Volume : 1 | Issue : 5 | Oct 2012 • ISSN No 2277 - 8160

Research Paper Economics

# Small Farmers Develpoment Agency and Their Role in Preserving Good Agricultural Practices

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**Introduction**

Climate change defined as "change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". United. Nations Framework Convention on Climate Change (UNFCCC). Many Scientists have specified various reasons for global warming effect of the environmental and for human life. It is not easy to point one reason for global warming effects, but recently you might have saw many change in global climate. Global warming effects have various consequences such as glacier volume decreasing, rise in sea levels, shrinkage of Arctic and altered fashion of doing agriculture have been named as direct effects on global warming. According to United Nations Environment Programme (UNEP), economic sectors likely to face difficulties related to climate change include banks, agriculture, transports and other. Developing countries dependent upon agriculture will be particularly harmed by global warming. Impacts of Global Warming

Greenhouse gas indices were used for, say, computing the current contributions to climate change by some region, then the question of how sudi an index should be construed, has not much to do with economics. Matters change, however, when they are used as they are in Kyoto type protocols. Any person, firm or government that has to match his CO2 equivalent emissions (however defined) with a corresponding number of permits, will have to consider how much resources he will spend on reducing emissions of say CH4 visa-vis CO2. The higher the weight that is put on methane, the more attractive it will be to reduce those emissions relative to CO2. Conversely, a lower weight will favor CO2 reductions. Therefore, the choice of metric will affect both the amount of resources put into reducing each gas, as well as how the climate will evolve in the short and long term.

The economics of the climate problem with a single greenhouse gas for an economist, the essence of the climate problem is that when someone emits a ton of a greenhouse gas, it will have a negative impact on others' welfare. In such situations, there is an abundance of evidence that in the absence of cooperation and regulation, the resource in question (a stable climate) will be overexploited to everyone's harm. The economist Pigou proposed in 1920 that this tragedy of the commons could be avoided by putting a price on emissions. The level of the price should reflect the negative consequences a unit of emissions has on others. Although most economists still agree that this is a good medicine for addressing the climate problem, there is, as in many other fields of climate change, a discussion about the most appropriate level of this price and how it should evolve over time.

The economics of the multi-gas climate problem in a world with multiple greenhouse gases, the above reasoning extends quite straightforwardly: One simply has to find the appropriate price on each and every gas. Alternatively, one can cap the total emissions of a basket of gases, and instead leave to the permit market to figure but the price on some chosen reference gas. In this case, one has to put into legislation the relative price for the other gases. That is, one has to come up with a metric to compare greenhouse gases, which gives the most appropriate incentives to get society out of the common tragedy. If we use the wrong metric, then resources will be wasted. That is something economists never recommend.

When would an economist be less negative to Global Warming Potentials or Global Temperature Potentials? An economist would have fewer problems with accepting Global Warming Potentials (GWPs), if the problem with climate change was that people would be exposed to radiative forcing, rather than facing more droughts, floods, migration, etc. Also, had it been reasonable to take into consideration the harm this will have on all people living from now to some chosen time horizon, and not those living thereafter, GWPs would be less problematic. Global Temperature Potentials (GTPs) would perhaps work fairly well if temperature change was the only problem; and since this metric is based on equivalence at exactly one point in time, only the people living at that time should enter the equation. This latter hypothesis is not an improvement of the traditional GWP for an economist.

In developing countries like India, climate change could represent an additional stress on ecological and socio-economic systems that are already lacing tremendous pressures due to rapid urbanization, industrialization and economic development With its huge and growing population, an 8,000 km long densely populated and low-lying coastline, and an economy that is closely tied to its natural resource base, India is considerably vulnerable to the different natural disasters induced by climate change. It is observed that there will be an increase in the frequency of heavy rainfall events in South and Southeast Asia due to the doubling in CO: concentrations in the atmosphere. Lai et al. (1995) present a climate change scenario for the Indian subcontinent, taking projected emissions of greenhouse gases and sulphate aerosols into account. It predicts an increase in annual mean maximum and minimum surface air temperatures of 0.70 C and 1.00 C over land in the 2040s with respect to the 1980s. Human society will face new risks and pressures. Some regions are likely to experience food shortages and hunger. Water resources will be affected as precipitation and evaporation patterns change around the world. Economic activities, human settlements, and human health will experience many direct and indirect impacts of climate change.

Developing countries are considered to be particularly vulnerable to climate change as many are in tropical and subtropical zones with economies and societies highly dependent upon the climate and heavily impacted by its variations. India has also not been spared the impact of climate change. The major threat that climate change poses to the country is through its impact on agriculture. Since agriculture is a source of livelihood for 65 per cent of the population and contributes to 27 per cent of the GDP, adverse impact on Agriculture would have serious effect on the economy of the country. In addition it will also have an impact on food security and health. It has been estimated that 0.5 degree rise in temperature would result in reduction of wheat yields by 1.0 per cent. However, the loss of crops and agricultural land due to disaster intensification and land degradation caused by climate change can not be estimated.

**Impacts on Agriculture**

The impacts of climate change on agriculture are a mix of positive and negative effects. Higher temperatures will allow farmers to grow different crops. Rainfall will increase in some places at some times, but decrease in others. The negative effects of drought are mitigated by a higher concentration of carbon dioxide in the atmosphere, which will improve the water use efficiency of crops. As prices move in the opposite direction of yields, the market will dampen the impact of climate change on cropping patterns.

In the Summary for Policy Makers of the 4th Assessment Report, Working Group II of the Intergovernmental Panel on Climate Change states that: "Crop productivity is projected to increase slightly at mid to high latitudes for local mean temperature increases of up to 1-3°C depending on the crop, and then decrease beyond that in some regions. At lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2°C), which would increase the risk of hunger. Globally, the potential for food production is projected to increase with increases in local average temperature over a range of 1-3°C, but above this it is projected to decrease."

Before many times back, many scientist and researchers were hopping that a positive effect of global warming would be increased agricultural yields (outputs). Because of the role of carbon dioxide in photosynthesis which is might behave in positive manner, but now it resulting in destructions of several crops. In the area of Iceland, due the rising temperatures which have made possible the widespread sowing of barley easily in an effective manner, which was not possible twenty years from now. The net result is expected to be that 33% less maize-the country's staple crop-will be grown. The reduction in rainfall has turned millions of land into deserts.

The Indira Gandhi Institute of Development Research has reported that, if the predictions relating to global warming made by the IPCC come to fruition, climate-related factors could cause India's

Gross Domestic Product GDP to decline by up to 9% contributing to this would be shifting growing seasons for major crops such as rice, production of which could fall by 40%. (Sethi, Nitin, 2007)

**Impacts of Climate Change on Agriculture**

Although increase in carbon dioxide is likely to be beneficial to several crops, associated increase in temperatures, and increased variability of rainfall would considerably impact food production. Recent IPCC report and a few other global studies indicate a probability of 10 - 40% loss in crop production in India with increases in temperature by 2080 -2100.

There are a few Indian studies on this theme and they generally confirm similar trend of agricultural decline with climate change. Recent studies done at the Indian Agricultural Research Institute indicate the possibility of loss of 4 -5 million tons in wheat production in future with every rise of 1°C temperature throughout the growing period (but no adaptation benefits). It also assumes that irrigation would remain available in future at today's levels. Losses for other crops are still uncertain but they are expected to be relatively smaller, especially for kharif crops.

It is, however, possible for farmers and other stakeholders to adapt to a limited extent and reduce the losses (possible adaptation options are described later in this document). Simple adaptations such as change in planting dates and crop varieties could help in reducing impacts of climate change to some extent. For example, the Indian Agricultural Research Institute study quoted above indicates that losses in wheat production in future can be reduced from 4-5 million tons to 1-2 million tons if a large percentage of farmers could change to timely planting and changed to better adapted varieties. This change of planting would, however, need to-be examined from a cropping systems perspective.

Increasing climatic variability associated with global warming will, nevertheless, result in considerable seasonal/annual fluctuations in food production. All agricultural commodities even today are sensitive to such variability. Droughts, floods, tropical cyclones, heavy precipitation events, hot extremes, and heat waves are known to negatively impact agricultural production, and farmers' livelihood. The projected increase in these events will result in greater instability in food production and threaten livelihood security of farmers.

Increasing glacier melt in Himalayas will affect availability of irrigation especially in the Indo-Gangetic plains, which, in turn, has large consequences on our food production.

Global warming in short-term is likely to favour agricultural production in. temperate regions (largely Northern Europe, North America) and negatively impact tropical crop production (South Asia, Africa). This is likely to have consequences on international food prices and trade and hence our food security.

Small changes in temperature and rainfall could have significant effect on quality of cereals, fruits, aromatic, and medicinal plants with resultant implications on their prices and trade.

Pathogens and insect populations are strongly dependent upon temperature and humidity. Increases in these parameters will change their population dynamics resulting in yield loss.

Global warming could increase water, shelter, and energy requirement of livestock for meeting projected milk demands. Climate change is likely to aggravate the heat stress in dairy animals, adversely affecting their productive and reproductive performance. A preliminary estimate indicates that global warming is likely to lead to a loss of 1.6 million tones in milk production in India by 2020.

Increasing sea and river water temperature is likely to affect fish breeding, migration, and harvests. A rise in temperature as small as 1°C could have important and rapid effects on the mortality of fish and their geographical distributions. Oil sardine fishery did not exist before 1976 in the northern latitudes and along the east coast as the resource was not available/and Sea Surface Temperature (SST) were not congenial. With warming of sea surface, the oil sardine is able to find temperature to its preference especially in the northern latitudes and eastern longitudes, thereby extending the distributional boundaries and establishing fisheries in larger coastal areas.

Corals in Indian Ocean will be soon exposed to summer temperatures that will exceed the thermal thresholds observed over the last 20 years. Annual bleaching of corals will become almost a certainty from 2050(Ashwani Sharma, 2008).

Agriculture represents a core part of the Indian economy and provides food and livelihood activities to much of the Indian population. While the magnitude of impact varies greatly by region, climate change is expected to impact on agricultural productivity and shifting crop patterns. The policy implications are wide-reaching, as changes in agriculture could affect food security, trade policy, livelihood activities and water conservation issues, impacting large portions of the population.

**The Major Impacts of Climate Change on Agriculture in Various Regions of India are as under:**

**East**

The increased disaster frequency and intensity indicates that the state is under severe stress due to climate change impacts.

In 2007 the coastal district of Balasore was affected by four floods virtually wiping out crops in the state and severely Effecting human beings and livestock.

The state suffered one of its worst droughts in 2001 which affected 11 million people in two thirds of the state's districts. The drought affected earlier drought free states such as Sundcrgarh and Kendrapara.

Agricultural land in the coastal region would be vulnerable to inundation and salinisation. This would affect the paddy crop adversely. Orissa normally produces about 5 million tons of rice each year. Effect on agriculture would also throw a number of people dependent on it out of work.

**West**

Climate change impacts have also affected the urban and rural areas in Western India. The effects have been more pronounced on the Eastern coast as more climatological disturbance is seen over Bay of Bengal than over the Arabian Sea. However, the effects on Agriculture and on communities on the Western coast are visible.

In the Western Indian .state of Kajasthan Pearl Millet is the main crop. The production of pearl millet is reduced by 10-15 per cent due to a 2 degree rise in temperature.

Rajasthan was affected by severe droughts in 2002. The drought affected 32 districts with a rainfall deficit of 53.4 per cent.

The effects of climate change are also visible in Jhalawaz-, Rajasthan. The area has been experiencing droughts since the last four years. Agricultural yields have also reduced substantially, particularly for the majority of fanners who lack irrigation facilities. The medium farmers are coping by. sale of available stock. The only option available to landless laborers is migration from the area. Small and marginal farmers cope in a number of ways which include sale of cattle, shift to other crops, labor and migration.

Maharashtra too has been facing the effects of drought. In 2001 20,000 villages in the state were affected by drought. The number of villages affected in 2002-03 and 2003-04 was 33 and II respectively.

**North**

In the Northern part of India, impacts of climate change have been on

water availability and agriculture. The average temperatures are also on the rise in these areas. The wheat yields and apple yields are also being affected due to rise in temperature. The rise in temperature raises issues for food security and livelihoods.

In Kullu valley apple production in 1995 was one fourth of peak production year of 1988-S9. In 1989-90 the production of apples reduced to 50 per cent of previous year's all- time-high production. The production has been declining since then. There have been seasonal shifts in the region due to climate change which have had an impact on the apple crop, o In Kashmir global warming is affecting agriculture and water security. It has been found that temperature in Kashmir region has risen by 1.45 degrees centigrade and in Jammu by 2.32 degrees centigrade. HMD's monitoring reveals increase in temperature in Jammu and Kashmir valley with increase in maximum temperature of 0.05 degrees centigrade per year.

The water level in almost ail streams and rivers in Kashmir has decreased by 2/3rd during the last 40 years. Ground water level has dropped by W in the upper areas of the region.

Agriculture in the valley has been adversely affected due to climate change. Yields of Paddy and Maize have reduced due to increase in temperatures. The almond crop has also suffered damage. Due to reduced water in streams Maize and Cherry yields have been reduced by half.

**South**

In Southern India Andhra Pradesh is an established climate change In Southern India Andhrr. Pradesh is an established climate change hotspot. The state has a long history of disasters. The coastal areas of the state are affected by cyclones and the areas in the interior are affected by droughts and heat waves. Certain districts namely, Ananthpur, Chittoor, Cuddapah, Hyderabad, Kamool, Mehboobnagar, Nalgonda and Prakasam are chronically drought prone. In 2003, 22 out of 23 districts in the state were affected by heat waves. In the same year 80 per cent of the state faced a drought.

Monsoon rainfall does not show significant trend over the century scale but decadal trends have been noticed. Decreasing trend in larger number of districts in the case of annual rainfall suggests that mere may be overall decrease in pre-monsoon and. post -monsoon rainfall. The results bring out a conspicuous observation that while no trend has been observed in some meteorological subdivisions, individual districts have shown a decreasing or increasing trend. It may be mentioned that the analysis has limitations due to several factors like deployment of rain gauge stations and their numbers (Srivastava et al, 1998).

The monsoon rainfall is expected to increase by up to 30 per cent by the end of 21st century, as a result of climate change, which again would affect agriculture which is largely dependent on rains. According to World Bank a seven per cent increase in rainfall accompanied by 2 degree centigrade rise in temperature will reduce net agricultural revenues for the whole country by 12.3 per cent.

The agricultural sector represents 35% of India's Gross National Product (GNP) and as such plays a crucial role in the country's development. The impact of climate change on agriculture could result in problems with food security and may threaten the livelihood activities upon which much of the population depends. Climate change can affect crop yields (both positively and negatively), as well as the types of crops that can be grown in certain areas, by impacting agricultural inputs such as water for irrigation, amounts of solar radiation that affect plant growth, as well as the prevalence of pests. Assessment of Vulnerability of Agriculture to Climate Change

The magnitude of projected changes in temperature, rainfall, and carbon dioxide in future of different parts of the world, including India has been compiled by IPCC (Watson et alv 1998). According to this report, by 2010 C02 level will increase to 397-416 ppm from the existing level of 368 ppm in the year of 2000. This will further increase to 605-755 ppm by 2070. There is considerable uncertainty in the projected magnitude of change in rainfall and temperature for India (Table-1). The increase in temperature is less in Kharif than in Rabi crops. The Rabi rainfall will, however, have larger uncertainly. Kharif rainfall is likely to increase by as much as 10 per cent.

**Table-1**
**The Expected Magnitude of Change in Climatic Factors in South Asia by 2010 and 2070 Ad Due to Global Warming**

| | 2010 | 2070 | 2010 | 2070 |
|---|---|---|---|---|
| Temperature increase °C | 0.3 to 0.7 | 1,1 to 4.5 | 0.1 lo 0.3 | 0.4 to 2.0 |
| CO2 | 397 to 416 | 605 to 755 | 397 to 416 | 605 to 755 |
| Rainfall change in southwest monsoon region per cent | 0 | -10 to 10 | 0 | 0 to +10 |

Sourece: Inter-Governmental panel on Climate Change (IPCC) of United Nations Report (Watson et.al, 1998)

Global climatic changes will affect agriculture through their direct and indirect effects on Kharif and Rabi crops/ soils, livestock and pests. Increase in atmospheric carbon dioxide has a fertilization effect on crops resulted into their growth and productivity. Increase in temperature can reduce crop duration; increase crop respiration rates alter photosynthetic, affect the survival and distributions of pest populations thus developing new equilibrium between crops and pests. This equilibrium decreases fertilizer use efficiencies and increase evapotranspiration. Indirectly, there may be considerable effects on land use due to snowmelt, irrigation, frequency and intensity of inter and intra seasonal droughts and floods, soil organic matter transformations, soil ferosion decline in arable areas due to submergence of coastal lands, and availability of energy. All these can have tremendous impact on agricultural production and hence food security of any region. Equally important determinants of food supply are socioeconomic environment including government policies, capital availability, prices and returns, infrastructure, land reforms, and inter and infra-national trade that might be affected by climate change.

There is a direct impact of climate change reported on the vulnerability of rice crop yield in North West India. It is because, the changed climate along with doubling of CO2 seems to have enhanced the yield potential of rice, while the irrigated rice yield seems to have decreased as compared to present climate, leading to more yield gap between achievable rice yield and potential rice crop yield in 2050's climate as compared to gap under existing climate. Reduction in irrigated rice crop yield ranges from about 12 per cent at Saharanpur (Uttar Pradesh) to 25 per cent at Hissar of Haryana (Gosain & Tripathi, 2002). The variability in the irrigated rice crop yield increases by the factors of 1.3 to 1.6 in 2050's anomaly climate as compared to present climate at various locations in India. This enhancement in year to year variability in rice crop yield raises concern about food security in India.

Enhancement of International Cooperation in pursuance of the objectives of the United Nations Framework Convention on ClimateChange (UNFCCC) India figures among the top ten contributors to greenhouse gas emissions. However, current per capita gross emissions in India are only one-sixth of the world's average. India is highly vulnerable to climate change as its economy is heavily reliant on climate-sensitive sectors like agriculture and forestry.

**Rising Growth of Greenhouse Gases**

Human induced radiative forcing of Earth's climate is largely due to increases in the concentrations of the long lived greenhouses gases CO2, methance (CH) and nitrous oxide (N2O), PFSs, and SF6 and ozone depleting substances (CFCs, HCFCs, Halons). The predominant sources of the increase in greenhouse gases are from the combustion of fossil fuels.

The larges growth in CO2 emissions has come from power generation and road transport, with in industry, households and service sectors. The land use change and forestry sector plays a significant role in the overall carbon balance of the atmosphere. Data indicate that the share of C02 emissions from deforestation and loss of carbon from the soil decay after logging was 7-16 percent of 2004 GHG (Green House Gases) emissions and 11-28 percent of 2004 fossil CO2 emissions. In the tropic there are large emissions from deforestation and other land use change activities (B.P. Yadav, 2007). How to Avoid Dangerous Climate Change

In the United Nations Framework Convention on climate change (UNFCCC) OF 1992, almost all nations of the world have committed, themselves to preventing a "dangerous interference" with the climate system. To avoid the most dangerous consequences of climate change, the

European Union has decided to halt global warming below 2° C above pre-industrial temperatures and many other countries have since endorsed this limit. To reach this goat, the greenhouse gas concentration in the atmosphere needs to be stabilized well below 450 ppm CC*2-equivalent (possible after some limited temporary overshooting of this value). To achieve this, the global. CO2 emissions need to be at least halved by 2050, compared to the level, of 1990. Carbon cycle feedbacks make this number uncertain, and the required reduction could turn out to be up to 70%.

According to latest economic modeling results (see special issue of the Energy Journal, 2006, edited by O. Endhofer et al. as well as the Stern Review published in November 2006), this can be achieved with minimal costs (less than 1% lower GDP by 2100) by induced technological innovation, including increased energy efficiency and renewable energy technologies (wind, biomass, solar). Detailed scenarios for the required energy transition have been worked out e.g. by the Advisory Council on Global Change of the German government (www.wbgu.de).

**Recommendations to the Policy Makers**
**Sustainable Development**

The impact of climate change is projected to have different effects within and between countries. Mitigating and adaptation actions can, if appropriately designed, advance sustainable development and equity both within and across countries and between generations (Jayant Sathayel et.al 2006). International Mechanisms: The protocol also includes three international mechanisms, called Flexible Mechanisms, which aim to make it cheaper to reach the Kyoto Protocol's targets of reducing greenhouse gag emissions in industrialized countries. Two of these mechanisms are intended to promote investment either in developing countries (through the Clean Development Mechanism), or in countries undergoing the transition lo a market economy (through Joint Implementation). The third mechanism, known a Emission Trading, allows one country to 'sell' parts of its emission quota to another, a move intended to maximize cost-efficiency in emission reduction strategies.

**The need to adapt to 'inevitable' climate change**

At the local level, adaptation is a process that takes place continuously in response to changes in the local environment. But in a climate change context, it can also refer to broader decisions, such a Planting Different Crop Varieties in drier years, building dams to protect communities from flooding or protecting particularly vulnerable natural ecosystems that are a source of livelihoods. Focused adaptation means taking steps now to warmer conditions-such as Using Pesticides to kill malaria-bearing mosquitoes/ improving farming practices and ending subsides to coastal development. These measures could virtually eliminate the threat of coastal flooding and cut in half the number of people projected to be at risk malaria and hunger (NCPA-2007).

Stabilizing carbon levels include improving power systems efficiency, both on the supply and demand sides, harnessing alternate sources of Clean Energy, developing nuclear power developing, and exploring long term options like carbon capture and storage (ADB 2007).If Market Based Greenhouse Gas Restrictions create a profit incentive to reduce greenhouse emissions, many good things should happen; New techniques for generating electricity will come into use. Green motor fuels will become more widely used. New fuels will be invented. Energy-efficient technology will raise in popularity Wind, Solar and nuclear power-all zero-greenhouse sources of energy-will rise in popularity (Greeg Easterbrook-June 2006). It would be advisable for policymakers to calculate the Opportunity Cost of Investments, or subsidies in the renewable energy sector. It would be cheaper, in the long run, to provide electricity to rural communities through the conventional fossil fuel route than through renewable energy sources. A decentralized and 'democratic' electric power system where large plants and national grids give way to stand-alone off-grid systems many become a reality in the distant future, as many Green Activists hope. Meanwhile, it would be wiser for policymakers to let developed economics conduct such risky experiments. Bowing down to the wishes of green activists and placing obstacles in the growth path of Conventional Electric Power Supply would directly contradict the poverty reduction goals of policy-makers (Sultana Guru 2002).

According to the findings of the 1PCC, the consequences of such environmental changes in South-East include an increased risk of floods and droughts in many regions, decreased agricultural productivity, adverse impacts on fisheries and adverse affects many ecological systems. Wheat yields would fall by 5-10 percent with every increase of 1°C and overall crop yields could decrease up to 30 percent in South Asia by the mid - 21st century. India could experience a 40 percent decline in agricultural productivity by 2080 as rise in temperature will affect wheat growing region, placing hundreds of millions of people at the brink of chronic hunger.

According to the IPCC, the three main causes of the increase in greenhouse gases observed over the past 250 years have been fossil fffels, land use, and agriculture. Agriculture is itself responsible for an estimated one third of global warming and climate change. It is generally agreed that about 25 percent of the main greenhouse gas, carbon dioxide, is produced by agricultural sources, mainly deforestation and the burning of biomass.

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