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Impact of extreme weather events in Indian agriculture : Enhancing the coping capacity of farm families

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सार – जलवायु परिवर्तन के संदर्भ में देखें तो मौसम की चरम घटनाएं खाद्य सुरक्षा और किसानों के जीवन यापन पर प्रमुख रूप से चेतावनी के रूप में उभर रहीं हैं। इन प्रचंड घटनाओं की वजह से होने वाले नुकसान पर आमदनी का काफी भाग व्यय हो रहा है। अत्यधिक भारी वर्षा (बाढ़ और सूखा दोनों ही) और तापमान फसल की पैदावार और उत्पादन पर हानिकारक प्रभाव विशेष रूप से डालते हैं। फसल की पैदावार और पैदावार की गुणवत्ता के संदर्भ में बढ़ोतरी के मौसम में अन्त: वार्षिक वर्षा में परिवर्तनशीलता के कारण विशेषकर मौसम की चरम घटनाओं के प्रभाव वर्षा पर आधारित कृषि पर होंगे। अनेक अध्ययनों में उनकी बढ़ी हुई घटनाओं का पूर्वानुमान दिया गया है और उसके कृषि के उत्पादन पर पड़ने वाले प्रभाव का आकलन करता है। हालांकि इन जोखिमों को देखते हुए क्षेत्र स्तर पर विशेष संदर्भ में परिचालनात्मक रणनीति तैयार करना महिला और पुरूष किसानों के लिए आसानी से सुलभ नहीं है। चूँकि ये घटनाएं भौगौलिक पैमाने में स्थान विशेष की है तो भी पुरूष एवं महिला किसानों की संपति और जानों तथा जीवन यापन की हानि को रोकने के लिए तैयारी और भरपाई के ढाँचे में विकेंद्रीकृत पक्ष का सुझाव दिया गया है। इस तर्क के आधार पर हमारे देश के छोटे आसामियों की अधिक संख्या को समर्थन देते हुए कुछ सरल व्यावहारिक रणनीति तैयार करने का सुझाव इस शोध पत्र में दिया गया है।

ABSTRACT. In the context of climate change, extreme weather events are emerging as a potential threat to food security and farmers livelihoods. Considerable proportion of the revenue is being spent in addressing the damages caused due to these intense events. Extreme precipitation (both flood and drought) and temperature are crucial in causing detrimental impact on crop yield and production. Particularly, the impacts of extreme events will be more in rainfed agriculture due to interannual precipitation variability over the growing season in terms of crop yield and yield quality. Several studies have forecasted its increased occurrence and estimated its impact on agricultural productivity. Nevertheless, field level operational strategies to address these risks are easily not accessible to men and women farmers in that specific context. Since these events are localized in geographical scale, decentralised approach in the framework of 'preparedness and recovery' is suggested to combat the loss of lives, livelihoods and assets of men and women farmers. In this backdrop, the paper suggests few simple practical decentralised strategies to support the vast majority of small holders in our country.

Key words – Extreme weather, Climate change, Agriculture.

1. Introduction

Extreme Weather Events are having significant impact on agriculture and food security which is the main source of income to a large section of the rural population in our country. The growing incidence and severity of droughts, floods, hailstorms and other extreme weather events severely affect the livelihood options for small-scale farmers. It is disturbing to note that India loses, annually, about 2% of its GDP and around 12 percent of central government revenues to natural disasters (Lester and Gurenko, 2003). The commonly observed climate anomalies which occur in India due to sudden variations in weather parameters are (*i*) cold waves (*ii*) heat waves, (*iii*) floods, heavy rain and landslides, (*iv*) cyclone and tidal waves, (*v*) Drought and (*vi*) hail storms/thunder storms. Of the six, flood and drought are more frequent due to adverse changes in temperature and precipitation.

The form, frequency and increasing intensity of extreme events like drought, heat waves or floods are largely attributed to changes happening in earth's climate. As indicated earlier, the socio- economic cost due to extreme events is increasing sharply and it has been notably high in the last decade of the twentieth century. In addition to the negative impacts of climate change, for the severe and increasing losses, Ugnar (1999) and De *et al*. (2005) attributed that these higher socio-economic losses

are also due to large growth of population and migration towards urban areas, which leads to greater vulnerability.

The IPCC fourth assessment report (2007) pointed out the correlation between extreme weather events and climate changes as, "since 1950, the number of heat waves has increased and widespread increases have occurred in the numbers of warm nights. The extent of regions affected by droughts has also increased as precipitation over land has marginally decreased while evaporation has increased due to warmer conditions. Generally, number of heavy daily precipitation events that lead to flooding have increased, but not everywhere. Tropical storm and hurricane frequencies vary considerably from year to year, but evidence suggests substantial increases in intensity and duration since the 1970s" (Meehl *et al*., 2007). The study conducted by Hirabayashi *et al.* (2008) projected that there is a possibility of hydrological drought and increase in the risk of floods in humid monsoon regions of South Asia. Similarly Rajendran and Kitoh (2008) and Orlowsky and Seneviratne (2011) indicated the chances of increase in the number of extremely hot days over East Asia and South Asia. The 4 × 4 Assessment Report, brought out by the Ministry of Environment and Forests, Government of India, in November 2010, makes the following projection about extreme weather events in India. "Climate change scenarios on extreme weather events for 2030's indicate that extreme temperatures are expected to increase by 1-4 °C, with maximum increase in coastal regions and extreme precipitation events are likely to increase by 5-10 days in all the regions". Also projections indicate that the frequency of cyclones is likely to decrease in 2030s, but cyclonic intensity may increase (MoEF, 2010).

The IPCC (2007) report further indicted that among the highly populated regions in the world, South Asia and Sub-Saharan Africa are most vulnerable to extreme weather events. The global as well as regional climate models predict that sub-regional variation in more extreme rainfall patterns, resulting in the frequent occurrence of droughts or floods, which have serious implications on food production and livelihoods of farmers, are likely to be on the increase in these regions. As a consequence the agricultural market prices can increase in near future, due to adverse demand-supply situation. Study of Willenbockel (2011) indicated that a strong upward trend in world market prices of the main staple crops is likely over the next 20 years, with a significant portion of the increase caused by climate change. Similar studies by Nelson *et al.* (2009) and Hertel *et al.* (2010) also projected high price volatility as a result of climate change and population growth in combination with low agricultural productivity growth. In addition, Extreme Weather Events can potentially damage agricultural infrastructure, affect soil conditions, water resources and natural ecosystems and damage trees and cause livestock loss and reduction in milk yield etc. Recovery from these effects will take time in the case of small farmers.

The adverse changes in the weather patterns that occur due to climate change, especially temperature and precipitation on the productivity of crops has been already well established by several research studies in staple foods like wheat, rice and other crops. These changes will have considerable loss to food production and have negative impact on food security. The detailed research studies based on different emission scenarios in India indicated that it may likely to reduce the irrigated rice yields by ~4% in 2020, ~7% in 2050 and by ~10% in 2080 climate scenarios. While in rainfed rice, yields may be reduced by ~6% in the 2020 scenario, while in 2050 and 2080 scenarios, the yields are expected to reduce marginally (<2.5%). The drought has greater impact than extreme rainfall events in rice production. Sinha and Swaminathan (1991) had shown that one degree rise in night temperature in north India would reduce the crop duration and thereby reduce yield by 400-500 kg per ha in wheat.

Venkateswarlu and Shanker (2012) reported that the negative impacts of climate change will be more in rainfed agriculture due to variability in rainfall as well as reduction in number of rainy days, which will have greater implications for farmer's on choice of crops, varieties, and cropping pattern and systems. Studies have also indicated that water requirement is estimated to increase by 10% for every 1 °C rise in temperature which has serious implications on productivity and water use efficiency in several crops. The unseasonal rain, changes in the relative humidity and heavy dew influence the micro climate of the crop which leads to unpredicted insect and disease incidences (Sharma *et al.*, 2013). In case of livestock, heat wave is the critical climate variable affecting its milk production and projections estimated that the yield loss would be 1.6 million tonnes in 2020 and 15 million tonnes in 2050, from current levels. Also it is reported that the reduction in milk production will be higher in crossbreds (0.61%) followed by buffaloes (0.5%) and indigenous breeds (0.4%) (Srivatsava, 2010).

Studies on climate modelling in different scenarios at both global and regional scales points to a rise in the frequency of extreme weather events. The response strategy to the rise in extreme weather events has to be in preparedness and recovery mode to combat the loss of lives, livelihoods and assets. Eternal vigilance is needed for managing adverse weather behaviour.

2. Decentralised preparedness and recovery plans at agro-ecological zone levels

Since extreme events are localized, zoning of prone areas are to be identified and decentralised anticipatory measures or strategies are to be prepared for each agro-ecological zones/region, to insulate the farmers from adverse impacts of extreme weather events and impart better stability to agricultural production. Both central and state governments need to adopt a comprehensive preparedness and recovery plans at the scale of agro-ecological zones to meet the loss in production and provide support to farmers to overcome the impact of financial and asset losses. Some of the important measures that are needed to be taken up on priority to meet these challenges are as follows:

- *Building capacity of the Agricultural officers* to deal in coordination with the other sectoral departments like animal husbandry, Disaster management board/dept, rural development etc., for community based comprehensive actions.

- *Preparing the farming communities for climate change* : In the context of increasing risks of extreme weather events due to climate change, sensitizing men and women farmers on their occurrence as well as localised coping practices. This will help them to adjust changes in cropping systems *vis-a-vis* markets and take informed decisions based on weather and climate.

- *Promotion of Climate Risk Management and Mitigation Centres* : Enhancing the coping capacity to the increasing extreme weather/climate events are necessary through appropriate preparedness strategy for insulating our men and women farmers from aberrant weather events to the maximum extent possible and to protect our food, water and livelihood security systems from the impact of global warming. In this context, the importance of having a decentralised 'Good Weather Code' which will spell out the types of activities that should be undertaken in the event of rainfall being good, along with provisions for its implementations that was insisted in early 1970's (Swaminathan, 1973), still holds relevant. The aim is to maximise production in years of normal and good rainfall and to minimise the loss to crop production in years of unfavourable monsoon. Considering the position of Agro Meteorological Field Units (AMFUs) in different agro-climatic zones of our country, a set of 'Good Weather Code', Drought Code and Flood Code depending upon local climate risks can be developed, along with necessary provisions for its implementation. The main aim of such Codes, detailing the anticipatory measures should be undertaken, is to reduce the adverse impacts of abnormal weather and maximise the benefits of good monsoons and favourable weather elements. For example as part of Drought Code, contingency plans involving the cultivation of alternate crops based on the rainfall pattern is recommended to cope the unusual situation. However, it will be possible only if the seeds of the alternative crops are available. Similar to grain reserves for food security, seed reserves of suitable crop varieties are important for crop security. To promote and facilitate such adaptation and mitigation practices at the local level, 'Climate Risk Management and Mitigation Centres' can be established at the panchayat/village level. The proposed center will work in collaboration other connected line departments of the state at block level considering the proposed initiatives of IMD for the block level weather forecasts. Such centers will train a cader of community based Climate Risk Managers.

- *Crop Insurance* : The implications of extreme weather events are not only seen in terms of overall food production of wheat or rice or other crops, but also in terms of income of small farmers. Hence it is essential to opertionalise the crop and animal insurance provisions with right spirit, as a part of a risk management strategy to enhance the coping capacity of men and women farmers to meet the unforeseen losses. The successful pilot initiatives using weather index based insurance, which is approved by India in 2007 can be studied and fine tuned to the local situation for wider use among small holders. Credit linked insurance will confer the greatest benefit to resource poor men and women farmers.

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