Agriculture and Food Security in South Asia

A Historical Analysis and A Long Run Perspective

উন্নয়ন অন্বেষণ
Unnayan Onneshan
The Innovators
centre for research and action on development

Agriculture and Food Security in South Asia

A Historical Analysis and a Long Run Perspective

উন্নয়ন অন্বেষণ
Unnayan Onneshan
The Innovators
centre for research and action on development

Imagine a New Southasia INSA
INSPIRE A NEW SOUTH ASIA! CELEBRATING UNITY IN DIVERSITY!!

Agriculture and Food Security in South Asia
A Historical Analysis and A Long Run Perspective

Authors
Rashed Al Mahmud Titumir
Jayanta Kumar Basak

Acknowledgement:

The Authors would like to thank Dr. Jiban Krishan Biswas, Dr. Md. Abdur Rashid Md. Abdus Salam of Bangladesh Rice Research Institute (BRRI) and Plash Kanti Das for their kind supports throughout this study. We are grateful to Mohammed Abdul Baten Mehruna Islam Chowdhury, Mohammad Tareq Hasan, Mahsoun N R Choudhury, Mohammad Shafiqual Alam and Md. Maher for valuable inputs during this study. The research has benefitted from grant received from Oxfam GB – South Asia.

Printed by: Dot Net Ltd. 51-51A Purana Paltan, Dhaka

For orders and request please contact:
Unnayan Onneshan-The Innovators
House: 19A, Road: 16 (New), Dhanmondi, Dhaka-1209, Bangladesh
Tell: +(880-2) 815 82 74, 911 06 36, Fax: + (880-2) 8159135
Email: info@unnayan.org
Web: www.unnayan.org

Agriculture and Food Security in South Asia

Contents

List of Tables

List of Figures

Executive Summary

This study has focused on the regional and national assessments of the potential effects of increasing population and changing climatic condition on food security in South Asian countries. The efforts have been put for the eight countries of South Asia. Probable population, food demand and production in future have been predicted with considering population growth rate, per capita consumption and the analysis of the last 47 years data of agricultural production, land, population, etc. The targeted years are estimated assessing demand-production gap and identifying the food situations on those years. Vulnerability to climate change and its effects on production system on the targeted years are also estimated and consequently relationship between these impacts and food security are estimated. Based upon identifying the gap between demand and supply, the study attempts to suggest some policy recommendations for the further improvement to achieve sustainable agricultural production in South Asia.

The long run estimates, based upon the trends in agricultural production for the last 47 years (1961– 2007), suggest that if urgent actions are not undertaken to averse the trend, above 17 percent of total population in South Asia may face food insecurity by 2050 and 35 percent population by 2100 due to shortage of staple. The country-wise simulation exercises, conducted by this study, predict that Bangladesh and Nepal might face a significant level of food shortage within 2020, if the present trend of population growth continues. In 2050, more than 29 million and 15 million population will face rice shortage in Bangladesh and Nepal, respectively, which is equivalent to 10 percent and 25 percent to the expected population in 2050. Considering the current business as usual growth rate of population, the food security in South Asia, without immediate action, will be more vulnerable by the end of the current century. More than 199 million people, according to this study, may face shortage of rice in Bangladesh which is more than 34 percent of the projected population in 2100. This will be more than 740 million (19.58 percent) for India, 549 million (43.71 percent) for Pakistan and 73 million (53.50 percent) for Nepal. Wheat production situation is more vulnerable compared to rice production, if the present trend continues. The recent wheat production trend will not fulfill the future wheat demand for most of the South Asian countries except India and Nepal.

Climate change is one of the major controlling factors of food security for South Asian countries. The study calculated that rice shortage might affect more than 90 million and wheat shortage might affect 672 million people. This could leave a shortfall to demand for a more than four percent of population of that particular time of 2050 in terms of rice while 33 percent could be affected in terms of wheat, calculated on the basis of IPCC Fourth Assessment Report (FAR). IPCC FAR predicted that due to climate change rice and wheat production will fall short of 8 percent and 32 percent, respectively by 2050. Similar results are more likely for other South Asian countries.

Agricultural production has increased in the last 47 years (1961 to 2007) from production per person of 0.478 tons in 1961 to 0.544 tons in 2007. But, the increased production did not come in a sustainable way, rather huge amounts of ground water, pesticides, herbicides and fertilisers have been used to increase the production. For example, the study calculates that fertiliser application has increased 890 times during the period of 1975 to 2005 in Bangladesh. Moreover, huge amounts of ground water have been withdrawn for crop production. A simulation exercise has been conducted with various dose of Urea fertilizer (N: nitrogen) between 120 and 200 kg per hectare in this study and it is found that production increases when the application is 120 -180 kg per hectare. If the current use of 110 – 150 kg per hectare goes beyond that threshold level (180 kg per hectare), the production yield would decline. Therefore, on the hand, these countries would face declining yield and the resultant deterioration in soil fertility.

The study through historical trend analysis shows that the share of agricultural land for every person is continuously decreasing in South Asia. The average agriculture land for each person has reduced by more than 50 percent during the period between 1961 and 2007. The share of agricultural land for every person was 0.45 hectare in 1961 and this has declined to 0.21 hectare in 2007. Many factors are responsible for agriculture land shrinkage such as population growth and demands for settlement, unplanned urbanization, increased non-agricultural activities, unplanned infrastructure development etc.

Recommendation

Food security in South Asia could be strengthened by increased national production of food, increased diversification of economy, increased employment and income generating opportunities and increased investment in this sector to achieve higher economic growth. Besides, it is more important for the region to have a long term strategy to achieve food security for all based on indigenous efforts.

Increasing productivity requires new knowledge both to maintain yields and to improve the quality of production. This would imply substantial investments in agricultural research and outreach programmes to disseminate technology know-how, effective communication that improves farmers' access to market information. Certainly improved technology may assist in more effective management in agricultural sectors, but it cannot produce an unlimited flow of those vital natural resources that are the raw materials for sustained agricultural production. Strategies for the future must be based first and foremost on the conservation and careful management of land, water, energy, and biological resources needed for food production. In that situation cropping pattern must be selected on the basis of available natural resources.

National:

- Adequate national policies on agriculture, trade and social protection in countries to ensure the right to food and protect women smallholders' livelihoods.
- Coherence of national level policies so that agriculture, trade and climate change policies strengthens smallholders' effort to improve agriculture productivity and food security.
- Investment policies do not threat the right to food and access to natural resources.
- Adaptation and mitigation policies do not harm smallholders, and offer opportunities to im prove food security and rural development.
- National plans for climate change adaptation and for food security are coordinated, and funding bodies are also coordinated.

Regional:

- Regional policy framework: Adequate regional policies at SAARC levels on agriculture, trade, energy and climate change.
- Regional investment policies: An investment fund to enhance collaboration on technological development regarding crop varieties such as Seed Bank, to enhance the right to food and access to natural resources.
- Effective regional emergency response: Promotion and implementation of SAARC food bank, seed bank.
- Common regional shared vision on "Climate change and food security"
- Adaptation and mitigation policies do not harm smallholders, and offer opportunities to improve food security and rural development.

Section 01

1.1 Introduction

Agriculture is the only source that provides adequate food to prevent widespread hunger and starvation. However, food insecurity is aggravating day by day, resulting in more number of undernourished/malnourished persons in the world. The ever-increasing population in the developing and least developed countries in South Asia is also a major constraint to supply enough food to their basic daily demand. Besides, climate changes in recent decades in the forms of natural calamities like drought, flood, fluctuation in rainfall pattern, cyclone, sea level rise also pose serious threat to ensure food security. Moreover, decreasing arable agricultural land in South Asia, together with increasing population and changing climatic conditions make this challenge more acute.

The concept of food security has evolved over a period of time. Until the early 1970s, adequate availability of food grains at the national level was considered a measure of food security. Emphasis was placed on food self-sufficiency at the national level, principally through domestic production. In 1974 World Food Conference added another dimension to food security when it emphasized, apart from the overall availability, stability of food supplies within and over the years. It was clearly enunciated in the World Food Conference (1974), declaring that "every man, woman and child has the inalienable right to be free from hunger and malnutrition." In 1983, Food and Agricultural Organization (FAO) expanded its concept and stated food security is about "ensuring that all people at all times have both physical and economic access to the basic food that they need." Afterward, the 1996 World Food Summit redefined the concept of food security and included main three aspects - demand, vulnerability and nutritional aspects - into account. At the summit, countries agreed that "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy lifestyle". In 2002, FAO gave a functioning definition of food security for all countries: food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Therefore, at minimum, to achieve food security four components such as availability, accessibility, stability and utilization are needed.

World Development Report (2006) noted that South Asia is a region where world's largest number of undernourished people (330 million, accounting for world's 40% hungry). The pace of development in agricultural sector has been miserably low as compared to GDP growth rates.[1] The annual average growth rate for the period of 1993-2006 for all South Asian economics has been 5.2%, 6.6%, 6.6%, 8.2%, 4.3%, 4.2% and 5.0% for Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, respectively whereas their agricultural sector grown with 3.5, 2.7, 2.6, (Maldives missing), 3.5, 3.3 and 1.3. According to FAO and (UNPD), for the period of 1995-2003 in South Asian context, food consumption crossed population growth rate. For example, in Pakistan, the population growth rate was 2.4 % and its agricultural sector recorded growth rate was 1.9%. FAO data (2002-2004) suggests 30% proportional to the total population remained undernourished; Bangladesh is in the poorest state of affairs and followed by Pakistan (24%), Sri Lanka (22%) and India (20%). Maldives is comparatively on a better pitch with just 10% of its population recorded as undernourished (Jappa, 2010).

The South Asian region is highly sensitive to the consequences of climate change and is known to be the most disaster prone region in the world.[2] Rising global temperatures are likely to lead an eastward shift in monsoon circulation which could result in more rainfall over the Indian Ocean, Myanmar and Bangladesh but less over Pakistan, India and Nepal. The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) lists the consequences of climate change for the South Asian region. The melting of the Himalayan glaciers will lead to increased flooding and affect water resources within the next two to three decades. A rise in temperature will negatively impact rice and wheat yields in the tropical parts of South Asia where these crops are already being grown close to their temperature tolerance threshold. Crop yields could decrease by up to 30% in South Asia by the mid-21st century. The Human Development Report (HDR), 2006, has pointed out that in South Asia alone 2.5 billion people will be affected by water stress and scarcity by the year 2050. This could hamper the achievement of many of the Millennium Development Goals (MDGs), including that of poverty eradication.

This study has focused on the regional and national assessments of the potential effects of increasing population and changing climatic condition on food security in South Asian countries. The efforts have been put for the eight countries of South Asia. Probable population, food demand and production in future have been predicted with considering population growth rate, per capita consumption and the analysis of the last 47 years data of agricultural production, land, population, etc.

[1]http://www.newscentralasia.net

[2]http://hdr.undp.org/en/reports/global/hdr2007-2008/papers/kelkar_ulka%20and%20bhad wal_suruchi.pdf

The targeted years are estimated assessing demand-production gap and identifying the food situations on those years. Vulnerability to climate change and its effects on production system on the targeted years are also estimated and consequently relationship between these impacts and food security are estimated. Based upon identifying the gap between demand and supply, the study attempts to suggest some policy recommendations for the further improvement to achieve sustainable agricultural production in South Asia.

1.2 Polices in Agriculture Sectors and Food security in South Asia[3]

Food availability is the most important component to assess the food security situation in a nation but, food availability does not ensure the over all food security. Accessibility, stability and utilization of food to the population are equally important. Most of the South Asian countries are net importers of food and have suffered severe terms of trade shocks and accelerated food price situation due to recent food crisis. Therefore it is necessary to reinforce sustainable system for achieving food security, coupled with sound economic management for sustaining growth and poverty reduction in the region. Governments of South Asian countries are making some major steps which are directly or indirectly linked to achieve the goal of food security.

In Afghanistan, food security is more vulnerably than any other South Asian country due to its highly complicated political and economic context. The agricultural sector is under extreme pressure and faces a great challenge to supply food for all. There is little scope for farmers to receive guidance and technical support for the development of farming activities. Moreover, employment opportunities are not increasing compared to the population growth rate (annual population growth rate is 2.62 percent). Therefore they could not provide a secure livelihood to a large segment of population. Different policies have been taken through Ministry of Rural Rehabilitation and Development in various years but they are yet to make sustained impacts due to conflicts. The National Risk and Vulnerability Assessment (NRVA, 2005) suggests that approximately 61 percent of the Afghan population experience low dietary diversity and very poor food consumption. One of the major sources of income for Afghans is to export fresh and dry fruits. Various International development agencies are helping them to secure food by increasing their income through the development of this sector. This includes a substantial amount of food aid. World Food Programme (WFP) is the largest food aid programme in Afghanistan WFP targets chronically poor and food-insecure families, school children, teachers, illiterate people, tuberculosis patients and their families, internally displaced persons and ex-combatants – with particular emphasis on the vulnerable group of women and girls. WFP also gives them training and educational facilities collaborating with Afghan Government, non government partners and communities. European Commission Humanitarian Aid Office and US Department of Agriculture (USDA) have also arranged various food aid programmes.

Over the last three and a half decades, Bangladesh Government has introduced reform measures and policies for agricultural development in its quest for ensuring food security for all. In early 1980, Bangladesh has pursued a policy of agricultural modernisation by supplying modern agricultural inputs such as seed, fertiliser and irrigation and modern agriculture technologies. The government also liberalised the seed market and developed the seed policy act of 1992 and 1998, for encouraging the involvement of the private sectors and NGOs in the seed delivery system. More recently, the newly elected government has decided to extend fertiliser subsidy to promote balanced fertiliser use. During this period, the Bangladesh government also took a series of measures to expand its irrigation network. To promote the use of irrigation facilities, electricity and diesel for irrigation purposes are subsidised. In recent time these subsidies are allocated through the card system, so that the farmers can avail the facilities directly. Domestic procurement of both rice and wheat is made by the government with a view to provide support to farmers and to procure quantity of food grains required to support the public food grain distribution system. The government distributes rice and wheat under the Public Food grain Distribution System (PFDS) both through monetised channels like Essential Priority

[3]Polices in Agriculture Sectors and Food security in adapted from the working paper “Food Security in South Asia: Issues and Opportunities

(EP), Other Priority (OP), Large Employee Industries (LEI), Flour Mill (FM), Open Market Sales (OMS), and Fair Price Card (FPC) and non-monetised (targeted) channels like Food for Work (FFW), Test Relief (TR), Gratuitous Relief (GR), Vulnerable Group Development (VGD), Vulnerable Group Feeding (VGF), Food for Education (FFE) and other relief channels. To ease the deficit in food availability from domestic production, import of agricultural commodities was liberalised and import duties and para-tariffs on various food items were substantially reduced by successive governments. In FY 2007 and FY 2008, government allocated special funds for agricultural research and currently a big project titled National Agricultural Technology Project (NATP) is being implemented. In 2009, four types of programmes are being implemented- cash transfer programmes, food security programmes, micro-credit programmes and, special funds and development sector programmes.

Bhutan has initiated several agricultural, food and trade policies to increase food production and ensure food security since 1961. But the limited resources and technology knowledge, makes it difficult for the multilateral and bilateral agencies to support them to achieve food self sufficiency. In 1983, the International Development Research Centre (IDRC) and IRRI supported “Rice Farming Systems Research” to build Bhutan’s rice research capabilities and this lead to a remarkable process in rice production. Now Bhutan Government is giving the training facilities of govt. officials and farmers to improve food production. Moreover, Bhutan has also set up the Food Corporation of Bhutan (FCB) to import food to meet domestic demand. Under the FAO and the Netherlands Partnership Programme (FNNP), the government chose rice, maize, citrus fruits and potatoes for pro-poor commodity chain analysis to both improve food security and increase rural incomes. Now Bhutan is intensifying and diversifying production to adopt an integrated approach to nutrient and pest management and to achieve at least 70 per cent self-sufficiency in food grains.

Agricultural policy in Nepal has been shaped by the Agricultural Perspective Plan (APP), which covers the period 1995-2010. The main objectives of the APP are to achieve economic growth and poverty reduction through accelerated growth of agriculture. In 2004, the National Agricultural Policy (NAP) added new food access provisions for vulnerable groups which are more radical than those of the APP. The interim constitution of Nepal 2006-07 recognised food sovereignty as a fundamental human right. The Food and Nutrition Security Plan (FNSP) that was subsequently introduced (NPC, 2007) places emphasis on self-reliance, food safety, adequacy of nutrition and improved food access. Nepal government also subsidised the transport sector for distributing food to the deficit hill and mountain areas. World food Programme (WFP) collaborating with the Nepal government provided rural employment opportunities to the poor people. A food for education programme in Nepal is directed at improving the nutritional status and school enrolment and attendance by children, a mother and child health initiative aimed at improving the health and nutritional status of pregnant women. These programmes are implemented by the Nepal government for a long term basis for its vulnerable people to ensure food security in the future.

Pakistan does not have any national food policy except for a few food security policies at the regional level. Food production in Pakistan increased but it is not sufficient to meet the country’s consumption needs. Procurement, handling, marketing, storage and supplies are handled by the four provincial food departments and the national agency, the Pakistan Agricultural Services and Supplies Corporation (PASSCO). The main role of the corporation is to provide support to the farmers, ensuring adequate supplies in deficit provinces, intervening in the open market to stabilise prices of agricultural commodities and above all maintaining strategic reserves to meet any emergent situation. In 2007-08, government revisited the food production and food security issues due to significant food crisis in that fiscal year. The Planning Commission of Pakistan formulated a task force to provide policy recommendation to ensure food security in 2008. Two major initiatives taken by the Pakistan government to improve food access are the Benazir Income Support Programme (BISP) and the Food Support Programme (FSP). The main aim of BISP is to cover almost 15 percent of the entire population, which constitutes 40 percent of the population below the poverty line and support them to increase their monthly income. Food Support Programme (FSP) was launched in 2002-03, targeting the poor to improve their living standard by providing them with financial support.

There are three main food security-related programmes in Sri Lanka targeted at special groups and the poor. These are Samurdhi programme, Thriposha Programme and the Mid-day meal programme in schools. The main objective of those programmes is to ensure food security. The Samurdhi programme is the largest welfare programme with the twin objectives of ensuring food security and reducing poverty which was launched in 1995. Intended to cover a target of 20 per cent of the population which is 17 below the poverty line, the programme actually covers half the total number of households in the country. The Thriposha Programme focuses on the specific group of mothers in low income groups with children below the age of one year and distribute supplement food cereals, pulses and micro-nutrient among the target group. The school mid-day meal programme targets children with the objective of improving school attendance and children's nutrition which have at least 30 per cent malnourished children.

Fisheries sectors are the main source of food security in Maldives and the Ministry of Fisheries, Agriculture and Marine Resources (MOFAMR) is responsible for the sustainable management and development of fisheries, agricultural and marine resource of the nation. Hydroponics Agriculture Pilot Project is one of the most important initiatives for achieving food security in Maldives taken up by the MOFAMR in 2006. The project aims to promote the development of hydroponics production system both by household and on a commercial scale to achieve food security, to provide additional avenue of employment and income generation, to increase availability of high quality horticultural products and to improve nutritional status in the nation. Besides, various food safety monitoring guidelines were developed for food processing units, resorts, hotels and guesthouse and port health authorities by Ministry of Health. These guidelines were basically developed on the lines of "Good Manufacturing Practices" (GMP) and "Good Hygiene Practices" (GHP). The government is considering the establishment of a National Food Safety Committee (NFSC) to provide a strong coordinating mechanism for uniform enforcement of food safety norms.

Market intervention aimed at both income and price stabilization, and increase in agricultural production are the main strategies for the Indian government to ensure food security for its citizen. To protect the poor from the vagaries of the market and to control production, supply and distribution of essential commodities, the Indian government introduced the Essential Commodities Act (ECA) in 1955. The main aim of the act was to ensure equitable distribution of food grains at the fair price. In the mid 1960 "green revolution" was initiated in India by encouraging the farmers to use high yielding varieties of seed, chemical fertiliser, and to expand the irrigation network. Most of the agricultural subsidies in these sectors help access agricultural inputs and improve farm productivity in the 1960's. One of the oldest initiatives taken by the Indian government was the establishment of a Public Distribution System (PDS) with the objective of making basic food grains available to all at a reasonable price. The PDS is seen by the government as the most effective programme to ensure food security both at national and households levels. It was implemented by the cards system. The cards entitle the household to monthly food stamps from prescribed distribution centres which could be encashed in food from any food store at a subsidised rate. In 1975, Indian government launched the Integrated Child Development Scheme (ICDs) to provide nutrition and health care services to children and women. The Antyodaya Anna Yojana (AAY) seeks to provide affordable food to below poverty level (BPL) households. The objective of the schemeis to make the PDS more focused and targeted an identified 10 million of the poorest of poor in the different states in India. Mid day meal scheme programme was launched in 1995 for the benefit of student by supplying free food grain. In 2005, the government passed the National Rural Employment Guarantee Act to improve the livelihood security of rural households by providing them with guaranteed wage employment for a minimum number of days in a year. Semi-skilled and unskilled workers living below the poverty line in rural areas have been specifically targeted under the programme. The National Rural Employment Guarantee Scheme was preceded by the National Food for Work Programme (NFFWP) which was implemented in 2004 in 150 of the most backward districts of the country. The objectives of the programme are to provide additional resources apart from the resources available under the Sampoorna Grameen Rozgar Yojana (SGRY) to generate supplementary wage employment and to provide food security. In 2007, the Indian government approved two initiatives – the National Policy for Farmers and the Rashtriya Krishi Vikas Yojana. The main objective is to secure food by supplying 25 kg food grains which are below poverty line (BPL families).

Section 02

2.1 Agriculture in South Asia

Agriculture is the mainstay of economy in South Asia countries, where most of the people live in rural areas. South Asia is still largely rural and most of the rural people depend on agriculture for their livelihood. Agriculture generates on average 29 percent of gross domestic product (GDP) and provides employment to 65 percent of the labour force. The industries and services linked to agriculture in value chain often account for more than 30 percent of GDP in transforming and urbanized countries (World Bank, 2008). Agricultural growth is especially effective in reducing poverty. Agriculture can reduce poverty of the poor people of South Asia countries directly and indirectly (e.g. by raising farm incomes, agricultural growth can help reduce poverty directly and by reducing food prices, though labour markets can help indirectly). The agricultural sector continues to be a significant source of value addition, employment, raw materials and exports for many economics in the region in which this sector is the major determinant of overall economic performance. Most countries of the region, therefore, need to pay greater attention to improve agricultural productivity. Based upon the criterion of food insecurity and poverty, South Asia has the distinction of being the worst affected region. A large majority of the poor and the food-insecured people live in this part of the world where the incidence of malnutrition is very serious.. Faster development of their agricultural sector enabled the countries in South Asia to make some dent in poverty and food security. Majority of workers in these countries derive their livelihood from agriculture, and the food expenditures account for a high proportion of the total expenditure of the poor households (Ahluwalia, 1985).

2.2 Agriculture and Economy in South Asia

Agriculture plays a pivotal role in the economics of these countries, although its share is declining day by day. Agriculture also claims a higher share in the total trade even in countries with lower share of agricultural income in GDP. Considering the status of agriculture sector in South Asia in 2006, value added in GDP presents that it is highest for Afghanistan which was 36 percent and lowest for Sri-Lanka in between are Bangladesh Bhutan, India, Nepal and Pakistan. A comparative picture of agriculture growth rate in Bangladesh, Bhutan, India, Nepal, Pakistan and Sri-Lanka shows positive sign except for Maldives. Agriculture is the main occupation of the people of South Asian countries. Nepal occupies the top in 2003 for employment in agricultural sector. India accounts for next position of employment in agriculture followed by Pakistan, Sri-Lanka, and Maldives, respectively (Table – 1).

Table 1: Status of Agriculture Sector in South Asia

Countries	Value added as % Of GDP in agriculture, 2006	Agriculture growth rate (Annual % growth, 2006)	Employment in agriculture (% of total employment)
Afghanistan	36	-	-
Bangladesh	20	4.94	51.70 (2003)
Bhutan	22	1.67	-
India	18	2.68	52.00 (2007)
Maldives	--	-0.65	17.30 (2003)
Nepal	34	1.19	66.40 (2001)
Pakistan	19	1.58	43.00 (2005)
Sri-Lanka	16	4.71	33.50 (2004)

(Source: World Development Indicators (WDI), 2008)

From the Table 2, it is observed that agriculture GDP of South Asian countries gradually decreased mainly for high rate of population growth, high concentration of poor households, labour migration to the non-agricultural sector, low per capita income etc.. It is found that GDP share in agriculture from the period 1990-92 to 1995-97, the highest change occurred in Nepal which was 7.15 percent and 1995-97 to 2003-05, the most declining situation observed in Bhutan which was 7.59 percent.

Table 2: Change in Agriculture Sector

Countries	% Share of agriculture in GDP		
	1990-92	1995-97	2003-05
Afghanistan	-	-	40.61
Bangladesh	30.00	25.95	20.98
Bhutan	35.38	32.52	24.93
India	29.31	26.66	19.34
Maldives	-	-	-
Nepal	48.72	41.57	36.36
Pakistan	26.03	26.11	22.34
Sri-Lanka	26.31	22.44	18.04

(Source: FAO, 2009 and WDI, 2008)

2.3 Agricultural Production, Land and Population in South Asia

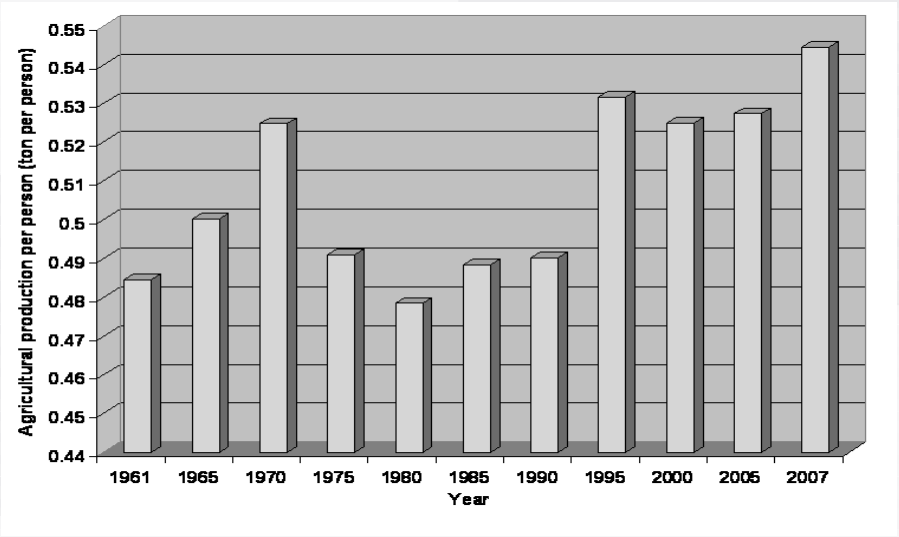
Every agricultural production directly or indirectly involves food security in any countries in this world. For example, jute, wool, greasy etc. do not provide food directly but indirectly those crops provide food security by supplying money to access food. In this study twenty agricultural crops are selected on the basis of production ranking and the crops these countries grow most. Moreover, agricultural land and population also include the whole production system and food security of a country directly involves three major areas – agricultural production, land, population. Therefore, it is necessary to see the changing patterns of production along with the land and population. Land and production data in the last 47 years are collected from the Food and Agricultural Organization (FAO, FAOSTAT, 2009).

Analysing agricultural and population data for the last 47 years, it is clear that agricultural production for every person is gradually increasing and in 2007 it reached the highest point from the period of 1961 to 2007 (0.544 tons per person). But in 1975 to 1990 this production rate passed extreme conditions and in 1980 it reached the lowest point (0.478 tons per person). After 1985, food production increased at a significant rate due to high yielding crop varieties, modern technology, new management practices (Fig.1). It might be assumed as a good indication for food security in South Asia, but its sustainability in future is in question because of the gradual decrease in agricultural land for food production and excessive use of chemical inputs. Analysing the agricultural land and food production data, it is found that in 1961 agricultural land was allocated above 0.75 ha for one metric ton food production, whereas in 2007 it was below 0.4 ha (Fig. 2). Therefore, contribution of agricultural land for food production is continuously decreasing, in the last 47 years and it has reduced by two folds.

Most of agricultural production is carried out in small pieces of lands. Moreover, the cropping intensity along with the cropping pattern played a vital role to the whole production system. Besides, high yielding crop varieties, modern technology, new management practices such as irrigation, fertilizer, crop management etc, are used to improve the production rate. For example in Bangladesh, fertilisers' application increased 890 times in same piece of land. In 1975-76, fertilises application were 0.36 kg for an hectare of agricultural land, whereas in 2007, it was above 298 kg (Fig. 4). So, it is clear that fertilisers create a force to increase productivity of land. On the other hand, soil fertility is decreasing due to use of huge amount of chemical fertilisers,

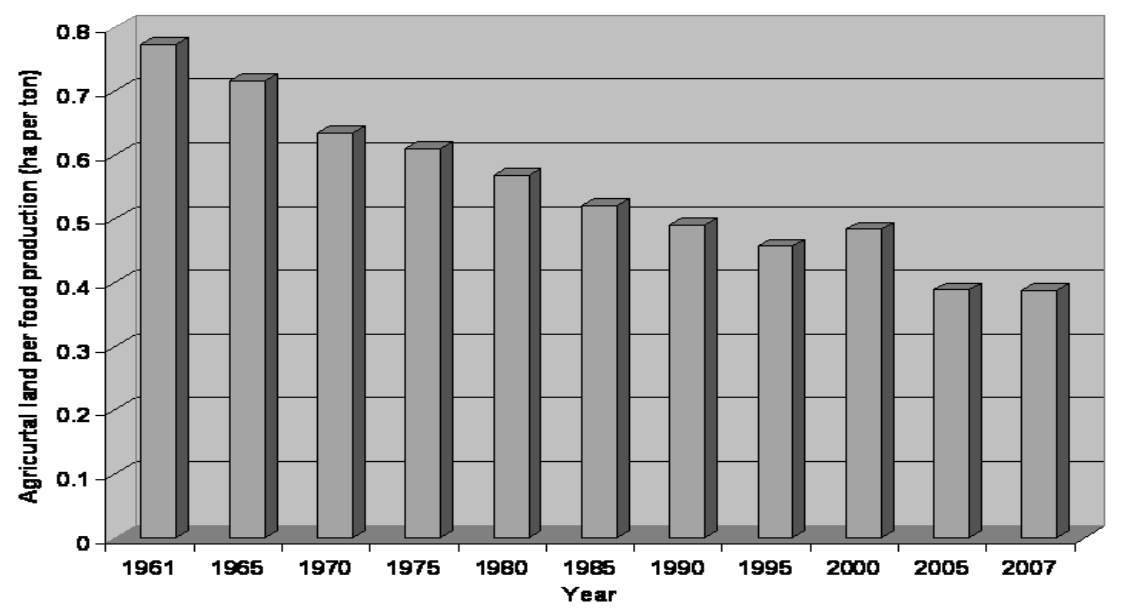
which is not at par with sustainable agriculture. Moreover, irrigation application mainly depends on the ground-water source. Groundwater water application increased many times to augment production, causing at the same time salinity of soil to increase and consequently declining land fertility. Besides, pesticide and herbicide are also used at a significant rate and this rate is continuously increasing. These agricultural inputs increased productivity of land above two times in the last four decades.

Fig. 1: Yearly agricultural production for every person (ton per person) in South Asia



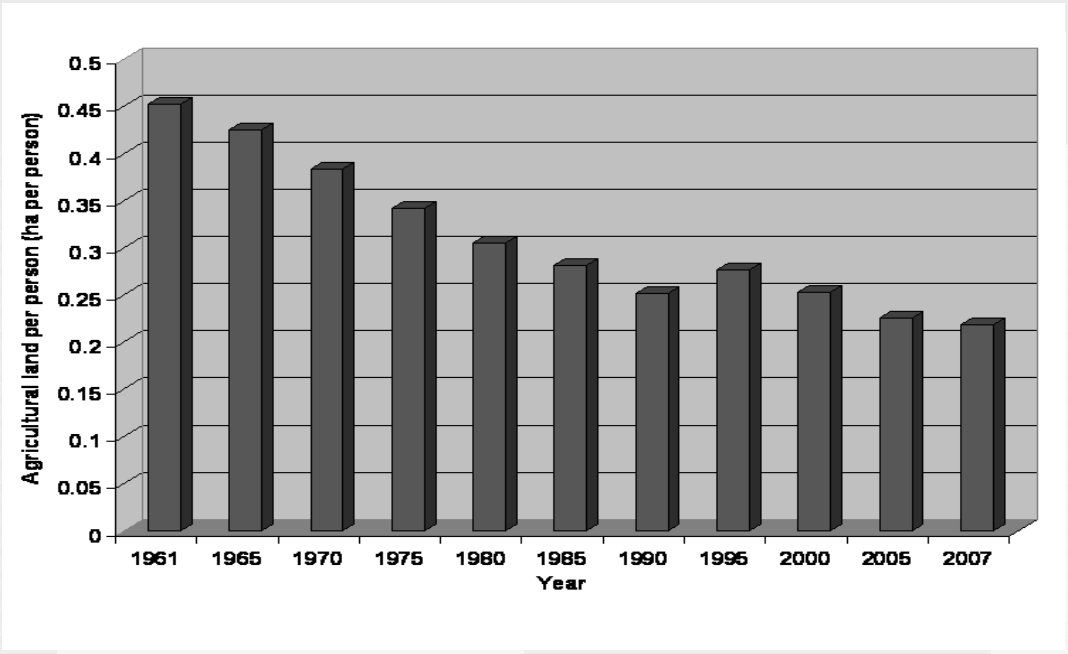
(Source: Authors' calculation based on FAOSTAT, 2009)

Fig. 2: Yearly agricultural land for food production (ha per ton) in South Asia



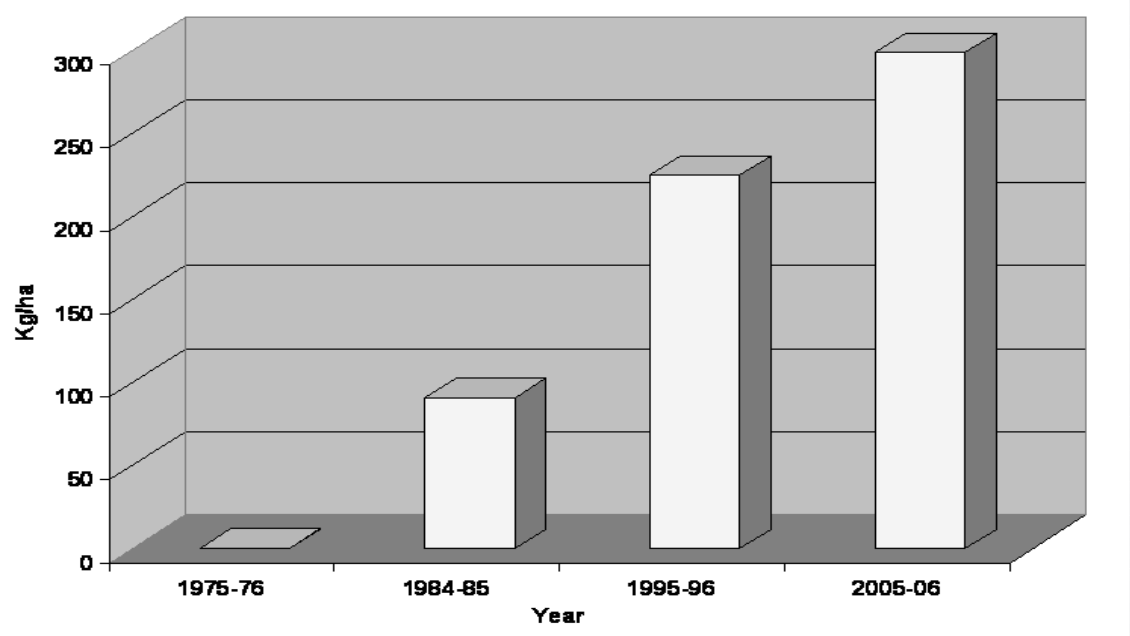
(Source: Authors' calculation based on FAOSTAT, 2009)

Fig. 3: Yearly agricultural land for every person (ha per person) in South Asia



(Source: Authors' calculation based on FAOSTAT, 2009)

Fig. 4: Fertilizer application (Kg per hectare) in Bangladesh (Year wise)



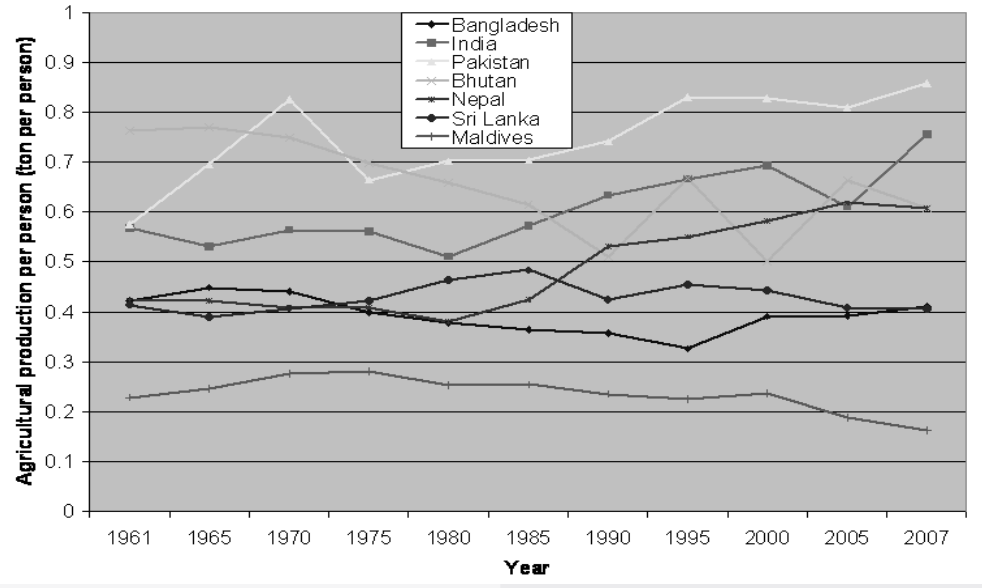
(Source: Authors' calculation based on Bangladesh Fertilizer Association (BFA) data, 2008)

But there are questions being raised on this particular pattern of agriculture as agriculture cannot sustain those inputs for a long period. In this research paper a modelling study (Decision Support System for Agrotechnology Transfer, DSSAT) has been conducted to see the application rate of urea fertiliser. This analysis has been conducted on rice in Bangladesh. In the model, we assume climatic factors (daily average maximum and minimum temperature, rainfall, solar radiation, etc.), soil data (percentage of sand, silt, clay, organic carbon etc), rice management practices and rice variety constant to understand the sustainable rate of fertiliser application that could maintain the yield. We conduct a simulation exercise, with various dose of Urea fertilizer (N: nitrogen) between 120 and 200 kg per hectare. We find that production increases when the application is 120 -180. If the current use of varying between 110 – 150 kg per hectare goes beyond that threshold level, the production yield would decline. Therefore, on the hand, we would be faced with declining yield and the resultant decline in soil fertility.

From the analysis of land and population data, it is also clear that allocation of agricultural land for every person is continuously decreasing. Allocation of agricultural land for every person in 1961 was 0.45 ha, whereas it is only 0.21 ha in 2007. High population growth rate (above 1.3 percent in South Asia except Sri Lanka 0.7 percent) and low economic conditions are the main reasons to reduce 2.14 times land for every person in the period between 1961 and 2007. Beside, demands for multiple cropping for maintaining livelihood in the same piece of land also create pressure upon the whole production system.

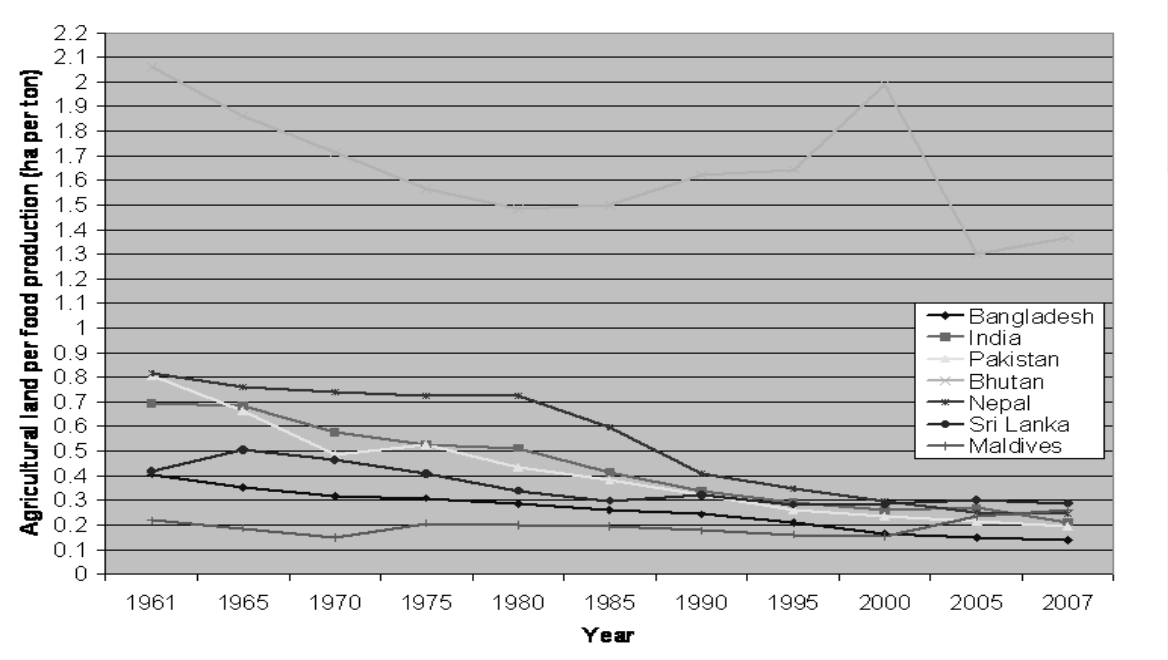
Country wise analysis has been also conducted for the seven (except Afghanistan) countries in South Asia for the same period (1961-2007). Agricultural production for every person is observed to have increased per person (Fig – 5) and land for food production has decreased (Fig – 6), causing agriculture land per person has declined (Fig – 7). This trend is comparatively higher for India, Pakistan and Bhutan (Maldives are not comparable to the other countries, because of the maximum agricultural production comes from the fisheries and other water related resources).

Fig. 5: Country wise agricultural production for every person in South Asia



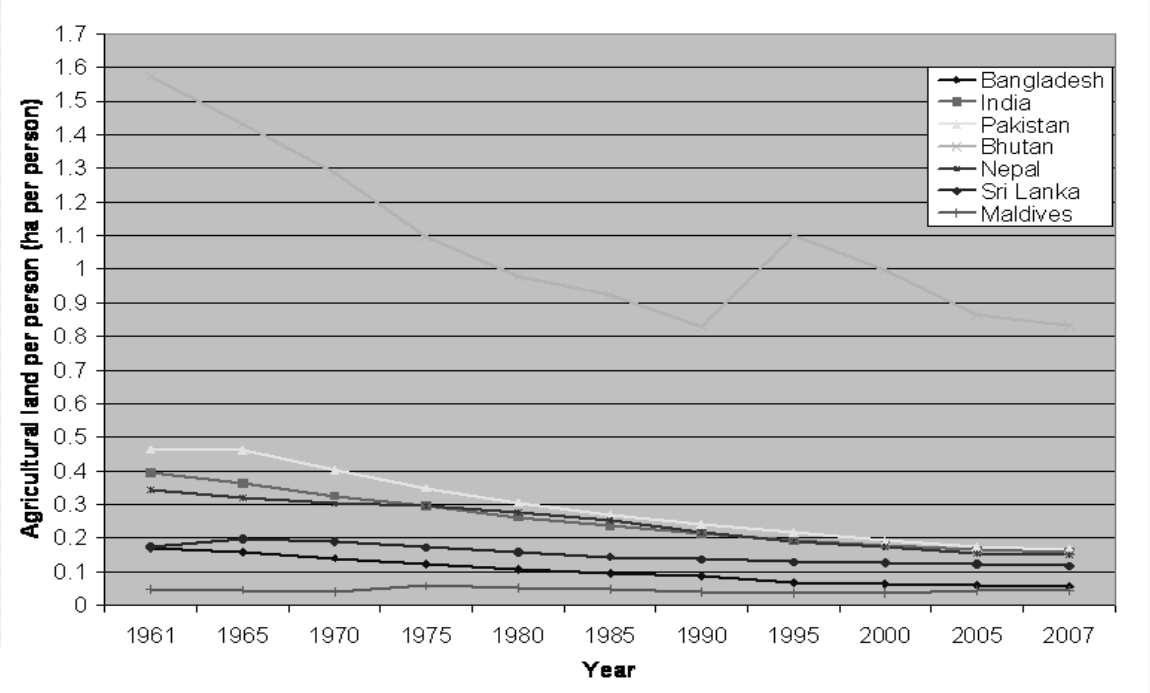
(Source: Authors' calculation based on FAOSTAT, 2009)

Fig. 6: Country wise agricultural Land for food production in South Asia



(Source: Authors' calculation based on FAOSTAT, 2009)

Fig. 7: Country wise agricultural Land for every person in South Asia



(Source: Authors' calculation based on FAOSTAT, 2009)

2.4 Future Population in South Asia

South Asia - Bangladesh, India, Nepal, Pakistan, Bhutan, Sri-Lanka, Maldives and Afghanistan - has a total population over one and half billion, more than one fifth of humankind and those contribute more than those of any other geographic region to the world's population growth. South Asia contains the bulk of the world's poor, and thus this is an area with major concern related to food security. As the population continues to grow, a huge pressure is being placed to ensure provision of an adequate supply food while maintaining the integrity of ecosystem. The annual population growth rate is 2.62 percent in Afghanistan which is the highest among the South Asian countries, whereas in Sri-Lanka, it is only 0.7 percent. The annual growth rate of population in South Asian countries is given Table 3.

Table 3: Population growth (annual percentage) in South Asia in 2008

Bangladesh	India	Pakistan	Sri-Lanka	Nepal	Afghanistan	Bhutan	Maldives
1.4	1.3	2.2	0.7	1.7	2.62	1.6	1.7

(Source: World Bank, 2009)

If the annual population growth continues at a business as usual rates, our estimates suggest the total population will be 1856.50 million in 2020, 2144 million in 2030, 2479 million in 2040, 2870.30 million in 2050, 3327.93 million in 2060, 3864.20 million in 2070, 4493.80 million in 2080, 5234.63 in 2090 and 6108.50 million in 2100 in South Asia. The projected population for the eight countries of South Asian countries is given Table 4. In 2100, under business as usual scenario, population could be more than 6 billion which is equivalent to current total population of the world. Therefore, huge amount of food will be necessary for the future generation to meet their food demand.

Table 4: Population (million) in South Asia

Year/Country	Bangladesh	India	Pakistan	Sri-Lanka	Nepal	Afghanistan	Bhutan	Maldives
2007	157.75	1124.79	162.48	20.1	28.11	26.27	0.68	0.305
2020	191.65	1347.73	220.35	22.16	35.59	37.78	0.84	0.387
2030	220.24	1533.55	273.92	23.76	42.12	48.97	0.99	0.458
2040	253.09	1744.98	340.51	25.48	49.86	63.48	1.16	0.542
2050	290.83	1985.57	423.29	27.32	59.01	82.29	1.36	0.641
2060	334.21	2259.33	526.20	29.29	69.85	106.7	1.59	0.759
2070	384.07	2570.84	654.13	31.41	82.67	138.3	1.87	0.898
2080	441.35	2925.29	813.15	33.68	97.85	179.2	2.19	1.063
2090	507.18	3328.62	1010.80	36.11	115.80	232.3	2.56	1.258
2100	582.83	3787.55	1256.60	38.72	137.10	301.2	3.01	1.489

(Source: Authors' projection based on World Bank data, 2009)

2.5 Future Rice and Wheat Demand for Food Security

For measuring the food security situation in future, we consider two main crops in South Asia – rice and wheat – because these are main staples in South Asia and supply carbohydrate to meet daily energy intake, and these are main crops. Amongst the twenty agricultural produces, shown in Figures 5, 6 and 7, rice contributed 66.20 percent and wheat contributed 1.62 percent in Bangladesh, 17 percent and 9 percent for India, 21.55 percent and 8.87 percent for Nepal, 18.12 percent and 2.20 percent for Bhutan, 6.02 percent and 48.90 percent for Afghanistan and 6 percent and 16.70 percent for Pakistan, respectively. A simulation exercise has been conducted to estimate the future rice and wheat demand. Future production has been calculated from the data of the last 47 years.

Rice is the major food grain in South Asia, except for Pakistan, Afghanistan and some parts of India. Per capita rice consumption rate is highest in Bangladesh (153.03 Kg per person per year), whereas Pakistan and Afghanistan these are only 17.96 and 16.70 Kg per person per year, respectively (Table 5). If the rice consumption continues at the same rate till 2100, the total demand of rice for Bangladesh, India, Pakistan, Sri-Lanka, Nepal and Afghanistan would be. This has been calculated by multiplying the population and consumption data for those specified years (Table 6).

Table 5: Rice and Wheat consumption rate (Kg per person per year) in South Asia
Crop/CountryBangladeshIndiaPakistanSri-LankNepalAfghanistanRice*

Crop/Country	Bangladesh	India	Pakistan	Sri-Lanka	Nepal	Afghanistan
Rice*	153 02	72.56	17.96	96.37	88.72	16.70
Wheat**	22	67	128	52	44	180

*Rice consumption rate is calculated from the last 40 years data (1964 -2003).
*Data source: Food and Agriculture Organization, FAOSTAT Update as of July, 2009.
** Source: CIMMYT, 1998/99, (www.cimmyt.cgiar.org)

If the production goes at business as usual rates, Bangladesh and Nepal may face a huge food shortage within 2020. The projection undertaken for the current research shows that the gap between rice production and demand for Bangladesh and Nepal are more vulnerable than India, Pakistan and Sri-Lanka. Afghanistan has not been considered due to production significance level is below 90 percent and rice production and consumption data for Bhutan and Maldives for such long periods are not available.

The rapid population growth rate makes it difficult to keep pace with the rising demand for food. In 2050, rice shortage will be 6.79 and 1.71 million tons for Bangladesh and Nepal, respectively. As a result more than 29 million and 15 million population may face rice shortage in 2050, which is equivalent to 10% and 25 % of the population of that particular point of time. Therefore a considerable amount of population for both the countries will face a remarkable amount of rice shortage. Rice shortage will be 45.7, 80.72, 14.8 and 9.76 million tons for Bangladesh, India, Pakistan and Nepal, respectively in 2100, if the current trend continues. Consequently more than 199 million people could face shortage of rice in Bangladesh which is estimated to more than 34 percent of the expected population in 2100 and it might be more than 740 million (19.58 percent) for India, 549 million (43.71 percent) for Pakistan and 73 million (53.50 percent) for Nepal.

Table 6: Paddy Rice Demand and Production

Year/Country	Bangladesh		India		Pakistan		Sri-Lanka		Nepal		Afghanistan	
	Demand (million ton)	Production (million ton) *	Demand (million ton)	Production (million ton) *	Demand (million ton)	Production (million ton) *	Demand (million ton)	Production (million ton) *	Demand (million ton)	Production (million ton) *	Demand (million ton)	Production (million ton) **
2020	44.87	44.10	149.60	167.00	6.05	9.30	3.27	3.80	4.83	4.75	0.97	0.400
2030	51.56	50.00	170.23	190.10	7.52	10.75	3.50	4.30	5.72	5.30	1.25	0.415
2040	59.25	55.40	193.70	213.50	9.35	12.00	3.76	4.80	6.77	5.80	1.62	0.420
2050	68.09	61.30	220.40	232.40	11.60	13.20	4.03	5.30	8.01	6.30	2.10	0.430
2060	78.25	67.50	250.79	253.20	14.50	14.52	4.32	5.80	9.48	6.81	2.73	0.435
2070	89.92	72.30	285.37	274.50	18.00	15.57	4.63	6.30	11.20	7.30	3.53	0.440
2080	103.30	79.20	324.71	295.80	22.30	17.20	4.97	6.70	13.30	7.82	4.58	0.445
2090	118.70	84.70	369.48	319.80	27.80	18.40	5.33	7.30	15.70	8.40	5.94	0.450
2100	136.50	90.80	420.42	339.70	34.50	19.70	5.71	7.70	18.60	8.84	7.70	0.460

(Source: Authors' calculation based on FAOSTAT and World Bank data, 2009)

:** Level of significance above 90%; *:** Level of significance below 90%

Wheat production involves a large area in South Asia where more than 100 million tons are produced annually. The wheat producing countries are India, Pakistan, Afghanistan, Nepal and Bangladesh in order of degree of production. The highest amount of wheat is produced in the Ganges and Nurmada basins of India and the Indus River Valley of Pakistan. India is one of the largest wheat producers in the world and consumption rate is 67 Kg per person per year. Afghans are the highest per capita wheat consumer (180 Kg per person per year) in South Asia, whereas average Bangladeshi consumes only 22 Kg in a year. Based upon the data of wheat for last 47 years, a simulation exercise has been conducted for the current research. The projected situation is more vulnerable in terms of wheat compared to that of rice production, if the business as usual situation persists (Table - 7). The research estimates find a daunting challenge for Pakistan and Afghanistan in meeting future demand.

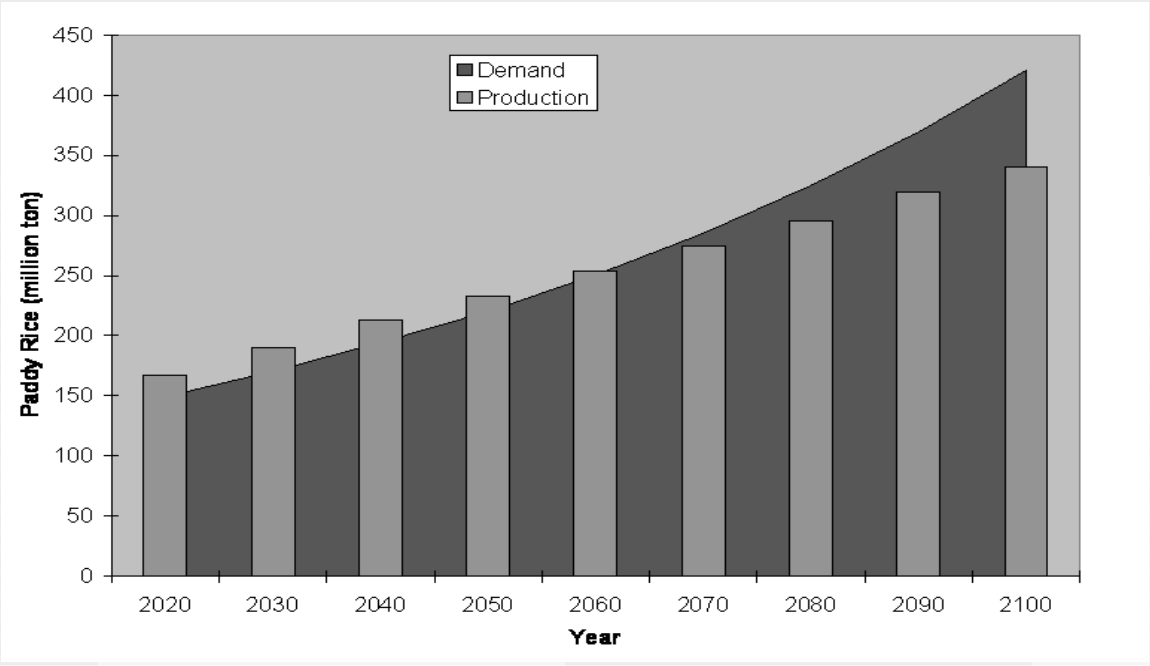
Table 7: Wheat Demand and Production

Year/Country	Bangladesh		India		Pakistan		Sri-Lanka		Nepal		Afghanistan	
	Demand (million ton)	Production (million ton) **	Demand (million ton)	Production (million ton) *	Demand (million ton)	Production (million ton) *	Demand (million ton)	Production (million ton) **	Demand (million ton)	Production (million ton) *	Demand (million ton)	Production (million ton) **
2020	4.55	1.68	97.52	98.10	30.46	26.00	1.24	0.011	1.69	1.71	7.34	2.80
2030	5.23	1.88	111.00	112.80	37.87	30.20	1.33	0.012	2.00	2.10	9.52	3.00
2040	6.01	2.08	126.30	130.20	47.07	34.10	1.43	0.012	2.37	2.35	12.30	3.20
2050	6.91	2.25	143.70	145.10	58.52	38.00	1.53	0.013	2.80	2.62	16.00	3.30
2060	7.94	2.45	163.50	159.60	72.74	42.00	1.65	0.014	3.32	2.93	20.70	3.40
2070	9.13	2.65	186.00	175.90	90.43	46.20	1.76	0.015	3.93	3.21	26.90	3.50
2080	10.50	2.83	211.70	191.00	112.40	50.40	1.89	0.016	4.65	3.52	34.80	3.60
2090	12.10	3.02	240.90	206.20	139.70	54.30	2.03	0.016	5.50	3.84	45.20	3.70
2100	13.80	3.25	274.10	232.20	173.70	58.20	2.17	0.017	6.51	4.20	58.60	3.80

(Source: Authors' calculation based on FAOSTAT and World Bank data, 2009)

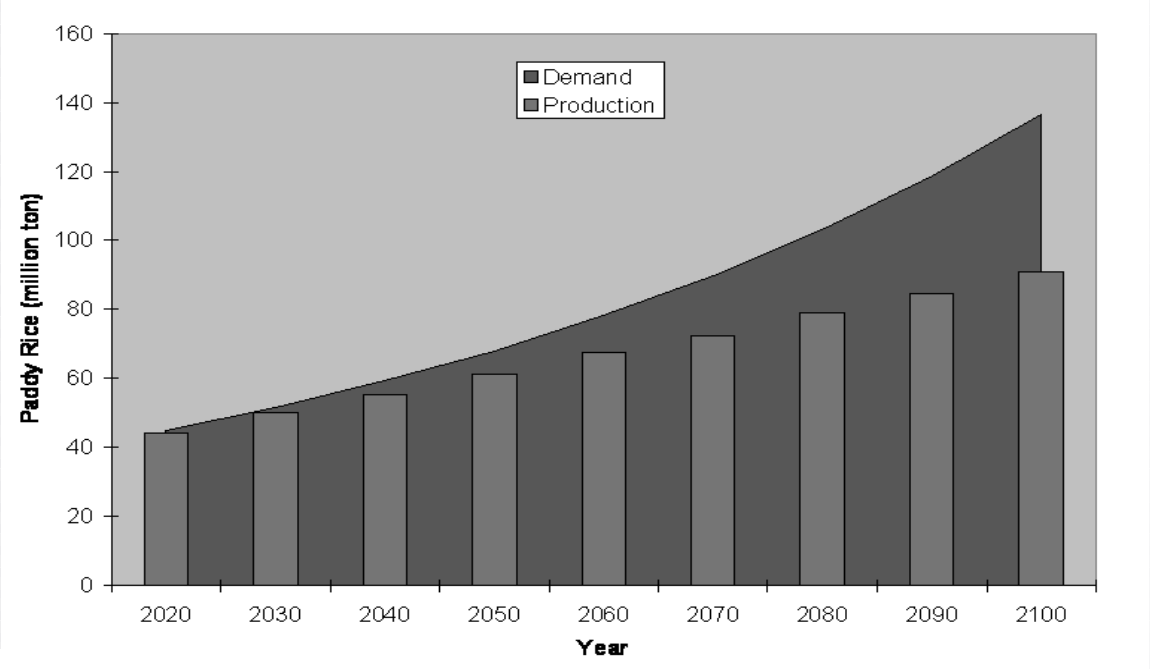
:** Level of significance above 90%; *:** Level of significance below 90%

Fig 8: Rice Demand and Production in India (Year wise)



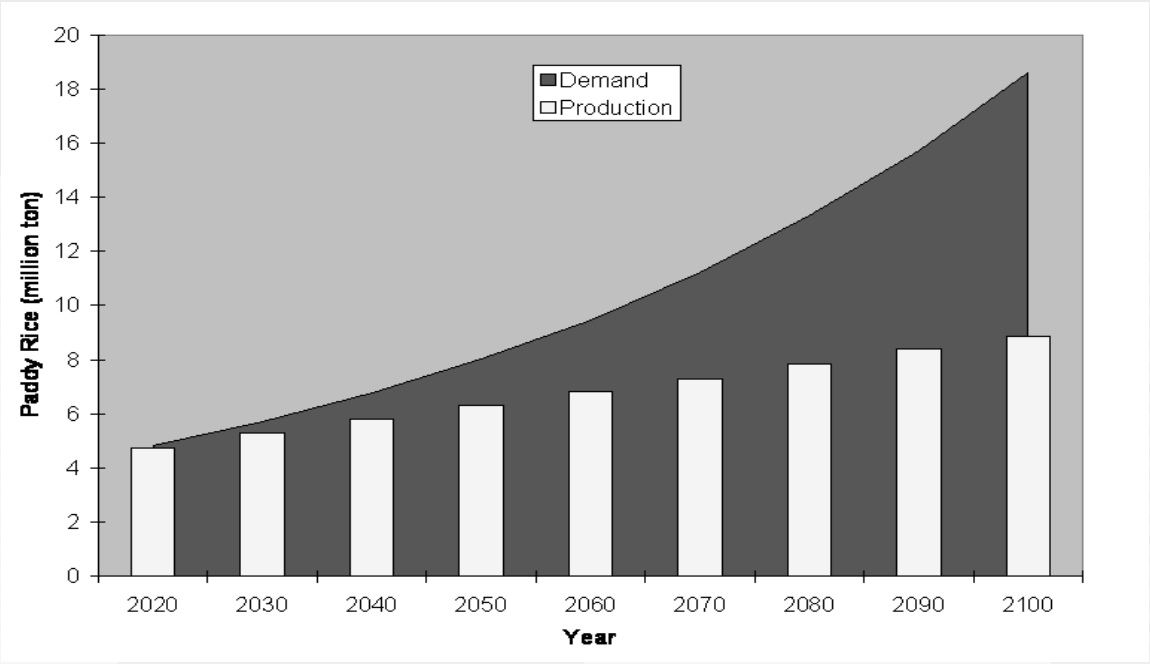
(Source: Authors' calculation based on FAOSTAT and World Bank data, 2009)

Fig 9: Rice Demand and Production in Bangladesh (Year wise)



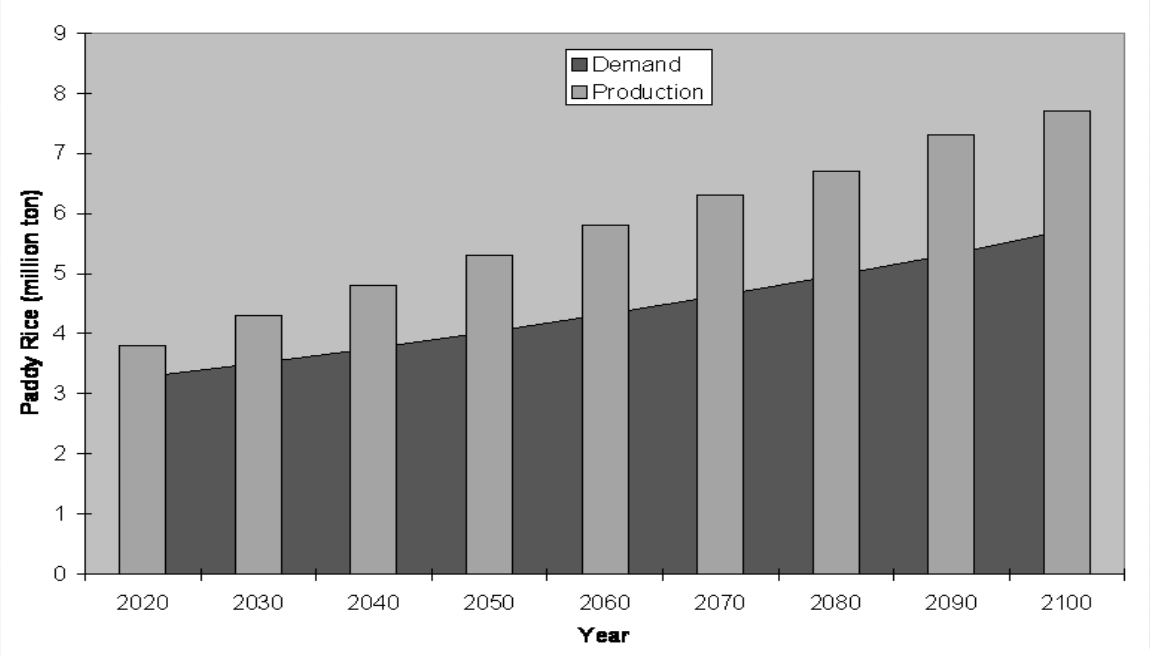
(Source: Authors' calculation based on FAOSTAT and World Bank data, 2009)

Fig 10: Paddy rice demand and production in Nepal (Year wise)



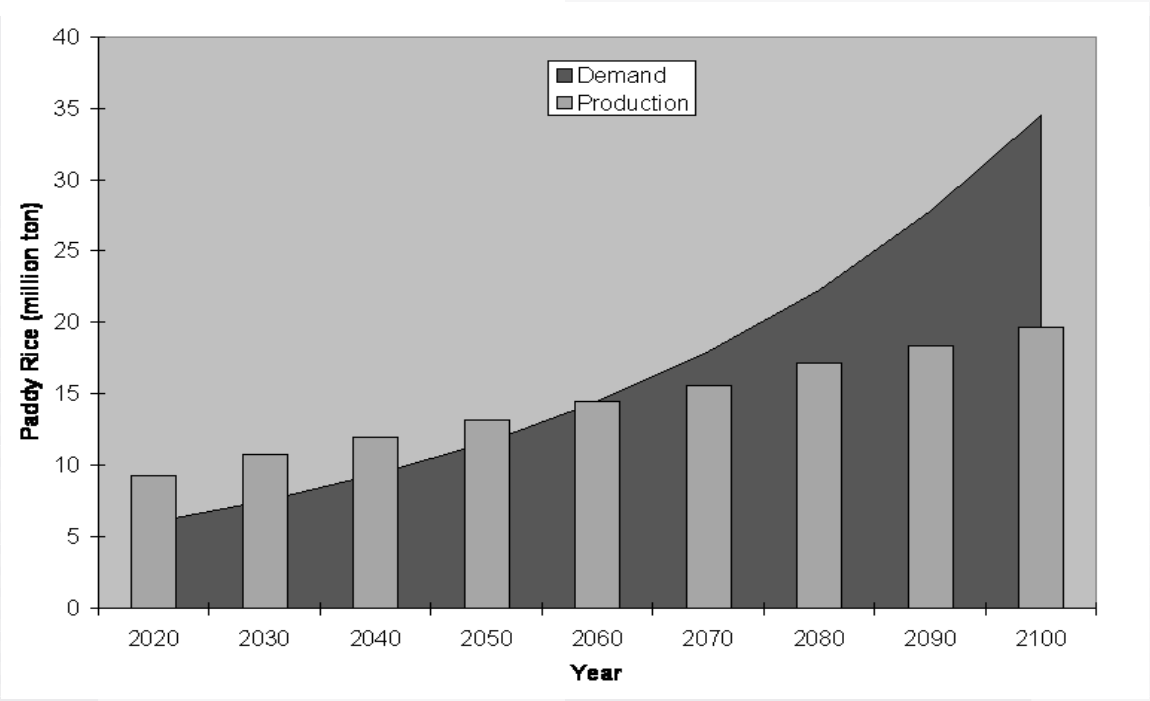
(Source: Authors' calculation based on FAOSTAT and World Bank data, 2009)

Fig 11: Rice Demand and Production in Sri-Lanka (Year wise)



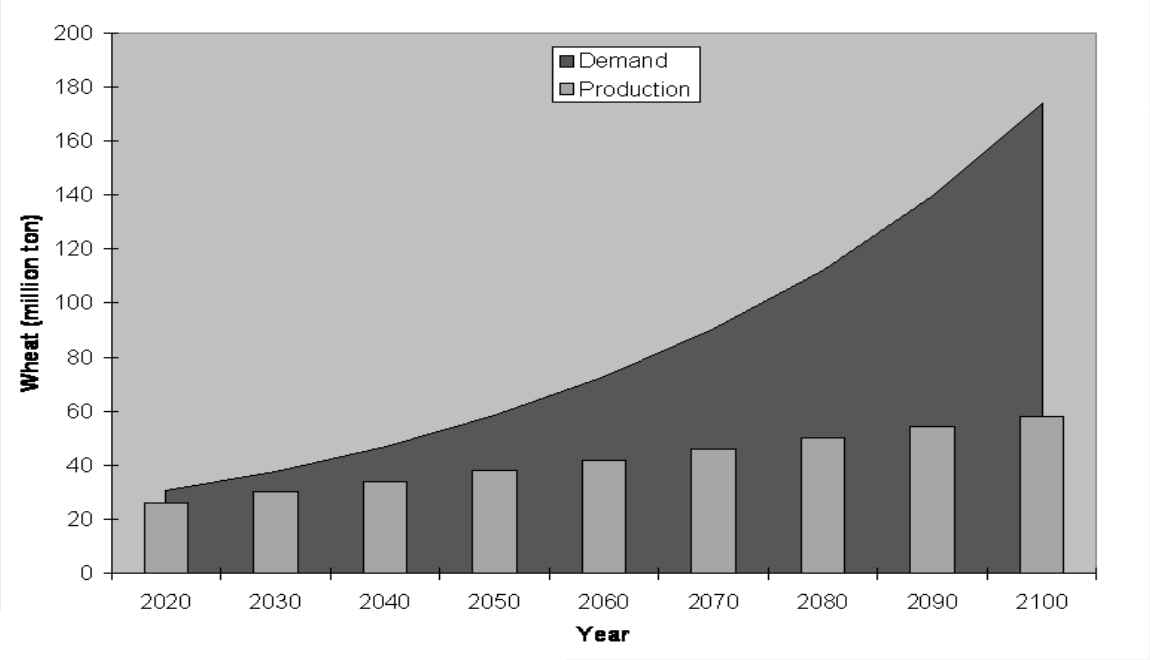
(Source: Authors' Calculation based on FAOSTAT and World Bank data, 2009)

Fig 12: Rice Demand and Production in Pakistan (Year wise)



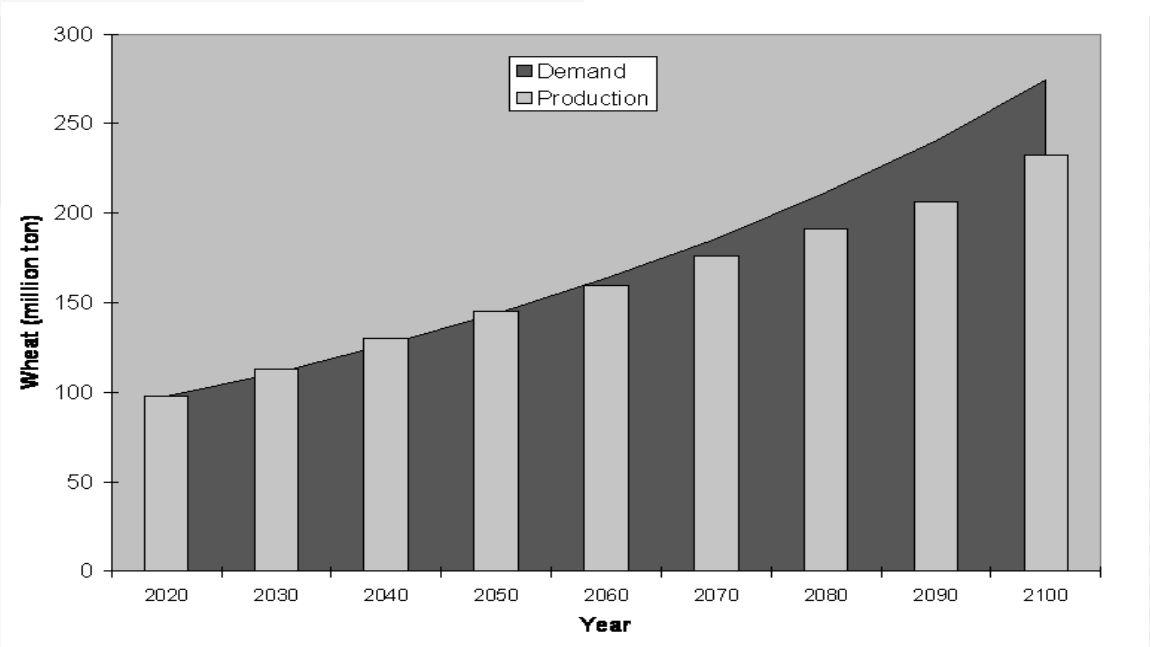
(Source: Authors' calculation based on FAOSTAT and World Bank data, 2009)

Fig 13: Wheat Demand and Production in Pakistan (Year wise)



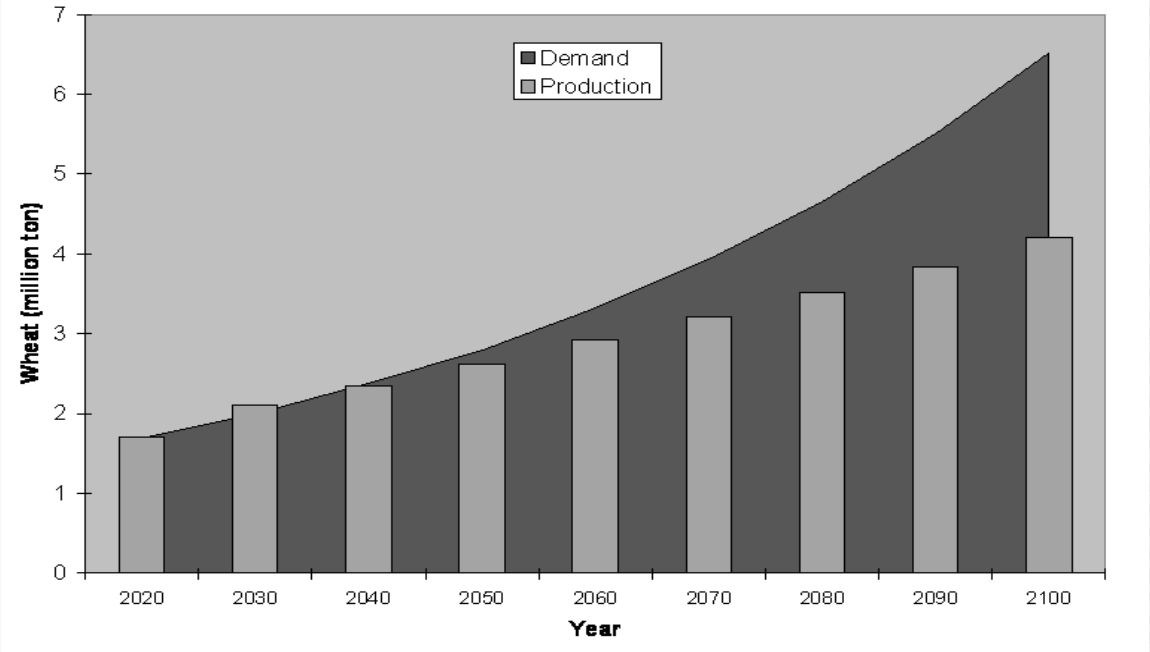
(Source: Authors' ccalculation based on FAOSTAT and World Bank data, 2009)

Fig 14: Wheat demand and production in India (Year wise)



(Source: Authors' calculation based on FAOSTAT and World Bank data, 2009)

Fig 15: Wheat demand and production in Nepal (Year wise)



(Source: Authors'' calculation based on FAOSTAT and World Bank data, 2009)

2.6 Climate change impacts on Food Production

Agriculture is one of the most sensitive sectors to climate change (Cline, 2007), particularly is affected by temperature, rainfall pattern and likelihood of extreme events such as droughts, flood, cyclone, salinity intrusion etc. Agricultural crops in South Asia are grown in diverse climatic conditions. Temperature influences not only the duration of growth, but also the pattern of growth and thereby impacting on the productivity. During the growing season, mean, sum, range, distribution, and diurnal changes of temperature, or a combination of these are highly correlated with yields of grains. For example, rice plant has nine growth stages with its three distinct growth phases and every stage requires an optimum temperature range for its proper development. The critical temperatures for the development of the rice plant at different growth phases (vegetative, reproductive and ripening) are shown in Table 8.

Table 8: Temperature for the Development of Rice plant at Different Growth Stages

Growth stages	Critical temperature (^{0}C)		
	Low	High	Optimum
Germination	16-19	45	18-40
Seedling emergence	12	35	25-30
Rooting	16	35	25-28
Leaf elongation	7-12	45	31
Tillering	9-16	33	25-31
Initiation of panicle primordia	15	-	-
Panicle differentiation	15-20	30	-
Anthesis	22	35-36	30-33
Ripening	12-18	>30	20-19

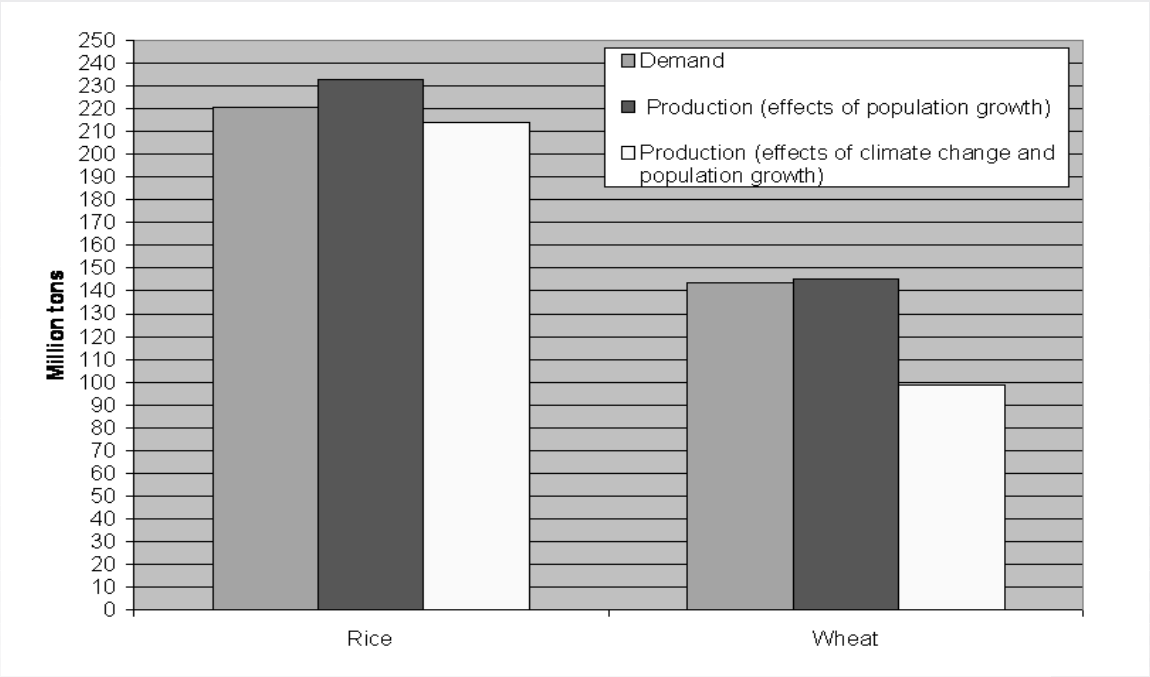
(Source: Yoshida, 1981)

The optimum growing temperature for wheat is about 25^{0}C, with minimum and maximum growth temperatures of 3^{0}C to 4^{0}C and 30 to 32^{0}C, respectively (Briggle, 1980). It can be grown in locations with precipitation ranging from 250 to 1750 mm (Leonard and Martin, 1963). Optimal production requires an adequate source of moisture availability during the growing season. However, too much precipitation can lead to yield losses due to diseases and root problems. In this study, we estimate rice and wheat production by factoring the projected loss due to climate change, as suggested by the IPPCC Fourth Assessment Report (FAR). To illustrate the projected impact of the climate change on production of rice and wheat, we estimate for India because consumption pattern of those two cereals are almost similar and the production trends for both rice and wheat for India are above 90 percent significant level in terms of regression coefficient. Moreover production and demand of these two crops are significantly higher in India compared to other countries.

The IPCC FAR noted that the production of rice and wheat could fall world wised by 8 percent and 32 percent, respectively by 2050 (Easterling, 2007). If only growth of population is taken as the only variable, the previous analysis (see section 2.4) shows that India might not face rice and wheat shortage till 2050. Even, if India can maintain the current level of production, India might have about 12 million tons of rice and 1.4 million tons of wheat as surplus in 2050. But when the climate change effects are considered, there is a considerable shortage of rice and wheat production which directly affects the total agricultural production in India, thereby consequently affecting the food security situation. Our estimation suggests that there might be shortage of 6.60 million tons of rice and 45.03 million tons of wheat in 2050. Consequently, rice shortage might affect more

than 90 million and wheat shortage might affect 672 million people. This could leave a shortfall to demand for a more than four percent of population of that particular time of 2050 in terms of rice while 33 percent could be affected in terms of wheat. Similar results are also expected for others South Asian countries.

Fig 16: Climate change effects on rice and wheat production in India



(Source: Authors' calculation based on FAOSTAT, World Bank and IPCC assumption)

Table 9: Climate change effects on rice and wheat production in India in 2050

Crop	Phenomenon	Demand (million tons)	Production (million tons)	Achievements /Shortage (million tons)
Rice	Effects of population growth	220.40	232.40	+12.00
	Effects of climate change and population growth	220.40	213.80	-6.60
Wheat	Effects of population growth	143.70	145.10	+1.40
	Effects of climate change and population growth	143.70	98.67	-45.03

(Source: Calculation based on FAOSTAT, World Bank and IPCC assumption)

2.7 Climate Change and Food Security

The economy of South Asia depends on a major part on agriculture and agriculture related production. More than half of the population of South Asia is engaged in or indirectly relies on agricultural activities. Moreover, agriculture production systems make a vital contribution to the reduction of hunger and poverty. The Food and Agricultural Organization (FAO) defines food security as a "situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary need and food preferences for an active and healthy life." This definition comprises four aspects of food security: availability, stability, access and utilization. This study has covered the major three portions of food security which are availability, stability, and access to food.

Impacts on Food availability: Availability of food is undertaken within the nation through domestic production, imports and carry-over of stocks. Climate change affects agriculture and food production in a complex way. It affects food production directly through changes in agro-ecological conditions such as changes in rainfall pattern, increase in temperature etc. and indirectly by affecting growth and distribution of incomes. Impacts of climate change on food production have been quantified in numerous studies under various sets of assumptions. For example, Basak et al., 2009; Mahmood et al., 2003; Mahmood, 1998; Karim et al., 1996) have carried out assessments on the impacts of climate change and variability on rice production in Bangladesh. Decision Support System for Agrotechnology Transfer (DSSAT) model has predicted significant reduction in Boro rice yield due to climate change. Yield reductions of over 20 percent and 50 percent have been predicted for the years 2050 and 2070, respectively (Basak et al., 2009). Karim et al., (1996) projected a net negative effect of climate change on the rice yields. The estimated impacts on rice yield vary between -6 to +14 percent depending on different climate change scenarios. Unnayan Onneshan in 2009 has conducted a research work for future food security situation in Bangladesh. The main finding of the research is that the rice shortage may occur more than 35 percent due to population growth (two million people per year) whereas it may be 50 percent for growing population and increasing temperature in 2050 compared to the total rice production in 2006-07 in Bangladesh (Basak, 2009).

The major food grain producing regions of Haryana, Punjab and western Uttar Pradesh experience the most negative effects, along with the coastal districts of Tamil Nadu. Punjab and Haryana are significant from the perspective of food security in India. These regions are also facing severe depletion of groundwater resources due to intensive cultivation techniques. Temperature rise of 1.5^0C and 2 mm increase in precipitation could result in a decline in rice yields by 3 to 15 percent. Sorghum yields would be affected and yields are predicted to vary from +18 to -22 percent depending on a rise of 2 to 4^0C in temperatures and increase by 20 to 40 percent of precipitation (IPCC 2001). Wheat yields in central India may drop by 2 percent in a pessimistic climate change scenario (GoI 2004). Upland crop production can be highly sensitive to variations in climate in Bhutan. Climate change may cause the cultivating zone to shift upwards to unsuitably steep slopes if temperatures increase by 2 ºC (NEC, 2000).

In Sri Lanka, most crops, e.g., coarse grain, legumes, vegetables, and potato are likely to be adversely affected due to climate change. The highest negative impact is estimated for coarse grains and coconut production. Tea, rubber and coconut industries are the major sources of income for labour. AIACC project confirmed that changes in the monsoon rainfall pattern and an increase in maximum air temperature are likely to be the two key factors that will affect coconut production in the principal growing regions.

In the hot climate of Pakistan, cereal crops are already at the margin of stress. An increase of 2.5^0C in average temperature would translate into much higher ambient temperatures in the wheat planting and growing stages. Wheat yields are predicted to decline by 6-9 percent in sub-humid, semiarid, and arid areas with 1°C increase in temperature (Sultana and Ali 2006); while even a 0.3°C decadal rise could have a severe impact on important cash crops like cotton, mango, and sugarcane (MoE 2003).

The impact of a rise in temperatures on wheat and maize is also expected to be negative in Nepal.

So, there is a huge probability the climatic variability and population growth may directly affect the food security and also make social security problems.

Impacts on the Stability of Food Supplies: Global and regional weather conditions are expected to become more variable than at present with increases in the frequency and severity of extremes events such as cyclones, floods, hailstorms and drought. If the climate changes fluctuations become more pronounced and widespread, it will adversely affect the stability of food supplies and consequently food security (Schmidhuber J and Tubiello FN, 2007).

On an average during the period 1962-1988, Bangladesh lost about 0.5 million tons of rice annually as a result of floods. This amounts to nearly 30 percent of the country's average annual food grain imports (Paul and Rashid 1993). If sea levels rise up to one meter, Bangladesh could have loss 15 percent landmass and up to 30 million Bangladeshi could be become climate refuges. Agricultural, industry, infrastructure, livelihoods, marine resources, forestry and biodiversity, human health, and utility services are expected to be adversely impacted. Such a scenario could lead to a decline in GDP of between 27 and 57 percent. The salinity intrusion experienced by the coastal area of Bangladesh is having serious implications for the quality of the soil in areas that are traditionally used for growing rice. The fisheries sector may also be affected by climate change. The changes in tidal patterns, as well as increasing saline intrusion into the freshwater rivers, associated with climate change, will impacts on fish populations, although the extent to which this occurs is still uncertain (Huq and Ayers, 2008).

Kumar and Parikh (2001) shows that even after accounting for farm level adaptation, a 2°C rise in mean temperature and a 7 percent increase in mean precipitation may reduce net farm revenues by 8.4 percent in India.

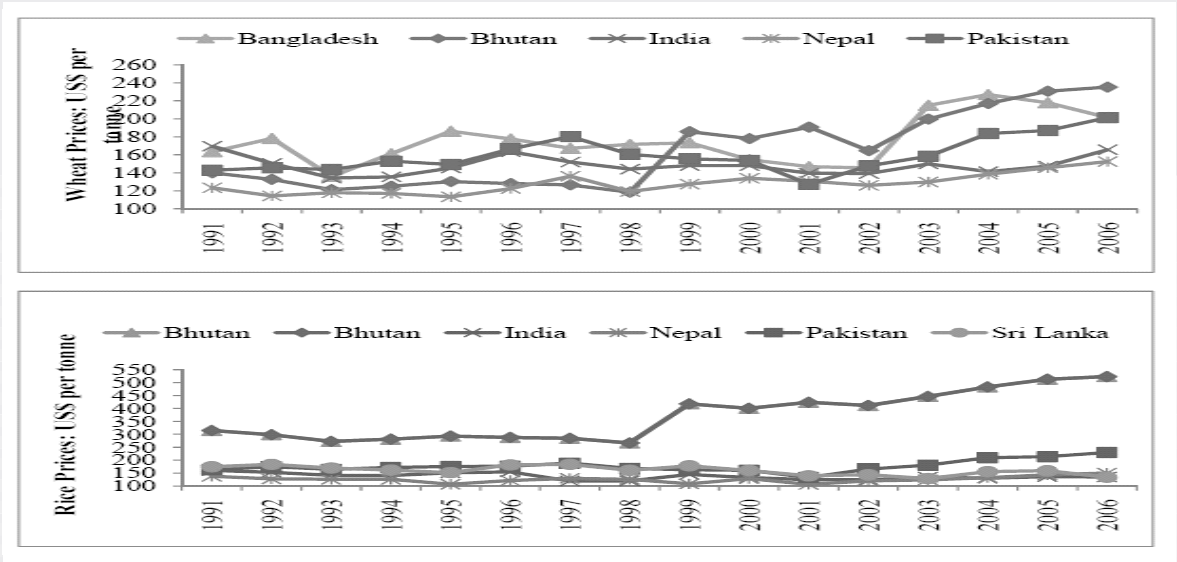
Soil loss is a major cause of decline in agricultural production in Nepal and the negative effects of climate change may further aggravate this situation.

In this study, it is found that agricultural land for food production and for every person is continuously decreasing in South Asia and if the trend continues, land for food production and land for every person will squeeze in the next decade. Therefore, a huge pressure would be put on already squeezing land to meet the growing demand of the growing population. The stability of food supply will be contingent upon climatic events, the investment in innovation and better management practices and storage facilities in agricultural production.

Impacts on Access to Food: Access to food refers to the ability of individuals, communities, and countries to purchase sufficient quantities and qualities of food (Schmidhuber J and Tubiello FN, 2007). Raising the real price of food has led to difficulty in access to food in South Asia. Over the last 17 years the price of rice and wheat increased at significant rates (Fig. 17), creating an additional burden on the lower income groups as they spend maximum of their income for purchase of food. For example food inflection rate in Bangladesh was 10.82 percent, 10.01 percent and 10.19 percent in July, August and September, respectively in 2008. This high inflation rate create a huge pressure to the poor people to fulfill their food demand and maximum case they were passing hungry life on this period. Besides climate change still exacerbate food security problem more acute.

There are a number of studies that have ventured to measure the likely impacts of climate change on food prices (Fischer et al., 2002, Reilly et al., 1996 and Darwin wt al., 1995). The basic messages that emerge from these studies are: first, on average, prices for food are expected to rise moderately in line with moderate increases of temperature (until 2050); some studies even foresee a mild decline in real prices until 2050. Second, after 2050 and with further increases in temperatures, prices are expected to increase more substantially. In some studies (Reilly et al., 1996) and for some commodities (rice and sugar) prices are forecast to increase by as much as 80% above their reference levels without climate change. Third, price changes expected from the effects of global warming are, on average, much smaller than price changes from socio-economic development paths. For instance, the SRES A2 scenario would imply a price increase in real cereal prices by ≈170%. The (additional) price increase caused by climate change (in the Hadley Centre Coupled Model, version 3, climate change case) would be 14.4%.

Figure 17: Trends in rice and wheat prices in South Asian Countries



Source: FAO Statistics, 2009
Food Security in South Asia: Issues and Opportunities by Surabhi Mittal and Deepti Sethi

Section 03

3.0 Conclusion

Agricultural is the main source to supply adequate food to the people of South Asia. But the food security condition in this region is aggravating day by day due to ever-increasing population. From this study, it is clear that the food production has increased by only creating huge pressure on agricultural land. Applications of huge amount of ground water, pesticide, herbicide, chemical fertiliser are continuously increasing in the agricultural sector. But every agricultural input has a maximum limit to contribute to the production system and therefore, if the current practise continues the system might turn out to unsustainable. The study estimates that the population in South Asia could be above 6 billion in the end of the century. Therefore a huge amount of rice and wheat (the main cereal crops in South Asia) will be required to meet the demand. The study shows, if actions are note taken, every country may face a severe food shortage. Food security in South Asia could be strengthened by increased national production of food, increased diversification of economy, increased employment and income generating opportunities and increased investment in this sector to achieve higher economic growth. Besides, it is more important for the region to have a long term strategy to achieve food security for all based on indigenous efforts.

Increasing productivity requires new knowledge both to maintain yields and to improve the quality of production. This would imply substantial investments in agricultural research and outreach programmes to disseminate technology know-how, effective communication that improves farmers' access to market information.

Environmental conditions all over this country are not the same. There are some heavy rainfall sub-regions, some are drought prone, some are flooded and cyclone affected sub-regions in every country within South Asia. This climatic variability is closely related with crop production. Therefore, development and use of temperature and drought tolerant crop varieties that can withstand the adverse efforts of climate change are important.

Certainly improved technology may assist in more effective management in agricultural sectors, but it can not produce an unlimited flow of those vital natural resources that are the raw materials for sustained agricultural production. For instance, fertilisers enhance the fertility of eroded soils, but human can not make topsoil. Indeed, fertilisers made from finite fossil fuels are presently being used to compensate for eroded topsoil. But this fuel can not supply soil nutrient for a long period due to excessive application that have an adverse effect on soil fertility. In this study it is found that the fertilisers' application in Bangladesh increased more than 850 times during the period of 1975 to 2005. The huge application of chemical fertilisers creates extra pressure on the soil to increase productivity of the land that is not sustainable for agriculture. Besides this, the supply of ground water is not only used for agriculture but also for industry and public sector. Every year a huge amount of water is withdrawn from the ground for irrigation and other purposes, resulting in continuous lowering of ground water table. Therefore, an appropriate strategy is needed to give a special priority for using surface water via construction and improvement of surface water bodies for supplying irrigation water and developing new surface irrigation related projects for sustaining agricultural sector.

Strategies for the future must be based first and foremost on the conservation and careful management of land, water, energy, and biological resources needed for food production. In that situation cropping pattern must be selected on the basis of available natural resources. For example, cropping pattern in most of the subregions in Bangladesh is rice based. Same types of crops are grown in the same piece of land hampering the soil fertility. Therefore, there is a need for change in cropping pattern for improving health of soil to sustain agriculture.

Yet none of these measures will be sufficient to ensure adequate food supplies for future generations unless the growth of human population is simultaneously controlled. In this study it is found that the total population in South Asia, if adequate actions are not taken, may reach to the peak of 2870.30 million in 2050 and 6108.50 million in 2100. This call for new strategy for conservation of land, water, energy, biological resources and productive environment in a sustainable way.

If agricultural production is not enough to meet the demand and associated food security related measures are not taken, a major part of population will be deprived from food and will remain hungry and und undernourished. Policy support for agricultural research and development to develop and transfer appropriate and efficient technologies will be vital for the realization of such measures in ensuring sustainable crop production.

As the key drivers of climate change with high variances are still unfolding, it is difficult to predict what would be the exact situations in this region. Moreover, the lower investment in agriculture by the countries in South Asia largely undermines the needs of increasing agriculture production and supports for small and marginal farmers. Until this trend is changed, South Asia will face chronic food insecurity and hunger.

From climate change perspectives, in this region one of the most common policy responses to food security is social protection system, mainly targeted at household level food insecurity. Though in some countries food security programmes have taken some aspects of household level income insecurity, the greater need of comprehensiveness remains untouched.

On food availability issue, emphasis has been given to food production. Now, at least theoretically, food security definition captured in other policy areas linked with income and livelihoods security but there are still gaps to combine all these policy links together. Moreover, the existing related policies are not being implemented effectively, which in turn is raising concerns on affordability and accessibility to food. Dramatically, last few decades, dependence on food aid and food imports have increased. Due to changes of climate, this dependency may further increase and create more pressure on food stability. In this context, the issue of food security not only put the existing policies at questions but also requires a region wide comprehensive intervention and steps.

At South Asia level, the idea of food bank was initiated to combat food insecurity at any emergency situations. In last SAARC summit, there was an attempt to materialize this with the growing concerns of facing more natural hazards and global food instability. This initiative is undoubtedly to foster the more regional cooperation.[4] However, proper infrastructure, location of storage etc. remain the main issues to be considered further.

Another important tool is having effective local and regional market (at least a greater integration of regional market). The starting point for a greater integration is South Asia Free Trade Agreement (SAFTA), which has remained non-functional compared to ASEAN blocks. In terms of addressing the food security issue, as mentioned food aid and imports are increasing, proper trade pact is necessary. A recent experience of no availability of food from the global market as well as from other regional sources exhibits the urgency of trade deal within the region.

In this backdrop, the following policy responses need to be taken up:

National:

- Adequate national policies on agriculture, trade and social protection in countries to ensure the right to food and protect women smallholders' livelihoods.
- Coherence of national level policies so that agriculture, trade and climate change policies strengthens smallholders' effort to improve agriculture productivity and food security.
- Investment policies do not threat the right to food and access to natural resources.
- Adaptation and mitigation policies do not harm smallholders, and offer opportunities to improve food security and rural development.
- National plans for climate change adaptation and for food security are coordinated, and funding bodies are also coordinated

Regional:

- Regional policy framework: Adequate regional policies at SAARC levels on agriculture, trade, energy and climate change.
- Regional investment policies: An investment fund to enhance collaboration on technological development regarding crop varieties such as Seed Bank, to enhance the right to food and access to natural resources.
- Effective regional emergency response: Promotion and implementation of SAARC food bank, seed bank.
- Common regional shared vision on "Climate change and food security"
- Adaptation and mitigation policies do not harm smallholders, and offer opportunities to improve food security and rural development.

[4]The joint projects would augment food production, invest in agriculture and related industries, conduct agricultural research, share technology, assist in procurement and distribution, as well as manage climatic and disease-related risks. The bank would hold 241,580 metric tonnes (MT) in rice and wheat reserves, contributed by each SAARC member, including Bangladesh (40,000MT), Bhutan (180MT), India (153,200MT), the Maldives (200MT), Nepal (4,000MT), Pakistan (40,000MT), and Sri Lanka (4,000MT). Afghanistan's share would be decided later. The reserves would remain the property of the individual member country and would be in addition to any national reserves. http://www.irinnews.org/report.aspx?ReportID=79689

References

Agrawala S,. 2003. Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundarbans, Organisation for Economic Co-operation and Development (OECD).

Ahluwalia, Montek. S. 1985. "Rural Poverty, Agricultural Production, and Prices: A re-examination." *In* John D. Mellor and Gunwant M. Desai (ed.)*, Agricultural Change and Rural Poverty*, Johns Hopkins University Press, Baltimore and London.

Basak, J.K., 2009. Effects of Increasing Temperature and Population Growth on Rice Production in Bangladesh: Implications for Food Security. Published by Unnayan Onneshan (www.unnayan.org), Dhaka, Bangladesh

Basak, J.K., Ali, M.A., Islam, M.N. and Alam, M.J.B. 2009. Assessment of the effect of climate change on boro rice production in Bangladesh using CERES-Rice model, Proceedings of the International conference on Climate Change Impacts and Adaptation Strategies for Bangladesh, 18-20 February 2009, p. 103-113.

Briggle, L.W. 1980. Origin and botany of wheat. In E. Häfliger, ed. Wheat documenta cibageigy, p. 6-13. Basle, Switzerland.

Cline, W.R., Global Warming and Agriculture. Impact Estimates by Country. 2007, Washington DC: Centre for Global Development and the Peterson Institute for International Economics.

Department of Census and Statistics, Institute of Policy Studies and Samurdhi Division, Ministry of Nation Building and Estate Infrastructure Development (2009). SAARC Regional Poverty Profile 2006/2007: Infrastructure Development and Poverty Reduction (to be published). Kathmandu: SAARC Secretariat.

Easterling, W.E., et al., Food, fibre and forest products, in Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, et al., Editors. 2007, Cambridge University Press: Cambridge. p. 273-313.

Food and Agriculture Organisation of The United Nations (2009). Statistics Division.
http://faostat.fao.org/default.aspx

GoI (Government of India). 2004. India's initial national communication to the United Nations Framework Convention on Climate Change. New Delhi: Ministry of Environment and Forests, GoI. 266 pp.
Harasawa H, Key vulnerabilities and critical levels of impacts on east and southeast Asia, in Avoiding Dangerous Climate Change, Schellnhuber H J, et al., Editors. 2006, Cambridge University Press: Cambridge. p. 243-249.

Hall GV., D'Souza RM, and Kirk MD. 2000. Food borne disease in the new millennium: out of the frying pan and into the fire? Med J Austral 177:614–618.

HDR 2007-08 – Human Development Report

http://www.wfp.org/country_brief/indexcountry.asp?country=004

Hunter PR. 2003. Climate change and waterborne and vector-borne disease. J Appl Microbiol 94:37–46.

Huq, S. and J. Ayers. 2008. Climate Change Impacts and Response in Bangladesh. International Institute for Environment and Development. United Kingdom: London.

Hydroponics Agriculture Pilot Project (MDV/98/006), taken up by Forestry, Agriculture Research & Development Section, Maldives.

International Development Association and International Finance Corporation Country Assistance Strategy for The Republic of Maldives, FY08 – FY12 (2007). Document of the World Bank, Report No. 41400 – MV.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge Univ. Press, Cambridge, UK) in press.

IPCC (Intergovernmental Panel on Climate Change). 2001. Climate change 2001: Impacts, Adaptation and Vulnerability. Cambridge: Cambridge University Press.

Jappa, M.Z.H. 2010. Food Security and Insecurity in South Asia: Perils and Prospects. News Central Asia. http://www.newscentralasia.net.

Karim, Z., Hussain, S. G. and Ahmed, M. 1996. “Assessing impacts of climatic variations on foodgrain production in Bangladesh”. Kluwer Academic Publishes, Netherlands.

Korenberg E, Izmerov NF, Revich BA, and Korenberg EI. 2004. In Climate Change and Public Health in Russia in the XXI Century, Proceedings of a Workshop, eds Izmerov NF, Revich BA, Korenberg EI (Adamant, Moscow), pp 54–67.

Kumar K S K and Parikh J. 2001. Indian Agriculture and Climate Sensitivity. Global Environmental Change 11(2): 147-154.

Lehane L, and Lewis RJ. 2000. Staphylococcal enterotoxins. Int J Food Microbiol 61:1–125.

Leonard, W.H. & Martin, J.H. 1963. *Cereal crops*. New York, NY, USA, MacMillan Publishing.

Mahmood, R., Meo, M., Legates, D. R. and Morrissey, M. L. 2003. The Professional Geographer, 55(2), 259-273.

Mahmood, R. 1998. Air temperature variations and rice productivity in Bangladesh: A comparative study of the performance of the YIELD and CERES-Rice models. Ecological Modeling, 106, 201-212.
MENR (Ministry of Environment and Natural Resources). 2000. Initial National Communication under the United Nations Framework Convention on Climate Change: Sri Lanka. Colombo: MENR, Government of Sri Lanka.

MOF (2008), ‘Economic Survey of Pakistan 2007-08’, Ministry of Finance, Government of Pakistan, Islamabad.

MoE (Ministry of Environment). 2003. Pakistan’s Initial National Communication on climate change. Islamabad: MoE, Government of Islamic Republic of Pakistan.

NEC (National Environment Commission). 2000. Initial National Communication under the United Nations Framework Convention on Climate Change. Thimphu: NEC, Royal.

Paul and Rashid, Flood damage to rice crop in Bangladesh. The Geographical Review 1993. 2(83): p. 151-159.

Percival, J. 1921. The wheat plant. A monograph. New York, NY, USA, E.P. Dutton & Company.

Reid, H. and A. Sims, Up in smoke? Asia and the Pacific. 2007, Up in Smoke Working Group on Climate Change and Development. p. 92.

Samaratunga, Parakrama A and Thibbotuwawa, Manoj (2009). Food Security in Sri Lanka. Mimeo, ICRIER

Schmidhuber J and Tubiello FN. 2007. Global food security under climate change. Eds William Easterling, Pennsylvania State University, University Park, PA

UNDP. 1996. Human Development Report.
World Development Indicators, 2008.
World Development Report. World Bank. 2008.
World Food Prices: South Asia’s Poor at Risk. World Bank, 2008.
World Food Programme (2008). Food Security Overview.
World Bank. 2009. World Development Report. http://web.worldbank.org
World Bank. 1996. World Development Report.

Yoshida, S. 1981. Fundamentals of Rice Crop Science. International Rice Research Institute. Los Banos, Philippines. pp. 269.

উন্নয়ন অন্বেষণ
Unnayan Onneshan
The Innovators
centre for research and action on development

House: 19A, Road: 16 (New), Dhanmondi, Dhaka-1209, Bangladesh
Tell: +(880-2) 815 82 74, 911 06 36; Fax: + (880-2) 815 91 35
E-mail: info@unnayan.org; Web: www.unnayan.org