Annotated Bibliography: Climate Change & Food Security

SDPI-CGIAR Project

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Climate Change – Pakistan

1. **Khan, J 2011, 'Changing climate patterns and their impacts with special focus on Pakistan', *Symposium on Changing Environmental Pattern and its impact with Special Focus on Pakistan*, Pakistan Engineering Congress, vol. 33, no. 285, pp.21-34, viewed on 10 October 2012, <http://pecongress.org.pk/images/upload/books/3-Changing%20Climate%20Patterns%20and%20their%20Impacts%20with%20Special%20Foc.pdf>**

This research paper is presented by a senior bureaucrat in the Ministry of Climate Change (formerly known as the Ministry of Environment). Citing recent examples of the Great Flood and the glacial dam burst in Pakistan in 2010, the study reiterates that climate change is an imminent threat to Pakistan and the world. The writer claims that although Pakistan plays minimal role in polluting the environment, compared to global standards – (it ranks 135th in global per capita emission of GHGs) – it is ironically one of the few nations that are highly vulnerable to the adverse impacts of climate change. The writer suggests that climate change can be best adapted to and mitigated by formulating and adopting a National Climate Change Policy.

2. **Iqbal, MM, Goheer, MA & Khan, AM 2009, 'Climate change and aspersions on food security of Pakistan', *Science Vision*, vol. 15, no. 1, viewed 5 October 2012, <http://www.sciencevision.org.pk/CurrentIssue/Vol15No1/Vol15No1_Complete_Issue.pdf#page=23>**

This article, published in a bi-annual science journal of COMSATS, highlights the important scientific and technological developments in agriculture that have a bearing on the food security situation in Pakistan, in the context of climate change. The lead author, who is a senior official at the Global Change Impact Studies Centre (GCISC), presents results from various studies on wheat and basmati rice. The study concludes that possible adaptation techniques could possibly be alteration of sowing dates of crops, cultivation of new crop varieties, advance seasonal forecast, new and innovative irrigation methods and use of resource conservation.

3. **Sheikh, BA, Sheikh, SA & Soomro, GH 2005, 'Pakistan agriculture in global perspective', *Pakistan Journal of Agriculture., Agricultural Engineering & Veterinary Science*, vol. 21, no. 2, pp. 53-59, viewed 9 October 2012, <http://www.sau.edu.pk/journals/baSheikh.pdf>**

In this review article, the writers critically analyze food security in the context of climate change, poverty and population growth. In Asia, it has shown its drastic impacts on crops and allied agriculture practices. The paper maintains that climate change is challenging the agriculture sector particularly in South Asian region. The paper cautions that climate change is likely to melt the Himalayan glacier, posing a threat to food and water security of Pakistan, India, Nepal, China and Bhutan.

4. **Ahmad, MA & Schmitz, M 2011, 'Economic assessment of the impact of climate change on the agriculture of Pakistan',** ***Business and Economic Horizons,*** **vol. 4, no. 1, pp.1-12, viewed 11 October 2012, <http://academicpublishingplatforms.com/downloads/pdfs/ati/volume1/20110320153 4_01_BEH_Vol4_GERMANY_MirzaNomman_Ahmed_and_Schmitz_Economic_I mpact_Climate_Change.pdf>**

The paper describes the impact of climate change on agriculture of Pakistan. It depicted the impact on agriculture productivity on all provinces of the country. It developed a panel model for modeling climate change impacts on agriculture in Pakistan. Solow model is exercised to address the aimed objective of research. The yield of crop was measured as weighted food crop yield per hectare. In order to include variable on extreme events in the model, measure of drought was used. Furthermore, to depict the effect of climate change, several control variables are introduced in a panel framework for inter temporal analysis. The result of the study was not satisfactory for the country as it showed lower agriculture productivity especially in arid zones where climate change stress is more. Authors suggested some adaptation policies regarding climate change in which there results showed that incremental units of fertilizer use in crops has made them more tolerant to climate change stress. Credit availability also enhances the production where analysis showed one unit increase in credit availability increase the production to 1100 kg per hectare. Extensive research on water cycle of country is of crucial importance, as the availability of water for irrigation will be a key aspect for determining the future impacts of climate change on yields in Pakistan.

5. **Iqbal, MM, Hussain, SS, Goheer, MA, Sultana, H, Salik, KM, Mudassar, M & Khan AM 2009,** ***Climate Change and Rice Production in Pakistan: Calibration, Validation and Application of CERES-Wheat Model,*** **Global Change Impact Studies Centre, GCISC, Research Report no. 15.**

This report assesses the impact of climate change on rice production in Pakistan. DSSAT-based CERES-Rice model is used for the assessment. This report concludes that climate change will have a negative impact on production of rice by lengthening seasons and raising average temperature in the semi-arid plains of Punjab province.

6. **Iqbal, MM, Hussain, SS, Goheer, MA, Sultana, H, Salik, KM, Mudassar, M & Khan AM 2009,** ***Climate Change and Wheat Production in Pakistan: Calibration, Validation and Application of CERES-Wheat Model,*** **Global Change Impact Studies Centre, GCISC, Research Report no. 14.**

The report utilizes crop simulation model CERES-Wheat for the climate change impact assessment. Different circumstances of irrigation water supplies are applied to analyze their impact on wheat crop. The report concludes that higher temperature will significantly reduce wheat yield in semi-arid, arid and sub-humid zones.

7. **Kaltenborn, BP, Nellemann, C, Vistnes, II 2010*, High Mountain Glaciers and Climate Change- Challenges to Human Livelihoods and Adaptation,* United Nation Environment Programme, GRID-Arendal.**

The report makes an interesting read for those interested in finding out more about how glaciers may be impacted by climate change. The report claims that in November 2010, over six million people were affected by floods in Pakistan, in terms of loss or damage to houses, livestock, crops and livelihoods. The report stresses on the need for good governance and better planning to improve resource-use efficiency in the agriculture sector.

8. **Tusneem, ME 2008, 'Food security in a changing climate', *Pakistan Development Review*, vol. 47, no. 4, pp. 815-816, viewed October 7 2012, <www.pide.org.pk/pdf/PDR/2008/Volume4/815-816.pdf>**

Climate variability raises the risk of crop failure and livestock mortality, ultimately leading to loss of income and food insecurity, argues the writer. In order to combat these, the paper proposes adaptation measures, such as more investment in agriculture research for improved production system, and improving reliability of seasonal forecasts for farmers for better planning. The writer also suggest developing new crop varieties, and changing farming practices from extensive to intensive production system. More importantly, the writer draws attention to the problem of waste management which pollutes the environment and has a potential to contribute to climate change.

9. **Shah, T & Lele, U (eds) 2011, *Climate Change, Food and Water in South Asia: Critical Issues and Cooperative Strategies in the Age of Increased Risk and Uncertainty*, Synthesis of Workshop Discussions, Colombo, Sri Lanka, 23-25 February 2011.**

This 32-page report is a synthesis of a discussions held in a workshop on climate change, food and water in South Asia, hosted by Global Water Partnership and International Water Management Institute on Water and Food Security. The workshop emphasized the effects of climate change on water sources, and water related natural disasters that will impact the region and in turn hamper food security in the region. In the context of Pakistan, experts had highlighted water storage as a key concern, and pointed out that more than any other river basin in the region, the Indus relied most heavily on glacier melts for its water source (45%) , making Pakistan increasing vulnerable to climate change. The workshop's core aim was to highlight, the hidden threats that exist in the interactions between climate change, water and food security, and the means to address them. The workshop emphasized coordinated strategies to dealing with the climate change problem, and by the end officials from the Planning Commissions of Pakistan and India had made agreements to find coordinated solutions. Overall the emphasis of the workshop was on climate change and water, and the effects on food security are mention in perfunctory manner.

10. **Thorpe, J & Fennell, S 2012, 'Climate change risk and supply chain responsibility: How should companies respond when extreme weather affects small-scale producers**

in their supply chain?', Oxfam Discussion Paper, viewed October 4 2012, <www.oxfam.org/.../dp-climate-change-risks-supply-chain-responsibility>

This paper studies the impact of climate change on the livelihoods of small-holder famers in Pakistan, Colombia and Nicaragua. It predicts that agriculture productivity will decline by 15 to 30 percent in developing countries by 2080. The paper calls for a more proactive role of the industrial sector in building capacity of small-scale producers to adapt to climate change.

11. **Hanif, U, Syed, SH, Ahmad, R & Malik, KA 2010, 'Economic impact of climate change on agriculture sector of Punjab', *Pakistan Development Review*, vol. 49, no. 4, pp. 771-798, viewed 6 November 2012, <http://www.pide.org.pk/psde/25/pdf/agm26/day3/Uzma%20Hanif.pdf>**

This journal article tries to quantify the economic cost of climatic impacts on Punjab's agriculture. The researchers use FGLS panel regression technique to quantify the above mentioned impacts. The results showed that the Kharif and Rabi variables are significantly related with per acre land prices, and the hypothesis that climate change has impacts on land prices was proved as a result of the study.

12. **Iqbal, MM, Goheer, MA, Sultana, H, Noor, SA, Mudassar, M, Salik, KM, Hasan, S & Khan, AM 2012, 'Climate change and agriculture in Pakistan: Adaptation strategies to cope with negative impacts', Global Change Impact Study Center, Islamabad.**

The report was written to be useful tool for national planners, policy makers, in addition to academic and research institutions. The report makes a systematic approach to addressing the issue of the impact of climate change on agriculture, starting first at the global and then scrutinizing the specifics of Pakistan, emphasizing impacts on wheat and rice productivity in the country. In proposing adaptation strategies, the report offers outlines results from experiments to determine the feasibility of these policies, highlighting policies for wheat and rice separately. For wheat production the recommendation proposed includes alternations in sowing window, improving irrigation water use efficiency. For rice the report assesses the impacts of dry sowing vs. transplanting, and optimization of transplanting date. Overall the report serves as an excellent tool for policy planning, though the detailed presentation of adaptation strategies that are accompanied with empirical evidence of their chances for success.

13. **Mohsin, M, Ghohar, MA & Arshad, MK 2009, 'Climate-change aspersions on food security of Pakistan', *Science Vision*, vol. 15, no 1, viewed 6 October 2012, <www.sciencevision.org.pk>**

This paper mainly focuses on the impacts of climate variability on the productive resources of land and water which are considered as a base for food production. It further explored that climate change is influencing these resources directly by increasing in glacier-melt, evapotranspiration and land-degradation, and indirectly by emission of greenhouse gases, unavailability of plant nutrients and increase in crop-water requirements. These disturbances

in pattern are result in losses in crop yields which is a threat to food security throughout the country. This paper also shows the results of some studies carried out at GCISC with the help of DSSAT based crop-stimulation models on impacts of climate change on productivity of wheat and rice.

14. Amir, P 2010, 'Adaptation', Policy Brief, LEAD and Ministry of Environment, Islamabad, Pakistan.

This policy brief proposes adaptation strategies to combat climate change. The paper asserts that adaptation in food security system and investments in development sector is very important in Pakistani context. The author brings to light several areas in which Pakistan is vulnerable to climate change and suggests policy responses to combat the emerging challenges of climate change.

15. Ramay, SA & Saleem, M 2012, 'Climate change and national security', Sustainable Development Policy Institute, SDPI, Policy Paper no. 39, viewed October 7 2012, <http://www.sdpi.org/publications/publication_details-348-27.html>

This policy paper explains reviews the potential impact of climate change on global, regional and national food security. The paper cautions that water and agriculture are two areas that are potentially threatened by climate change in Pakistan. The report persuades the government to make appropriate plans for dealing with the future impacts of climate change. They warn that without effective policies, Pakistan cannot tackle with climate change.

16. Mustafa, Z 2011, 'Climate change and its impacts with special focus in Pakistan', *Symposium on changing environmental patterns and its impact with special focus in Pakistan*, Pakistan Engineering Congress, vol. 33, no. 290, viewed 9 October 2012, <http://pecongress.org.pk/images/upload/books/8-Climate%20Change%20and%20its%20Impact%20with%20Special%20Focus%20in%20Pakistan.pdf>

The paper explores the issue of climate change, in the context of Pakistan's agriculture sector, and its economic, social and environmental impacts. The study claims that 22.8% of Pakistan's area and 49.6% of Pakistanis are at risk. The study advocates for renewed support for scientific research on climate change, and increased investment in innovating new technologies in key areas of climate change.

17. Janjua, PZ, Samad, G & Khan, NU 2010, 'Impact of Climate Change on Wheat Production: A case study of Pakistan', paper presented at the International conference of Pakistan Society of Development Economics, Islamabad, viewed 9 October 2012, <http://econpapers.repec.org/RePEc:pid:journl:v:49:y:2010:i:4:p:799-822>

The paper was presented at a conference in Islamabad. It seeks to evaluate the impact of climate change on wheat production in Pakistan. The study uses vector auto regression model to assess the impact of climate change on wheat production. In addition, it analyzes historic data from 1960 to 2009, and produces simulation on wheat production in Pakistan for 2010-

2060. The researchers recommend adopting new technologies for improved productivity, improving irrigation systems, and ensuring timely cultivation of wheat.

18. **Mirza, AN & Michael, S 2011, 'Economic assessment of the impact of climate change on the agriculture of Pakistan', *Beh-Business And Economic Horizons*, University of Giessen, Germany, vol. 4, pp. 1-12, viewed 13 October 2012, <http://academicpublishingplatforms.com>**

The article investigates the impact of climate change on three major crops (maize, rice and wheat). While reviewing previous literature, the paper maintains that food security has been threatened by glacier melt, decreasing rainfall in the past, which has resulted in reduced crop productions in the past in Pakistan, Bangladesh and India. The study recommends establishing a closer link between research institutions, policymakers and involved government departments in order to raise awareness about adaptation of agriculture sector to climate change.

19. **Sayed, AH 2011, 'Climate change and its realities for Pakistan', *Symposium on changing environmental patterns and its impact with special focus in Pakistan*, Pakistan Engineering Congress, vol. 33, no. 288, pp. 79-92, viewed 6 November 2012, <http://pecongress.org.pk/images/upload/books/6-Climate%20Change%20and%20its%20Realities%20for%20Pakistan%20%286%29.pdf>**

The paper explores causes of climate change, such as deforestation and burning of fossil fuels, all of which are greatly affecting water, food and energy sectors. The paper suggests that the problem of climate change must be combated by taking adaptation measures at the national as well as the global level.

20. **Sheikh, MM, Iqbal, M, Ali, G & Khan, MA 2011, 'Global warming in the context of Pakistan: Major concerns and remedial strategies', *Symposium on Changing Environmental Pattern and its impact with Special Focus on Pakistan*, Pakistan Engineering Congress, vol. 33, no. 287, viewed 12 October 2012, <http://pecongress.org.pk/images/upload/books/5-Global%20Warming%20in%20the%20Context%20of%20Pakistan%20Major%20Concerns%20and.pdf>**

This paper highlights the negative impacts of global warming and climate change, such as rising GHG concentration in the atmosphere, rising sea levels and temperature, and frequent extreme events like floods and cyclones. The paper assesses future climate change projections by using the Global Circulation Models (GCMs). The paper cautions that global warming and climate change present a great threat to water and food security of Pakistan, and proposes adaptation measures which must be taken at the micro and macro level particularly in the agriculture sector.

21. Planning Commission 2010, *Task Force on Climate Change*, PC, Government of Pakistan, viewed 11 October 2012, <http://www.pc.gov.pk/usefull%20links/Taskforces/TFCC%20Final%20Report.pdf >

This report by Pakistan's Planning Commission Task Force on Climate Change elaborates on how climate change vulnerabilities are affecting socio-economic sectors of Pakistan. The report recommends developing effective mitigation and adaptation strategies for climate change. It also proposes working harder towards international negotiations on future climate change regime.

22. Harmeling, S & Eckstein, D 2012, 'Global Climate Risk Index 2013: Who suffers most from extreme weather events?', Germanwatch, Briefing paper, pp.1-28, viewed on 9 October 2012, < http://germanwatch.org/en/5696>

This recent report evaluates the extent to which countries have been affected by weather-related natural crises. It reviews past events that have occurred across the globe since 1992 through 2011. It brings forth insightful findings, according to which the developing countries are more vulnerable to the negative impacts of climate change. If furthermore provides evidence that Pakistan is indeed the third worst affected country by climatic events in 2011. The report hinges much hope on the upcoming COP to scale-up international response to combat climate change.

Climate Change – Regional/Asia

23. Kumar, K 2009, 'Climate sensitivity of Indian agriculture', Working Paper no. 43/2009, Madras School of Economics, MSE, Chennai, viewed 10 October 2012, <www.sandeeonline.com/uploads/.../868_PUB_Working_Paper_45.pdf>

The paper was presented at the Fourth Congress of the Latin American and Carribean Association of Environmental and Natural Resource Economics, held in Costa Rica in March 2009. Using Ricardian approach to analyze 40 years data on climate variables, this paper tries to study the sensitivity of Indian agriculture to climate change. The research finds that agriculture sector is increasingly becoming sensitive to climate change. It proposes to develop appropriate mitigating strategies which should be incorporated in the national development policy.

24. Boomiraja, K, Chakrabartia, B, Aggarwala, PK, Choudharya, R & Chanderb, S 2010, 'Assessing the vulnerability of Indian mustard to climate change', *Agriculture, Ecosystems and Environment*, vol. 138, no. 3-4, pp. 265–273, viewed 8 October 2012, <www.sciencedirect.com/science/article/pii/S0167880910001507>

India is the second largest producer of rapseed mustard in the world. This paper examines climate sensitivity of the plant. The study, funded by University Grants Commission of India, presents simulation yields of rapseed mustard, and estimates that it will be sensitive even to slight fluctuations in atmospheric carbon dioxide and temperature. The simulation study also discloses that rapseed production is likely to decrease varyingly in rain-fed and irrigated regions by 2080. Production is likely to decrease most drastically in eastern parts of the country.

25. Sanghi, A & Mendelsohn, R 2008, 'The impacts of global warming on farmers in Brazil and India', *Global Environmental Change,* vol.18, no.4, pp. 655-665, viewed 16 October 2012, <https://openknowledge.worldbank.org/handle/10986/5337>

The paper is an attempt to estimate climate sensitivity of Brazilian and Indian agriculture using cross-sectional analysis. Panel data is used to assess changes in farm income and/or property values, as a result of climate change. The study estimates that global warming will negatively impact Brazil and India. However, the writers claim that these damages can be reduced by encouraging carbon fertilization. The study concludes that by 2100, climate shift will be beneficial for farmers in temperate regions, whereas it will have no significant impact on crop yields in tropical regions.

26. Shiene, SD & Mirzabaev, A 2009, 'Food security and disappearances of glaciers: Impacts and adaptation options in Central Asia', Centre of development research university Bonn, viewed 9 October 2012, <www.zef.de/fileadmin/downloads/.../2009_3_Shiene_Alisher.pdf>

This term paper studies the impact of global warming on food security by studying the melting of glaciers. The paper cautions that the Himalayas, on which 1.3 billion people are dependent for their food and livelihoods, are melting because of global warming. This is likely to decrease water and food availability in Central Asia in coming decades. The writers conclude that in order to increase access to food, Central Asian countries will need to focus on alleviating poverty and diversifying livelihoods. It is cautioned that in order to cope with climate change, human security conditions will need to be improved and natural resources better managed.

27. Malla, G 2008, 'Climate change and its impact on Nepalese agriculture', *Journal of Nepalese Agriculture,* vol. 9, pp. 62-71, viewed 13 October 2012, <www.nepjol.info/index.php/AEJ/article/view/2119>

This review paper highlights the impacts of climate change on Nepalese agriculture. The paper claims that slight increase in temperature and CO_2 levels is beneficial for agriculture in the short-run, because it results in increased rice & wheat production; however, maize production is expected to decline. The writer warns that such shifts in average temperature and CO_2 levels may undermine food security status of the people by giving way to 'hidden hunger' (as a result of lesser nutritional food). The paper concludes that climate change will have negative consequences for the Nepalese agriculture sector.

28. Thapa, S & Joshi, GR 2010, 'A Ricardian analysis of the climate change impact on Nepalese agriculture', Paper no. 29785, Munich Personal RePEc Archive (MPRA), viewed 7 October 2012, <mpra.ub.uni-muenchen.de/29785>

This paper utilizes Ricardian approach to estimate climate change impact on Nepalese agriculture, using secondary data from various government studies. The paper suggests that impact of climate change on the agriculture sector is likely to vary with variation in environmental variables (precipitation and temperature). For instance, the study claims that lower rainfall, complimented by higher temperature, during the harvesting seasons (winter and spring) will increase farm revenues. It also reveals that farmers will benefit differently from climate change depending on access to socioeconomic resources. Farming households that have better access to credit, livestock, market, education and irrigated cropland are also the ones who are likely to increase farm incomes in the advent of climate change.

29. Haq, S & Hannah R 2005, *Climate change and development consultation on key researchable issues*, Project Report No. 2004GW35, International Institute of International Development, viewed 18 October 2012, <http://pubs.iied.org/pdfs/G00024.pdf?>

This report was commissioned by and prepared for DFID, by the International Institute for Economic Development. It was prepared to facilitate DFID's regional priorities for poverty, and sustainable development in the presence of climate change and variability. The report highlights the linkages between climate change and various facets of the development paradigm, such as livelihoods, water resource management, public health, ecosystems, and agriculture and food security. This report provides a literature review of the existing research on the above-mentioned issues. Hence, it provides a useful tool for anyone looking to study climate change in South Asia. The report concludes with a brief assessment of climate change related programs in each of the South Asian countries.

30. Kumar, A 2011, 'The Environmental Challenges and its Security Implications for South Asia', in M Behnassi, S Draggan & S Yaya (eds), *Global food insecurity: Rethinking agricultural and rural development paradigm and policy*, Springer, New York.

This chapter, written by Abhay Kumar, found in the book *Global Food Insecurity* Published by North South Research Centre, an independent research body based out of Morocco, with members from both developed and developing countries (North and the South.), a collection of highlights the security implication of climate change in the South Asian region. While the article is less focused on food security, and hence limited in its relevance it addresses the volatile nature of South Asian politics and how shifts in climate patterns can upset the already unstable equilibrium, adding a new dimension to the climate change equation and how the problem is analyzed.

31. Ramachandra, N 2011, 'Climate Change, Seasonality and Hunger: The South Asian Experience', in M Behnassi, S Draggan & S Yaya (eds), *Global Food Insecurity: Rethinking Agricultural and Rural Development Paradigm and Policy*, Springer, New York.

This publication is the result of "The integration of sustainable Agriculture, Rural Development, and Ecosystems, in the context of Climate Change, Energy Crisis and food Insecurity" held in Morocco in 2009. The author's intent is to highlight the role of seasonality in causing food security and hunger in the region, and how the effects of climate change will exacerbate the situation. The chapter outlines the dependence of South Asian countries on agriculture and the dependence of the said on seasonal patterns. When climate change alters seasonal patterns it results in severe food insecurity.The chapter takes a socio-anthropological approach to analyze the impacts of climate change on food security. Emphasizing the effects on the poorest strata of society, residing in rural areas, and relying heavily on rain fed agriculture, allows the author to focus on the most vulnerable group.

32. Lal, R (ed) 2011, *Climate change and food security in South Asia,* Springer, New York.

The book is a collection of research papers submitted at the symposium on Climate Change and Food Security in South Asia, held in Dhaka from 25th to the 29th August. As an anthology the book consists of various independently written chapters relating to the broader theme. Chapters cover technical themes of soil degradation, food security, climate change and the interaction of the three.

33. Barnett, J 2008, 'Climate change and security in Asia: Issues and implications for Australia', Melbourne Asia Policy Papers no. 9, University of Melbourne, Melbourne, viewed 8 October 2012, <http://asialink.unimelb.edu.au>

This 16 page report outlines the effects of climate change in Asia, concentrating on the Asia Pacific region and the implications for Australian policy. These effects are conveyed with the understanding that as a developed country, with significantly higher carbon emissions than its Asian neighbors, Australia bears some responsibility for climate change in the region. The author outlines Australia's resistance to adopting the Kyoto protocol. Three policy options are offered for Australia going forward: the first involves doing nothing, and maintaining the current state of affairs. The second deals with adaptation, to assist those countries most affected by climate change, with no steps towards cutting carbon emissions. The third recommendation is for mitigation, and steps towards cutting carbon emission and adherence of the Kyoto protocol.

34. Chhetri, N & Chaudhary, P 2011, 'Green Revolution: Pathways to Food Security in an Era of Climate Variability and Change?', *Journal of Disaster Research*, vol. 6, no. 5, pp. 486-497, viewed 9 October 2012, <http://www.fujipress.jp>

The paper critically evaluates the achievements and failures of the Green Revolution in ensuring food security over time. The authors argue that although the Green Revolution was successful in increasing crop productivity in the short run, it largely ignored the diversity of local agriculture production systems, biodiversity, and knowledge base of smallholder farmers. Moreover, it viewed climate as an unchangeable phenomenon. The writers assert that the Green Revolution was inadequate to bring about required changes in agriculture production system. Citing examples from Karnataka, India, the researchers claim that local farmers are switching back to cultivating traditional varieties of rice, which, albeit produce lesser yields, show higher resistance to climatic fluctuations. The paper recommends

adapting agriculture policies that are holistic, sustainable, socially-just, and that give credence to the knowledge systems, and increase access to agri-services to local smallholder farmers.

35. Subash, N & Mohan, HSR 2010, 'Assessment of the influence of monsoon rain on rainy season rice (Oryze sativa) productivity over major rice growing states', *Indian Journal of Agricultural Sciences*, vol. 80, no. 7, pp. 606-615.

This paper studies the impact of monsoon rains on rice productivity in different rice-growing states of India. A total of 14 states were surveyed and precipitation data for the past 30 years was analyzed. The results show that rice productivity has increased in all the states that were studied. The highest productivity is obtained in the state of West-Bengal followed by Bihar state.

36. Titumir, R &Basak, J 2010,*Agriculture and Food Security in South Asia: A Historical Analysis and A Long Run Perspective*, UnnayanOnneshan Center for Research on Development, Dhaka, viewed 10 October 2012, <http://www.bdresearch.org.bd>

The report published by UnnayanOnneshan a Bangladesh based Think Tank, attempts to assess the impacts of population growth and climate change and food security, on a national and regional level. This study funded in part by Oxfam GB, highlights climate change as a key deterrent of food security in the region. The analysis has been conducted using secondary data for 47 years. Their results reveal 17% of total population in South Asia could suffer from food security by 2050. Climate change has been highlighted as a key concern for food security in the region with a prediction that changing climate patterns will lead to drops in wheat and rice productions. The report also makes policy recommendations on a national and regional level. At the national level the report recommends policies that keep smallholder farmers at the forefront of agriculture, climate change and food security policies. At the regional level the report, much like others on the topic, recommend a coordinated strategy, with regional level policies, and investments.

37. Chttergee, B & Kadhka, M 2011, *Climate Change and Food Security in South Asia*, Report no. 1114, Consumer Unity& Trust Society International, CUTS, Jaipur, India, viewed 13 October 2012, <http://re.indiaenvironmentportal.org.in>

This report is published by CUTS, an NGO based in India, in partnership with Oxfam Novib, with the intent of bringing farmer perceptions to the forefront of policy considerations. The report used surveys of 3000 smallholder farmers to determine their perception of economic wellbeing in light of climate changes. Through various sections the report builds to its final analysis, starting at the global level, and moving down to the specifics of climate change and food security in each of the four South Asian countries included in the analysis (Afghanistan, Bangladesh, India and Pakistan) and ending at the chapter on farmer perceptions. The report ends with policy recommendations that emphasize shifts in cultivation practices and the start of a regional food bank. The overall analysis is highly useful for gaining a background on issues of climate change and food security in the South Asian region, though the report is light on technical information related to climate change.

38. Macchi, M, Gurung, AM, Hoermann, B & Choudhury, D 2011, *Climate Variability and Change in the Himalayas*, International Centre for Integrated Mountain Development, ICIMOD, Kathmandu, viewed 18 October 2012, <http://books.icimod.org>

This book is based on the community-based vulnerability and adaptive capacity assessment conducted by International Centre for Integrated Mountain Development (ICIMOD**)** in four different areas under the framework of International Fund for Agriculture Development (IFAD), Technical Assistance Grant on livelihoods and ecosystem services in Himalayas. Methodology for the study included focus group discussions and in-depth interviews. The study was limited to Hindu-Kush Himalayan region of Nepal, Bhutan and India. The findings in the report indicate that poor farmers of the region not only face rapidly changing socio-economic conditions but, are also vulnerable to changes in temperature and water availability resulting from climate variability leading to livelihood changes and food insecurity. These stresses are expected to increase and continue if new and effective initiatives are not pursued.

39. Pandey, N 2006, *Societal Adaptation to Abrupt Climate Change and Monsoon Variability: Implications for Sustainable Livelihoods of Rural Communities*, Winrock International, New Delhi, viewed 8 October 2012, <http://lib.icimod.org/record/12507/files/4590.PDF>

Pandey explores monsoon climate variability by reviewing wide-ranging literature on climate change and adaptation techniques, and their implications for income generation for local communities. Using participatory approaches, the author discovers that rural communities that have been living in regions of climatic variability for a long period of time have learned adaptive measures that the contemporary world can learn from. The report claims that learning about institutional, cultural and behavioral impacts of climate change is equally important to learning about its biophysical impacts. The author justifies that this enhances societal, cultural and socioeconomic adaptation to climate change. However, considering that climate change is a wide-scope subject that covers problems such as global warming, rising sea levels, increased variability of climate, this report is rather narrow in scope because of its exclusive focus on monsoon variability.

40. Macchi, M, Gurung, AM, Hoermann, B & Choudhury, D 2011, *Climate Variability and Change in the Himalayas: Community perceptions and responses*, International Centre for Integrated Mountain Development, ICIMOD, Kathmandu, viewed 17 October 2012, <http://books.icimod.org>

Through this study, ICIMOD explores the impacts of climate change on the livelihoods of mountainous communities in the Hindu-Kush and Himalayas regions of India, Nepal and Bhutan. By conducting a community-based vulnerability and adaptive capacity assessment, the study investigates risks and vulnerabilities that communities are exposed to. The report concludes that poor farmers are facing rapid socio-economic and environmental change with increased climatic variability. The study warns that this is likely to adversely affect their livelihoods and food security.

41. Rosegrant, M, Ringler, C, Msangi, S, Sulser, T, Valmonetssantos, R & Wood, S 2007, 'Agriculture and food security in Asia: The role of agricultural research and

knowledge in a changing environment', *Journal of Semi-Arid Tropical Agricultural Research*, ICRISAT, vol. 4, no. 1, viewed 18 October 2012, <http://harvestchoice.org>

The study was presented at the 'ICRISAT and CGIAR 35th Anniversary Symposium on Climate-Proofing Innovation for Poverty Reduction and Food Security', held on 22-24 November, 2007. This paper presents some of the major challenges and opportunities that Asian region is likely to face in the agriculture sector in the upcoming decades. Using International Model for Policy Analysis of Agriculture Commodities and Trade (IMPACT), the study conducts two sets of simulations which predict agriculture and food security prospects in the cases of (a) higher investments in agriculture sector, and (b) higher agricultural growth complimented by improvements in other important development sectors. The research paper concludes that although the impacts of climate change cannot be accurately predicted, they are certainly underway, and are likely to harm the poor the most.

42. **Speth, GJ 1994, *Food security, environment and poverty*, proceedings of a lecture, Bangladesh Centre for Advanced Studies, BCAS, Dhaka, Bangladesh.**

The above-mentioned is proceedings of a lecture delivered at United Nations Development Program on 5 February 1994 in Dhaka. The policy speech by the then-UNDP Bangladesh head, Mr. Speth, elaborates on various sectors through which food security can be strengthened, i.e. agriculture, resource management and poverty alleviation. The speaker recommends fostering better ties between government, civil society, and private sector in order to fight hunger, poverty and environmental changes that undermine food security of millions of Bangladeshis.

43. **Lobell, BD, Burkey, BM, Tebaldi & M, Naylor, M 2007,'Prioritizing Climate Change Adaptation Needs for Food Security in 2030', *Science*, vol. 319, no. 5863, pp. 607-610, viewed 9 October 2012, DOI: 10.1126/science.1152339, <www.sciencemag.org>**

The article emphasizes on the importance of adaptations strategies as a way to combat adverse impacts of climate change. The study claims that investment in evolving better adaptation strategies is vital for increasing agricultural productivity. The paper justifies this claim by providing evidence collected from 12 regions. Using statistical crop models and 20 general circulation models (GCMs), the study simulates climate change scenarios for 2030.
Findings indicate that food systems and agricultural productivity in South Asia and southern Africa are most likely to be adversely affected by climate change. Due to the unpredictable nature of climate change, national institutions need to set priorities for making appropriate and timely investments for climate change adaptation.

44. **Chatterjee, B & Khadka, M (eds) 2011, *Climate Change and food security in South Asia*, Consumer Unity and Trust Society, CUTS International, Jaipur, India.**

CUTS (India), in partnership with SDPI (Pakistan) and other organizations, carried out this joint study with the support of Oxfam Novib. The research focuses on farmers' perception of climate change and its imminent impact upon their livelihoods for four South Asian

countries: Pakistan, Bangladesh, India and Afghanistan. It aims at addressing food insecurity and livelihood threats in South Asia by changing the region's cultivation practices and operationalizing the regional food bank. Proper agro-climatic zoning was done and sample of 1200 small and marginal scale farmers. The perception study reveals that climate change is adversely affecting farmers across South Asia, and the extreme events like heavy floods and droughts are afflicting the poor disproportionately. The research concludes that climate change has severely impacted agriculture and has resulted in a substantial decline in subsistence farming across all select South Asian countries.

45. **Oxfam 2009, 'Suffering the science: Climate change, people, and poverty', Oxfam Briefing Paper no. 130, Oxfam International, viewed 14 October 2012, <http://policy-practice.oxfam.org.uk/publications/suffering-the-science-climate-change-people-and-poverty-114606>**

The 61-page policy brief is based on proceedings of a conference of scientific community, held in Copenhagen in March 2009. The paper draws practical lessons from poor communities in vulnerable regions of Africa and Asia that are becoming increasingly exposed to unpredictability of climate change. The paper makes a good reading for beginners who are interested in briefly examining the cross-sectoral impacts of climate change on development sectors such as food security, health and migration.

Climate Change – Global

46. **Beddington, J, Asaduzzaman, M, Fernandez, A, Clark, M, Guillou, M, Jahn, M, Erda, L, Mamo, T, Bo, N, Nobre, CA, Scholes, R, Sharma, R & Wakhungu, J 2011, 'Achieving food security in the face of climate change: Summary for policy makers from the Commission on Sustainable Agriculture and Climate Change', CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark, viewed 13 October 2012, <www.ccafs.cgiar.org/commission>**

This summary presents some policy recommendations for policy makers on food security and climate change. The policy brief is prepared by the Commission on Sustainable Agriculture and Climate Change, which compromises of experts from around the globe. It mainly recommends the integration of food security into national and international policy framework. It emphasizes on the need to invest in sustainable agriculture for increased food productivity and environmental sustainability. It also highlights the need to target vulnerable populations that are at risk of food insecurity and climate change. It also encourages policy makers to devise ways to decrease wastage of food and resources particularly by shifting food access and consumption patterns at the local, national and global level.

47. **Parry, M, Rosenzweig, C, Iglesias, A, Livermore, M, & Fischer, G 2004, 'Effects of climate change on global food production under SRES emissions and socio-**

economic scenarios', *Global Environmental Change*, vol. 14, no. 2004, pp. 53-67, viewed 7 October 2012, <www.preventionweb.net/files/1090_foodproduction.pdf>

This research article analyses the potential impact of climate change on global food production. This is done by studying the results of various models, including HadCM3 global climate model, which develops climate change scenarios to calculate changes in crop yields, and Basic Linked System (BLS), which estimates changes in the global cereal price and production, and the number of people who are food insecure. The study claims that moderate rises in temperature do not guarantee a decrease in cereal production. The study urges governments to build adaptive strategies in order to increase resilience to climate change.

48. Rosenzweig, C & Parry, M 1994, 'Potential impact of climate change on world food supply', *Nature*, vol. 367, no. 13, pp. 133-138, viewed 6 October 2012, <www.nature.com/nature/journal/v367/n6459/abs/367133a0.htm>

The study assesses the potential impact of climate change on global food supply. It explores the disparities that emerge between North and South as a result of climate change. Using various models and data sets, the study compiles a broader picture of food security status of selected countries. The paper finds that crop production is likely to increase in developed countries, as opposed to developing ones. The results also indicate that, in terms of food production, countries lying in temperate zones are likely to benefit from climate change, whereas those in tropical and sub-tropical zones will become more vulnerable to adverse impacts of changing climate.

49. Parry, M, Rosenzweig, C, Iglesias, A, Fischer, G & Livermore, M 1999, 'Climate change and world food security: a new assessment', *Global Environmental Change*, vol. 9, no. 1, pp. 51-67, viewed 17 October 2012, <www.elsevier.com/.../Climate_change_and_world_food_security.pdf>

This research is a sequel to a previous study. The study discloses that climate change is likely to benefit high- and mid-latitude areas in terms of crop yield, while lower latitudes might be at disadvantage. This is mainly because of shortening of growth period of crops and lower water availability in plants due to high temperatures. Using HadCM2 global climate scenarios, the researchers argue that improved or genetically modified crop varieties should not be the sole solution to climate change. The researchers warn that beneficial impacts of climate change in temperate regions can be harnessed only if direct effects of CO_2 on crops are fully realized. The research concludes that climate change may increase regional differences in food security, such that the developed countries prosper more, compared to developing ones, through the use of innovative technology.

50. Moorhead, A 2009, *Climate, agriculture and food security: a strategy for change*, Consultative Group on International Agricultural Research, CGIAR, viewed 14 October 2012, <http://cgiar.bio-mirror.cn>

This Danida-funded report is commissioned by the Consultative Group on International Agricultural Research (CGIAR). It sheds light on multiple aspects of climate change, and their impact on agriculture and food security. It lays emphasis on innovation and changes in

existing production methods, and highlights the importance of productive coping strategies for climate change.

51. Vermeulen, SJ, Aggarwal, PK, Ainslie, A, Angelone, C, Campbell, BM, Challinor, AJ, Hansen, J, Ingram, JSI, Jarvis, A, Kristjanson, P, Lau, C, Thornton, PK & Wollenberg, E 2010, *Agriculture, Food Security and Climate Change: Outlook for Knowledge, Tools and Action*, CCAFS Report 3, CGIAR-ESSP Program on Climate Change, Agriculture and Food Security, Copenhagen, viewed 14 October 2012, <http://ccafs.cgiar.org/sites/default/files/pdf/ccafs_report_3-low-res_final.pdf>

The report is prepared by CCAFS on behalf of CGIAR as a background paper, to be presented at the Hague Conference on Agriculture, Food Security and Climate Change. The report evaluates the current state of scientific innovation in agriculture, food security and climate change, in order to assess its capacity to predict, manage, adapt to and mitigate the risks associated with climate change. The authors assert that there is a need to deepen our understanding on climate change, and its uncertain impacts on agriculture and food security, through collaborated research. They also suggest investing in knowledge sharing and capacity building, for making better-informed policies across various sectors.

52. Beddington, J 2012, 'The role for scientists in tackling food insecurity and climate change', *Agriculture and Food Security*, vol. 1, no. 4, pp. 1-9, viewed 10 October 2012, <http://www.agricultureandfoodsecurity.com/content/1/1/10>

This paper, published in an open access journal, focuses on bringing to light the issues surrounding global food security. The article focuses on the scientific expertise that will be required to combat the issue of climate change on global warming. The authors focus on seven policy requirements for the future where action from the scientific community will be required, the specifics of the contribution center around innovation to develop best practices, and promoting evidence based policy making. As a short document this article does not provide a lot of new information; however it addresses a very important group in the climate change and food security adaptation and mitigation discourse i.e. the scientific community.

53. Huelsenbeck, M 2012, *Ocean Based Food Security Threatened in a High CO2 World: A Ranking of Nations Vulnerability to Climate Change and Ocean Acidification*, Oceana, viewed 15 October 2012, <http://oceana.org/sites/default/files/reports/Ocean-Based_Food_Security_Threatened_in_a_High_CO2_World.pdf>

The report largely studies the impact of carbon emissions on ocean-based food sources. The report ranks Pakistan as the 7th most vulnerable nation to ocean-based food insecurity. According to the report, ocean acidification and rising global temperatures are forcing many fish species to move away from the tropics and towards colder regions. The report assesses vulnerability as a sum of exposure, dependence (on seafood), and lack of adaptive capacity (low GDP, high population growth, and high rates of undernourishment). The report recommends reducing carbon emission, ending fossil fuel subsidies, stopping overfishing and establishing marine protected areas. While most reports document changes in wheat and rice production, this report brings to the forefront those communities that rely on ocean-based food for their survival.

54. Nelson, GC, Rosegrant, MW, Palazzo, A, Gray, I, Ingersoll, C, Robertson, R, Tokgoz, S, Zhu, T, Sulser, TB, Ringler, C, Msangi, S & You, L 2010, *Food security, farming and climate change challenges to 2050: Scenarios, results, policy options*, International Food Policy Research Institute, IFPRI, Washington D.C., viewed 10 October 2012, <www.ifpri.org/sites/default/files/publications/ib66.pdf>

This 140-page monograph is an attempt to forecast the future of food security in light of climate changes. The target audience for the monograph and the issue brief is policy makers, to provide a multidimensional outline. The study outlines 3 future scenarios, a basic scenario with moderate economic and population growth) a pessimistic scenario with low economic growth and high population growth and finally an optimistic scenario with high economic growth and low population growth. These scenarios are then pairs each of the scenarios with four potential climate scenarios ranging from "slightly too substantially hotter and wetter" and includes an extreme scenarios of complete mitigation, building to 15 possible scenarios. The three scenarios are plotted on a series of graphs to determine the various trajectories food security could take in the future. The conclusion of the reports highlights four key concerns going forward. Among the key results of the report are: (i). Broad Based Economic development is central to improvements in food security and livelihood; (ii). Climate change "off-sets" some of the improvements brought on by economic growth; (iii). International trade is key to adapting to the effects of climate change; (IV)properly targeted agricultural productivity investments can mitigate the impacts of climate change.

55. Crosson, P 1997, *Impacts of Climate Change on Agriculture*, Climate Issues brief no. 4, Resources for the Future, Washington DC, viewed 8 October 2012, <www.rff.org/rff/Documents/RFF-CCIB-04.pdf>

This brief is published by Resources for the Future is a part of the climate Economics and Policy program, and written for a "non-technical" audience. The paper uses figures and estimates from an IPCC report published in 1996, and first outlines the global context followed by an analysis of the US. Global impacts are given in light of four scenarios relating to carbon dioxide fertilization (which serve to offset drops in yield). The results indicate a decline in wheat yields in developing countries as opposed to developed countries, which benefit from both their geographical location (Northern countries) and their increased adaptive capabilities. The key policy recommendation of the brief for less developed countries is to expand the knowledge base to promote more sustainable agricultural systems. The report downplays the impacts of natural resource degradation and concluded that in the long run the impact of climate change on global and LDC agriculture will be small. As this brief was published in 1997, its relevance can be questioned.

56. Van Steenbergen, F, Verheijen, O, Aarst, SA & Haile, AM 2011, *Spate Irrigation, Livelihood Improvement and Adaptation to Climate Variability and Change*, IFAD, viewed 10 October 2012, <http://www.spate-irrigation.org/wordpress/wpcontent/uploads/2011/06/IFAD_MM_spate_irrigation.pdf>

The paper was released by IFAD (International Fund for Agricultural Development, and written with the intent of highlighting the potential benefits of spate agriculture, that is specifically used in arid regions adjacent to highlands. This form of irrigation is found in

among other place Spate irrigation can be found in West Asia (including Pakistan, Middle East, North Africa, and the Horn of Africa. According to the paper, despite the large potential in terms of area and the benefits to be accrued, spate irrigation remains a largely unknown and untapped agricultural tool. The authors go on to cite spate irrigation as the "quintessential" adaptation to climate change, as there mechanisms within the spate irrigation system that help adjust to the variations caused by climate change. The paper also highlights areas for improvements in spate irrigations, also points to IFAD' role in the promoting spate irrigation, highlighting both their existing work and areas where they need to be more involved. The paper recommends active involvement for IFAD in Pakistan and Ethiopian both promoting spate irrigation. The scope of this paper therefore is not to address and analyzes the issue of climate change and food security, but to bring to the forefront discussion on how to combat these issues.

57. Quan, J & Dyer, N 2008, 'Climate Change and Land Tenure: The Implications of Climate Change for Land Tenure and Land Policy', Land Tenure Working Paper no. 2, Food and Agriculture Organization of the United Nations, Rome, viewed 10 October 2012, <ftp://ftp.fao.org/docrep/fao/011/aj332e/aj332e00.pdf>

This document is based on a study carried out for the Land and Water Division of FAO, in view of the High Level Conference on World Food Security: the Challenges of Climate Change and Bioenergy (3-5 June 2008), by the Natural Resources Institute (University of Greenwich) in collaboration with the International Institute for Environment and Development (IIED, London). The focus of the paper and its research is on the impact of climate change on land tenure and land policy. The authors highlight the almost tangential relationship between land tenure and climate change. The link they propose is through the degradation of eco-systems and land capabilities, the pressure upon the continually diminishing viable land will increase leading to competition for limited land holdings. The paper analyses the potential impacts of climate change on a variety of different landscapes, from coastal belts, Africa's dry-lands, forest land, using case studies. The paper then proposes policy action to strengthen land tenure. The paper has an interesting take on climate change and livelihood analysis.

58. Turral, H, Burke, J & Faures, JM 2011, *Climate Change, Water and Food Security*, FAO Water Reports no. 36, Food and Agriculture Organization of the United Nations, FAO, Rome, viewed 6 October 2012, <www.fao.org/docrep/014/i2096e/i2096e.pdf>

The report, intended for policy makers, summarizes contemporary knowledge on the impacts of climate change on water availability for agriculture. It begins by highlighting the issues facing agricultural productivity and water availability in the absence of climate change, which include structural changes altering the preferences of agricultural commodities away from staples that thrive on ground water and more towards luxury items such as meat and vegetables, which rely more heavily on irrigated agriculture. The report then delves into the climate change conundrum, and outlines the direct impacts of climate change on the water supplies of the world, and eventually on the impact on agricultural productivity.

59. Food and Agriculture Organization 2008, *Climate Change and Food Security: A Framework Document*, Food and Agriculture Organization of the United Nations,

FAO, Rome, viewed 15 October 2012, <ftp://ftp.fao.org/docrep/fao/010/k2595e/k2595e00.pdf>

The FAO report serves as a background document, outlining the impact of climate change on food security. The paper attempts to broaden the scope of the discourse on climate change and agriculture from its emphasis on food supply to a wider understanding of food security issues. It begins by defining the key concepts of climate change and food security, followed by potential mitigation strategies, which involve containing risk, by reducing uncertainty, strengthening resilience which include improving coping strategies, changing consumption patterns, and raising agricultural productivity, and mitigating climate change, by cutting carbon emissions among other greenhouse gas emissions.

60. **Karfakis, P, Lipper, L & Smulders, M 2012, *The assessment of the socio-economic impacts of climate change at household level and policy implications*, Food and Agriculture Organization of the United Nations, viewed 10 October 2012, <http://typo3.fao.org/fileadmin/templates/agphome/documents/faooecd/HouseholdLevel.pdf>**

The paper attempts to highlight the impacts of climate change at the household level. Covering issues of livelihood change, vulnerability, and food security. There is a strong emphasis on the dearth of studies assessing the impact of climate change on vulnerable households. The authors start by outlining the direct (income, resource availability, and reallocation) and the indirect impacts of climate change on welfare. For the purpose of analysis, 4 broad household analytic groups are formed. The authors go on to recommend an analytical framework for conducting vulnerability and resilience analysis, and also provide a short analysis of existing work done on the subject, outline the methodology and results achieved by those studies. This report offers a good background of the literature, and models available on household vulnerability to climate change at household level.

61. **Food and Agriculture Organization 2010, *Climate-smart agriculture: Policies practices and financing for food security, adaptation and mitigation*, Food and Agriculture Organization of the United Nations, FAO, Rome, viewed 10 October 2012, <http://www.fao.org/fileadmin/user_upload/newsroom/docs/the-hague-conference-fao-paper.pdf>**

The paper was written with the collaboration of various departments of the Food and Agriculture Organization of the United Nations (FAO). The scope of the paper is to promote "climate-smart" agriculture" defined here as "agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals." According to the authors, by the year 2050 agriculture production will need to increase by 70% by the year 2050 to meet demands, a task this is further that is complicated by climate change which is expected to diminish agricultural productivity, stability, and lower incomes, leading to a worsening food insecurity. The paper outlines several examples of climate smart agriculture that cover a wide range of agricultural issues, from rice production to livestock rearing to agroforestry. The paper then outlines the policy options and institutional mechanisms available to make climate-smart agriculture happen. The paper also highlights the importance of making financing available for climate-smart agriculture.

62. Ericksen, PJ, Ingram, J & Liverman, DM 2009, 'Food security and global environmental change: Emerging challenges', *Environmental Science and Policy*, vol. 12, no. 4, pp. 373–377, viewed 11 October 2012, <www.sciencedirect.com/science/article/pii/S1462901109000653>

This editorial explores the additional threats to food security arising from global environmental changes that must be countered through understanding the multiple dimensions of food systems. It recommends a shift in research priorities from finding technical fixes and improving agricultural practices to developing an integrated food systems approach. The multiple dimensions of food systems include some sensitive areas that are important to understanding food security, environmental changes and its implications for adaptation strategies. Governance of food systems and price variability need to be studied more in depth. It talks about two phenomenon i.e. effect of climate change on agricultural production and impact of agriculture in changing the climate. The analysis shows that technical grooming alone will not be sufficient to combat with food security challenges.

63. Food and Agriculture Organization 2008, *Climate change energy and food*, Report no. HLC/08/BAK/2, Food and Agriculture Organization of the United Nations, FAO Rome, viewed 14 October 2012, <ftp://ftp.fao.org/docrep/fao/011/i0291e/i0291e00.pdf>

This paper is based on an expert meeting held in Rome 26-28 Feb 2008 as a preparation for the FAO High Level Conference (HLC) on World Food Security and the Challenges of Climate Change and Bioenergy in June 2008. It reiterates that changing rainfall patterns influence not only agriculture productivity, but also biophysical characteristics which increase risks to food security. The report maintains that better management of water resources is the key to sustaining agri-production which ultimately contributes to food security.

64. Eriyagama, N, Samakhtin, V & Gamage, N 2009, *Mapping drought patterns and impacts: A global perspective*, International Water Management Institute, IWMI Research Report No. 133, Colombo, Sri Lanka, viewed 18 October 2012, <www.iwmi.cgiar.org/Publications/IWMI_Research.../RR133.pdf>

The report studies global drought patterns in order to understand the impact and risks that are associated with droughts. It then examines drought-related characteristics that are reported worldwide, which are then presented in the form of visual maps to aid better understanding of the issues discussed. The scope of the study covers aspects such as climate change, water resource management, and agricultural economy. It concludes by recommending some policy options for better drought preparedness in the short and long term.

65. Paul, H, Semino, S, Lorch, A, Andersen, BH, Gura, Susanne & Ernsting, A 2009, *Agriculture and climate change: Real problems, false solution*, Grupo de Reflexion Rural, Biofuelwatch, EcoNexus & NOAH - Friends of the Earth Denmark, viewed 15 October 2012, <http://www.econexus.info/pdf/agriculture-climate-change-june-2009.pdf>

This report was prepared for the Conference of the Parties, COP15, of the United Nations Framework Convention on Climate Change (UNFCCC), held in Copenhagen, December 2009. The scope of the report touches upon important areas of the agriculture sector, such as genetically modified (GM) crops, industrial livestock production, non-tillage or conservation agriculture, marginal lands, and agricultural biodiversity. The report claims that carbon trading has done little to cut down carbon emission in the North; rather, it has been used to subsidize pollution-emitting industries in the South. The report concludes that despite ambitious lobbying by industrial sector, the agriculture sector must remain outside the carbon trading system.

66. Ranuzzi, A & Srivastava, R 2012*, Impacts of climate change in agriculture and food security*, ICRIER Policy Series, Paper no. 16, viewed 16 October 2012, <www.icrier.org/pdf/Policy_Series_No_16.pdf>

This paper explores the multi-dimensional impacts of climate change on food production systems and food security. In order to analyze interrelationship between climate change and food security, the authors utilize 'Pressure-Impact-Response Framework'. The paper suggests that rural communities must build adaptive measures in order to build resilience to climate change. It must be accompanied with mitigation strategies. The report suggests that adaptation and mitigation strategies must be integrated into mainstream development policies for improving productivity of the agriculture sector and livelihoods of rural communities.

67. Meakin, S & Kurvits, T 2009, 'Assessing the Impacts of Climate Change on Food Security in the CanadianArtic', GRID-Arendal, Arendal, Norway, viewed 19 October 2012, <www.grida.no/files/publications/foodsec_updt_LA_lo.pdf>

Reiterating that climate change and food security are complex and dynamic issues that touch upon various disciplines, the report analyses the impacts of climate change on the food security situation in Artic Canada. The report approaches the issue of climate change in the wider global arena, before examining it in the Canadian context. The report concludes that 'rising sea levels, bigger hurricanes and storm surges, the migration towards the people of diseases now confined to the tropics- will arrive on schedule or before, but nothing matters as much to human beings as the food supply'.

68. Cordell, D, Drangert, JO & White, S 2009, 'The story of phosphorus: Global food security and food for thought', *Global Environmental* Change, vol. 19, no. 2, pp.292-305, viewed 9 October 2012, <www.agci.org/dB/PDFs/09S2_TCrews_StoryofP.pdf>

This paper argues that, like other non-renewable natural resources, phosphorous is fast depleting. Recognizing its vital role in the fertilizer industry, it is important to evaluate the future consequences of intensive phosphorous usage. They emphasize on the urgency of this issue because agricultural productivity and food security may be hampered if we exhaust natural reserves of phosphorous.

69. Fraiture, DC, Smakhtin, V, Bossio, D, Mccomick, P, Honah, C, Nobel, A, Gichuki, F & Finlayson, M 2007, 'Facing climate change by securing water for food, livelihoods and ecosystems', *Journal of Semi-Arid Tropical Agricultural Research*, ICRISAT,

vol. 4, no. 1, pp. 1-21, viewed 8 October 2012, <http://ejournal.icrisat.org/SpecialProject/sp11.pdf>

This paper was presented at the 'ICRISAT and CGIAR 35th Anniversary Symposium on Climate-Proofing Innovation for Poverty Reduction and Food Security', held on 22-24 November, 2007. This paper describes how climate change influences water availability for agriculture in wetland areas that are mostly dependent on irrigation and natural rainfall for growing food. The paper examines alternative means through which farmer vulnerability to climate change can be reduced. It explores various options in order to take necessary measures in water management of agriculture so that poor people's susceptibility to climate change can be reduced by minimizing risks. The paper identifies policies to be formulated in order to reduce risk and promote resilience of the agricultural system. IWMI formulate and implement the agenda to improve the research in food, water and livelihood nexus.

70. **Hisas, L 2011, *The Food Gap – The impacts of climate change on food production: A 2020 perspective,* Universal Ecological Fund, FEU-US, Alexandria, USA, viewed 17 October 2012, <http://www.feu-us.org/images/The_Food_Gap.pdf>**

The study warns that average temperature rise in Asia, Africa, Latin America, Europe, Northern America and Oceania will drastically affect water and food production systems. The report estimates the impact of climate change on major food crops (namely, wheat, rice, maize and soybean) in the context of population growth. This result shows that the availability of food will decrease, and as a result, food prices will increase, raising the share of the food insecure. This report claims that by cutting GHG emissions, we can mitigate the adverse impacts of climate change on food production.

71. **Parry, M 2007, 'The implications of climate change for crop yields, global food supply and risk of hunger', *Journal of Semi-Arid Tropical Agricultural Research*, ICRISAT, vol. 4, no. 1, pp. 1-44, viewed 14 October 2012, <www.icrisat.org>**

This paper was presented at the 'ICRISAT and CGIAR 35th Anniversary Symposium on Climate-Proofing Innovation for Poverty Reduction and Food Security', held on 22-24 November, 2007. The paper evaluates the regional impact of climate change on crop yield, hunger risk and food production in Africa and Southern Asia. The study concludes that areas of lower latitude are more vulnerable to climate change; adaptation strategies are more vigorously adapted in developed economies; and that climate change is likely to decrease production potential.

72. **Parry, M, Rosenzweig, C, Livermore, M 2005, 'Climate change, global food supply and risk of hunger', *Philosophical Transactions of the Royal Society*, vol. 360, no. 1463, pp. 2125-2138, viewed 11 October 2012, <www.icrisat.org/journal/SpecialProject/sp14.pdf>**

This paper estimates the effects of climate change on global agricultural production, and the number of people who will be rendered food insecure. Crop model is used for producing climate change scenarios; it is used for assessing the levels of carbon dioxide at which crop

production will decrease. The paper claims that regional food prices will increase as a direct result of lower crop production.

73. Tubiello, FN, Soussana, J-F & Howden SM 2007, 'Crop and pasture response to climate change', *Proceedings of National Academy of Science of the USA*, vol. 104, no. 50, viewed 10 October 2012, DOI: 10.1073/pnas.0701728104, <http://www.pnas.org>

The authors analyze the impacts of climate change on crop and pasture plant species. This paper claims that extreme temperature and precipitation by excessive soil moisture and high concentration of CO_2will negatively affect crop and pasture. Crop model is used to evaluate climate change uncertainties (for example temperature, precipitation and CO_2 emissions). The study highlights the knowledge gap in climate change responses for crops that are of value to poor farmers. The authors propose that a better research agenda should be evolved in collaboration with scientists and modelers across disciplines.

74. Parry, M, Evans, A, Rosegrant, M & Wheeler, T 2009, *Climate change and hunger: Responding to the challenges*, World Food Program, the International Food Policy Research Institute, the New York University Center on International Cooperation, the Grantham Institute at Imperial College London, and the Walker Institute, University of Reading (UK), viewed 7 October 2012, <www.wfp.org/.../climate-change-and-hunger-responding-challenge>

This report reviews the effects of climate change on hunger. It warns that if mitigation strategies are not adapted in time, and GHG emission not cut down immediately, hunger will rise most drastically in the South. The report claims that Africa will be most adversely affected, whereas Southern and South-Eastern Asia will be negatively affected in terms of agriculture production. First area of focus is access of food and second one is the food production. While focusing on two components of food security (food availability and access), this report concludes that climate change will reduce global food production and the resultant food-price hike will increase the risk of malnutrition and hunger.

75. Gerald CN, Jawoo, K, Richard, R, Timoth, S, Tingju, Z, Amanda, P, Marilia, M, Mandy, E & David, L 2009, *Climate change: Impact on agriculture and cost of Adaptation*, International Food Policy Research Institute, Washington D.C., viewed 18 October 2012, <www.ifpri.org>

In summary, the report tries to evaluate the impacts of climate change on agriculture sector, and its implications for food security. This is done by analyzing patterns of food consumption, agricultural production, food price and trade. The model used in this is study is global agricultural supply and demand projection model (IMPACT 2009), which is linked to a biophysical crop model (DSSAT) to evaluate climate change effects and CO_2 fertilization. The study finds that crop yields and production will decrease; foodprices will increase; cereals consumption will decline; consequently, calorie intake will also decline which will undermine not only food security but also human security.

76. Frison, EA, Cherfas, J & Hodgkin, T 2011, 'Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security', *Sustainability*, vol. 3, no. 1, pp. 238-253, viewed 8 October 2012, DOI 10.3390/su3010238, <www.mdpi.com>

The review paper, published in Sustainability journal, argues that agricultural biodiversity has a potential to greatly increase productivity. The study claims that a manifestation of agricultural biodiversity is the delivery of secure food supply, enhanced soil fertility, increased productivity of farming systems (having a range of growing conditions), providence of better nutrition and health, and better human productivity and livelihood. It is also affirms that agricultural biodiversity promotes more resilient ecosystems which can effectively adapt to climate change.

77. Willenbockel, D 2012, *Extreme weather events and crop price spikes in a changing climate: Illustrative global simulation scenarios*, Oxfam Research Reports, Institute of Development Studies, University Of Sussex, United Kingdom, viewed 9 October 2012, <www.oxfam.org>

This Oxfam report focuses on the impacts of extreme events on food prices. The study uses a global dynamic multi-region computable general equilibrium (CGE) model to explore the potential impact of a number of extreme weather event scenarios in 2030 on food prices, for three major staple crops (i.e. rice, maize and wheat).

Food Security – Pakistan

78. Kugelman, M & Hathaway, RM (eds) 2010, *Hunger Pains: Pakistan's Food Insecurity*, Woodrow Wilson International Center for Scholars, Washington, DC, viewed 18 October 2012, <http://www.wilsoncenter.org/topics/pubs/ASIA_100412_PakistFood_rptL0713FINALVERSION.pdf>

The report is a compilation of essays that cast light on the status of food security in Pakistan. It highlights some of the social, political and environmental shifts that aggravate food security in Pakistan. For instance, one research essay discusses at length the future of agro-systems in the context of ongoing development projects. Another essay highlights the decay of social institutions in rural areas as a result of limited economic opportunities, migration, and major politico-economic shifts.

79. Arif, M 2008, 'Agriculture and Food Security in Pakistan: A thematic paper', South Asia Partnership in Pakistan, SAP-PK, Lahore, pp. 1-26, viewed 2 October 2012, <http://sappk.org/sites/default/files/publications/eng_publications/Agriculture_and_Food_Security.pdf>

The article discusses the differences between administration and customary crop growing practices which ultimately affect the productivity of crops. These differences affect agricultural growth, as well as rural livelihoods. The paper reiterates that inefficient use of irrigation water degrades land and lowers crop yield. The writer proposes improving overall food security in Pakistan by adopting modern technologies, providing extension services, and improving management of water and land resources.

80. Suleri, AQ & Haq, S 2009, 'Food Security in Pakistan', Sustainable Development Policy Institute, SDPI, Swiss Agency for Development and Corporation, SDC, and World Food Programme, WFP.

This report analyzes socio-economic and political challenges that affect food security in Pakistan. Some of the issues highlighted include, the macro-economic instability that came in Pakistan post-2008, as a result of global fuel, food, and financial crisis; conflict and terrorism; political unrest in terms of mass movements for restoration of judiciary, and the like. While comparing the food security situation of 2009 to that in 2003, the discussion paper blames low productivity, non-availability improved inputs, and delayed harvesting of kharif crops for worsening food security in Pakistan.

81. Mahbub ul Haq Human Development Center, *Human Development and Food Security in South Asia,* Oxford University Press, Lahore.

This MHHDC's annual report tries to outline some of the economic, political, social and environmental factors that cause or aggravate food security. The study conducts case

analyses of three South Asian countries: Pakistan, India and Bangladesh. Some of the issues that the report touches upon include, governance, trade, social services and environmental crises. It makes a good reading for those interested in conducting a comparative study of food security in the region.

82. Iqbal, M & Amjad, R 2010, 'Food Security in South Asia: Strategies and Programs for Regional Collaboration', Munich Personal RePEc, viewed 9 October 2012, <http://mpra.ub.uni-muenchen.de/38077/1/MPRA_paper_38077.pdf>

The paper analyses changes in food prices from mid-2007 to mid-2008. According to the Food and Agriculture Organization, food price index rose on average by 56 percent in this period and an estimated 75 million people were pushed towards hunger in 2007 (FAO, 2008). Many of the poorest households spent four-fifth of total income on food consumption pattern. The fluctuation in the commodity and food prices would be a threat to purchasing power of the poor, and would eventually lead to a reduction in food consumption in developing countries like Pakistan.

83. Zafar, Sobia & Shahzad, M 2012, 'Climate Change, Its Impact on Food Security and Its Implications - A Case Study of Pakistan)', Working paper no. 12-10, South Asia Network of Economic Research Institutes, Dhaka, viewed 10 October 2012, <http://www.saneinetwork.net/Files/3008201204432112.10.SZafar.pdf>

The working paper is published by South Asia Network of Economic Research Institute (SANEI), a Dhaka-based umbrella organization of research institutes from five South Asian countries (Pakistan, India Nepal, Bangladesh, Sri Lanka), with members that include SDPI and PIDE from Pakistan. The study was designed to determine the impacts of climate change on wheat production in Pakistan use in Vector Auto Regression as a tool to determine how the global change would affect the production of wheat in Pakistan. Use in data from 1960 to 2009 in their study. The historical trends from this data is used to extrapolate trends for wheat production from 2010-2060. The study concurrently uses a Global Impact Model, which determines. The results conclude that the most effected groups are small-holder farmers and subsistence farmers, and the study focuses on rural households in Pakistan. The paper uses the concept of "adaptive-governance" and applies it to the local government framework to find solutions for farmers. The paper outlines the effects of climate change globally, and then brings the focus to Pakistan, outlining the various meteorological patterns that have emerged in recent years, leading to a discussion of the risks associated with climate change, and those threats, which have already been witnessed. Covering the more scientific and geographical impacts of climate change, than the socio-anthropological this paper is an excellent reference

84. Athar, NK, Ghauri, BM, Jilani, R & Rahman, S n.d., 'Climate change: Emissions and sinks of greenhouse gases in Pakistan', *Symposium on changing environmental patterns and its impact with special focus in Pakistan*, pp. 146-158, viewed 6 November 2012,

<http://pecongress.org.pk/images/upload/books/11Climate%20Change%20%20Emissions%20and%20Sinks%20of%20Greenhouse%20Gases%20in%20P.pdf>

The team worked on estimating the amount of greenhouse gases that are emitted during the fiscal year July to June of 2007-08. They studied the emission of CO_2, CH_4, N_2O and Halocarbons. The process of estimation utilized the revised guidelines for national greenhouse gas inventories (1996) of Intergovernmental Panel on Climate Change (IPCC). The results were comparably satisfactory that the emission of these gases is less than neighboring countries like India and China. For instance, per capita CO_2 emission remained 0.65 tons from July 2007 to June 2008 in Pakistan, while in India and China the figures were 1.5 and 5.3 tons respectively.

85. **Rosegrant, MW, Gai, X & Cline, SA 2002, *World water and food to 2025: Dealing with scarcity*, International Food Policy Research Institute, Washington, D.C., viewed 13 October 2012, <http://books.google.com.pk/books?hl=en&lr=&id=jxANzj_5CksC&oi=fnd&pg=PR5&dq=+%E2%80%98World+water+and+food+to+2025:+Dealing+with+scarcity%E2%80%99,+International+Food+Policy+Research+Institute,+Washington,+D.C.&ots=2rJkXkuDVX&sig=2n0AAyDaw9KaplRP0LDShYXNmeI>**

The report is published by International Food Policy Research Institute (IFPRI). The report is written by a team of authors who focused on the concerns regarding water and food globally. The report also highlights Pakistan case in this regard. Pakistan is not using its water resources efficiently resulting in loss of water. Annual subsidies spend by the government on water sector is estimated to be 0.6 billion, still its proper management is not up to the mark. Authors further extend the idea that cost of exploiting new water sources has increased a lot and during 1980 and 1990, the cost has increased to double. The next best option besides exploiting new water resources is to save the currently available water. In Pakistan, huge volume of water is lost during irrigation and efficiency of irrigation in Pakistan lies between only 40 to 45 %. Similarly, cost recovery ratio is very less and in Sindh, it is less than Punjab. Pakistan has to look again on its water use and management, policy as it has already disputes with India on water issues. Authors also stressed on harnessing maximum benefits from the rain water for crop production. They cited that only 7.4 % cereal harvested area is rain fed. Report further demands water management and incentive policy reforms to increase water efficiency to cope in the future challenges. It further added that new goals regarding global freshwater assessment and improving long-term prediction should be set in a manner that translates global climate change and growing human impacts efficiently.

86. **Mohsin, M, Ghohar, A & Khan, AM 2010, 'Climate-Change Aspersions on Food Security of Pakistan', *Science Vision*, vol. 15, no. 1, viewed 12 October 2012, <http://www.sciencevision.org.pk/CurrentIssue/Vol15No1/Vol15No1_Complete_Issue.pdf#page=23>**

This paper mainly focuses on the impacts of climate variability on land and water resources, which are considered as a base for food production. It further explores how climate change is influencing these resources directly by rise in glacier-melt, evapotranspiration and land-degradation, and indirectly by emission of greenhouse gases, unavailability of plant nutrients

and increase in crop-water requirements. These disturbances result in yield reductions, which presents a threat to food security of the country. The paper also discusses the results of some GCISC studies that were carried out with the help of DSSAT based crop-stimulation models to study the impacts of climate change on productivity of wheat and rice.

87. Aga Khan University, Pakistan Medical Research Council, Nutrition Wing & UNICEF 2011, *National Nutrition Survey 2011,* AKU, PMRC, Cabinet Division of Government of Pakistan and UNICEF, Islamabad.

The national nutrition survey links household food security with daily nutrition intake. The survey claims that 58 percent of households in Pakistan are food insecure. Province wise, Sindh is shown to be the most food insecure province (72% HHs being food insecure), while Baluchistan, Punjab and FATA fall close in rank. The survey primarily focuses on the 2nd and 3rd aspects of food security, i.e. food access and utilization.

88. Ahmad, MA & Siddiqui, R 1995, 'Food security in Pakistan can be achieved? paper presented at the International conference of Pakistan Society of Development Economics, April 18-21, 1995, viewed 21 October 2012, <http://www.pide.org.pk/pdf/PDR/1995/Volume4/723-731.pdf>

This paper sheds light on the situation of food security in Pakistan back in the 1990s. The study predicts that per capita wheat demand will decrease as a result of change in income (expecting that growth rate of population will decline). The paper proposes to reduce food imports by providing incentives to farmers, improving yield production and technology, and by controlling population growth.

89. Polly, E, Philip, T, An, N, Laura, C, Peter, J & Mario, H 2011, *Climate Change Agriculture and Food Security: Mapping hotspots of climate change and food insecurity in the global tropics,* CCAFS Report No. 5, viewed November 2012, <http://ccafs.cgiar.org/resources/climate_hotspots>

This CGIAR supported study explores the areas that are vulnerable to climate change and are food insecure. The research was conducted by a team of scientists of International Livestock Research Institute (ILRI). Vulnerability to climate change was measured by the domain approach which was based upon IPCC, from which nine domains were identified and categorised. The report maintains that South Asia, along with Africa are particularly food insecure regions..

90. FAO, WFP & IFAD 2012, *The State of Food Insecurity in the World 2012,* FAO, Rome, FAO, viewed 8 October 2012, <http://www.fao.org/publications/sofi/en>

This joint study explores strategies through which poverty, hunger and malnutrition can be reduced globally. The report claims that economic growth needs to be complimented by public action. In order to enhance the nutrition of vulnerable, the poor must participate in the growth process. On the other hand agriculture growth is particularly affecting hunger and malnutrition.

The report recommends working on an improved governance system, rule of law and human rights, equitable access to resources, social services and women empowerment.

91. CGIAR 2011, *Climate Change Agriculture and Food Security (CCAFS)*, International Center for Tropical Region, viewed 27 November 2012, <library.cgiar.org/bitstream/handle/.../crp_7_Proposal_Final.pdf?...1>

The document is composed by IRI on agro-climate tools for climate-smart agriculture. The report maintains that food security can be improved by interlinking climate information and agriculture practices. The study proposes that donors and governments should invest in capacity building of local farmers, as well as investing in low-cost technology which can improve food security.

92. Moorhead, A 2009, 'Climate, agriculture and food security: A strategy for change', CGIAR, viewed 28 November 2012, <ccafs.cgiar.org/sites/default/files/.../CC_for_COP15_Final_LR_2.pdf>

The paper was released by CGIAR (Consultative Group on International Agricultural Research) and written to be helpful tool for national planners, policy makers, in addition to academic and research institutions. The report makes a systematic approach to address the issue of the climate change and its impact on agriculture, and food security.

93. CGIAR & ESSP, *Climate change, agriculture and food security,* Consultative Group on International Agricultural Research (CGIAR) and Earth System Science Partnership, viewed 29 November 2012, <ccafs.cgiar.org/sites/default/files/publication.../ccafs_pamphlet_en.pdf>

This document, published by CCAFS under CGIAR, highlights the role that agriculture sector (including livestock, fisheries and forestry) plays in improving food security. The report emphasizes on improved mitigation and adaptation strategies that can combat climate change, and at the same time can build resilience and sustainably of agriculture sector and food systems.

Agriculture in Pakistan

94. Hussain, H, Zaman, QU, Nadeem, MA & Aziz, A 2010, 'Response of maize varieties under agro-ecological conditions of Dera Ismail Khan', *Journal of Agriculture Response,* vol. 48, no. 1, viewed 18 October 2012, <http://www.jar.com.pk/JAR%2048(1)march2010/Issue%20No.1/Paper%20No.7.pdf>

Maize is Pakistan's third most important cereal crop after wheat and rice. Considering that maize production in Pakistan is considerably low (3427 kg/ha), compared to other developing countries, such as Italy (9478 kg/ha) and USA (7974 kg/ha). The paper proposes

strategies through which food security of Pakistan can be enhanced by focusing on maize production.

95. Junejo, M, A, Rohra, C & Kanasro, H, 2007, 'Analyzing the Impact of Sindh Rice Industries on Economy of Pakistan', *Australian Journal of Basic and Applied Science*, vol. 1, no. 4, pp. 853-859, viewed 8 October 2012, <http://www.ajbasweb.com/ajbas/853-859.pdf>

This paper talks about the importance of rice in Pakistan's economy and food security. According to the article, Pakistan is the 14th largest rice-producer and 6th largest rice-exporter in the world. This paper further claims that rice industries in Pakistan contribute about 21.75 percent in national economy. However, the quality of seed and its availability is leading to a decline in per acre yield of rice production. The paper claims that rice mill owners are using old technologies like old rubber shellers for de-husking.

96. Iqbal, M, Ahmad, M & Kalbe, A 2003, 'The Impact of Institutional Credits on Agriculture Production in Pakistan', *Pakistan Development Review*, vol. 42, no. 2, pp. 469-485, viewed 5 October 2012, <http://mpra.ub.uni-muenchen.de/3673/1/MPRA_paper_3673.pdf>

This paper links institutional credits with agricultural GDP which was found to be positive and significant. Availability of water for irrigation and labor for cultivation per hector are the important determinants of agriculture GDP. The paper suggests that commercial banks and financial institutions should encourage small farmers by launching incentives and insurance schemes to promote agriculture trends and investments for their assistance in drought, heavy rain and in floods.

97. Planning Commission 2012, *Canal Water Pricing for Irrigation in Pakistan*, PC, Government of Pakistan, Islamabad, viewed 5 October 2012, <http://www.pc.gov.pk>

This government report measures current water charges for canal irrigation and analyses the cost of recovery, financial sustainability and efficiency of used water in Pakistan. This study collects the critical financial data of irrigation systems from four provinces and it gives an overview of the existing gap between recovery and assessment of water charges. This report concludes that canal irrigation system is financially unstable in Pakistan. It also recommends that all four provinces need to develop an asset management plan for the financial sustainability of irrigation infrastructure.

Food Security – Regional/Asia

98. International Food Policy Research Institute and Asian Development Bank 2007, *Agricultural and Rural Development for Reducing Poverty and Hunger in Asia In Pursuit of Inclusive and Sustainable Growth*, IFPRI & ADB, viewed 15 October 2012, <http://www.ifpri.org/sites/default/files/publications/adbmanilasynopsis.pdf>

This report issued jointly by IFPRI and ADB, is the outcome of "Agricultural and Rural Development for Reducing Poverty and Hunger in Asia: In Pursuit of Inclusive and Sustainable Growth" policy forum held in Manila in August 2007, outlining the key findings are recommendations. The report is divided into three sections. The first section highlights the current realities, related to growth, poverty, and agricultural and rural development. The second more detailed analysis is on predicting trends going forward, and for a host of different factors associated with the topic, outlining both the risks to rural livelihoods associated with changes associated with the factors as well as the innovations required to importance for securing the livelihoods of rural poor including food markets and agriculture, smallholder farmers, nonfarm activities, trade liberalization, natural resource management. And the third section details policy actions for rural development inclusive agriculture, that include productive safety nets, encouraging development of finance and insurance interventions for the poor, promoting rural-urban linkages.

99. ESCAP 2009, 'Sustainable agriculture and food security in Asia and Pacific' ST/ESCAP/2535, United Nations ESCAP, viewed 4 October 2012, <www.unescap.org/65/documents/Theme-Study/st-escap-2535.pdf>

This report focuses on role of food systems and agriculture sector in ensuring food security of Asia and Pacific. The report claims that national food availability is affected by local production and trade policy. This report tries to build linkages between five regional institutions for revitalizing small-scales stainable food production for Asia-Pacific. The report encourages states to increase technology transfers and food related trade, and improve transport facilities, ensure evidence-based advocacy and development of appropriate technology.

100. Mittal, S & Sethi, D 2011 (eds), *Policy Options to Achieve Food Security in South Asia*, Cambridge University Press, New Delhi, India.

This book is a compilation of research essays on food security and policy options for South Asian countries. Claiming that half of the world's malnourished population is South Asian, it draws attention to the various problems associated with food insecurity, such as malnourishment, poverty, natural calamities and lack of economic opportunities. The compilation asserts that the problem of food insecurity can be resolved with the help of appropriate government initiatives.

101. Food and Agriculture Organization 2011, *World Livestock 2011: Livestock in food Security*, FAO, Rome, viewed 19 October 2012, <www.fao.org/docrep/014/i2373e/i2373e00.pdf>

This report expands the 2009 State of Food and Agriculture and basically it is an attempt to overcome the gaps of earlier reports on the role of livestock in sustaining the food security. The report summarizes the ways to deal with livestock and to make livestock sector productive by avoiding externalities. FAO in this report portrayed three perspectives of food security. First perspective of report examines the role of livestock in multiple dimension of food security because livestock contributes a lot in human nutrition. Besides this it also examines that how livestock improves the household access to food especially for poor families and how livestock contribute in their income and food. Secondly this report explores the three situations of food security on the basis of livestock and how it contributes in the situations. The situations are categorize in "Livestock dependent societies" which is totally based on livestock and are producers, "Small-scale mixed farmers" which is based on livestock as well as on farming and these are producers and consumers, and the third one is " city population" which are only consumers of livestock. The third and final part of the report talks about the expected future demand of livestock according to the growing population. This portion of report highlighted some of the factors which are disturbing livestock food and also suggest some techniques to deal with.

102. Drimie, S, Arntzen, J, Dube, P, Ingram, J, Mano, R, Mataya, C, Muchero, M, Vhurumuku, E & Ziervogel, G 2011, 'Global environmental change and food systems in Southern Africa: The dynamic challenges facing regional policy', *Journal of Geography and Regional Planning*, vol. 4, no. 4, pp. 169-182, viewed 18 October 2012, <http://www.academicjournals.org/JGRP>

This research article studies the impact of changing environmental conditions on various aspects of food security in three southern African countries. The authors primarily highlight the hazardous impacts that such changes can have on health and nutrition status of populations through disruption of food chains. The study points out institutional and administrative weaknesses of the countries studied in linking environmental & climate change research with development agenda. The paper proposes to tackle global environmental change with investment in scientific research and technology, and by developing appropriate policy framework based on good governance. Similar institutional and administrative weaknesses in Pakistan have been a major hurdle in forming a comprehensive strategy on climate change and food security. The paper will make an interesting reading for those interested in exploring how the three broad areas of health, agriculture and governance will be intervened by climate change.

103. Moore, N, Alagarswamy, G, Pijanowski, B, Thornton, P, Lofgren, B, Olson, J, Andresen, J, Yanda, P & Qi, J 2012. 'East African food security as influenced by future change and land use change at local regional scales', *Climatic Change*, vol. 110, no. 4, pp. 823-844, viewed 7 October 2012, DOI 10.1007/s10584-011-0116-7

This article is based on a research conducted under the Climate-Land Interaction Project. The paper explores the potential impact of climate change on food production systems in Eastern

Africa. This is done by using a regional climate model that is derived from Regional Atmospheric Modeling System (RAMs). The study uncovers regional disparities in crop yields as a result of changes in projected GHGs levels and Land Cover/Land Use change (LCLUC). The study also identifies LCLUC as an important driver of yield variability. However, the researchers warn that the projections are peculiar to the region studied, and cannot be generalized for other areas. It would be interesting to conduct similar simulations in the context of Pakistan using the LCLUC methodology and analyze to what extend yields of major crops will be affected by climate change.

104. Kandji, ST, Verchot, L & Mackensen, J 2006, 'Climate Change and Variability in the Southern Africa: Impacts and Adaptation Strategies in the Agricultural Sector', World Agroforestry Centre, ICRAF, and the United Nations Environment Programme, UNEP.

This paper provides information about climate-change adaptation strategies that are in practice in the agriculture sector of various southern African countries. The objective of the paper is to help rural communities adapt to climate change by providing them successful examples from the region. The writers persuade target audience to build productive, sustainable and flexible agriculture systems that can adequately cope with imminent climate change variability. However, it remains unclear how well the recommended adaptation strategies will be able to deal with shifts in agri-practices that occur as a result of climate change, given that the potential impacts of climate change (like changes in rainfall, average temperature) remain largely unknown. Understanding that a large portion of Pakistan's population is rural, it is imperative for research bodies and government organizations to conduct similar studies at a broader scale in Pakistan in order to assess the impact of climate variability in the agriculture sector.

105. Tunde, AM 2011, 'Perception of Climate Variability on Agriculture and Food Security by Men and Women Farmers in Idanre L.G.A, Ondo State Nigeria', *Ethiopian Journal of Environmental Studies and Management*, vol. 4, no. 2, pp. 19-32, viewed 6 October 2012, <www.ajol.info/index.php/ejesm/article/view/69148/57195>

This research paper studies the perceptions of farming communities on climate change in Idanre L.G.A, Ondo State in Nigeria. Analyzing data collected from 180 randomly sampled questionnaires, the study reveals that women farmers are more likely to be affected by climate change than their male counterparts. It also discloses that almost half of the male and female farmers perceive climate change as an event that delays rainfall, while one-fifth of the population felt that it causes rise in average temperature. The paper advocates using more climate resilient crop varieties, and recommends empowering women farmers through a more proactive role in agriculture decision-making.

106. Codjoe, SNA & Owusu, G 2011, 'Climate change/variability and food systems: evidence from the Afram Plains, Ghana', *Regional Environmental Change*, vol. 11, no. 4, pp. 753-765, viewed 3 October 2012, <link.springer.com/article/10.1007%2Fs10113-011-0211-3>

This paper focuses on food systems of Ghana in the context of climate change. It covers three communities in Afram plains. The results reveal that the studied areas are food secure.

However, slight shifts in climate are likely to alter the situation by adversely affecting food systems (e.g. food storage), livelihoods, and the like (as in other regions such as South Asia and particularly Pakistan). The writers recommend improving access to food by investing in transportation and related infrastructure in order to increase linkages between food systems and the local market. In addition, they recommend minimizing post-harvest losses for a sustainable food system in the face of climate change.

107. Seo, SN, Mendelsohn, R, Dinar, A, Hassan, R & Kurukulasuriya, P 2008, 'A Ricardian analysis of the distribution of climate change impacts on agriculture across agro-ecological zones in Africa', Policy Research Working Paper no. 4599, Development Research Group, World Bank, viewed 7 October 2012, <www.scielo.cl/pdf/chiljar/v68n1/at07.pdf>

This working paper analyses the potential impacts of climate change on sixteen agro-ecological zones in Africa using Ricardian model analysis. The research is based on secondary data collected from various FAO and WB studies. The paper maintains that the impacts of climate change will vary across the studied zones. It also claims that slight climatic shifts are likely to increase the livelihoods of African farmers. However, the study warns that drastic changes in the climate can hamper their livelihoods. Although the impact of climate change in Pakistan is considered negative overall, there are places that have benefited from the slight change in climate. The northern areas of Pakistan can now cater to tourism for a much longer time then it was possible two decades ago. However it has to be kept in mind that a drastic change in climate can also have an adverse impact on these people in the shape of land sliding, and the like.

108. Ziervogel, G & Frayne, B 2011, 'Climate Change and Food insecurity in Southern African cities', *Urban Food Security Series*, no. 8, Queen's University and African Food Security Urban Network (AFSUN), Kingston and Cape Town, viewed 15 October 2012, <queensu.ca/samp/afsun/files/publications.php?&dwnlds=482>

The report is prepared by African Food Security Urban Network in collaboration with Queen's University. It studies food security situation in various southern African urban areas. The study discloses that fighting poverty is imperative to decrease urban inequalities, because they undermine access to food. The research claims that in order to fight hunger in a broader context, the ecological and poverty dimensions of climate change too need to be addressed. The research advocates for the integration of climate change and food security in urban development policies. The report also recommends strengthening of science, policy and practice interface, increasing allocation of resources to the urban areas, and improving research. There are very few studies in Pakistan that take into account the urban dimension of food security, despite having a large urban population. This report proves affirms that urban food security is indeed an issue that demands immediate attention of policy makers not only in the African regions but also in Pakistan.

109. Wlokas, HL 2008, 'The impacts of climate change on food security and health in Southern Africa', *Journal of Energy in Southern Africa*, vol. 19, no. 4, pp. 12-20, viewed 9 October 2012, <www.erc.uct.ac.za/jesa/volume19/19-4jesa-wlokas.pdf>

This study explores the impact of climate change on food security and health in Southern Africa. Reiterating what has already been observed in previous IPCC studies, this paper confirms that Southern Africa is vulnerable to climate change. The writer proposes that national and international collaboration on adaptation and mitigation measures is necessary to ensure food security and nutrition in the advent of climate change. The past decade has shown that Pakistan is particularly vulnerable to climate change. Similar efforts need to be taken locally and with the help of international donors to improve food security and health in Pakistan.

110. Van de Steeg, JA, Herrero, M, Kinyangi, J, Thornton, PK, Rao, KPC, Stern, R & Cooper, P 2009, 'The influence of current and futureclimate-induced risk on the agricultural sector inEast and Central Africa', International Livestock Research Institute, ILRI, Working paper no. 22, viewed 16 October 2012, <http://www.asareca.org/resources/reports/ASARECA_Ilri%20climatechange1.pdf >

The report is prepared by a cooperation of a number of authors under the umbrella of International Livestock Research Institute (ILRI). This organization is a member of the CGIAR Consortium that works with partners to help poor people keep their farm animals alive and productive. It also helps them to increase and sustain their livestock and farm productivity and find profitable markets for their animal products. The report works on assessing the influence of climate change and its risk on agriculture sector of East and Central Africa. Many studies have been done and also in progress regarding reducing the vulnerability of climate change. For least developing nations, National Adaptation Plans of Action (NAPA) have been developed under the United Nations Framework Convention on Climate Change (UNFCCC). However there is lack of coordination to adapt these strategies. Pakistan being a developing country is confronted with various agricultural challenges. Pakistan has formed a ministry to deal with livestock. Strategies need to formulate and the global climate change needs to be kept in perspective.

111. Hahn, MB, Riederer, AM & Foster, SO 2009, 'The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change: A case study in Mozambique', *Global Environmental Change*, vol. 19, no. 1, pp. 74-88, viewed 20 October 2012, DOI: 10.1016/j.gloenvcha.2008.11.002.

The paper focuses on estimating the risks that are possibly in sight due to climate variability and change. Study was conducted in two districts: Mabote and Moma districts of Mozambique. Team of authors developed a Livelihood Vulnerability Index (LVI) to estimate climate change vulnerability. 200 household were surveyed in each district for data collection on certain socio-demographics, livelihoods, social networks, health, food and water security, natural disasters and climate variability. The results showed that different coping strategies have been adapted by the households in surveyed areas. For example, southern Mozambique faces recurrent drought, the households have adapted to install large cans of 210 liters, that's why they have to travel less for water fetching. Due to this water management practice, it has decreased the vulnerability of water sector in Mabote and is reflected in its low Water vulnerability score despite drought conditions. Similarly authors stressed on educating the households about different food storage practices so to have a sustain supply of food during the hard times especially in the changing climate scenario.

The recent disasters in Pakistan have shown that there is a dire need to educate and train the local community to handle crisis situations. People can better cater to their needs when confronted with disasters like droughts in the past and floods of 2010. Efforts like food storage can help the people survive when they are cut off from the rest of the country by natural disasters or calamities.

112. Jones, PG & Thornton, PK 2003, 'The potential impacts of climate change on Maize production in Africa and Latin America in 2055', *Global Environmental Change*, vol. 13, no. 1, pp. 51-59, viewed 16 October 2012, <http://wema.aatf-africa.org/files/files/project_sites_publications/impact-climate-change-maize-production.pdf>

This article looks at effects of climate change on maize production in Latin America and Africa. As the report covers 2 large regions that represent a vast majority of the developing world, the information seen therein is very useful for global comparison studies, against South Asia, and in particularly Pakistan. The article outlines the potential effects of climate change on maize production till the year 2055, by running a simulation model of maize crop using high-resolution methods to generate daily weather data. The results indicate a 10% drop in maize production leading to $2 billion in losses; however these results do not bring to light variability among the different regions. The article was written in 2003, and its relevancy can therefore be questioned.

113. Thornton, PK, Jones, PG, Alagarswamy, G & Aderson, J 2009, 'Spatial variations of crop yield response to climate change in East Africa', *Global Environmental Change*, vol. 19, no. 1, pp. 54-65, viewed 8 October 2012, <DOI:10.1016/j.gloenvcha.2008.08.005, www.researchgate.net>

The article attempts to analyze the impact that changing weather patterns will have on maize and bean crops. The paper utilizes 'high resolution methods' to produce weather patterns for a variety of future emission scenarios to derive detailed simulation models for crop production. The results indicate a varied response across the East African region, where there is considerable variation in topography and temperature, leading to the conclusion that a large scale climate change adaptation policy may not be the most efficient solution and more strategies need to be targeted at community level to build the adaptive capacity of the locals. Maize is a major cash crop of Pakistan. As obvious from this report, maize and beans are susceptible to negative effects of a shifting climate. In the absence of appropriate policy, the government of Pakistan needs to build capacity of the state and peoples to adapt to adverse impacts of climate change on agriculture sector.

114. Ringler, C, Zhu, T, Cai, X, Koo, J & Wang, D 2012, 'Climate Change Impacts on Food Security in Sub-Saharan Africa', International Food Policy Research Institute, IFPRI, Discussion Paper no. 01042, viewed 10 October 2012, <www.ifpri.org/category/.../discussion-papers/ifpri-discussion-paper>

This discussion paper analyzes the impacts of climate change in Sub-Saharan Africa, using a climate change scenario that integrates climate projections from 17 Global Circulation Models (GCMs). It estimates the GCMs relative performance regarding their prediction of temperature and precipitation for the region. According to this paper, even in the absence of

climate change the Sub-Saharan region faces the risk of increased child malnutrition over the next two decades. The problem is will be exacerbated by climate change. The paper also highlights the negative impact of climate change on food prices, with the prices of maize, rice and wheat expected to rise by 4, 7 and 15 percent respectively by 2050 across Sub-Saharan Africa.
Climate change has had a negative impact on food crop production in Pakistan. A large portion of the children in the country already suffers from malnutrition due to poverty. The climate change will only worsen the present predicament.

115. Turral, H, Bruke, J & Faures, JM 2008, *Climate Change, Water and Food Security*, FAO Water Report no. 36, Irrawaddy Delta, Mayanmar, viewed 19 October 2012, <www.fao.org/docrep/014/i2096e/i2096e.pdf>

This report assesses the impact of climatic shifts on water and agriculture in Mediterranean basin and semi-arid areas of America, Australia and southern Africa. The report claims that rural and urban livelihoods are at risk due to limited water availability. The report recommends various policy measures, such as increasing water efficiency, and increasing investment in adaptation measures, in order to ensure food security. The findings find resonance in Pakistan. Water resources are fast depleting while water inefficiency remains high. Urban and rural areas alike are beginning to experience water shortages. It is clear that water availability will threaten food security if the climate changes in coming times. Such reports present valuable options that decision-makers can chose to adapt to, and mitigate, the adverse impacts of climate change.

116. Food and Agriculture Organization 2008, *Climate Change and Food Security in Pacific Island Countries*, Food and Agriculture Organization of the United Nations, FAO, Rome, viewed 8 October 2012, <ftp://ftp.fao.org/docrep/fao/011/i0530e/i0530e.pdf>

The report is published by the Natural Resources and Environment Department and FAO Sub-Regional Office for the Pacific Islands. The regional assessment has been carried by the Secretariat of the Pacific Regional Environment Programed (SPREP) in close partnership with FAO and the University of South Pacific. It outlines the challenges of combating food insecurity and poverty in Pacific region in the presence of climate change and energy insecurity. The study is useful in the Pakistani context, taking into account the fact that poverty, food insecurity and the energy crisis are among major challenges that afflict Pakistan today.

117. Drimie, S, Arntzen, J, Dube, P, Ingram, JSI, Mano, RT, Mataya, C, Muchero, MT, Vhurumuku, E & Ziervogel, G 2011, 'Global Environmental Change and Food Systems in South Arica: The dynamic challenges facing regional policy', *Journal of Geography and Regional Planning*, vol. 4, no. 4, pp. 169-182, viewed 16 October 2012, <www.academicjournals.org/jgrp/pdf/.../Apr/Drimie%20et%20al.pdf>

Global Environmental Change (GEC) is a hot issue in the world, especially in Southern Africa, and especially so in the context of food systems and food security. The paper reaffirms that severe malnutrition and stunting in children in the region studied will threaten food security in the future. Environmental changes influence food systems, in terms of food

production, infrastructure of food storage, and food distribution systems. In short, this paper encircles two main objectives i.e. affecting pattern of GEC in creating stress on food systems, and minimizing the chronic food insecurity through adaptation and implementation in agriculture promotion.
Pakistan's food production and infrastructure of food storage and distribution has been a victim of global environmental change, as in South Africa. Various crops productions have deteriorated and the distribution system has been hampered due to large scale floods. Perhaps academics and policy makers can learn from the South African experience and make appropriate policy choices before it is too late.

118. Holst, R, Yu, X & Grun, C 2010, 'Climate change, risk and grain production in China', paper presented at the *Agricultural & Applied Economics Association 2010 AAEA,CAES, & WAEA Joint Annual Meeting,* Denver, Colorado, 25-27July 2010, viewed 7 October 2012, <http://ageconsearch.umn.edu/bitstream/61177/2/Rainer%20Holst%20-%20Climate%20Change,%20Risk%20and%20Grain%20Production%20in%20China.pdf>

This paper presented at the AAEA, CAES & WAEA Joint Annual Meeting uses the production function-based proposed by Just and Pope (1978, 1979). This paper explicitly analyzes production risk of Chinese grain production in the context of climate change; in the same breadth, it also gauges the impact of climatic factors on Chinese grain production. The paper mainly highlights that china may be a net beneficiary of climate change in short or medium run – meaning that increase in average temperature will have a positive impact on mean output and will in addition reduces the level of production risk.
Similarly, in Pakistan, there are certain grains or agricultural inputs that can benefit from climate change. Wheat is one particular crop that has benefited from rise in average annual temperature in terms of wheat production.

119. Hertel, TW, Bruke, MB & Lobell, DB 2010, 'The poverty Implications of Climate-Induced Crop Yield Changes by 2030', GTAP Working Paper No. 59, viewed 11 October 2012, <iis-db.stanford.edu/pubs/22837/GTAP_2_2010.pdf>

The researchers in this study utilize Global Trade Analysis (GTAP) in order to assess the impact of climate shocks on livelihoods. The paper reveals that agricultural growth is affected by climate change, which will directly or in directly affect the income of poor states. It also cautions that inflation will rise in developing countries by 10-60% by the year 2030. This is likely to increase poverty from 20-50% in agri and non-agri households of Africa, Asia, and Latin America. In Pakistan, we have seen similar predictions. For sure, the impact of climate change has been evident in Pakistan's agriculture sector. Agricultural output has been greatly reduced due to climate change, which in turn has also been a factor in not only raising prices but also rate of poverty.

120. Mamouda, MNA & Diop, C 2010, 'Climate change adaptation and food insecurity in Maradi district – Niger', in proceedings of the *Second International Conference on Climate, Sustainability and Development in Semi-Arid Regions (ICID+18),* Fortaleza-Ceara, Brazil, 16-20 August, 2010, viewed 15 October 2012, <

http://www.dewpoint.org.uk/Asset%20Library/ICID18/15-MOUSSA_NA_ABOU_et_al_ICID+18.pdf>

This paper, presented in an international conference, reveals that that more than 80% of population in Maradi district (Niger) comprises of farmers that depend on rain-fed agriculture. However, precipitation is becoming more uncertain and temperature more variable as a result of climate change. Farmers face various challenges, such as fetching surface and groundwater for irrigation, as a result of which they have adapted various coping mechanisms to ensure their food security. The most severe adaptation/coping strategy that people are adapting is out-migration towards West African countries. The issues faced by Maradi farmers are similar to those faced by Pakistani farmers. A large proportion of Pakistan's labor force is dependent on agriculture sector. As climate change has altered the temperature in certain parts of the country, people have migrated over time from food insecure districts towards those that are less food insecure.

121. Thornton, P, Herrero, M, Freeman, A, Mwai, O, Rege, E, Jones, P & Mcdermott, J 2007, 'Vulnerability, climate change and livestock – Research opportunities and challenges for poverty alleviation', *Journal of Semi-Arid Tropical Agricultural Research*, ICRISAT, vol. 4, no. 1, pp. 1-23, <www.researchgate.net/.../49466860_Vulnerability_Climate_Change_...>

This paper highlights the important role that livestock play in income generation and poverty alleviation in Sub-Saharan Africa and Asia. It analyses how the local livestock systems and the people who depend on them will be affected by climate variability. Although the study does not focus on Pakistan, it is very relevant to the Pakistani context. Baluchistan and Northern areas of Pakistan are not rich in agricultural resource; they are mostly dependent on livestock for food security. Climate variability is likely to affect the livelihoods and food security of those who are dependent on livestock production.

122. Ziervogel, G, Nyong, A, Osman, B, Conde, C, Cortes, S & Downing, T 2006, 'Climate variability and change: Implications for household food security', Assessments of impacts and adaptation on climate change, AIACC, working paper no. 20, viewed 30 October 2012, <www.aiaccproject.org/working.../AIACC_WP_20_Ziervogel.pdf>

This paper examines how households in a number of regions, such as Nigeria, Sudan, South Africa and Mexico, are confronted with food insecurity. The study finds that rural livelihoods present a serious threat to the regions studied.

123. Rao, KPC, Verchot, LV & Laarman, J 2007, 'Adaptation to Climate Change through Sustainable Management and Development of Agroforestry Systems' *Journal of Semi-Arid Tropical Agricultural Research*, ICRISAT, vol. 4, no. 1, pp. 1-30, viewed 4 October 2012, <www.icrisat.org/journal/SpecialProject/sp18.pdf>

This paper was presented at the 'ICRISAT and CGIAR 35th Anniversary Symposium on Climate-Proofing Innovation for Poverty Reduction and Food Security', held on 22-24

November, 2007. This paper describes how agroforestry system of a small farm holder in tropical regions in general and sub-Saharan Africa can adapt to the expected changes in climate. The fundamentals of agroforestry system play an important role in climate change adaptation and change in microclimate, improving efficiency of soil, opportunities for diversification of the agriculture systems, protection through provision of permanent cover, climatic and water resources, increasing sequestration and reducing the greenhouse gas emissions. This paper suggests that for a sustainable agroforestry system there is a great need to improve market linkages for the production of goods and services and promotion of market system. This paper concludes that there is a dire need to evaluate the agroforestry system and through this component species can be determined, the trees used can be classified, which in result can be used to improve the systems in soil, climate, and socio-economic limitations. This paper suggests that agroforestry systems for developing and agricultural countries, such as Pakistan, which can be beneficial by reducing carbon and GHG emissions.

124. Huda, S, Sadras, V, Wani, S & Mei X, 2010, 'Food Security and Climate Change in the Asia-Pacific Region: Evaluating Mismatch between Crop Development and Water Availability', *General,* vol. 2, no. 2, pp. 137-144., viewed 18 October 2012, <ifsa.boku.ac.at/cms/fileadmin/.../2010_WS3.1_Huda_Sadras.pdf>

The idea behind this research is that climate change may alter the rate of phonological development and the amount and distribution of rainfall during growing season, as these changes may in turn result in mismatch between water demand by crops and water availability from rainfall. The research illustrates that how an understanding of the impact of climate shifts on key crops will enable the Asia-Pacific farmers, community workers and policy agencies to better prepare and adapt to climate change. The paper discusses the existing policy and practices like timing of planting, managing rainwater resources, use of new varieties, disease management protocols, alternate crops and shift in geographic distribution of crops. An international project is discussed in this research, which combines a new analysis of realized changes in meteorological parameters, and use of estimates from published work on future climates to assess temporal shifts in crop phenology, likely shifts in the pattern of rain and water availability, mismatch between crop phenology and water availability, and the expected consequences of this mismatch for food security.
In the context of Pakistan, it can be said that climate change is more or less parallel with that in the world. Unexpected rainfall, such as that in 2010 and 2011 which caused floods in the country, is worsening food security and poverty in the country.

125. Rosegrant, MW, Ewing, M, Yohe, G, Burton, I, Hug, S & Valmonte-Santos, R 2008, *Climate Change and Agriculture: Threats and Opportunities*, Deutsche Gesellschaftfür Technische Zusammenarbeit (GTZ) GmbH, Germany, viewed 18 October 2012, <ccsl.iccip.net/gtz_climatechange-agriculture.pdf>

The report examines some of the challenges that developing countries face in the agriculture sector due to climate change. The study lays emphasis on adaptation measures which are important for alleviating poverty especially in rural areas. Like other developing countries that are surveyed in this report, Pakistan is also being confronted by similar challenges which

are identified in this report, such as deforestation, rapid urbanization and rising carbon emissions.

126. Terry, C 2002, *Food security, development and climate change: Livelihood and institute group*, Natural resources institute, University of Greenwich, UK.

The report focuses on decreasing the adverse impacts of climate change in agriculture sector, while also eliminating hunger and poverty. The study confirms that food security can be accomplished through agricultural production. The report concludes by recommending a more proactive role of government in enhancing agricultural production. Considering that Pakistan is largely an agricultural economy, it can benefit immensely from this study by enhancing water efficiency and availability, land productivity and resource management.