Agricultural Risk Management to Combat Climate Change Effects

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Introduction

The urgent need to increase food production to feed the ever-growing population has resulted in a large increase in the land area used for agriculture especially in developing countries. In recent years the world community has become increasingly concerned about the adverse effects of climate change on food production, natural ecosystems, freshwater supply, health sector and property loss. Climate change effect is already seen and is bound to continue, even under the most optimistic emissions scenarios. The Intergovernmental Panel on Climate Change (IPCC) projects that the global mean temperature may increase between 1.4 and 5.8 °C by 2100 (IPCC, 2007). The impact due to this unprecedented increase in extreme weather events would be particularly severe in the tropical areas, which mainly consist of developing countries, including India. An analysis of 100 years of rainfall data in India reveals that the frequency of 'below-normal rainfall in arid, semi-arid and sub-humid regions is 54-57%, while severe and rare droughts occurred once every eight to nine years in arid and semi-arid zones. For instance, the impact of the drought 2002 spread over 56% of the land mass and threatened the livelihoods of 300 million people across 18 states in India.

The main determinant of agricultural production is the variation of weather variables like temperature, precipitation and sunshine etc. Extreme weather events like, droughts, floods, frost and heat and cold waves affect both crops and livestock. The major concern is the frequency of occurrence of these events. Farming community especially small and marginal category does not have fast resilient ability to tide over ill effects of vagaries of weather and therefore they are disproportionately vulnerable to the severity of extreme climate events. Nonetheless, the impact of climate variability and change on farmer's livelihood in different agro-climatic regions and the changes in risk management approaches have shaped the mitigation and the response strategies of farmers and societies over the years. There has been a dramatic technological progress in the understanding of climate systems, as well as in monitoring and forecasting weather events on the scale of seasons and beyond. The advent of more reliable forecasts goes hand-in-hand with emerging trends in risk management, where reactive strategies are gradually being replaced with more anticipatory, proactive and forward looking approaches. The enterprise of agriculture is so fragile, affected by many uncontrollable events that are often related to weather including excessive or insufficient rainfall, hail, extreme temperatures and frost etc. that can severely impact yields and production levels. In the light of above, it is imperative to understand agricultural risks due to climatic variability and change and the ways of management deserves serious attention and research.

Greenhouse gases and agriculture

Human activities primarily burning of fossil fuels and changes in land cover are modifying the concentration of atmospheric constituents. Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since Pre industrial period(1750) is presented in the following table. (IFAP Technical Report, 2007).

Comparison of atmospheric concentration of GHGs during 1750 and 2006

Green House Gases	Pre industrial level	2006 level	% increase	% Contribution to global warming
CO_2 (ppm)	280	381	36	63.0
CH_4 (ppb)	715	1782	155	18.6
N_2O (ppb)	270	320	19	6.2

The primary source of the increased atmospheric concentration of carbon dioxide, since the pre-industrial period results from fossil fuel use and with land use change (deforestation). It is very likely that the observed increase in methane concentration is due to anthropogenic activities, predominantly agriculture and fossil fuel use. More than 33% of all nitrous oxide emissions are anthropogenic and are primarily due to agriculture.

Agriculture risk

Agriculture risk is systemic in nature. Thus, it is believed that risk affecting farmers in an area could be fairly dealt under the 'Area Approach'. The other risks affecting items other than crops are 'independent' in nature and hence, it will be difficult to connect loss / damage of other assets, to operation of systemic risks. In other words, the assets other than crops can be correctly indemnified in the event of loss only under 'individual assessment'

Understanding the climate mechanisms, that contribute to climate and weather related risks are imperative. Climate disasters can be divided into extreme events and regional climate anomalies. Global climate change may produce a larger number of climate disaster occurrences. This is based on the fact that a linear increase in the average of a climatic variable implicates a nonlinear increase in the occurrence of probability of extreme values.

Risk management in agriculture

Agriculture in general, is often characterized by high variability in production outcomes, that is, by production risk. Agricultural production can also be hindered by adverse events during harvesting or collecting that may result in production losses. In discussing how to design appropriate risk management policies, it is useful to understand strategies and mechanisms employed by producers to deal with risk, including the distinction between informal and formal risk management mechanisms and between ex-ante and ex-post strategies. The ex-ante or ex-post classification identifies the time in which the response to risk takes place: ex-ante responses take place before the potential harming event; ex post responses take thereafter. World Bank in 2001 reported that the inability to accept and manage risk respectively reflected in the inability to accumulate and retain wealth is sometimes referred to as the "the poverty trap" (World Bank, 2001).

Based on Clarkson et al. (2001), there are six requirements that must be met if farmers are to manage risks related to climate extremes, variability and change. These include:

1. Awareness that weather and climate extremes, variability and change will impact on farm operations
2. Understanding of weather and climate processes, including the causes of climate variability and change
3. Historical knowledge of weather extremes and climate variability for the location of the farm operations
4. Analytical tools to describe the weather extremes and climate variability
5. Forecasting tools or access to early warning and forecast conditions, to give advance notice of likely extreme events and seasonal anomalies
6. Ability to apply the warnings and forecasts in decision-making

Risk management strategies

1. Changes in land use and management

Small changes in climatic parameters can often be managed reasonably well, by altering dates of planting, spacing, input management, new cultivars adapted to drier conditions, salt water resistant varieties of crops in the areas where drainage is poor development of irrigated agriculture and farming systems like mixed cropping, crop-livestock and that are more adapted to changed environment can further ease the pressure. In addition to these, improving technology to increase production in climate favourable sites in order to offset uncertain production in marginal areas, better adaptation of agricultural calendar, crop diversification to spread risks and setting up processing and storage facilities.

World over, crop diversification is regarded as the most common and effective risk management strategy that is employed by farm households. Multiple cropping system is another strategy that even if a particular crop does not do well, the loss will be compensated by gains in another crop. Optimum use of fertilizers and ecologically clean agrotechnologies would be another risk management strategy. There are some limitations of this strategies however. First, diversification is clearly a feasible strategy to the extent that crop risks are independent, however, if returns are strongly correlated across crops, the risks facing farmers are similar to systemic risks and crop diversification will not be effective in reducing producer risk. Second, crop diversification calls for spreading resources across crops even when a particular crop offers higher average net returns than other crops. Therefore, the price of diversification is the income foregone, on average, by not growing the remunerative crop. Third, if there are fixed costs in the cultivation of a particular crop, then there is a minimum efficient scale and that may conflict with the requirements of crop diversification. Farmers with smallholdings are likely to run into this constraint. The major impact of climate change in arid and semi-arid regions is likely to be an acute shortage of water resources associated with significant increases in surface air temperature. Some of the management strategies in semi-arid and arid region are as follows:

Semi-arid regions:

1. Shift to drought tolerant cultivars
2. Enhancement and maintenance of soil fertility and protection of soils from degradation
3. Development of complementary irrigation
4. Development of early warning system on drought and other climate induced natural disasters
5. Implementing crop livestock integration
6. Implementing agroforestry systems

Arid regions:

1. Shifting from agriculture to other less climate sensitive activities (Livestock, Agroforestry)
2. Use of short duration varieties
3. Optimize planting dates

2. Development of resource conserving technologies

Recent research and developments have shown that surface seeding or zero-tillage establishment of upland crops after rice gives similar yields to when planted under normal conventional tillage over a diverse set of soil conditions. In addition, such resource conserving technologies restrict release of soil carbon thus mitigating increase of CO_2 in the atmosphere. Greater emphasis on water harvesting and improving the efficiency of regional as well as farm water use efficiency could help to face uncertain rainfall.

3. Risk transfer through agriculture insurance support services

One element of climate risk management strategies is to enhance the financial services available to cope climate risk. Many farmers in the developed world have insurance for crop failure resulting from adverse climatic conditions. Few farmers in developing countries have access to such mechanisms, which would allow them to take greater risks and achieve higher overall incomes. An option being tried in several countries is the use of weather index insurance or weather derivatives. Although these mechanisms can be powerful, they can also become a disincentive for adaptation (World Bank, 2005). They should be used to promote activities consistent with projected climate trends, as well as with market conditions. Any effective system of insurance is based on accurate and timely data. Also effective insurance mechanism operates on the law of large number and that in turn requires effective distribution channels.

An important impediment to the expansion of insurance for poor farmers is the cost of reinsurance to local financial institutions. The World Bank Group has proposed a Global Index Insurance Facility (GIIF) a risk-taking entity that would originate, intermediate, and underwrite weather, disaster and commodity price risks in developing countries (World Bank, 2006).

Livestock Insurance

Livestock forms a significant proportion, of rural wealth and is an important source of rural livelihood in India. Almost all over the country, livestock-related economic activities are an indispensable adjunct of agricultural activity. In addition, livestock-related activities form the exclusive source of income for some groups of the rural community. In other words, the livestock economy is itself a source of insurance for farmers in that it provides a diversified source of income and mitigates the uncertainties of seasonal income.

There is one more reason to include livestock insurance in risk management in agriculture, viz.:

a) India has three decades of experience with livestock insurance, so the physical and managerial infrastructure is in place.
b) The Animal Husbandry Department, GOI, has been taking a keen interest in livestock insurance and has launched its own initiative, in the form of a national livestock insurance scheme, whose pilot is under implementation in selected districts of India.

4. Nutritional strategies for managing heat stress in dairy animals

Nutritional modifications can help to maintain homeotasis in dairy animals or prevent nutrient deficiencies that result from heat stress, thereby minimizing the production losses associated with heat stress. The livestock owners, in several regions, based on their indigenous technical knowledge, apply numerous nutritional modifications that are useful for hot weather feeding; however, many need.

Challenges in combating climate variability and change

There are, however, formidable challenges in making use of climate forecast technologies and information, for societal benefits. Some of the major barriers are:

(i) Most of the climate information products and tools, which were developed by various scientists for risk management, are not fully utilized. This is partly because of we are still developing institutional, economic and cultural frameworks, within which decisions are made in any society. Further, decision makers frequently do not actively seek new technologies and sources of information or initiate contacts with experts who could be helpful in making more informed decisions.

(ii) While capacities to generate most of the climate information products rest with advanced global climate research centres, the need and demand for these products lies within local at-risk communities.

(iii) The uncertainties associated with climate change as well as socio-economic scenarios, in the next 100 years and beyond do not lend urgency to efforts, in mainstreaming climate change adaptation options into the immediate development planning process.

(iv) The financial and managerial constraints in developing appropriate interventions to spread, share and master the climate and other risks in agriculture seriously undermine the benefits of technological breakthroughs in climate forecasting.

(v) Practice is lagging behind the science. Neither farmers nor policy makers have easy access to relevant decision information, beyond that offered by general climate forecasts. Without climate impact assessments and risk evaluations, many decisions are made without complete impact/risk knowledge, thereby leading sometimes to sub-optimal outcomes.

Like all knowledge intensive processes the use of climate information requires national and local institutions, with a capacity to interpret and effectively disseminate probabilistic climate information products, to match needs. Recent experiences in the use of climate information in the country, to anticipate and manage risks in agriculture, provide useful insights.

Recommendations

i. Agriculture is at the heart of risks associated with climate variability and change and its centrality should be recognized, in mitigating and adapting to their effects. Climate change mitigation and adaptation measures should therefore be integrated into the country's Five Year Plans and its poverty reduction strategies.

ii. Capacity building activities are required in developing countries to promote more active applications of climate information and knowledge. Capacity building should specifically target: a) development of institutional structures and communication lines for developing and developed countries in regards to methodologies, climate forecast interpretation and climate/agricultural applications, and b) accessibility of necessary software, hardware, data and decision tools.

iii. Tailored training should be available to consultants, advisers, and decision makers (farmers and policy) on the fundamentals of statistical methods, climate variability, climate change, forecasting and applications, as needed to make informed decisions in natural resources management and agricultural production. Regular training seminars should be held for user communities on seasonal to inter annual climate forecast applications.

iv. Large-scale use of remote sensing technology in the agricultural insurance programme for timely settlement of claims including for on account payments, the introduction of new distribution channels like post offices and micro insurance agencies and the creation of a nationally consistent database with timely dissemination of information from crop-cutting-experiments and cleaning of historical data, etc.

v. Many developing countries do not have human and financial resources to develop climate-forecasting applications on their own. Developed countries together with donor agencies should explore innovative ways of extending climate forecasts and agricultural applications to developing countries.

vi. Weather insurance must continue to be the dominant insurance concept as the coming years will experience more frequent extreme weather events like heavy rains, droughts heat and cold waves etc.

vii. Finally, issues related to climate change and variability needs to be treated as a major economic and social risk to national economies, not just as a long-term environmental problem.

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