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SUSTAINABILITY OF INDIAN AGRICULTURE WITH EMPHASIS ON CLIMATE CHANGE

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ABSTRACT

The major cause of climate change has been ascribed to the increased levels of greenhouse gases like carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2), cholorofurocarbons (CFCs) due to the uncontrolled activities like burning of fossil fuels, increased use of refrigerants and enhanced agriculture related practices. There is no doubt that climate is changing. The main reason for climate change is the increase in the concentration of greenhouse gases in the atmosphere due to several natural and anthropogenic activities. The level of greenhouse gases has already increased considerably over the period particularly after industrial era (1850). Agriculture is an economic activity that is highly dependent on climate in order to produce the food and fiber necessary to sustain human life. The agriculture in India is highly sensitive to variations of weather and climate. The history of Indian agriculture reflects a series of adaptation. Soil, water, terrain, climate, technological developments and market factors provide constraints and opportunity for agricultural productions. Climate change has already been a reality for Indian farmers. These changes over time represent stimuli that affect the success of farming activities negatively and that prompt adjustments to altered circumstances. Since the inceptions of 'sustainable agriculture' in Rio Summit in 1992, a diverse range of approaches are put forward by researchers, state organization, nongovernmental development bodies, private organization in India but guided by the basic principle of sustainability. Sustainable agriculture must be economically viable, socially responsible and conserve land, water, genetic and other resources for future generation.

KEYWORDS: Agriculture, Climate Change, Greenhouse Gases, Sustainability, Vulnerability

INTRODUCTION

Climate induced natural disasters has a growing concern for their effects on agriculture and have stimulated academic, public and policy level interests on the analysis of the impacts of climatic variability on agricultural production systems(Lavelle *et al* 2009). The spectrum of climatic change will exacerbate its impact on agricultural production in most part of the world. The global environmental change juxtaposed with frequency and intensity of climate induced natural disasters like storms, droughts and floods alter the hydrological cycle and precipitation variability having implication in food availability in developing world (Dash *et al* 2009; Dash *et al* 2007; Rao*et al* 2008). India makes up roughly 20% of GDP and provides nearly 52% of employment, with the majority of agricultural workers drawn from poorer segments of the population (FAO 2006). India`s agriculture is highly sensitive to the vagaries of weather, particularly variability in rainfall. Thus Indian Agriculture faces the dual challenge of feeding a billion people in a changing climatic and economic scenario. Sustainable development has caught the imagination and action of the world for more than a decade.

IMPACT OF CLIMATIC CHANGE ON AGRICULTURE

Atmospheric CO_2 Concentration

The atmospheric CO2 concentration has increased 35% percentage from a pre-industrial value, from 280ppm by volume (ppmv) in 1880 to 379 ppmv(2005) (Solomon et al 2007). The increasing CO2 concentration in the atmosphere and the anticipated climate change due to global warming are likely to affect future global agricultural production through changes in the rate of plant growth (Lemon 1983; Cure and Acock 1986; Rotter and Van de Geijn 1999), transpiration rate (Morison 1987; McNaughton and Jarvis 1991; Jacobs and DeBruin 1992).

Temperature

The linear warming trend of the last 150 years (0.13^0C per decade) is nearly twice that for the last 100 years. This rise in globally averaged temperatures since mid twentieth century is considered to be very likely due to the observed increase in anthropogenic greenhouse gas atmospheric concentrations (Solomon et al 2007). Increased surface temperature is expected to affect agricultural production world-wide.

Precipitation

Globally, rainfall is predicted to increase by about 25% by 2050in response to climate change. However, the regional distribution of rainfall will be uneven (Houghton et al 2001). Increased precipitation is very likely in high altitudes and decresed precipitation is likely in most subtropical regions, especially at the poleward margins of the subtropics (Solomon et al 2007).

Storms

According to intergovernmental panel on climate change projects, there is likely to be an increase in tropical cyclone mean and peak precipitation intensities in some areas as a result of global climate change (Houghton et al 2001, Solomon et al 2007).

Flood

The impact of climate change on flood frequency is often defined by the percentage change in a flood peak of a given period. In India climate change appears to be influencing the monsoon and tropical cyclones, the two prime drivers of flood events which will be affected by changes in temperature and in rainfall. Rising temperatures will accelerate the rate of melting snow and glacier ice and thereby increasing seasonal peak flows of Himalayan headwaters. This in turn may lead to an increased frequency of flooding particularly along waters whose channel capacity has been reduced by sedimentation (Aggarwal et al 2004).

Sea-Level Rise

Global sea level rise is one of the more certain outcomes of global warming. In India a possible sea-level rise of 15-38 cm by 2050s would cause saline water to penetrate further inland and ultimately damage the coastal agriculture (Ravi 2008).

MODERN SUSTAINABLE AGRICULTURE APPROACHES USED IN INDIA

Introducing the concept of Conservation Agriculture (Resource Conserving Technologies) was an important breakthrough for sustaining productivity, natural resource base and economic growth of the farmers. Some of the modern methods of sustainable agriculture practiced in India are described below:

Bio fertilizers

Biofertilizers are microbial inoculants that artificially multiplied cultures of certain organism that fix nitrogen from air and improve soil fertility and crop productivity. This technique is known in India since ancient times but the role of biological nitrogen fixation was discovered more than a century ago and commercial production of such biological process is recent interest and practices. Bio fertilizers offer a new scientific approach to Indian agriculture holding a promise to balance many of the shortcomings of the conventional chemical based technology and certainly will help in sustaining Indian agriculture in the era of climate change.

Vermicompost

Vermitechnology is an important part of biotechnology where earthworms are used to convert various types of organic wastes into valuable resources (Padma et al. 2002; Prabha et al. 2005). It is very much rich in nutrients like 1.5% nitrogen, 0.5% phosphrous and 0.8% potassium as well as micro nutrients. Earthworms are considered as the key stone organism in regulating nutrient cycling processes in many ecosystems (Tripathi and Bhardwaj 2004). It is successfully used in India to clean the environment as it uses the waste as raw material and convert the polluted costly conventional chemical farming to sustainable agriculture (Lal et al 2003).

Zero Tillage System

This is one of the most important principles of sustainable agriculture, where the seed is placed into the soil by a seed drill without prior land operations. This approach has been tested and being practiced over 2 million hectares in India. This technology has high relevance in higher yielding and more mechanized area like north western India (RWC-CIMMYT 2005).

Laser Land Leveling

Unevenness of soil surface has major impact on farming operations. Therefore the land leveling is precursor to good agronomic, soil and crop management practices. Laser land leveling is a recent technique used as inputs in intensively cultivated irrigated farming that meets the twin objective of achieving a better crop stand, save irrigation water and improves the input efficiency (Jat et al 2005).

Crop diversification

It is like inclusion of certain crops in sequential and intercropping system help in mitigating the environmental problems arising on account of monoculture and obnoxious weeds. Nitrate leaching are threats inevitable under these agricultural production systems. Choices of appropriate cropping systems and management help in minimizing nitrate leaching. Crop diversification in India is slowly picking up momentum in favour of legume intercropping in cereals.

Crop Reside Management

Crop residues are good source of plant nutrients (25% of nitrogen and phosphate, 50% of sulphur and 75% of potassium) and also important component for stability of agricultural systems (Jat et al 2004). Residue characteristics and soil management factors affect residue composition in the soil management factors affect residue decomposition in soil. Sufficient efforts are being made during the recent past to develop efficient technologies but the development of new generation drills has been proved to be significant achievement in the direction of conservation of agriculture.

Stability over Long Term

Organic agriculture considers the medium and long term effect of agricultural interventions on the agro-ecosystems. It aims to produce food while establishing an ecological balance to prevent soil fertility and pest problems. Organic agriculture takes a proactive approach as opposed to treating problems after they emerge.

Soil

Soil building practices such as crop rotations, inter cropping, symbiotic associations, cover crops, organic fertilizers and minimum tillage are central to organic practices. These encourage soil flora and fauna, improving soil formation and structure and creating more stable systems.

Water

In many agricultural areas, pollution of groundwater causes with synthetic fertilizers and pesticides is a major problem. As the use of these is prohibited in organic agriculture, they are replaced by organic fertilizers (Ex. compost, animal manure, green manure) and through the use of greater biodiversity in terms of species cultivated and permanent vegetation, enhancing soil structure and water infiltration (Vani 1992, 2002).

Air and Climate Change

Organic agriculture reduces non-renewable energy use by decreasing agrochemical needs. Organic agriculture contributes to mitigating the greenhouse effects and global warming through its ability to sequester carbon to the soil raising productivity and favouring carbon storage.

Biodiversity

Organic farmers are both custodians and users of biodiversity at all levels. At the gene level, traditionally adapted seeds and breeds are preferred for their greater resistance to diseases and their resilience to climatic stress. At the species level, diverse combinations of plants and animals optimize nutrient and energy cycling for agricultural production. At the ecosystem level, the maintenance of natural areas within and around organic fields and absence of chemical inputs create suitable habitats for wildlife (Sofia et al 2006).

CONCLUSIONS

Concerns about climate change are global and real. As all communities try to get adapted to the challenges of their local climate, they are today sensitive to its variations. Indian agricultural systems are threatened by the predicted effects of climate change because of their economic dependence on climate for development whose backbone is agriculture. The task of bringing in a paradigm change in India's agriculture system is by no means going to be straight forward task. In the last

couple of decades, the government has been implementing many plans and programs for the development of the agricultural lands and non-agricultural lands whose implementations have added significant values to the sustaining food and land productivity in the case of evolving climatic vulnerability. Scientists and farmers must join efforts to further understand crop climate relationships and formulate viable, locally adapted production technologies that will address critical issues such as climate variability. In this context, conservation agriculture has been identified as the immediate as well as long term solution.

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