore, recommends using food security as an indicator to climate vulnerability.[12]

Box 2: "Slow-onset" impacts of climate change on Indian agriculture: Some Projections

- 10-40% loss in crop production in India by 2080-2100
- Loss of 4-5 million tonnes in wheat production with every rise of 1oC temperature throughout the growing period (assuming current land use patterns)
- 2-4 C° temperature rise to decrease rice yields by 0.75 tons/ha. (IFAD
- Temperature rise bad for maize and sorghum yields, but could be offset by more rains; however newer studies suggest that with a 2 C° temperature rise, yield loss is unlikely to be improved even with doubling of rainfall
- Significant and variable increase in rainfall in drought prone regions of Maharashtra (20% to 30%) along with higher temperatures (2.4 C to 3.8 C). As a result, yields of several dry land crops will rise, including millets such as jowar and bajra, which could boost the incomes of small rain-fed farmers by about 8-10%
- Sugarcane yields to decline by as much as 30%
- In arid regions of Andhra Pradesh, yields of all major crops – rice, groundnut, and jowar – are expected to decline, although groundnut is expected to fare better than others
- Increased heat stress to reduce milk production of dairy animals by 10-25%; Increased heat stress and incidence of disease in animals, depletion of fodder for livestock

Sources: a (Rosenzweig et *al*., 1994; Fischer et *al*. 2002; Parry et *al*. 2004; IPCC 2007b) In NAPCC 2008 or NMSA; b (Aggarwal, 2008); .c (Srivastava et *al*., 2010); d World Bank e INCCA:

Change in monsoons impacting cropping seasons

The climate change impact on the summer monsoons will have a drastic effect on the country's food production. Seventy-five to eighty percent of the annual rainfall happens in the monsoon months.[13]

The Southwest monsoon is responsible for nearly 50% of the food grains production and 65% of the oilseeds in India.[14]

India has two major cropping seasons, the *Kharif* and the *Rabi*. The *Kharif* season typically lasts from May-September/October (depending on when the monsoon arrives and ends) and the *Rabi* season lasts from October/November-April—it is also referred to as the "winter season." The moisture retained in the soil from the summer monsoons serves this season in rainfed areas. But planting times for both seasons are shifting all across India due to rain variability. *Kharif* rainfall is going to increase in parts of India and this might be positive for *Kharif* crops such as rice, pulses and various edible oilseeds. A one-degree temperature rise may not have significant implications for productivity of *kharif* crops if there is adequate rain, however, the projections of temperature rise are higher past 2030. But for the *Rabi* season, even a 1 degree temperature rise will severely impact production of wheat, a critical food-grain crop. This loss may be reduced to 1-2 million tons if farmers shift planting times effectively according to the shift in rainfall patterns.

Water Stress in dry season

A major impact of climate change will not only be erratic rainfall and shifting rainfall patterns, but also acute water stress in the dry season. Receding Himalayan glaciers will impact river flows and, as a consequence, critical dry season water sources. Eighty-five percent of the dry season water flow in the Indian northern plains comes from glacial melt of the Himalayas (source of nine major rivers in Asia including India's Ganges and Brahmaputra).[15] The projected water stress is particularly troubling given the high degree of water scarcity the country currently faces with receding groundwater tables in all major agriculture areas.

Stress on Livestock

Livestock will be severely impacted by temperature rise and water stress. Temperature increases in India will increase heat stress in animals and impact their milk production and reproduction. Most crossbred cows will be very vulnerable to higher temperatures compared to *Desi* (local Indian breeds) cows and buffalos. Increased temperatures and sea level rise will also reduce the availability of land to grow feed for animals and result in lower crop yields thereby reducing crop residue—a major source of fodder in India. An increase in the severity and spread of animal diseases is also predicted.

Rise in Pests and Diseases

Insect populations, pests and virulence are also supposed to increase with rising temperatures and humidity. This is already visible in agricultural systems in India. For instance, Rice Hispa was never a serious pest on rice in the Telangana region of Andhra Pradesh (AP), but it has increased in the last two years due to prevailing dry conditions. Farmers have suffered huge losses.

In AP, like many other states, crop monoculture, genetically modified Bt cotton seed and chemical pest management practices have resulted in pest shifts from those that eat leaves and fruits to those that suck juices from plants. For example, after the introduction of Bt cotton, there has been a prevalence of mealy bugs and jassids. These types of "sucking pests" are on the rise and along with them, so are viral diseases because these insects are good vectors for viruses. As a result, viral diseases are increasing in groundnut, cotton and in most fruit crops and vegetables. Climate change is predicted to increase the spread and incidence of such pests and diseases.

The impacts of climate change are already visible. A network of 15 centers of Indian Council for Agriculture Research (ICAR) has reported that apple production is declining in Himachal Pradesh due to inadequate chilling. This is also causing a shift in the growing zone to higher elevations (Rana et al.). Similarly in the case of marine fisheries, it has been observed that sardines are shifting from the *Arabi*an Sea to the Bay of Bengal, which is not their normal habitat.

Part II: Impacts of Agriculture on Climate Change

In India, the production and consumption of synthetic nitrogen (N) fertilizers and inundated paddy fields have been large sources of nitrous oxide and methane, respectively. India consumes ~14 Metric tonnes of synthetic N every year, of which about 80 per cent is produced within the country, making it the second largest consumer and producer of synthetic N fertiliser in the world, after China. The GHG emissions from fertiliser manufacture and use in India reached nearly 100 million tonnes of CO_2 equivalent in 2006/07, which represents about 6 percent of total Indian greenhouse gas emissions (Roy *et.al* 2010). Urea, a widely used fertilizer by farmers all across India, was 81% of the total N fertilizer produced and used. The production and transport of all fertilizer generates 6.7 kg of CO2 equivalent emissions for every kg of fertilizer produced in the country according to research done by the Center for Sustainable Agriculture (CSA) using IPCC accounting

Farmers standing in queue for purchase of chemical fertilizer in Ananthpur in 2008-Photo published in local daily.

methodology. Fertilizer production is also highly energy intensive and thus requires large amounts of fossil fuel energy.

Yet Galloway et al 2008 maintain that globally, an average of 50% of the nitrogen used in farming is lost to the environment. Significant amounts escape into the air, or seep into the soil and underground water, which in turn results in a host of environmental and human health problems, from climate change and dead zones in the oceans to cancer and reproductive risks.

Fertilizer prices increase as the feed stock prices of nitrogen, phosphate or potassium rise. The increased costs are subsidised by the Central Government and primarily benefit fertilizer companies, not farmers who have actually been calling for the termination of fertilizer subsidy. This subsidy reached Rs. 90,000 crore in the Indian Budget during 2011-12 as per the revised estimates. After India's nutrient based subsidy was introduced in 2008, fertilizer prices were no longer fixed by the State except for urea and prices have increased five-fold.

Other sources of agriculture emissions in India

Burning Crop Residues: There are many unsustainable practices in agriculture mostly in green revolution areas of the country like in Punjab. In Punjab, wheat crop residue from 5,500 square kilometers and paddy crop residues from 12,685 square kilometers are burnt each year. Every 4 tons of rice or wheat grain produces about 6 tons of straw (Gupta *et al.*, 2004). This in turn impacts soil fertility. If this biomass was recycled back into the soil, it could potentially translate into 38.5 lakh tonnes of organic carbon, 59,000 tonnes of natural nitrogen, 2,000 tonnes of phosphorous and 34,000 tonnes of potassium every year according to CSA. However, for farmers to be able to do that, their input costs must be manageable—which means a fundamental shift away from high external input agriculture.

Inundated Paddies: The other example is that of water intensive rice farming in the irrigated areas of the country. Rice paddies emit CH_4 when they are flooded as organic matter decomposes in the soil (Nouchi *et al.*, 1990). In India, of a total area of 99.5 Mha is under cereal cultivation out of which nearly 43% (42.3 Mha) is rice grown under flooded conditions. The amount of emissions varies depending on a large number of factors such as temperature; soil type, rice variety, water management and fertilization with organic carbon and nitrogen (see reviews by Le Mer and Roger, 2001, and Conrad, 2002).

Large Dams: India's dams emit 27.86 % of the total global methane emissions from large dams— more than the share of any other country (Lima *et al.* 2007). They contribute 18.7% of India's total emissions.

Apart from the massive displacement of communities and inundation of forests and agriculture land, this is one more reason why the government needs to shift to micro-hydel projects that are locally based.

Livestock: Unlike industrialized countries' confined animal farm operations (CAFOs), India's animal husbandry sector is primarily household-based, primarily women-led and mostly integrated with crop production. The crop residues are used as fodder and the animal waste is used as manure for fields. The impacts of livestock on climate change needs to be understood in this context given that livestock plays a vital role for food security, nutrition and as a safety net for many of the poorest households in the country. Enteric fermentation in livestock constituted 63.4% of the total GHG emissions (CO2 eq) from agriculture sector in India. However, this includes all livestock: cattle, buffalo, sheep, goats, poultry, donkeys, camels, horses and others (MOEF, 2010).

Local milk cooperatives and small producers are increasingly finding it difficult to compete with privately owned dairies in India. India is the second largest global producer of cows' milk and first in buffalo milk. It is also the world's biggest milk consumer and demand for milk and other dairy products is growing by 7 to 8% per year. New Zealand and the European Union are clamoring to enter India's market through free trade agreements. Middle class demand and global competition is pushing India's dairy industry to go the way of industrialized countries. This is the wrong approach to developing India's dairy sector with negative repercussions for local communities, livestock related emissions and animal welfare. The government must assess the food security implications and the climate footprint for this approach.

Part III. The Ground Reality: Impact of Climate Change on Agriculture: Sharing Communities Experiences

Two regions where ActionAid and CSA held consultations are drought prone regions, while a third has become increasingly drought prone.

Andhra Pradesh's Ananthpur district falls in a natural rain shadow zone and cut off by the Western Ghats and the coast. The Southwest monsoon (June to September) contributes 66% of the state's rainfall with 920mm as the average rainfall over 48 years. Ananthpur, in contrast, receives an average of 550 mm. In addition, soils of Ananthpur are poor in nutrients with high erosion rates. Their low-medium organic content and poor water-retention capacity among other factors makes crop production difficult.

Odisha's Balangir district is one of the most drought prone districts of the State. It is part of the Kalahandi-Balangir-Koraput (KBK) region of Odisha which is notorious for starvation deaths, overwhelming malnourishment, and acute poverty with nearly 62 percent of the 134,000 people living below the poverty line as per Census 2001.

Uttar Pradesh's Lalitpur district is located in the Bundelkhand region of the state. In the last ten years, the entire region has been affected by drought and drought-like conditions. Drought was far less frequent in the past.

The account is a synopsis of the input given by fifteen villages in these three districts across

Box 3: Changing Climate: An overview of the three districts

Ananthpur District*

- Higher minimum and maximum temperatures in general but especially in winter
- Increase in untimely rainfall (pre and post monsoon showers)
- Delayed beginning of monsoon and thus shorter growing seasons
- Less predictable monsoon rains; Less rainy days characterized by heavier precipitation;
- Less rain in the winter months

Balangir District, KBK

- Rainfall more erratic
- More drought and persistent dry spells;
- Higher day-time temperatures and colder night-time temperatures
- Natural disasters, flash floods increasing with harsher environment

Lalitpur District

- Erratic and unpredictable rainfall patterns
- Long periods of drought whereas drought rare in the past

*Reproduced from Sustainnet for Ananthpur District

India of how the drought resistant food crops are replaced by the monoculture cash crops and how these communities experience impacts of a changing climate.

a. Ananthpur District, Andhra Pradesh:

In Ananthpur, farmers in the area used to grow sorghum (jowar) and seven kinds of millets in the region because of limited rain. Millets adapted very well to arid conditions and also ensured food security. The pest incidence in millets was less and local cultural practices also led to better pest management. In the 70s, farmers in the area were introduced to groundnut which has now become the main income source for farmers as a cash crop. Though groundnut is nitrogen-fixing in soils, its monoculture planting, season after season has led to severe soil depletion and pest build-up. Also unlike millets, groundnut is much more affected by rainfall patterns. The first four months after planting, are critical and typically need irrigation to achieve a good harvest. However, erratic and less rainfall (even less than what they are used to) has changed the living conditions of the farmers. In the past, the first monsoon showers arrived in the district by the first week of June, but during the past five years, the first monsoon showers have been delayed till mid July. This 45-days delay in the first showers has altered the sowing dates for groundnut, thereby throwing agricultural activities completely out of gear.

In addition to the delayed onset, irregular rains also affect the crop very much. Groundnut has been popular due to its survival rate in drought conditions and better economic returns vis-à-vis millets; however, if drought occurs during groundnut's seedpod formation, the yields are badly affected. Similarly, untimely rains at harvest time ruin the harvest. The more frequent irregularities in rain, have deepened the farmers' crisis.

According to Ananthpur farmers, the conventional wisdom of planetary positions and *karthes* (seasons) played a crucial role in determining when the crop had to be sown in the past. It was during *arudra karthe* (the arrival of the first showers) that the sowing of the seed used to happen. Accordingly, all other agricultural operations were planned and implemented. However, majority of farmers now observe that this traditional knowledge is rendered meaningless with the delays in the arrival of the first showers. Changing rainfall patterns are impacting cultural traditions and knowledge regarding agricultural practices thereby hampering farmers' ability to adjust to changing weather patterns.

b. Balangir District, Odisha

Since the 60s, Odisha has chronically dealt with floods, droughts and cyclones with varying intensity. This has impacted food production severely in the years when these extreme events have occurred during the crop season. For instance between 1990-2007, Odisha's farmers faced drought, floods, cyclones, moisture stress or several of these conditions simultaneously in twelve out of 17 years.

Due to the frequent occurrences of these natural calamities, there is always reduction in *Kharif* yields. Similarly in drought years, there is considerable loss in production of pulses and oilseeds both during *Kharif* and *Rabi*. The farmers, therefore, engage in a variety of activities for their livelihood. They farm, collect and sell minor forest produces (MFPs), especially the *kendu* leaf and *mahua* flowers, and rear livestock. *Mahua* flowers are sold for making popular traditional liquor while *kendu* leaves are used to make *bidis* (handmade local cigarettes).

Agriculture still remains their primary source of income for six months. They grow paddy and pulses as the main crops and varieties of millets like Ragi, Gurji etc, and vegetables like tomatoes, brinjal (eggplant), chili, onion and okra/lady fingers as the supplementary food crops. During the drought season when the paddy crops fail or the yield is affected, the millets provide the best food security to the most of the families.

Though the cotton is grown as cash crops earlier, but since last few years the cotton is being aggressively promoted in large tract of the district, replacing the traditional drought resistant crops like millets. In 2005, Bt cotton was introduced in these villages. After the initial years of good yield, the yields of BT Cotton decreased by one- third. Communities attribute this to higher temperatures and prolonged dry spells along with monoculture practices. According to local people, Western Odisha is increasingly experiencing desert-like climate with increasing day time temperatures and colder night-temperatures.

It is also ironic to note that large scale maize production as a cash crop is being promoted in this chronic drought prone district, given the fact that maize needs more water.

According to the communities, the combination of increasing dry spells and rising input costs is making farming unviable. Fourteen thousand hectares of land has been diverted from agriculture to non-agricultural use in sixteen years. This is a staggering figure considering that the average land holding in Odisha was 1.25 hectare with marginal and small holdings accounting for nearly 84% of the total operational holdings (00-01 figures). The net sown area of 4,69,000 hectares declined to 3,30,000 hectares in 2006[16].

Though Balangir boasts to have network of traditional water harvesting systems which provide life saving irrigation to the crops during the drought or moisture stress period, but it is observed that this unique system of traditional water management has remained unused due to lack of maintenance and renovation of the water bodies.

c. Lalitpur District, Uttar Pradesh

Drought in the district used to occur once in sixteen years or so, however the frequency has increased dramatically in recent years. There was continuous drought for four years from 2004-08. In the following year when there was drought in several parts of UP, there was excessive rainfall in the region causing massive runoff and soil erosion from the barren hills which swelled up the seasonal streams and rivers[17]. Rainfall in 20 of the past 28 years was less than the average rainfall of 1,044mm, with 2005 and 2008 being the exceptions. Rainfall patterns are changing and the quantity of rain overall is decreasing.

Out of the five villages in which consultations took place, 46% of the villagers owned less than 2.5 acres or were landless, only 30% owned land over five acres. They shared that rainfall has changed so much that at times it rains in the village but fields remain dry. One farmer said, "The rains were not scattered like this about 10 to 15 years ago. Rains generally started in June and generally continued until October. Sometimes, it also rained in the winters, which was very useful for crops. Not only have the rains been decreasing for about a decade now, but the number of rainy days has also drastically reduced."

According to another farmer, "When rains start, heavy rains come for a very short time period and once they stop, no rains come, sometimes even for an entire year." Due to quick and heavy rains, the bulk of rainwater is wasted as runoff. And erratic rainfall makes it difficult to harvest crops at the end of the season as well. He gave the example of last year when it rained heavily for a very short period and then there were no rain after plowing. Most households of his village could not sow crops during last year's monsoon.

Farmers from Dudhai village shared that years ago when it rained regularly, coarse grains such as *jowar* (sorghum) and *bajra* (pearl millet) were cultivated even in the *pathari* (rocky) land of the village, but now such land has remained barren for more than a decade. Similarly, about 75 Acres of once arable landholding in Sipri village has been transformed into barren land due to erratic rainfall.

People of Dugaria village also reinforced that rainfall has reduced significantly. Sorghum, pearl millet and nutrious crops such as *Til* (sesame) and *Arhar* (a type of lentil) were easily harvested. The rainfall pattern became erratic after the 80s and harvesting of such crops became difficult. Gradually, virtually all traditional varieties of crops disappeared from fields—not just because of weather, but also because of the interest in growing cash crops such as wheat and maize.

Farmers also complained about wide swings in rainfall from year to year. A farmer from Chautarghat village said, "In 2010, maize planted in 150 acres was destroyed due to scanty rainfall and in 2011, the maize was destroyed due to heavy rainfall." Thus in both years, farmers suffered heavy losses from erratic rainfall.

One villager said, "It has become so unpredictable that at times it rains in the village, but the fields remain dry. Sometimes, it rains on one side of the road and the other remains dry!"

Moisture related changes have impacted in other ways as well. For instance, farmers said that until the 80s, morning fog was common in November-December. It usually lasted for 15-20 days and helped pulses and oilseed crops like Arhar, Gram, Masoor and Mustard to ripen because of the moisture it provided in the form of dew. The fog and hence the dew has not been present since 15-20 years and because of its disappearance, crops develop prematurely without the grains having fully developed.

While understanding the impact of climate change in agriculture in the preceding section, we enquired that how the high input, mechanized, monoculture promoting, agrochemical based model of agriculture marginalises small and marginal farmers and make them more vulnerable to climate change. And how the farmers adapt to the climate change.

In all fifteen villages where the community consultations took place, farmers shared their experiences that weather-related changes compounded their existing vulnerability. All three areas' farmers stated that their cost of production was always higher than the income they received through farming. They needed ever more fertilizer to get the same yields as in the past. Monoculture practices, introduction of cash crops and purchase of poor quality store bought seeds had virtually made traditional varieties and intercropping practices disappear. Pest attacks had also increased as a result of these practices with a corresponding pesticide use. This was compounded by the acute lack of water at the appropriate times in all three regions and heavily depleted water tables in both Balangir and Ananthpur.

In Uttar Pradesh as a whole, fertilizer consumption in agriculture has increased 182 times since the 1950s.[18] The per hectare fertilizer consumption increased by 30 kg in just six years between 2000-01 and 2006-07 (from 117.05 kg to 147.57 kg). In Anantapur district, cost of production has increased by 500 per cent in the past 10 years, whereas prices increased by 25 per cent. After fertilizer manufacturers were given a free hand to fix prices, the cost of fertilisers, except urea, increased by more than 300 per cent. Despite this, there is an increased dependence on chemical fertilisers to meet soil fertility needs. In Balangir, between 1990-2006, farmers also increased their chemical fertilizer use. On average, 150 -200 kg of fertilizers and 1000 ml pesticides is being used for cotton crops per acre and 75 kg of fertilizer and 250 ml of pesticides for paddy crop per acre. Prices have skyrocketed since the government deregulated fertilizer prices due to pressure by the fertilizer lobby. In June 2011, a bag of DAP (phosphatic fertilizer) was Rs. 510 and in January, 2012 it was Rs. 1030.

Rising production costs and the failure of formal and effective credit systems has made these farmers dependent on local money lenders. Each new planting season, farmers enter a new and ever increasing cycle of debt after taking loans for the season and their personal needs. As a result, many are leaving farming or working as agriculture or urban labourers while women tend to the fields and their communities. Increasingly, the new face of Indian agriculture is women—whose workload has increased with increasing rural poverty while men migrate to earn income elsewhere.

Another common trend in all three regions was the shift towards growing one or two cash crops as opposed to growing a large number of traditional varieties in the past that could at a minimum meet food security needs of the household. In Lalitpur for instance, there was a drastic shift in just two decades from using a large number of traditional varieties of local wheat, coarse grains, pulses and edible oilseeds to just wheat or wheat and maize (see Table 3).

In Ananthpur district in the past, pearl millet (sajja in local language) was sown as the main crop with field beans (anumulu), green gram (pesalu), redgram (kandi) and cowpea (alasanda) sown as intercrops. These crops served two major purposes: effective pest control and food and nutrition security for farmers and their households. In case of weather vagaries and crop failures, farmers at least harvested one crop out of the five that were planted. Red sesame also served as an effective pest trap in many crops. These methods lead to low input costs for cultivation. Unfortunately, various factors have contributed to the decreasing popularity of millets in the diet of the people in the region. Besides the monoculture, cash crop agriculture, the government scheme of providing rice as the only food grain in the Public distribution system has made the need of millets in the dietary habits of the villagers more obsolete.

Also, the government supplies seed on 50% subsidy, thus farm saved seed have become uneconomical to farmers in terms of labor time in saving and storage. The quality of the seed supplied under subsidy is also very poor. CSA proposes that the government subsidize locally produced seed bought directly from farmers and women groups. It would not only reduce the subsidy burden of the government, but it would make quality seed available to farmers at an affordable price. Such models are already in place by local organisations such as CSA and the Society for Elimination of Rural Poverty.

How farmers adapt:

1. Changing the cropping pattern:

Our research on the ground found that in a couple of villages, farmers are experimenting with altering their cropping patterns as a result of these problems. For instance, in Battalapalli (Ananthpur), some farmers are sowing short-duration drought-resistant pulse crops like horsegram in September instead of sowing groundnut in July. In Bandlavanipalli, mixed cropping with beans, red gram, green gram and millets is making a return.

Table 4: Change in cropping pattern in the study villages

Villages	2010	2000	1990	1980
Sipri	Wheat	Wheat	Maize, Kaudo, Masoor, Alsi, Fikra, Wheat	Fikra, Kaudo, Janwa, Jowar, Amari, Rotka, Rali, Kutki, Til, Wheat
Chautaraghat	Wheat, Maize	Wheat, Maize,	Fikra, Kaudo, Janwa, Jowar, Bajra	Fikra, Kaudo, Janwa, Jowar, Bajra
Dugaria	Wheat, Massor, Gram	Wheat, Masoor, Pee, Gram, Alsi	Fikra, Kaudo, Janwa, Jowar, Bajra	Fikra, Kaudo, Janwa, Jowar, Bajra, Amari, Rotka, Rali, Kutki, Til,
Dudhai	Wheat, Maize	Wheat, Maize	Fikra, Kaudo, Janwa, Jowar, Bajra	Paddy, Maize, Amari, Rotka, Rali, Kutki, Til
Bajrandgadh Pali	Wheat, Gram	Wheat, Maize, Masoor	Fikra, Kaudo, Janwa, Jowar, Bajra, Maize,	Fikra, Kaudo, Janwa, Jowar, Bajra, Amari, Rotka, Rali, Kutki, Til

Both pearl and finger millet, as well as locally grown pulses are better adapted to Ananthpur's climate as well as more nutritious. They are not only more drought and heat resistant, but also need less water and have shorter growing cycles. Furthermore, their crop residues make good fodder that can be dried and stored over the year, thus keeping livestock healthy as well.[19]

In Lalitpur's Dugaria village, one farmer has started to use only local manure and organic fertilizer preparations made at home on his 9 acre land. He planted masoor (a type of pulses), Gram and Wheat in 3, 2 and 4 acres respectively. He noted (and other villagers confirmed) that his fields produce more than others'. He firmly believes that if his community gets back its traditional seeds and starts using manure again, their land will improve, climate-related risks will be reduced and the debt will start to disappear. However, he is a more well off farmer than others around him.

In Balangir's Ganeri village , Keshari Sahu shared his following experience that how he ensured his family's food security by cultivating Gurjee, the millet which was forgotten due to the advancement of varieties of cash crops.

The scanty and irregular rainfall this year resulting in heavy damage to Kharif paddy crop and consequent drought, accentuated the food insecurity of farmers, mostly small and marginal farmers in Balangir district. The extensive cultivation of hybrid/high yielding variety paddy, has not been able to bear the brunt of drought and could ensure food security to the farmers. However, it is one of the drought resistant minor millets –Gurjee, notwithstanding less rainfall, could ensure the food security of the farmer in Ganeri village. In our village after paddy, cotton is being promoted and cultivated in a large scale in the *Att land* (up land) as an alternative cash crop says Keshari Sahu. Even as many of our villagers, this year, goes for cotton cultivation, to earn more money, I decided to take up Gurjee cultivation in three acres of *Att land* (up land) out of the five acres of land to tide over my food stress period and to get tasty and nutritious food says Keshari Sahu. Gurjee is usually sown in the month of June and harvested two months later, requires almost no use of chemical fertiliser. Moreover at the end of two months it provides food to poor farmers, says Keshari.

“Gurjee is both tasty and nutritious and its cultivation should be promoted. Unless this is done, the cultivation of other cash crop like cotton, maize would overtake Gurjee, which would further reduce the area under millet cultivation, points out Bhajaram Sahu of Janamukti Anusthan, Bongomunda.

“Since last few years the rainfall in our area has become irregular and its quantity has declined and I believe it is due to change in climate. As a result of inadequate rain the moisture content in the soil is also coming down. To tide over the crisis, each year I used to apply three cartloads of cow dung, organic manure, to maintain the soil moisture and fertility”, says Keshari Sahu. Had there been regular and adequate and timely rain Gurjee productions would have gone up further. Notwithstanding all this I have earned rupees 7000/- by selling Gurjee this year, says Keshari. As Gurjee cultivation requires less effort and less application of chemical fertiliser and which could be harvested within two months, Keshari resolves to continue with Gurjee cultivation in future.

Mukund Sargia of Silet Pada of Balangir district, shared his experience of using traditional Paddy seed in drought season which could save the paddy crop. Paddy cultivation in Balangir district is crucially dependent on monsoon rainfall and whichever year the monsoon rainfall plays truant, farmers are destined for a hard times that year as there would be loss of crop and food insecurity will rise further. Over the years there has been a sharp variation in both temperature and quantity of rain in this area. We believe this has been taking place due to change in climate says Mukund Sargia. As every cloud has a silver lining, farmers in rural areas devise their ways and means available with them, to adapt to this change in climate. This year monsoon rainfall in Balangir district has been extremely irregular, erratic and scanty. Those who raised paddy seedling in the nursery bed suffered heavily as it could not be planted in land due to shortage of water in the field, says Mukund Sagaria. Paddy is cultivated in two methods namely- broadcasting and transplanting. I had decided to experiment with both the methods and raised paddy seedlings by using 40 maans of HYV seed. As there was less rainfall, there was shortage of water in paddy field; the seedlings could not be planted. Another 20 Maans of traditional paddy seed like Nenka, Saria, Budelphuli, and Saan chergudi was broadcasted in 4 acres of land. However this crop was also affected due to drought. But fortunately not the whole crop was affected and the total quantity of seed used in this field could be collected, says Mukund Sagaria. And to cope with the crisis, Mukund Sagaria renovated an old well and took up cultivation of vegetable like tomato, ladies finger and onion. Mukund Sagaria believes that the desi- traditional variety seed can withstand the drought and ensures the minimum returns even if there is total crop failure. This has not been possible in case of high yielding/hybrid paddy seed.

2. Managing the ground water-Social Regulation of Groundwater:

An action research project called “Social regulation of groundwater management at community level” was initiated in 2004 in CR Pally Village in Ananthpur district by the non-governmental organization Centre for World Solidarity (CWS) in partnership with local grass-root NGO Jana Jagriti. The project interventions began with a participatory assessment of the water resources status in the village. Participatory Rural Appraisal (PRA) methods were used to map the resource status and existing water utilization pattern for different purposes, such as drinking, domestic, irrigation. Growth of groundwater-based irrigation and trends in groundwater levels over a period of time were thoroughly discussed and analysed in community level meetings, wherein women and men from all households participated. Series of such meetings and interactions helped to arrive at the crux of the issues, i.e., frequent failure of bore wells and increasing debts of farmers due to investment on new bore wells. The competition between neighbouring farmers often leads them to drill bore wells as close as 2 m apart. The project focused on the fact that there is need for changing the mind-set of farmers from “competition” to “cooperation” and to increase the “water literacy” among the farmers for efficient use of water.

The last 3 years of intensive grass-root work and facilitation has resulted in the community realizing the ill-effects of indiscriminate drilling of bore wells and use of groundwater. The community evolved and agreed on the following ‘social regulations’ and interventions in the village:

- No new bore wells to be drilled in the village
- Equitable access to groundwater to all the families through well sharing
- Increasing the groundwater resources by conservation and recharge
- Efficient use of irrigation water through demand-side management

Small groups of farmers were formed in all the project villages between a bore well owner and 2 or 3 neighbouring farmers who did not own bore wells. Bore well owners were motivated to share by explaining that drilling new wells in the vicinity of their wells may render them dry due to competitive extraction of groundwater. Instead, sharing a portion of water from his well helps his neighbours and at the same time secures his access to water and thus livelihood. Sharing water with their neighbours will be a "win-win" situation benefiting both the bore well owners and water receivers.

Now there are 34 functional tube wells shared between 56 farmers.

Sharing water from Bore wells

Year	No. of bore wells being shared	No. of Farmers in group sharing	Total extent of crops under group wells	
			Kharif	*Rabi*
2003-04	-	-	-	-
2004-05	11	22	136 Acre	115 Acre
2005-06	17	36	212 Acre	176 Acre
2006-07	34	50	221 Acre	207 Acre
2007-08	34	56	305 Acre	260 Acre
2008-09	34	60	365 Acre	317 Acre
2009-10	34	60	369 Acre	171.5 Acre
2010-11	36	103	296 Acre	160 Acre

Growing affirmation to seek an alternative:

In several of our consultations, the experts and the small farmers observed that the policy thrust and aggressive extension service of the government to promote green revolution model of agriculture has left little choice for the farming communities to grow and sustain traditional crops which are mostly suitable to the dry regions. It is evident that monoculture practices and the shift to cash crops that are ill-suited for the climate are making farmers more vulnerable to climate change. Farmers' dependence on buying inputs such as fertilizer and seed is increasing their input costs while yields continue to decline. However, agriculture policy is still supporting chemical fertilizers and purchased seed. All districts are facing difficulty with erratic rainfall, prolonged dry spells and heavy downpours. Farmers are already experiencing and acknowledging climate change and temperature variability. Not surprisingly, indigenous communities, women and dalit small and marginal farmers were the most vulnerable. And worryingly, the largest coping method under an increasing debt burden, rising input costs and ever unfriendly planting and harvesting conditions seems to be to leave agriculture altogether and increase trend of distressed migration is noticed in the three districts. This is not adaptation. This is the abandonment of agriculture in absence of qualitatively better and viable livelihood options

Though this was increasingly being realized by the scientific communities and policy makers in the context of current climate change discussions, but political will to present viable alternatives to the farmers especially small and marginal farmers to adapt to the climate variation is still a far cry. But there are hopes. The situation can be reversed with concerted and imaginative actions. The small and marginal and tenant farmers who own less than 2 Hectares of land and constitute around 94% of the farming households, produce around 50% of the total crop production would lead the change process. Many of them are still practicing low input agriculture and in the face of massive agrarian crisis they would play the pivotal role in reversing the situation from input intensive agriculture to climate resilient agriculture.

The next chapters look at the international, national and state-level policy process on climate change and agriculture and draw the experiences of best practices from India in the areas of adaptation. The last chapter addresses that how the changing agriculture practices, policies and support can bring back resilience into farming communities that helps them to adapt to the climate change.

Chapter 3

International and National Responses to Climate Change

Part I. The International Response

Agriculture has been a small negotiating track since 2009 in the climate negotiations at the UN Framework on Convention on Climate Change (UNFCCC). This is because the larger fight for binding global emissions reductions targets and the fate of the Kyoto Protocol[20] remain a key priority for the global community. The United States and other industrialized countries, known as "Annex 1" countries in the UNFCCC have historical responsibility for the onset of global warming and continue to emit more greenhouse gas emissions per capita. Rather than meeting their legally mandated emissions reduction targets enshrined in the Kyoto Protocol, countries such as the United States (which has never been part of the Protocol), Japan and Russia are demanding that the Kyoto Protocol be scrapped so that developed and developing countries alike have binding reduction targets. This has been opposed by countries like India on the principles of "equity" since the UNFCCC follows the principle of "common but differentiated responsibility" (CBDR). CBDR in UNFCCC parlance means that Annex 1 countries must take leadership in meeting their emission reduction targets because they are responsible for the extent of global warming we face today; and they must provide financial support and technology transfer to developing countries for getting on a low carbon development path.

Latest scientific estimates suggest that even a two degree temperature rise by 2050 could lead to catastrophic climate change. Therefore, a legally binding global cap on emissions is urgently needed with binding commitments by Annex 1 countries that keeps carbon dioxide levels below 350 parts per million in the atmosphere. It also means that developing countries cannot pursue economic development in the same manner as Annex 1. It is time for a paradigm shift.

Annex I countries total 17 percent of the world population, but are responsible for 26 percent of global nitrous oxide emissions from soils, 30 percent of methane emissions from enteric fermentation (digestive process of ruminants), and 52 percent of CH_4 and N_2O emissions from manure management.[21] These emissions increased by nearly 17 percent between 1990 and 2005 according to the IPCC. Globally, New Zealand, Ireland and Australia ranked as the top three emitters for per capita agriculture production in 2005, while the OECD outpaced the entire world. The United States, Canada and the European Union are not far behind.

This chart below shows the per capita consumption of fertilizer (a good proxy for nitrous oxide emissions).

TABLE 1. PER CAPITA FERTILISER CONSUMPTION OF COUNTRIES

COUNTRIES	PER CAPITA CONSUMPTION IN 2008 (IN TONNES)	POPULATION IN AGRICULTURE (IN %)
WORLD	0.02397	40
US	0.05639	2
CANADA	0.07721	2
FRANCE	0.04301	2
GERMANY	0.02327	2
UK	0.02034	2
AUSTRALIA	0.07072	4
NEW ZEALAND	0.18431	8
ARGENTINA	0.03113	8
BRAZIL	0.05266	12
CHINA	0.03780	62
INDIA	0.01911	55
PHILLIPINES	0.00769	35
THAILAND	0.02952	50
KENYA	0.00455	71

Data Sourced from: FAO Statistical Yearbook 2010 accessed at http://www.fao.org/docrep/015/am081m00a.pdf
Reproduced from Sharma and Stabinsky 2012

Agriculture in the Climate Talks

Agriculture was actively pursued in the UNFCCC in Copenhagen in 2009 with a "mitigation" focus in the Ad Hoc Working Group on Long-term Cooperative Action (LCA), one of the two main negotiating tracks at the UNFCCC (the other track is the Kyoto Protocol). It falls under the negotiating agenda that refers to "cross-sectoral approaches and sector-specific actions." These terms refer to the UNFCCC Article 4.1(c) which states that all Parties shall:

Promote and cooperate in the development, appli-cation and diffusion, including transfer, of technologies, practices and processes that **control, reduce or prevent** anthropogenic **emissions of greenhouse gases** not controlled by the Montreal Protocol **in all relevant sectors** (emphasis added), including the … agriculture … sector…

Sectors such as industry and waste are also mentioned in the article, but the proponents of the agriculture negotiations have sought to push mitigation in this sector alone. Given the overloaded UNFCCC agenda, only a handful of countries have actively directed the agriculture discussions. These are the agriculture-export-dominant countries such as New Zealand, Canada, Australia and the United States. Developing countries such as Argentina, Brazil, Uruguay, Philippines, Thailand, Bolivia have been active in the debate at different times due to concerns about trade restrictions being put on their exports and food security. Moreover, many developing countries feel that they must prioritize agriculture adaptation over mitigation given the large dependence they have on the sector for livelihoods and food security. Given that industrialized agriculture of Annex 1 countries results in the largest per capita emissions of both nitrous oxides and methane, they should be the ones to take the lead in creating a paradigm shift away from these harmful agriculture practices.

These talks have been riddled with controversy on several key issues: 1) whether parties should agree to launch an agriculture work program in the Subsidiary Body for Scientific and Technical Advice (SBSTA) and when; 2) whether governments could effectively address adaptation under a negotiating track set for mitigation and 3) what role carbon markets and soil carbon sequestration offsets will play in emissions reductions by Annex 1 countries to avoid making genuine emissions reductions in their domestic economies.

Soil carbon offsets would require the aggregation of thousands of hectares and thousands of farmers to quantify the so-called carbon sink. Such offsets, financed through the carbon market, are being promoted by international organizations such as the World Bank as the solution for agroecological investment in and financing for agriculture in developing countries—similar to the CDM (clean development mechanism). Only the CDM does not accept soil carbon credits because carbon is easily lost from soils and even harder and costlier to quantify with accuracy. Many civil society organizations, including ActionAid, are concerned that the soil carbon market is simply a distraction from the real financing that developed countries must deliver for climate change adaptation of developing countries. Currently, adaptation is being seen as a "co-benefit" of soil carbon sequestration methodologies that are promoting carbon credits in soils.

In March 2012, interested parties to the UNFCCC submitted their input to the secretariat about how agriculture should be addressed within the UNFCCC. In May, parties will once again debate whether the right approach is to launch an agriculture work program under the SBSTA or not. ActionAid feels that a mitigation-based work program for developing countries is a step in the wrong direction at the international level because a key outcome of this will be voluntary targets by all to engage in soil carbon sink projects targeting small farmers in developing countries. ActionAid feels that getting the largest emitters to curb and reverse global warming must be the UNFCCC's first priority. Small farmers need a cooler planet and support to adapt, not the burden of emissions reductions on behalf of industrialized countries. ActionAid is therefore pushing for financing for adaptation for agriculture in developing countries.

Given the number of people in agriculture in developing countries, the per capita consumption of fertilizer in industrialized countries still exceeds that of India and China. Yet the talks in the UNFCCC are not about binding targets for Annex I countries in curbing their nitrous oxide and methane emissions in agriculture.

Part II. The National Response to Climate Change and Agriculture

In 2008, the Government of India came out with the National Action Plan on Climate Change (NAPCC). The NAPCC created eight missions, one of which is the National Mission for Sustainable Agriculture (NMSA). According to the Plan, the NMSA would "devise strategies to make Indian agriculture more resilient to climate change…identify and develop new varieties of crops…and alternative cropping patterns, capable of withstanding extremes of weather, long dry spells, flooding, and variable moisture availability." In addition, the Mission would strengthen information and research systems to better monitor climate change to modify agriculture practices and integrate "traditional knowledge and prac-tice systems, information technology, geospatial technologies and biotechnology." The focus would be on rainfed agriculture productivity. New forms of credit and insurance would be devised to help farmers adopt new practices. The NAPCC stressed four priority areas for the agriculture mission: 1) dry land agriculture 2) risk management 3) access to information 4) use of biotechnology.

Priority actions for dry land agriculture were identified as the following: Development of drought and pest resistant crop varieties; improving methods to conserve soil and water; stakeholder consultations, training workshops and demonstration exercises for farming communities, for agro-climatic information sharing and dissemination; financial support to enable farmers to invest in and adopt relevant technologies to overcome climate related stresses.

Civil Society organizations have put forward their critique of the National Action Plan and the National Agriculture Mission. The Mission is still in its early stages and therefore, there is still time to make necessary changes in the vision, focus and implementation of the Plan and Mission:

Response to the NAPCC proposals under National Mission on Sustainable Agriculture[22] -Establish a sound and holistic definition of sustainable agriculture: *The Mission must define what it means by "sustainable agriculture" through consultations with farmers, forest dwellers, fish workers, small and marginalized farmers, women and indigenous communities and civil society organizations. The proposed measures are likely to continue business as usual because agriculture is still viewed in these plans as an "input" and "output"-based intensive and linear model of production that externalizes environmental and social costs and creates a large dependence on external agencies, including for agriculture knowledge. The Sustainable Agricuture definition must incorporate a holistic and cyclical definition of agriculture that sees agriculture as a way of life, leads to improving soil health and quality of life and which internalizes costs and inputs.*

Shift Policy towards agroecology: *Strategies should be evolved for a time-bound phasing out of climate change-inducing practices towards sustainable agriculture with clear targets and financial outlays. This includes a focus on the integrated role of pasture lands, fisheries and animal husbandry (not just crops). Community/farmer governed seed banks should be a key strategy for adaptation. Access to information, therefore should be locally appropriate, not just packaged and top-down. Extension should illustrate the costs and benefits of conventional versus organic practices so that farmers can make informed choices. Extension should also be geared towards women's needs and their time restrictions as the sector is increasingly women-centered. It should build upon traditional knowledge.*

Remove Focus from Biotechnology: *The GoI should focus on drastically reducing the present GHG-emitting subsidies and practices like fertilizer use; rather than research and development in GE seed varieties. Using extremely costly and proprietary GE tools to convert C3 plants to C4 that may not yield any lasting results if at all. The government should promote and revive traditionally grown crops like millets which have a C4 pathway and are more efficient in adapting to climate vagaries. A conclusive assessment of the stress (in) tolerance of GE crops, resource consumption and biosafety should be a prerequisite before government bodies begin to promote genetic engineering as an agricultural technology in the era of climate change.*

Revive and strengthen traditional knowledge & genetic resources: *The Action Plan pays lip service to traditional resources and knowledge. Traditional Knowledge should be a cornerstone for interventions on sustainable agriculture and adaptation. Traditional Knowledge and its ever evolving innovations in fields by practicing organic farmers should be considered a critical component of adaptation, in particular for varieties that are known to be drought and heat tolerant, have short cropping cycles, withstand heavy precipitation etc. Such practices, their tried variations and the farmers who practice them should be identified and lessons should be learnt and disseminated through the extension system. Indigenous resources (seeds, animal breeds etc.), which have a proven track record of adaptation to stress conditions should be revived and popularized. The NMSA talks about establishing a 'Seed Grid' in a centralized seed system. The earlier experiences of the National Seeds Corporation and State Seed Corporations have failed to deliver. As part of the NAPCC, there should be a mechanism evolved to track and guard against genetic erosion in all parts of the country. The Mission should also align its framework with other progressive seed and biodiversity measures in place like the Plant Variety Protection Act and the National Biodiversity Action Plan.*

Initiate 'Land to lab' programs: *NAPCC's focus on setting a research agenda for the National Agricultural Research System (NARS) repeats past mistakes of following the 'lab to land' research model rather than participatory research with farmers on the farm. Farmers urgently need transformative and resilient adaptive techniques that are relevant for their farms now and cannot wait for more lab-based research to trickle down. Solutions must be created, assessed and validated on farms, in different conditions and disseminated. There are now enough time-tested practices and experiences from the ground to enable a transformation from the current agrarian crisis to resilient and sustainable farming systems. These initiatives must be led by those affected. Alternative, horizontal extension systems with farmers' organizations at the centre are critical for any approach to research and information in addressing climate change. At the bureaucratic level, intensive capacity building needs to take place with agriculture scientists and extension workers on locally appropriate and non-proprietary agroecological practices so that collaboration with farmers leads to a shift away from high input, high cost techno-fixes that are neither practical, nor affordable in the long-run.*

Revamp and create effective risk management systems: *Early warning system to monitor changes in pest and disease profile and predict new outbreaks should be created. The agriculture credit and insurance systems should be made more comprehensive and responsive to the needs of small farmers.* [23] *Existing risk management strategies have failed farmers. Completely new ways to assess loss and damage on the farm and better ways to deliver full support including livestock and crop insurance and safeguards against weather-related damage must be devised in participation with food producers.*

Entitle food producers with social safety nets: *As part of adaptation and risk reduction strategies, strong social security nets should be put in place for rural households and women, including provisions for minimum incomes, pensions, life insurance, etc. with a special emphasis on women and agricultural workers.*

Ensure synergy and not duplication: *The Plan should clearly spell out how it converges with other plansand missions both within the NAPCC as well as with other agencies and programs like the Planning Commission, the Public Distribution System, the proposed Food Security Bill etc.*

Facilitate subsidiarity between Centre-State relations: *State governments should be involved in consultations and planning right from the beginning – it is not enough that centrally-evolved plans are imposed upon them. In fact, it is ultimately the state-level departments of agriculture, the extension and delivery mechanisms that will work most closely with farmers and support them to adapt to climate change. For instance, states, not the centre, should evolve seed rolling plans with an emphasis on revival and restoration of open-pollinated, "orphaned", traditional and locally adapted varieties.*

Enforce 'Public-People' Partnership: *There should be recognition that market-driven technologies may not be the answer in the era of climate change. Public-people partnerships might work best where risk is high and both governments and people have the most to lose with inappropriate investments.*

Create a massive paradigm shift: *The NAPCC does not assess Green Revolution-induced climate change in India. Shying away from assessing the pitfalls of the current model will not create the imperative for a shift to* *sustainable agriculture, which is a requirement both for mitigation as well as adaptation. The NAPCC should clearly specify incentives for farmers for shifting to organic/agroecological farming and sustainable agricultural practices which will help farmers create resilient communities and revive agroecosystems. ActionAid sees emissions reduction as a "co-benefit" of agroecological approaches that prioritize adaptation. In the NAPCC, the reference to mitigation is linked to the introduction of genetically engineered crops as well as forays into soil carbon sequestration. This is the wrong approach. Adaptation must be the priority and important co-benefits of mitigation can be derived from weaning away from extensive fertilizer use and proprietary seeds.*

Part III. State level Action Plans on Climate Change

There are currently ten draft state plans on the MOEF website, including that of Andhra Pradesh and Odisha. According to NGO Pairavi, as many as 14 had been submitted to MOEF by June 2011 but not all were publicly available. From an initial glance, the draft State Action Plans on Climate Change (SAPCCs) seem to be drawn largely from the National Action Plan. There seems to be dearth of state specific responses with concrete adaptation strategies relevant for the states.

The AP consultations took place in December 2011 in four cities with as few as 29 people attending in Hyderabad. The consultations were not publicized—as such the CSA was not informed though the organization has been actively engaged on this issue and even given input at the national level. The majority of the stakeholders were government departments. Not a single farmers group is even referenced in the list of CSO participants, though the category of rural development NGOs is mentioned. Without conducting consultations in rural areas, how is the state supposed to get proper feedback from those who will be most vulnerable to climate change?

The table below shows the highlights from AP's state plan on agriculture. As the table demonstrates, there doesn't appear to be a rigorous approach to the challenge that climate change will bring to agriculture. Given the state's enormous dependence on agriculture (and the country's dependence on AP's rice), it is unclear how the various action points set benchmarks for specific objectives of creating resilience in agriculture, reducing vulnerability and shifting from high input, high cost and high risk measures for food producers, particularly the poorest.

Highlights of Odisha's SAPCC (reproduced from State Plan)

- Rapid screening and strategy assessment of State Agriculture Policy
- Establishing an effective institutional delivery mechanism to promote best practices on climate change
- Undertaking capacity building
- Continuing the livelihood-focused, people-centric integrated watershed development in rain fed areas
- Increasing the area under perennial fruit plantation
- Developing water use-efficient micro-irrigation methods and individual /community farm ponds
- Improving monitoring and surveillance techniques
- Developing sustainable soil, water and crop management practices
- Breeding studies on major crops for tolerance/resistance
- Conducting climate-linked research studies

Highlights on Agriculture (reproduced from Odisha State Plan)

Key Issues for Agriculture	Implemented Adaptation interventions for Agriculture	Feed back from Consultations:	State Action Plan on Agriculture
• Temperature fluctuations affect *Rabi* crops severely. • Decrease in winter rainfall has a negative impact on *Rabi* crops especially in the rained areas. • Heat waves result in dehydration of plants • The decrease in area under crops on account of insufficient rainfall, particularly in theSouth-West Monsoon period. • Rain fed agriculture has become risky due to unpredictable rains. • Due to loss in vegetation, heavy run-off takes place resulting in wastage of water and soil erosion. • Dryland areas (parts of Anantapur, Kurnool, Kadapa, west Guntur, eastMahaboobnagar, Prakasam, Nalgonda) exist in the State where annual rainfall isless than 550 mm and farming is not viable. • Loss in fertility of soil in many areas due to excessive use of fertilizers and pesticides.	• Financial support to the farmers in event of crop failure as a result of drought,cyclone incidence of pest & diseases etc. • Crop Insurance • Adoption of inter cultivation • Stocking of quality seeds well in advance for immediate distribution for re-sowing in the areas affected by drought and floods. • Encourage farmers to adopt progressive farming practices, high value in-puts and higher technology in agriculture. • Insurance provided to small and marginal farmers under national agriculture insurance scheme in order to recover the loss occurred during *Kharif* 2009 season, where 20 crops covered under crop insurance. •Jalayagnam irrigation initiative: Several new projects, expansion of older projects and completion of incomplete projects to bring 73 lakh acres of land (additional) under irrigation in 5 years.	• Promotion of organic farming reducing dependence on chemical fertilizers and pesticides • Development of temperature resistant, flood and drought resistant varieties of crops and temperature resistant breeds of livestock • Implementing micro irrigation schemes, and constructing more check dams • Awareness and training dissemination of sustainable practices in agriculture • Insurance for crop failure • Reduction in plastic usage • Research and training centres for producing natural fertilizers and pesticides • Promoting farm mechanization • Financial support through micro financing • Protection against seasonal diseases in crops and animals • Review of subsidies to pesticides and fertilizers and subsidies to organic agriculture • Establishing village level agro meteorology centres • Better solid waste management practices like recycling and reuse • Promotion of watershed development program • Promotion of less water intensive hybrid crops	• Composting of organic wastes for enhancing soil quality and fertility. Composting is widely practiced by farmers. Centralising would increase energy use. • Establish Specific Centres for critical climate analysis and to study likely impacts of Climate Change on cropsUse of Biotech: • Researches on breeding of heat and photo insensitive crop varieties, erection of polyhouses, alternative cropping patterns capable of withstanding extremities in weather, dry spells, flooding and variable moisture availability, etc. • Establish of biotechnology R&D centres for agriculture in the State. • Check excessive fertilizer/pesticide use by promotion of bio-fertilizer. • Promote development of crops, with enhanced capacity for CO_2 fixation, which in turn can result in producing high biomass and increased productivity. • Promote diverse livelihoods such as agro-processing and value addition to farm products to protect against any severe climatic hazards, by diversifying livelihood and enlarging earning potential in allied sectors of agriculture which are not directly affected by climatic impact. • Credit provision can help to fund sustainable agriculture and would help to promote self-reliance among farmers and to provide small and short loans and other benefits to them.Government would lend money to a SHG or a community at a subsidized rate with little or no collateral.Strengthening of crop insurance to protect farmers against vagaries of nature, rather than merely protecting the bank loan. • Agriculture Universities to create a Climate data bank and conduct awareness programmes/ trainings etc. In each agro-climatic zone establish an agro-meteorological field station for providing weather based advisory, technical advice to farmers and information on market prices. • Increase the percentage of sown area under irrigation. Water harvesting check dam, dugout farm ponds and soil and water conservation measures are required. Increase canal irrigation and make ground water a sustainable resource. • Interlinking of rivers/canals

Odisha's plan states that 85% of its people depend on agriculture with 60% of it rainfed. It also deals with the dire issues confronting Odisha's agriculture and food security in a cursory manner. The budget for these activities for the period of 2010-2015 is set for Rs. 1500 crores—out of a grand total of Rs. 17000 crores.

There are several concerns with this top-down approach to making national and state-level plans. First, it's hard to see how these plans will change in light of changing circumstances and knowledge and how new learning and concerns from citizens will play a part in modifying action points and budgets. Second, it is not clear how food security and livelihood security is concretely embedded in these plans. The state plan of Odisha banks on its mining and extractives sector for state income and livelihood options—but says little about the social unrest taking place in the state regarding this particular economic strategy and its sustenance in the future when minerals are depleted.

Pairavi's critique[24] of the development of state plans deserves attention:

> Most of these plans are being developed in complete isolation (from) views of experts, researchers, academics and civil society in the state. A number of them are seen to be completely disconnected with the geography, economy and social realities of the state; the templates could be equally relevant (rather irrelevant) for any state with the change in name and title. Many of the states are being helped by World Bank, UNDP, DFID, GIZ etc. and have enough suggestions on how these state plans are being influenced by international climate change politics, manifolds increase in power production being one of them. It is exactly from where strong proposals to earn carbon credits from forests and soil carbon sequestration are coming, without states knowing much about the prevalent debates and apprehensions on these aspects. Most of the states have actually developed these plans without any mapping, vulnerability assessment of regions or sectors and does (sic) not seem to go beyond the generally prevalent bureaucratic lethargy…

Final Note on the National and State Plans: Understanding Vulnerability and Risk

> Vulnerability to climate change refers to the propensity of human and ecological systems to suffer harm and their ability to respond to stresses imposed as a result of climate change effects. The vulnerablity of a society is influenced by its development path, physical exposures, the distribution of resources, prior stresses and social and government institutions.
>
> -IPCC AR4, Working Group 2, Chapter 17, pg 720

> Ecosystem management and restoration activities that focus on addressing deteriorating environmental conditions are essential to protecting and sustaining people's livelihoods in the face of climate extremes (high agreement, robust evidence). Such activities include, among others, watershed rehabilitation, agro-ecology, and forest landscape restoration. Moreover, provision of better access to and control of resources will improve people's livelihoods, and build long-term adaptive capacity. Such approaches have been recommended in the past, but have not been incorporated into capacity building to date. [5.3.3]
>
> -IPCC SREX 2012, pg 294

Though these plans were supposed to include farmers and engage in a participatory process, there is little evidence of an inclusive consultative process or any rigorous vulnerability and risk assessments. This is highly problematic. Climate adaptation is a dynamic process that involves a locality's economic and natural resources, how social networks, entitlements and institutions are set up to serve people as well as the adequacy of governance, human resources and technology.[25] As such, adaptation cannot just be focused on specific measures to address climate change, but must also address economic, social, environmental and political factors that increase or reduce vulnerability. This is one of the key weaknesses of both the national and the state-level plans. A rigorous, in-depth and participatory vulnerability and risk assessment needs to be carried out at the state level and extrapolated, bottom-up at the national level to priorities the cross-cutting issues affecting the most vulnerable populations in the country. This means that factors in addition to climate need to be taken into account.

For instance, O'Brien et al. (2004) ranked districts in India in terms of vulnerability to climate change and import competition stemming from economic globalization. The government is in the process of negotiating several free trade agreements that will have tremendous impacts on import competition in agriculture. At the same time, laws and regulations on investment, land acquisition and rehabilitiation are changing, while a food security act is being drafted. A vulnerability and risk assessment should incorporate all of these emerging issues to ensure that vulnerability and risk decrease rather than increase with the finalization of these laws and regulations. O'Brien et al. noted that a large number of districts in the interior of the country were vulnerable to climate change and import competition. The government should engage seriously on these cross-cutting issues.

The next and final chapter shows that agriculture adaptation is already taking place in the plethora of sustainable agriculture practices that are being developed in the country (and around the world). The government should adopt the sustainable agriculture framework presented in the next chapter and use it as the primary strategy for climate change adaptation.

Chapter 4

Adaptation: Building Climate Resilient Farming Communities

A whole-systems approach to food, feed, and fibre production that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. It combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. Inherent in this definition is the idea that sustainability must be ex-tended not only globally but indefinitely in time and to all living organisms including humans.

ActionAid's definition of "Sustainable Agriculture" *adapted from Professor Stephen R. Gliessman1 and the International Federation of Organic Agriculture Movements (IFOAM)2*

The identification of the major risks and challenges local communities face, and/or are likely to face in the near future, and designing and implementing site-specific adaptation strategies aimed at reducing vulnerabilities and increasing the resilience of the smallholder production systems.

ActionAid's idea of building "Climate Resilience" in Sustainable Agricultural Systems

Towards Sustainable Agriculture and Climate Resilience

Solutions for Indian agriculture's adaptation to climate change necessitate dealing with the causes of the agrarian crisis and overcoming it. Chapter 2 demonstrated that farmers are actually leaving agriculture in districts across India as a way to survive and cope. This is neither a solution for livelihood improvement nor for national food security.

Adaptation will require strategies to reduce vulnerabilities, strengthen resilience & build the adaptive capacity of rural and farming communities. Industrial agro ecosystems damage environmental goods and services and so have weak resilience. The ecosystem approach with crop rotations, bioorganic fertilizers and biological pest controls, improves soil health and water retention, increases fertile top soil, reduces soil erosion and maintains productivity over the long term. The more diverse the agro ecosystems, the more efficient the network of insects and microorganisms that control pests and disease. Building resilience in agro ecosystems and farming communities, improving adaptive capacity and mitigating GHG emissions is the way to cope. (Source: Dr. Suman Sahai's Blog)

ActionAid's definition of sustainable agriculture includes dimensions of social, economic and ecological "resilience." It is well past time for Indian agricultural policies and practices to shift from costly, resource depleting, high external inputs to agro ecological ones for farmers, farm workers, rural and forest dependent communities. The good news is that substantial experience on such practices already exists across the sub-continent. People and communities without government intervention and often in spite of it are reviving watersheds, biodiversity and building resilience in extremely harsh conditions.

1. Seeds, Biodiversity, Mixed Crops: Beej Bachao Andolan

Community-based organizations such as the Beej Bachao Andolan and organizations with scientific expertise such as the Gene Campaign are just two of many organizations and communities working together to bring back locally grown seeds to address climate variability and high costs. Together with communities, they are reviving India's agro ecological gene pool and anticipating climate change—by creating heartier, more diverse systems and community-based and led resources.

Mixed cropping models are also better for agriculture workers since monocropping leads to a total of less labour days, but peak labour requirement for a short period of time during a specific time of the crop cycle. This means that there is high demand for labour for a very short period of time—this increases migration and costs of labour.

Beej Bachao Andolan (Save the Seed Campaign)'s Mixed Farming System, Uttarakhand

Terrace farming is practised in the Uttarakhand district of the middle Himalayas. *"Fasal Chakra"* or Crop Cycle is a method of farming adapted to the climatic conditions. Modern agriculture has tried but not succeeded in destroying this tradition of mixed cropping.

"Barah Anaaj"• – Twelve food grains: traditional mixed farming system Mixed cropping of *"Barah Anaaj"* or the twelve food grains is done prior to the *Kharif* season. In different regions, these seeds are sown from mid-May to mid-June and harvested from mid-September to mid-October. These fields are left fallow after that, and are prepared again at the end of March. Farmyard manure is applied. Paddy and barnyard millet are sown and harvested by end September. In the *Rabi* season, wheat, barley and masur dal is grown and harvested by end April. Again in the third year, twelve grains mixed cropping is done.

Twelve food grains mixed system: *Ragi* (finger millet) is the main crop of this system. *Amaranth*, *rajma* (kidney beans), *lobia*, horse gram, math (traditional soya), buck wheat, sesame, *mangjeer* (*tilhan* – an oil seed), *makka*, green gram, black gram, local gram varieties etc. are sown together. In some regions, more or less than twelve grains are grown too. This method is foolish in the opinion of agricultural scientists. But, as it has been developed based on the knowledge and experience of the local people and got accepted from generation to generation, it cannot be unscientific.

Nutritional value of this system: Bread (*roti*) prepared from ragi flour supplies energy for a day of heavy work. It is rich in calcium, iron and iodine. *Ragi* grain extract has medicinal properties for animals. *Ragi* malt and extract can be consumed. *Amaranth* is used to make bread (roti) and sweetmeats during the fasting and festival period. It is rich in fibre and protein. Buck wheat is used similarly. Both crops can be used as greens and have an economic value too. Traditionally, these crops were bartered for salt, but now they have good demand in the plains too. *Amaranth*, maize and sorghum plants are tall. Kidney beans climb on these tall plants. These crops do not compete with each other. On the field bunds and rocky parts of the farm, *lobia,* black gram, local gram, horse gram, green gram and traditional soya are grown. These are consumed as dal and are used for other delicacies. Horse gram prevents the formation of stones in the kidney and other organs. And for those with the problem, consuming boiled horse gram water for one month can help cure it without surgery. Traditional soya is considered the best among the *dals*. It is roasted and eaten like gram and is very delicious. Its flour is given to lactating cows to increase milk production. These cereals, pulses, and oil seeds provide all the nutritional requirements of the farmers. The crops of the *"Barah Anaaj"* system strengthen the inseparable relation between farming and livestock. The crops give valuable straw and husk for animal consumption.

Pest, disease and drought resistance:This system is more or less free of pests and diseases. Even if it exists, only one or two crops in the mixture are affected. The rich biodiversity protects the other crops. Even in the case of heavy wind or storm, only one or two crops are affected. The *ragi,* pulses and oil seeds also show resistance against drought. At sowing time, the fields are very dry and the air is dusty. After one ploughing, *ragi* is sown and it needs only one shower to germinate.*Ragi* can survive even an extreme drought. Again, after a light rain and sunny period, inter-cultivation is done with the help of bullocks and local implements.

Problems with modern agricultural science: Modern agricultural science, however, emphasises only mono-cropping. In the hill areas, the agricultural scientists criticise the *"Barah Anaaj"*• system of cropping as backward and uneconomical. Instead, they promote the growing of soyabean as a monocrop. The Government and the scientists of G.B. Pant Agriculture University promoted soyabean as a cash, oil, fuel and protein crop with free seeds and fertiliser kits.

Save the Seeds Campaign:The farmers in the hill area boycotted such cash crops through *"Beej Bachao Andolan"*• (Save the Seeds Campaign). This campaign posed some questions to the Department of Agriculture and the agricultural scientists: Who will process the soyabean crop into oil and milk? For whom is the rich protein? In fact, the soyabean is meant for big industries and multinational companies; farmers selling their own products to the market and buying poor quality from the market for their own consumption. Understanding this trap, the farmers are turning back to the traditional system of farming. The "Save the Seed"• Campaign is not only about conserving traditional seeds; it is about saving agricultural biodiversity, organic methods of farming and local traditions. The campaign has been able to conserve about 500 crop varieties. Out of this, the farmers are successfully growing about 100 varieties of paddy, 170 varieties of kidney beans, 8 varieties of wheat, varieties of barley, and about a dozen varieties of pulses and oil seeds every year.

Reproduced from: http://beejbachaoandolan.org/resources/traditional-mixed-farming-system/

2. Marrying Traditional Knowledge and Science for Climate Adaptation: Gene Campaign

Agriculture biodiversity is central to an agro ecosystem approach to food production. The genetic diversity in livestock and fish species and breeds is as important as in crop varieties. Genetic diversity gives species the ability to adapt to changing environments and combat biotic and abiotic stress like pests and disease, drought and salinity. A knowledge intensive, rather than input intensive approach should be adopted to develop

JHARKHAND FARMERS RECOGNISED AS GENE SAVIORS[26]

325 traditional rice varieties from the Gene-Seed Bank collections of Gene Campaign were shared with the Genetics Division/ IARI, New Delhi. The varieties were screened and field tested for disease resistance to the Bacterial Leaf Blight (BLB) disease over a period of five years. The current data shows that eight traditional varieties ***Hardimuri, Kala Jeera, Bhatind, Sitwa Dhan, Sarna Gora, Chaina Gora, Lamba Asari*** and ***Jhulur*** are resistant to BLB. *This underscores the crucial importance of conserving traditional crop varieties and the valuable genes that they contain, showing the relevance of such genetic resources to future food security.*

Strengthenic Genetic Diversity, Creating Resilience[27] Recognizing the importance of agro biodiversity to ensuring viable agriculture under difficult situations like that predicted by global warming and climate change, Gene Campaign began a few years ago to collect, characterize and conserve the agro biodiversity of local crops like rice, millets, legumes, vegetables and oilseeds, chiefly in Jharkhand and Uttaranchal. The focus of Gene Campaign's conservation exercise is rice because it is an important staple food and because India is the Centre of Origin and the greatest genetic diversity of rice is found here. The Eastern Indian region consisting of Orissa, Jharkhand and Chattisgarh constitute the primary Centre of Origin of rice, in other words, its birthplace. This is the region where several thousand years ago, rural and tribal communities bred rice from wild grasses and where large numbers of land races and farmers' varieties are found. Gene Campaign decided that in order to prepare for the challenges that will confront rice cultivation, conservation efforts must be focused in areas where the largest number of genes can be identified and saved for future use. In collaboration with Birsa Agricultural University, the organization has since identified 48 varieties that are drought resistant. Gene Campaign has been involved in a project in collaboration with Birsa Agriculture University in which they have identified 48 varieties which were drought resistant. In other words, efforts should be made to identify the varieties from the existing germ plasm which can withstand adverse climatic conditions. Throughout history agriculture has undergone several crises and the farmers have designed interventions to overcome these crises, which sounds more like a workable proposition. Farmer-level field gene banks, a labor-intensive model promoted by Gene Campaign with no energy costs: Both the government owned National Gene Bank in Delhi and the farmer-level gene bank are for *ex situ* conservation of agro biodiversity. However, the monthly electricity bill of the National Gene Bank is over 20 lakh rupees (approx $45,000) a month. The Zero Energy Gene-Seed Banks, being set up by Gene Campaign, on the other hand, have no carbon footprint and they are located within the communities which administer and use the banks.

adaptation strategies. Traditional knowledge about the community's coping strategies should be documented and used in training programs to help find solutions to address the uncertainties of climate change, build resilience, adapt agriculture and reduce emissions.[28]

3. Planting Short-cycle Crops to deal with flood-prone areas

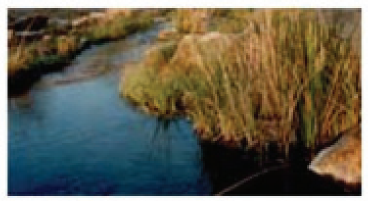
In flood-prone areas (large swathes of the state of Bihar for instance), short cycle crops can be grown that withstand heat and ripen before heavy rains result in flooding. Narendra 97 is a good example of a short cycle paddy crop grown in UP that withstands intense heat, ripens in a shorter period than the commonly used paddy.[29] It has proven effective in flood prone areas. Barnyard Millet is another short cycle coarse grain grown in the flood-prone Madhubani District of Bihar which can be harvested prior to the floods and is hearty against high temperatures.[30] A compilation of such homegrown short cycle crops should be created, utilized, disseminated and field-tested in conjunction with food growers in different parts of the country.

4. Reviving Watersheds amidst drought, heat and water stress

Water stress has been identified as a major issue for the sub-continent. Heavy rains and severe droughts are already common in this part of the world. Communities and organizations such as the Tarun Bharat Sangh in

DARK ZONE TO FLOW[31]

Reviving traditionally used "*johads*" made the *Tarun Bharat Sangh* an oft quoted example of successful Rain-Water Harvesting (RWH). A *johad* is basically a check dam or a traditional water storage "tank," used in Rajasthan once upon a time, but which had gradually fallen into disuse. *Tarun Bharat Sangh* has constructed around 10,000 *johad* with village communities to date. What was once a rivulet called Arvari has now become a river in just 25 years and changed the area from being officially marked a "dark zone" to "a water surplus" zone. The first johad was constructed in 1987 in Bhaota village near



Alwar: "Later seeing the advantage of johad, many villagers came forward to build such structures in their own areas. Now there was simply a craze for johads. And to this date, there are 375 RWH structures in the catchment area of the river Arvari. Water in RWH structures raised the water table in the entire catchment area of the river. This in turn, enriched the forest in the same area. Forests and scrubs helped to retard the run-offs of monsoon waters. This way, in a decade, the river Arvari came to life from a dried up dead water-course. Today, the river-flow continues the year round. *The effects are visible in terms of recharging of wells and aquifers, renewed flow of rivulets which had been dry for many years, increased bio-mass productivity, significant increase in agriculture production, reversal of out-migration and reduction in women's drudgery. Due to high fodder availability, villagers have also benefited from selling milk products through an informal cooperative arrangement."*

Rajasthan and Western Odisha Rural Livelihood Project have demonstrated that ecosystems, where water is scarce can be revived through a range of imaginative approaches. The key is that it must start from the ground up and it must make sense to the people who need to rebuild their lives through sustainable resource management.

5. Sustainable Livelihood Approach: The Western Odisha Rural Livelihoods Project (WORLP)

Odisha implements around 10 different watershed programmes and projects in the State through the Odisha Watershed Development Mission (OWDM), an autonomous State level agency constituted under the Department for Agriculture that plans, implements and monitors watershed development programmes in the State. The Western Odisha Rural Livelihoods Project (WORLP) is one of these programmes. WORLP is a partnership between the Government of Odisha and the UK's Department for International Development (DFID). The cost of the project is Rs. 230 crores (GBP 32.75 million). The aim of WORLP is to alleviate poverty and reduce vulnerability. It works in four of the most disadvantaged districts in the state of Odisha: Bargarh, Balangir, Kalahandi and Nuapada. It was designed to cover 1,180 villages in 677 watersheds in these four districts, where human development indicators are very low - comparable to sub-Saharan Africa. The project initiated a new approach to watershed management, termed "Watershed Plus" during its design, which put the focus on the poor, their ways of making a living and the provision of a range of livelihood support services.

WORLP was designed using the Sustainable Livelihoods Approach, which provides a conceptual and methodological framework for addressing poverty. It was not designed with any climate change objectives, and no environmental impact was envisaged other than the enhancement of natural resource assets. Nonetheless, the project has increased the asset levels of the poor and very poor, which in turn has helped to ensure that they are better able to cope with anticipated hazards, and to adapt to a changing environment and circumstances, by building their resilience.

> In western Odisha greater challenges are faced by the people: fertile lands positioned between the Udanti and Harida rivers produced bumper crops until flash floods hit. Instead of bringing fertility typical with flood plains, the floods of July 2006 left about 130 acres of standing crop waist deep in sand or "sand cast". Bhimsen Rana who owns two acres of the land says "I don't have money to remove the sand. Since the sand has stones and pebbles in it, I can't grow anything either. I have decided to work as a halia (farm labourer) in the nearby villages." The government relief provided compensation for land owners affected by flash floods but only enough to remove six inches of sand - not six feet! Water harvesting work undertaken by WORLP helps to prevent future flash floods and simultaneously provides support to marginal farmers already affected.

Lessons from WORLP

The reduced vulnerability of people to climate change related shocks can be attributed to a number of project interventions and outcomes.

Including the poor

In a partnership between communities, project and government staff, participatory micro planning processes which have had the full engagement of poor and very poor people have helped to build trust and good relations, identifying local needs and concerns of those most at risk. The approach has created an enabling environment, empowering and informing people, and allowing them to make informed choices for their long-term well being.

Reducing poverty

Recent impact surveys have shown that WORLP has had a substantial impact on poverty, with a 30% reduction in the number of poor households - approximately 15,000 households or 72,000 people have moved above the poverty line. Much of this can be attributed to enhanced levels of financial, human, natural and social assets, which also have built resilience, and improved adaptability, to climate change.

Building human capacity

Increased community resilience has developed through the project's efforts in building the capacity of individuals, households, and groups who face multiple environmental and other pressures, and in ensuring their increasing control over resources. Farmers have been supported to increase their skills in cropping, agricultural diversification, vegetable gardens, aquaculture, ducks, goats and other livelihood activities. This increase in skills enables people to adapt their livelihoods, and build resilience to climate changes and shocks. This has also been supported by increases in health and wellbeing through health camps, water and sanitation initiatives, the introduction smokeless chullahs (firewood stoves) and other technologies such as treadle pumps.

Reducing migration

The increases in skills and opportunities have been evidenced by a decrease in stress induced migration from 47% of households in 2000 to less than 15% in 2008. It is the poorest of the poor who constitute the distress migrants; previously they were unable to fi nd work in the *rabi* season when water is scarce.

Increasing incomes and food security

Fewer households now suffer 'lean season' food defi cit days, a decrease from 25% before the project to 5% in 2009, and thus food security is improved. This has happened as a result of enhanced coping capacity and increased incomes through increased agricultural production and diversification of livelihood activities.

This includes support and training in artisan craft work, and establishment and management of petty businesses by the very poor, particularly by women and the landless, as well as better access to employment and consumption credit.

Building institutions of the poor

Through close contact with communities, over 4,254 Self Help Groups (SHGs) with around 65,000 members have become established and registered during the project, and continue to function well. The number and strength of SHGs has increased social cohesion, reduced people's vulnerability, and increased the opportunity for collective action in case of climate-related shocks. Groups are better able to manage common property resources, and provide quicker, better informed and more appropriate responses to stress situations. In particular, the status and voice of women have been benefited through SHG activities.

Providing access to resources

In western Odisha the capacity to adapt to changes in climate depends to a large extent on securing entitlements to natural resources, particularly water. Control over resources affects the strategies available to people for dealing with climatic change, such as soil and water conservation, investment in resilient agriculture (such as pest or drought resistant seed, improved farming practices), and the ability to draw on alternative sources of food and income when the main supply fails.

Water harvesting

Water storage structures and soil and water conservation, developed in partnership with communities through participatory micro planning and the use of local labour, has provided more immediate round water recharge, reducing intra-annual fl uctuation in the water table and improving hydrological and soil moisture conditions. This has improved resilience to increasingly variable monsoon rain, prolonged dry spells and drought. Interventions have also had marked effects on groundwater tables which have been raised by as much as 2 to 4 metres on an average.

Changes in land use

Water harvesting technologies have also checked runoff and reduced sediments, enhancing crop production and the productivity of water resources, which now incorporate fish farming. Through increased water availability the land use patterns have changed, permitting a second crop during the *rabi* season. The Gross Cropped Area has expanded by 16% and the Cropping Intensity is up by at least 10%.

Enhanced agricultural productivity

Increased water availability has had an impact on agricultural production and productivity, mainly through greater crop diversification and improved crop yields. Yield increases in the order of 50- 100% has been regularly recorded. Livelihoods have become more robust through diversification into livestock, aquaculture, horticulture, silviculture plantation and activities such as honey bee keeping and mushroom cultivation. The growing practice of seed exchange and onion storage has also enhanced returns.

Tunu Sabar of Semelpali village owns 2.5 acres of land, but the poor rice yields were not sufficient to feed his family of 10 and he had no option but to migrate annually to Andhra Pradesh to work in the brick kilns. WORLP encouraged and supported Tunu in developing a vegetable garden, for cash cropping, on a rotational basis. The project also helped farmers to build low cost onion storage. Tunu's land is now being used optimally growing a range of vegetable crops thoughout the year. Tunu is now earning around Rs. 20,000 per year. He has bought some goats and sends three of his children to school and his eldest son to a local college. He does not need to migrate any more and works instead on his farm year round.

Key conclusions

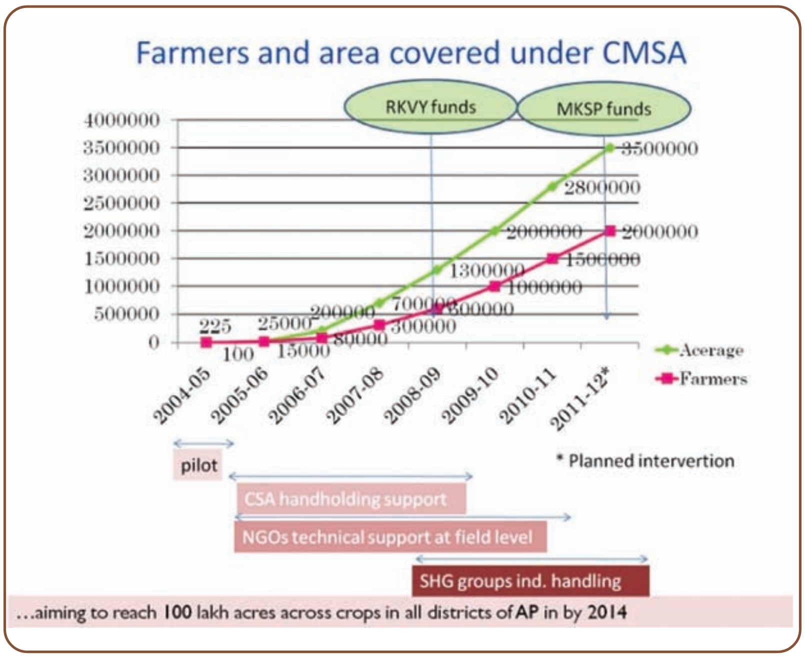
Successful features of the project which have reduced vulnerability and are suitable for replication include:

Reducing poverty by diversifying livelihoods offers a good platform for climate change adaptation. WORLP has succeeded in reducing poverty, and this is a pre-requisite in development of greater climate change adaptability. The dual focus on natural resource management and people's livelihoods provides a strong response to increased vulnerability. The Sustainable Livelihoods Approach (SLA) recognised that poor people are prey to increased vulnerability, where shocks, adverse trends and seasonality have the capacity to drag people back into poverty if permitted to do so. The model has proven to be robust in the face of recent climate change evidence. Building institutions of the poor is fundamental for reducing vulnerability and enhancing their capacity to adapt. WORLP has put into place institutions, organisational practices, systems and procedures necessary for communities to be at the centre, and better able to address issues of inclusion and equity. WORLP operates within government, and the Government of Orissa has already scaled up the project to non-WORLP districts. National policy has also been infl uenced through inclusion of a livelihoods focus. This will help build resilience to climate change for millions of the rural poor in India. WORLP is a long-term, large-scale investment, and this has enabled it to achieve its goals in a sustainable way. Advocating new approaches, building capacity and strengthening processes though existing institutional structures is not easy and requires a big investment in time and resources. Future climate change may be of a different order. Whilst there is good evidence that project activities have increased resilience, it seems likely that in future things will get worse. Continuous assessment of the adequacy of current strategies needs to be institutionalised. (Source: Climate Change Adaptation Western Odisha, Odisha Water Shed Development Mission, Dec, 2009)

6. Scaling up from the Ground Up: CSA's experience

Sustainable agricultural (ecological farming/organic farming/LEISA/Non Pesticidal Management/ SRI/Integrated Farming Systems etc) approaches are now acknowledged for a wide set of ecological and economic benefits for producers as well as consumers. These approaches use low levels of energy and are less polluting because they are based on low external inputs. They thus help in adapting to climate change and lower the carbon footprint of agriculture at the same time. However, the practicality of scaling up sustainable agriculture practices is often questioned.

In the last few years, two large scale initiatives- Community Managed Sustainable Agriculture (CMSA) in Andhra Pradesh and System of Rice Intensification in states of Tripura, Odisha and Tamil Nadu have provided new knowledge and proven that such practices can be scaled up if carried out with farmer input and participation and without big, costly "techno-fixes."



For instance, the success of these experiences had three things in common: 1) coordinated action was led by groups or communities at the local level 2) they made use of locally adapted resource conserving technologies and 3) external (or non-local) government and/or non-governmental institutions worked in partnership with farmers to support these initiatives and did not impose implementation from the top. These achievements took place amidst an agriculture development environment which still strongly favors 'modern" technology-based approaches that are led by "experts" from the outside. The challenge before us is to convince policy makers that the bottom up, low-cost, low technological and chemical external input can be scaled up across the nation. Such a "paradigm shift" requires different approaches to capacity building such as "horizontal" as opposed to "top-down" learning and newer institutional systems and forms of finance.

The table below shows the cost difference between conventional agriculture practices and sustainable agriculture practices (organic) and resulting income for 8 farmers in Punukula village on 6.4 hectares of land in AP (*Kharif* 2001-2002):

Particulars	Sustainable Agriculture	Conventional Agriculture
Average cotton yield (kg/ha)	1575	1450
Cost of plant protection ($/ha)	4300	8595.2
Net income ($/ha)	3420	-5200
Source: CSA, Hyderabad		

Another increasingly popular agro ecological practice being adopted in Western and Southern India is called "Zero Budget Natural Farming." Like its title, it's a zero cost, no external input, no external labor organic practice that may work for small and marginal farmers.

Knowledge-generation, innovation and experiments are happening all across India right now by farmers. It is imperative that the government agencies tasked with the challenge of climate change adaptation integrate these learnings in adaptation-oriented research, development and implementation by accepting farmers as equal partners in these initiatives.

A woman farmer in a mix crop field in Ananthpur

Chapter 5

Recommendations for the way forward

1. Promote Sustainable agriculture:

The capacity of a farming system to adapt to changing climate and weather conditions is based on its natural resource endowment and associated economic, social, cultural and conditions. The viability of these elements also constitutes the basis for sustainable agriculture, understood as agricultural production that ensures adequacy of food production; does not harm the resource base; is economically viable; and enhances quality of life. Many climate and weather risk management strategies fit squarely into such sustainable agriculture practices: locally adapted cropping patterns using local and natural resources and processes, based on local knowledge, skills and innovations. These should be promoted by government programs and policies.

Strategies:

a. Changes in cropping patterns and cropping systems to suit the local resource and weather conditions. Multiple/mixed cropping, intercropping systems with legume components etc.

b. Ecological farming practices which can maximise the local resource use. Many of these practices are based on indigenous knowledge and focus on building soil biological productivity. Non Pesticidal Management, Organic Soil Management, Community Seed Banks, System of Rice Intensification, Soil moisture management etc have already proven to be useful.

c. Locally adopted crop varieties, short cycle crops, especially in saline, flood prone areas and drought prone areas, making suitable selections adopting Participatory Plant Breeding and Participatory Varietal Selection.

d. Developing suitable farming systems integrating agriculture, horticulture and livestock.

e. Research on improvising these practices and building upon them

f. At the macro level, there is a need to revisit the paradigms governing agricultural research in the country. The concept of agroclimatic zones needs to be revisted in the light of climatic changes and possibly be regrouped in light of these changes.

g. There are many technologies/varieties that are sitting in the laboratories of the public sector research organizations. These varieties should be inventoried and field-tested to see which prove affective in the changing environment

h. An early warning system should be put in place to monitor changes in pest and disease profile and predict new pest and disease outbreaks. The overall pest control strategy should be based on Integrated Pest Management because it takes care of multiple pests in a given climatic scenario.

2. Invest in natural resource generation:

Soil health and fertility and watersheds should be recognized as critical natural resources for adaptation and the government should invest in reviving them with appropriate incentives.

Strategies:

a. Enrich and increase soil organic matter and soil conservation through agroecological practices.

b. Revive traditional water harvesting structures. These structures can be revived through the imaginative use of MNREGA funds and watershed funds.

3. Encourage Farmer-led initiatives and institutions:

Organized communities have proven to be more effective in planning and managing their resources and livelihoods, lobbying for policy changes and securing entitlements.

Strategies:

a. Appropriate institutional systems for each locality should be encouraged and established based.

b. These institutions can plan, mobilise resources, organise production and take up post harvest management and marketing activities.

c. Producer collectives can improve collective bargaining power of farmers and help internalize market activities like bulking, primary and secondary processing which improve the village economy.

d. Uncertain weather will disrupt established cropping patterns, requiring a different set of crop varieties for which seed will have to be produced. Decentralized seed production involving local communities will help to produce locally adapted seed of the main and contingency crops. A network of community level seed banks with the capacity to implement contingency plans and alternative cropping strategies depending on the behavior of the monsoon will be a key adaptation.

4. Diversify food production and distribution to increase food and livelihood security:

The Shift to sustainable agriculture is often seen as a compromise on food security, data from the National Centre for Organic Farming (NCOF), ICRISAT and CMSA prove that crop productivity can be maintained with organic/ecological farming. This is mainly because food is understood as only wheat and rice, few pulses, oilseeds and vegetables. The food basket increases dramatically if we expand the PDS to include millets and other coarse cereals, dryland fruits and uncultivated greens. These crops also increase nutrition security. Beyond PDS and mid-day meal schemes, the food security system (and proposed act) needs to improve livelihood security by sustaining food production in villages, improving income generation opportunities for small farmers and agriculture labor—especially in rainfed regions. Such a system must ensure that farming communities have food and means of sustaining themselves and their livestock during lean periods of the year and during droughts and other climate failures.

Strategies:

a. Build household food security systems by incentivising suitable cropping patterns

b. Via the PDS procure coarse grains, pulses and other locally grown food, set up local grain storage and distribution systems

Efforts to revive a traditional water tank in Balangir District, Odisha

c. Support the creation of village level management systems that include local foodgrain reserves, seed banks and other helpful safetynets for communities

d. Identify and generate suitable off-farm and non-farm employment opportunities to ensure food and income year round.

e. A national grid of grain storages, ranging from Pusa Bins and Grain Golas at the household/ community level to ultra- modern silos at the district level must be established to store buffer stocks to ensure local food security and stabilize prices.[32]

5. Revamp and Improve Financial support and Rural Credit for Agriculture Production:

Create proper support systems for farm internalized inputs, community based infrastructure, knowledge and skill building and dissemination.

Strategies:

a. Revamp agriculture subsidies by providing direct subsidies to farmers for the production, use and maintenance of their own local ecological inputs (manure, organic fertilizer, composting, seedbanks and generation) rather than current practice of subsidizing external inputs.

b. Integrate NREGA with sustainable agriculture so that each farmer gets 100 labor days for farming, for instance.

c. Explore tools like Direct Income Support which exist in many developed/developing countries—price support cannot and does not necessarily meet costs of production plus a decent living wage. Financial support must ensure that farmers earn their cost of production plus a decent profit.

d. Formal credit systems must be accessible and practical for obtaining and repaying credit by food producers. Moneylending and the concentration of inputs and output purchases in the hands of local moneylenders must be stopped and regulated.

e. A special climate risk insurance should be launched for farmers and the agriculture credit and insurance systems must be made climate responsive and more sensitive to the needs of small farmers.

6. Partnerships:

Partnership between various governmental and non governmental agencies at the district level must be created to implement programs. An alliance of public sector research organisations, extension agencies, departments dealing with rural livelihoods and farmers groups and CSOs at the national level should be formed and engage on sustainable agriculture/organic/natural/ecological farming.

Adaptation and mitigation support structures in the form of Climate Risk Research Centers should be established at each of the 128 agro-ecological zones in the country. The Centers should prepare computer simulation models of different weather probabilities and develop and promote farming system approaches which can help to minimize the adverse impact of unfavorable weather and maximize the benefits of a good monsoon. *Gyan Chaupals* and Village Resource Centers with satellite connectivity should disseminate value added weather data from the government's Agromet Service to farmers through mobile telephony, giving them information on rainfall and weather in real time[33].

Finally, investments must be made in strategic research of both anticipatory and adaptive nature. This should cover all aspects of food production, starting with farming systems and including crop, fodder, livestock, fish and the key aspects associated with each of these.[34]

CONCLUSION

Indian farming is at a cross-roads and climate change is a powerful and potentially crippling force adding to the existing agrarian crisis in the country. It should serve as an urgent and decisive wake up call for a radical shift at all policy levels on how food should be grown, distributed and sold in this country. The climate, trade, finance and investment policies in this country should be reviewed to ensure a stable, sustained and sustainable supply of food production in this country that feeds everyone and creates resilient rural communities, farms, forests and fisheries including for the smallest food producers to the most marginalized. This also means that a concerted effort must be made to educate the middle class about the impacts of its increasingly runaway consumption habits.

Fundamental changes have to come from the acknowledgement and realization that unilateral, top-down, "knowledge generation and transmission" models of the green revolution ilk have in fact resulted in an ecological, economic and social crisis in the farming sector within a mere 40 years of their adoption. Climate change now brings a massive challenge (and opportunity) in our midst to redress the current untenable situation.

Sustainable agriculture and agroecology holds immense adaptation potential with mitigation "co-benefits." These practices must and have proven to improve rural livelihoods and address the ecological crisis of genetic erosion, land degradation, water depletion and contamination resulting from prescribed Indian farming practices.

As the International Assessment of Agricultural Science & Technology for Development (IAASTD) concluded: business as usual is no longer an option. In fact, there can be no turning back for the Indian government and its food growers but to establish, promote and adopt sustainable agriculture.

End Notes

[1] Pg. 36 of National Action Plan on Climate Change (NAPCC) 2008

[2] Ministry of Chemicals and Fertilisers, 2008

[3] NCRB, 2010

[4] [base year 1999-2000] Handbook of Statistics on Indian Economy, Reserve Bank of India, 2008-09

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[7] World Bank Group 2009. Why is South Asia Vulnerable to Climate Change?

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[9] ibid

[10] INCCA 2010

[11] NAPC 2010

[12] FAO 2010. Climate Change and Food Security in the Context of the Cancun Agreements.Submission to the 14th session of the AWG-LCA, in accordance with paragraph 1 of the Bali Action Plan. Accessed at: http://www.fao.org/news/story/en/item/54337/icode/

[13] IFAD

[14] Mall et al 2006

[15] IFAD

[16] Directorate of Agriculture and Food Production accessed at: www.orienvis.nic.in/soe/agriculture.pdf on 3.1.12)

[17] ibid

[18] From 20,500 metric tonnes to 3,734,516 metric tonnes in 2006-07).

[19] Sustainet: 42

[20] A legally binding protocol of the UNFCCC in which industrialized countries pledged to cut their emissions by 5% below 1990 levels by 2012. New pledges were to be made before the second commitment period began in 2013, but has continued to face deadlock because the United States, Japan and Russia are some of the countries that want the protocol to be scrapped.

[21] Sharma and Stabinksy

[22] These critiques and alternatives have been reproduced, paraphrased and edited from a paper by Dr. Ramanjaneyulu and Dr. Kavitha Kuruganti and reinforce the suggestions put forward by Dr. Suman Sahai from the Gene Campaign.

[23] Suggestions from Dr. Suman Sahai, Gene Campaign

[24] Jha, A. 2011 *Much ado about the State Action Plans on Climate Change; its business as usual for the governments. Pairavi Occasional Papers, August.*

[25] Para 17.3.3: http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter17.pdf

[26] *Reproduced from: http://www.genecampaign.org/Sub%20pages/recent-Happenings-p2=ID2.htm*

[27] This section reproduced and adapted from: YTC*

[28] Source : Dr. Suman Sahai's blog

[29] Kapoor, Aditi- "Sustainable Agriculture: Issues and Action Points" In Towards Sustainable Communities—Alternatives in a Low Carbon Path, Chapter 3

[30] ibid

[31] This box reproduced and adapted from: http://www.tarunbharatsangh.org/regional%20level.html and http://www.tarunbharatsangh.org/dark%20zone%20to%20flow.html

[32,33,34] Source : Dr. Suman Sahai's blog

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