Chapter 14
Implications of Climate Change on Agriculture and Food Security in South Asia

M. Ad Spijkers

Contents

Abstract It is estimated that the current food production in South Asia has increased three times from 117 million tonnes in 1961 to 348 million tonnes in 2006, but the dietary energy consumption has improved not enough emphasising the fact that the growth rate is not sufficient to tackle the emerging challenges in addition to population pressure. Ensuring food security in the future requires a great deal of additional efforts in yield improvement, with limited scope for expanding area under cultivation.

FAO has revealed recently (2008) that the Boro rice output in Bangladesh is estimated at record 17.54 million tonnes, increased by some 17.2% from the previous year and 29.3% above the 5-year average. This increase of production was mainly due to favourable weather conditions and extra efforts made by farmers and Government in response to the high food prices and production loss of 1.4 million tonnes in 2007 Aman season following severe flood and Cyclone Sidr.

We in FAO strongly feel that it is not enough; adaptation and mitigation requires socio-institutional learning process and participatory community based actions for technology refinement and transfer. Location-specific technologies and good practices need to be built upon an improved understanding of the links between climate change and food provision, while promoting socio-economic development and limiting further environmental degradation.

M. Ad Spijkers (✉)
FAO Representation, FAO, House #37, Road #8, Dhanmondi Residential Area, Dhaka, 1205, Bangladesh
e-mail: ad.spijkers@fao.org

R. Lal et al. (eds.), *Climate Change and Food Security in South Asia*,
DOI 10.1007/978-90-481-9516-9_14, © Springer Science+Business Media B.V. 2011

Keywords Gross domestic product • Poverty line • Fragile ecosystems • Glacier melting • Hydrologic cycle • Disaster risk management

14.1 Introduction

Securing world food security in light of the impact of climate change may be one of the biggest challenges we face in this century. An estimated 1,020 million people in the world today suffer from hunger. Of those, more than 95% live in developing countries, the countries expected to be most affected by climate change. Projected population and socio-economic growth will double current food demand by 2050. To meet this challenge in developing countries, cereal yields need to increase by 40%, net irrigation water requirements by 40–50%, and 100–200 million ha of additional land may be needed, largely in Asia, sub-Saharan Africa and Latin America.

The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) states that warming of the climate system is unequivocal, as is now evident from observations of increase in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level (IPCC 2007). Observational evidences from all continents and most oceans show that many natural systems are being affected by regional climate changes, particularly temperature increase. In terrestrial ecosystems, earlier timing of spring events and pole ward and upward shifts in plant and animal ranges are with very high confidence linked to recent warming. In some marine and freshwater systems, shifts in ranges and changes in algal, plankton and fish abundance are with high confidence associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation. All these changes are already affecting agriculture and allied sector and food security in many parts of the world.

South Asia (as defined in this paper comprises eight countries; Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka,) faces key development challenges such as population growth, high incidence of poverty, urbanization and the degradation of the environment. Climate change could make this region more vulnerable and reverse country's efforts towards achieving the Millennium Development Goals (MDGs) by causing reduction in agricultural yields, increased water stress due to changes in precipitation patterns and glacier melting, decline in fishery products, degradation of natural grasslands and impacts on forest products. South Asia lags on most human development goals, although it will likely meet the poverty reduction MDG (World Bank 2008).

The climatic conditions, combined with socio-economic situations make South Asia, one of the most vulnerable regions in the world with regard to climate change. The climate of South Asia is characterised by extremes and natural hazards like cyclones, wind storms, droughts and heat waves, floods, Glacial Lake Outburst Floods (GLOS), land slides, pest and disease outbreaks etc.. The assessments of the impacts of natural disasters revealed that South Asia accounts for almost 80% of the total population affected and 86% of total damage due to drought in Asia.

Similarly, this sub-region account for 35% of the total population affected and 28% of the total damage due to floods in Asia (CRED 2008). Moreover, the productive sectors which include agriculture accounted for over half of associated damages and losses. Climate change will superimpose itself on these existing trends, significantly increasing production risk and rural vulnerability, particularly in regions that already suffer from poverty and hunger.

14.2 Current Agriculture Production and Food Security Status in South Asia

The majority of the south Asian countries share similar economic and sustainable development challenges. The most prominent similarities are frequent occurrence and susceptibility to natural hazards, excessive dependence on agriculture, widespread poverty and vulnerability to climate change. Five out of eight countries in the region are characterised as Least Developed Countries (LDC), and of these five LDCs, three are Land-Locked Least Developed Countries (LLDC) possessing low-income, weak human resources and economic vulnerability. The South Asia region contains a population of 1,507.5 million (2007) and projections anticipate 1,727 million by 2015. Agriculture represents a high share of GDP and approximately 150 million households, with 751 million people classified as agriculture dependent. Since 1990, millions more people are chronically hungry in sub-Saharan Africa and in Southern Asia, where half the children under age 5 are malnourished (United Nations 2005).

South Asia possesses diverse farming systems ranging from intensive rice-wheat systems to sparse arid regions and mountains. Large parts of the region face severe environmental constraints like erratic and uneven distribution of rainfall, water stress risk, low soil suitability, steep slopes and mountains, severe land degradation and low to medium climate production potential (Dixon et al. 2001). The area under arable land and permanent crops is estimated at 213 million ha (FAO 2008a) and expected to show only a marginal increase by 2030; the region's irrigated land area will grow from 85 million ha to about 95 million ha in 2030.

The current total food production in South Asia has increased threefolds from 117 million tonnes in 1961 to 348 million tonnes in 2006 (FAO 2008b), but the dietary energy consumption has increased only marginally. The current dietary energy consumption is 2,364 kcal/person/day and is expected to increase to 2,790 by 2015 and 3,040 by 2030. It requires additional efforts in yield improvement, given the fact that there is limited scope for expanding area under cultivation and area under irrigation.

South Asia is home to the largest concentration of poverty and undernourished population. FAO estimates that 312 million (21%) people are still undernourished (FAO 2008c) and 26.4% of the population is below poverty line (ADB 2008). Indicators of other dimensions of poverty, such as female illiteracy (59%), child mortality (89 per 1,000 in children <5 years), and child malnutrition (51%) also point to extensive poverty. Nearly 40% of the world's poor earning less than a dollar a day live in the region (Dixon et al. 2001).

14.3 Climate Change and Its Implications for Agriculture and Food Security in the Sub-region

Changes in climate and other important environmental factors pose a major concern to food security in the region. This is because such changes not only directly threaten the production of food from land and sea for local consumption, but also threaten revenue generation at farm scale. The adverse impacts of climate change are a major barrier to food security and achievement of sustainable development goals in South Asia. They are anticipated to exacerbate the impact of existing development challenges such as loss of market and declining value of traditional exports, declining domestic food production and increasing imports; and environmental degradation.

Arable land, water resources and biodiversity are already under pressure and are expected to be stressed by changes in precipitation patterns. With climate change, negative impacts on agriculture are predicted; coral reefs and mangroves will be threatened by increased sea surface temperatures, and sea-level rise. Predicted impacts of climate change in the region include extended inundation of arable land, salinity intrusion and reduced fresh water availability. For example, in India freshwater availability is predicted to decrease by 47% in 2025 due to climate change and population growth.

The fragile ecosystems vulnerable to climate change impacts are: mountain/Himalayan ecosystems (e.g. Nepal, India, Bhutan), mangroves, salt marshes and coral reefs (e.g. India, Bangladesh and Sri Lanka), semi-arid and arid resource poor dry lands (e.g. India and Pakistan). The low lying coastal regions would be affected due to Sea Level Rise (SLR) and/or increase in extreme climate events (e.g. Maldives and Bangladesh).

Semi-arid tropics are vulnerable due to reduced rainfall and increased evapotranspiration and drought (e.g. central and peninsular India; Sindh and Balochistan of Pakistan; North West Bangladesh), while small islands are extremely vulnerable due to high exposure of population and agricultural infrastructure to sea level rise (e.g. Maldives) and increased storm surge. The Magna basin and north eastern hoar region of Bangladesh is vulnerable to flash floods.

Fresh water availability in South Asia is projected to decrease and temporal and spatial changes in precipitation and associated droughts have major implications for agriculture. Temperatures are projected to increase by as much as 3–4°C towards the end of the twenty-first century. In India, climate change may aggravate the current problems of sustainability and profitability of agriculture in many regions. Studies on socio-economic impact of climate change indicate that the loss in farm-level net revenue may range between 9% and 25% for a temperature rise between 2.0°C and 3.5°C (MoEF-GOI 2004).

In Pakistan, studies indicate that fourteen crops (eight field crops, three vegetables and three fruits) have shown some degree of vulnerability to heat stress under a climate change scenario of a rise in temperature of 0.3°C per decade. Under the scenario where rainfall decreases by 6%, net irrigation water requirements could increase by 29%. Over 1.3 million farm households (30% of the total), cultivated

cotton and 27% of reporting households had paddy fields which will be exposed to negative climate change impacts (MoE-GIRP 2003).

Glacier melting in the Himalayas is projected to increase flooding and affect water resources within the next two to three decades. Glacial Lake Outburst Floods (GLOF), landslides, flash flood and droughts are key hazards affecting Bhutan. Decreased water availability for crop production, increased risk of extinction of already threatened crop species (traditional crop varieties), loss of soil fertility due to erosion of top soil and runoff, loss of fields due to flash floods, landslides, crop yield loss due to hailstorms and forest fires are the key vulnerabilities. There are an estimated 2,674 glacial lakes in Bhutan out of which 562 are associated with glaciers and 24 glacial lakes are potentially dangerous (NEC-RGB 2000).

Agriculture remains Nepal's principal economic activity, employing 80% of the population. The Terrai plains constitute 43% of the total cultivated land. Recurring natural disasters undermine agricultural productivity causing poverty and food insecurity. In Nepal, the potential yield of Terrai rice is estimated to increase by about 18–21% when CO_2 increases to 580 ppm. However, with an increase of temperature beyond 4°C, the yield is projected to decrease. Similarly, temperature changes will affect the availability of forages and alter the movement of Yaks in the mountains between 3,000 and 5,000 m elevation (MoEST 2004).

It is projected that Sri Lanka's rice output would be reduced by 5.91% with a temperature increase of 0.5°C. Approximately 740,000 ha are cultivated with paddy in Sri Lanka and of this 44% is irrigated under major irrigation schemes and another 24% under minor irrigation schemes (GoSL 2000). The bulk of this land is in the dry and intermediate zones and is vulnerable to fluctuation in rainfall pattern. Increased temperatures are also expected to negatively affect high value crops such as vegetables and potatoes. The impact of salt water intrusion on low lying agriculture would be significant and loss and degradation of arable lands will significantly lower the agricultural output in coastal areas. A temperature rise of about 2°C may have substantial impacts on the distribution, growth and reproduction of fish stocks.

Over 80% of the land area of the Maldives is less than 1 m above mean sea level and is extremely vulnerable to sea level rise and beach erosion. Agriculture is a comparatively small sector in the Maldivian economy with a GDP share of about 3.5%. However, the sector is considered important because of its potential on generating employment, income opportunities and attaining local food security. A wide range of crops are grown, with a heavier concentration of root crops in the south and more field and grain crops in the north. The Maldives tuna fishery is affected by the seasonal monsoon and their associated currents.

The hydrological cycle is predicted to be more intense with increased intensity of daily rainfall during monsoon season which may lead to intensified flooding and inundation of agricultural areas. The most intense cyclones crossing the East coast of India and Bangladesh are associated with storm surges, strong winds, coral bleaching, ocean spray and inundation of land, and erosion. In South Asia, analysis of data has shown that the number of very warm days and nights is increasing. There is a trend towards an overall increase in precipitation, with prolonged dry spells having occurred over the last few decades. Climate change projections show

marked increase in both rainfall and temperature over the region. Temporal and spatial changes in glacier melting and precipitation patterns; associated droughts, floods, and more intense or frequent cyclones are likely to negatively affect all agricultural sub-sectors.

The crop yields could decrease up to 30% in the region by the mid-twenty-first century and considering the population growth, the risk of hunger is projected to remain very high. Impact analysis based on statistical crop models and climate projections for 2030 from 20 general circulation models, revealed that South Asia, without sufficient adaptation measures, will likely suffer negative impacts on several crops that are important to large food-insecure human populations (Lobell et al. 2008). Other projected impacts of climate change include inundation of arable land, salinity intrusion, reduced fresh water availability and persistence of transboundary pest and diseases. Irrigation demand for agriculture in arid/semi-arid regions is expected to increase by 10% for temperature increase by 1°C; and increased dryness during pre-summer season may accelerate the rate of forest fire incidence and threaten rural livelihoods.

Extreme weather events can be very damaging to fisheries industry, hitting fishing gear, fishing vessels, but also coral reefs, mangroves and coastal vegetation, which act as protective barriers for the coastlines. The unprecedented increase in the movement of people, animals and goods, multiplies the pathways for the dissemination of transboundary animal diseases and plant pests (including insects, pathogens, and plants as pests) and aquatic species. Once introduced, climatic change combined with change in crops, landscapes and human activities may create favourable ecological conditions for the persistence of transboundary diseases and pests.

14.4 Initiatives on Climate Change Adaptation and Mitigation in the Agriculture Sector

Several regional and national initiatives have been undertaken in the recent past on climate change adaptation and mitigation. The South Asian Association for Regional Cooperation (SAARC) has prioritized regional issues, strategies, programs and projects on food security. The prioritized issues related to climate change impacts are: low and stagnating production and productivity, high pre and post harvest losses, overexploitation and degradation of natural resources.

The fourteenth SAARC Summit (New Delhi, 3–4 April 2007) expressed deep concern over global climate change; the New Delhi declaration called for pursuing a climate resilient development in South Asia. The SAARC Expert Group Meeting on Climate Change (Dhaka, 1–2 July 2008) recommended a draft SAARC Action Plan on Climate Change and stressed the need for actions relevant to agriculture, among others: adaptation of technologies and practices, sharing of best practices on sustainable forest management and sharing of good practices in disaster management.

India released its National Action Plan on Climate Change in June 2008 with a focus on harnessing renewable energy. The action plan identifies eight priority missions that will promote India's development objectives, with the "co-benefit" of

tackling climate change. The missions are: solar energy, enhanced energy efficiency, sustainable habitats, water conservation, sustaining the Himalayan ecosystem, developing a 'green' India, sustainable agriculture and building a strategic knowledge platform on climate change. The Government of Bangladesh has prepared a first draft Climate Change Strategy and Action Plan (2008) for discussion. Three of the five LDCs in the region, -Bangladesh, Bhutan and Maldives-, have submitted their National Adaptation Programme of Action (NAPA), recognizing that agriculture (including livestock, fishery and forestry) is highly vulnerable to climate change and prioritizing several adaptation projects in these sectors.

FAO assists member countries in the region in identifying potential adaptation and mitigation options most applicable to their particular circumstances, in mainstreaming climate change responses in food and agricultural policies and programmes and in including adaptation measures into National Programmes for Food Security (NPFSs), Special Programmes for Food Security (SPFSs), National Forest Programmes (NFPs) and other policy and planning processes.

FAO has initiated programmes targeting food security in the sub-region: (i) pro-poor policy formulation, dialogue and implementation to reduce rural poverty through enhanced institutional capacity to analyze, formulate and implement agricultural and rural development policies, (ii) support for the preparation of a Regional Programme for Food Security (in Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka) and (iii) the Initiative on Soaring Food Prices.

FAO has implemented and/or is in the process of implementing many projects in South Asia directly addressing climate change adaptation at the local level: (i) strengthening support to disaster preparedness in agriculture in Bangladesh (2004–2006), (ii) livelihood adaptation to climate change in drought-prone and coastal areas of Bangladesh (FAO/UNDP-CDMP: 2005–2009), (iii) strengthening capacities for disaster preparedness and climate risk management in the agriculture sector in Nepal (FAO-TCP: 2008–2010), (iii) enhancing capacities for disaster risk management (DRM) and climate change adaptation (CCA) for sustainable livelihoods in the agriculture sector in Nepal (FAO-UNDP). In Pakistan, technical support is being given for crop area and yield forecasting.

The donor funded projects have identified a multitude of adaptation options for South Asian countries which include engineering solutions such as sea defences, costal embankments, polders and the provision of water storage. The technological solutions in agriculture include use of more drought and salinity tolerant crops, terracing, contour farming, rain water harvesting, vegetative barriers, wind breaks and watershed management. In spite of the wide range of adaptation options, there are constraints that can limit the choices of options and their implementation such as inadequate data, lack of technical and institutional capacity and limited financial resources. FAO provides capacity building through field projects and legislative solutions such as agro-ecological zoning, land zoning around coasts, coastal forestry and updating food security policy and provides technical assistance to the focal ministries to participate in the NAPA processes.

The priority actions to protect local food supplies, assets and livelihoods against the effects of increasing weather and extreme events are: (a) vulnerability and risk analysis and risk management specific to agricultural eco-systems, (b) crop varieties

and breeds adapted to changing climate conditions, (c) introducing alternatives to provide food, fodder and energy and enhance cash incomes, (d) promotion of insurance and relocation of vulnerable assets, and (e) rain water harvesting, water storage and in-situ conservation.

The priority actions to avoid disruptions or decline in food supplies due to changes in temperature and precipitation are: (a) efficient agricultural water management and drainage, (b) adjustment of planting and harvesting schedules, (c) floating agricultural systems for flooding, risk diversification in drought prone areas, (d) improving weather/climate and flood forecasting and warning, and (e) improved livestock management, altered grazing and rotation of pasture.

The eco-system management through provision of environmental services needs to be ensured by: (a) use of degraded/marginal lands for productive planted forests or biomass for alternatives fuels, (b) watershed management and prevention of land degradation, (c) regulation through planning legislation and zoning, (d) protection of coastal areas from cyclones and other coastal hazards, (e) forest fire management through altered stand layout, (f) preservation of mangroves and their contribution to coastal fisheries, and (g) biodiversity conservation.

FAO promotes options for climate change mitigation in the food and agriculture sector by reducing emissions without compromising food security. Sustainable land management practices can diminish the conversion from forested area to cultivated or grazing land, increase the efficiency of water, soil and energy use and at the same time reduce emissions from deforestation, forest degradation (REDD), cropland and pastures. For example, Bhutan has 72.5% of its total land area under forest cover and high per capita GHG sequestration potential.

In agriculture, reducing methane emissions from ruminant livestock, rice paddies, manure and nitrous oxide emissions from soil need attention. Carbon sequestration in biomass and soils can be enhanced by (a) sustainable forest management, (b) reforestation and afforestation, (c) rehabilitation and restoration of degraded grasslands, (d) rehabilitating and restoration of cultivated organic soils, (e) promoting conservation agriculture, (f) grazing land management and (g) residue retention and conservation tillage systems.

14.5 Experiences Gained and Lessons Learned

FAO is implementing programs and projects in the region on climate change adaptation at multiple levels targeting agriculture sector. The experience clearly shows that the climate change impacts exacerbate existing vulnerabilities; adaptation must be addressed in the broader context of vulnerability. Addressing current climatic risks is a suitable operational entry point to launch climate change adaptation. Adaptation is considered as a social learning process and needs to involve institutions and multiple actors within the agriculture sector and other relevant sectors.

Awareness raising and institutional capacity building are the key. Adaptation is location specific, requires demand-driven research and extension strategies for

technology development and transfer. Cross-sectoral livelihoods perspectives with strengthened institutional systems are essential to capture farmers' needs and to respond to location specific demands.

Improved operational linkages between climate change adaptation, disaster risk management and development are needed. Re-strengthening agriculture research (action-oriented/adaptive research), extension services and development links are essential for continuous adaptation. Synergies between climate change adaptation and mitigation exist and need to be exploited.

Responses to climate change need to be coordinated and integrated with existing policies of socio-economic development and environmental conservation to facilitate sustainable development. There are several initiatives like regional consultations on food security and ministerial meeting on climate change organised by SAARC to implement potential adaptation measures to help increase resilience to the impacts of climate change. These initiatives and follow-up actions need to focus on strengthening of institutions, capacity building, and mainstreaming climate change issues into policy and regulations, and on field activities such as the promotion of water storage and drought and salinity tolerant crops.

Re-orientation of water resource management to take care of the impacts of climate change is very much needed as South Asia's food production depends heavily on fresh water resources including groundwater. National Agriculture Ministries, Agricultural Research Systems, Universities, FAO and several other development agencies have promoted innovative approaches of water management, and key issues still need to be addressed, such as: (i) reform of irrigation agencies, (ii) modernization of irrigation systems, (iii) changes in water governance, (iv) river basin management and (v) water policy related to agriculture sector aiming to meet food security in the region.

Community-level actions to demonstrate viable adaptation options in the drought-prone areas of Bangladesh improved the adaptive capacity of the marginal farmers against climate risks and helped to accelerate adaptation processes. The Farmers Field School (FFS) approach promoted by FAO and Danida provides excellent opportunities for integrating climate risk management strategies and practices into the FFS modules.

14.6 Knowledge Gaps, Opportunities and Key Messages

Comprehensive impact assessments on agriculture and food security and adaptation strategies for smallholder systems need be strengthened. Highly vulnerable micro-environments and their significance to the socio-economic status of the small and marginal farmers should be identified and suitable adaptation strategies have to be prioritized. Information and knowledge on the effects of elevated CO_2 and increased temperature on non-cereals, pest, diseases and weeds have to be improved to facilitate development of new technologies. Impacts of climate change on aquatic biota, coastal and mountain ecosystems have to be properly understood. Policy instruments

to guide adaptation and mitigation actions in agriculture are required to speed up location-specific actions.

Adaptation requires targeted research and participatory extension strategies for technology development and transfer. Location-specific technologies and good practices are needed as well as decentralised ways of working, within the framework of coherent national and international policies. Within this context, support to the emergence of national/regional programmes for food security that are responding to location-specific needs to be associated with climate change concerns. There are several initiatives in the sub-region aimed at livelihood adaptation (e.g. LACC), cyclone risk management and rehabilitation programmes (in Bangladesh) and strengthening institutional capacity to manage risks associated with climate variability, change and natural hazards. These initiatives and good practices need to be scaled up.

Adoption of risk management practices and policies for hazard vulnerability reduction help South Asian countries in preparing better for climate change impacts. Risk transfer could occur through micro-insurance, catastrophe bonds and reduced insurance premiums as an incentive to take preventive measures. However, the lack of financial mechanisms act as an obstacle to insurance initiatives.

Policy formulation needs to be built upon an improved understanding of the links between climate change and food provision, while promoting socio-economic development and limiting further environmental degradation. Given the magnitude of the impacts of climate change, a comprehensive climate strategy for the region needs to focus on adaptation as a first priority. Mitigation activities such as soil carbon sequestration, ecosystem restoration, protecting mangroves in coastal areas and reduced emission from deforestation and forest degradation promotes ecosystem resilience and improves adaptive capacity of the communities against climate risks.

Several opportunities exist to streamline the climate change adaptation and mitigation interventions through the Regional Action Plan adopted by SAARC member states. Synergies are expected in identification, development and promotion of agricultural practices for mitigation and adaptation without compromising food security in the region. Collection, exchange, and dissemination of meteorological, hydrological data and statistics within the SAARC region would strengthen the adaptation and mitigation planning process.

The diversity of experience in the region provides an opportunity to upscale climate change adaptation and mitigation initiatives. Collaboration between countries in the sub-region in developing regional and national policies, legislation for sustainable development and institutional mechanisms would provide a common platform for sharing of information, technologies and capacity building.

The Government of Bangladesh recognised the need for regional collaboration and requested the development partners to assist in establishing an International Centre for Adaptation in Bangladesh which will provide a forum to study aspects of the vulnerability of countries to climate change, scope and constraints to adaptation, develop relevant data bases, provide a network among countries and professionals (Karim 2007). FAO has already responded to the request and submitted a technical proposal (FAO 2007) for consideration.

Acknowledgement The paper is prepared in consultation and inputs from Environment, Climate Change and Bioenergy Division, FAO, Rome.

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