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UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Subsidiary Body for Scientific and Technological Advice
Thirty-ninth session
Warsaw, 11–16 November 2013

Item 10 of the provisional agenda
Issues relating to agriculture

Views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries, and taking into account the diversity of the agricultural systems and the differences in scale as well as possible adaptation co-benefits

Submissions from Parties and admitted observer organizations

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its thirty-eighth session, invited Parties and admitted observer organizations to submit to the secretariat, by 2 September 2013, their views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries. This should take into account the diversity of the agricultural systems and the differences in scale as well as possible adaptation co-benefits.[1] It requested the secretariat to compile the submissions into a miscellaneous document for consideration at SBSTA 39.[2]

[1] FCCC/SBSTA/2013/3, paragraph 81.
[2] FCCC/SBSTA/2013/3, paragraph 82.

FCCC/SBSTA/2013/MISC.17

GE.13-63058

2. The secretariat has received 13 such submissions from Parties. In accordance with the procedure for miscellaneous documents, these submissions are attached and reproduced* in the languages in which they were received and without formal editing.[3]

3. In line with established practice, the two submissions received from intergovernmental organizations and the eight submissions received from non-governmental organizations have been posted on the UNFCCC website.[4]

* These submissions have been electronically imported in order to make them available on electronic systems, including the World Wide Web. The secretariat has made every effort to ensure the correct reproduction of the texts as submitted.

3 Also available at <http://unfccc.int/5901>.

4 Available at <http://unfccc.int/7482>.

Contents

* This submission is supported by Albania, Bosnia and Herzegovina, Iceland, Montenegro, Serbia and the former Yugoslav Republic of Macedonia.

Paper no. 1: Burundi

PROPOSITION DU BURUNDI POUR L'AGRICULTURE ET LE CHANGEMENT CLIMATIQUE LORS DE LA 39ème SESSION DE SBSTA.

1. Introduction

L'économie burundaise dépend fortement de l'agriculture qui contribue à plus de 46 pourcent dans le PIB, emploie plus de 90 pourcent de la population active, fournit plus 95 pourcent de l'offre alimentaire et plus de 80 pourcent des recettes d'exportation.

Le secteur agricole burundais dépend fortement du climat. En effet, on enregistre une baisse de la production agricole très importante due au changement climatique (sécheresse et pluies diluviennes). Cette baisse affecte le bien-être et la sécurité alimentaire de la population Burundaise dont 58% souffrent de la malnutrition. Dix années après les accords de paix, la situation économique reste encore très fragile avec un PIB de 110 dollars US par tête et la pauvreté affecte plus de 65% de la population. La situation alimentaire et nutritionnelle est particulièrement préoccupante. Le déficit global en équivalent céréales avoisine 470 000 T par an et l'insécurité alimentaire touche plus de 75% de la population. De plus, l'apport du secteur agricole au PIB est passé de 70% en 1990 à 46% en 2012.

Face à cette problématique, le Burundi mène des actions d'adaptation et d'atténuation malgré les maigres moyens techniques, financiers et technologiques dont il dispose mais le chemin à parcourir reste encore long.

2. Les défis

- ✓**Une utilisation accrue des ressources en eau pour la production agricole**. Le Burundi possède un potentiel important de terres irrigables aussi bien au niveau des marais et des plaines mais aussi au niveau des collines mais moins de 10% des superficies sont irriguées. Le recours à l'irrigation pourrait accroître l'intensification des cultures, augmenter les rendements et réduire les pertes causées par les irrégularités pluviométriques

- ✓**Un recours intégral aux bonnes pratiques de protection des ressources naturelles et des systèmes d'élevage. L**e relief accidenté occasionne les pertes énormes des terres fertiles calculées à 18 tonnes par hectare et par an dans la région naturelle de Mumirwa. L'augmentation excessive de la température provoque de nouvelles maladies des végétaux et des animaux qui occasionnent des chutes de production. Ainsi, le recours à la protection des bassins versants, à la restauration de la fertilité des sols et à la protection intégrale des ressources naturelles est indispensable

- ✓ **Manque d'information fiable et en temps réel sur le climat.** Le changement climatique entraîne la perturbation du calendrier agricole. Une information fiable et à temps réel et un système d'alerte précoce permettront aux agri-éleveurs de s'adapter au changement climatique.

- ✓ **Faible capacité technique, humaine et financière d'analyse et de suivi météorologique, climatique et hydrologique.** L'Institut Géographique du Burundi « IGEBU » accuse de faible capacité pour analyser et suivi l'évolution de la météorologie, du climat et de l'hydrologie pour fournir une information aux utilisateurs des données climatiques.

- ✓ **Faible capacité de la recherche sur le changement climatique.** La recherche joue un rôle primordial dans la proposition des voies d'adaptation au changement climatique. Cependant, la recherche sur cet aspect reste encore lacunaire. Le renforcement des capacités dans le cadre de la recherche permettra d'avoir des solutions appropriées.

- ✓ **Insuffisance des données statistiques de l'impact du changement climatique sur l'agriculture.** Les données statistiques de l'impact du changement climatiques permettent une prise de décision appropriée.

- ✓ **Les connaissances traditionnelles dispersées et non valorisées.** Le Burundi dispose des connaissances traditionnelles mais qui sont dispersées et non valorisées. Traditionnellement, les noms vernaculaires des mois de l'année ont trait au climat. Cependant, toutes ces connaissances sont faiblement valorisées pour s'adapter au changement climatique.

3. les domaines prioritaires d'intervention

3.1. Renforcement des capacités : le renforcement des capacités sera concentrée dans

- ✓ L'appui technique et humain en matière de gestion des ressources naturelles
- ✓ L'analyse et de suivi météorologique, climatique et hydrologique.
- ✓ La recherche sur le changement climatique
- ✓ La disponibilisation de l'information fiable sur le climat
- ✓ Les techniques modernes de l'utilisation de l'eau pour la production agricole

3.2. Transfert de technologies : l'accès à des technologies nouvelles et innovantes permet de mieux s'adapter au changement climatique. Ainsi,

- ✓ Technologies de suivi météorologique, climatique et hydrologique ;

✓ Technologies de recherche

3.3. Promotion et valorisation des connaissances traditionnelles

✓ Inventorier toutes les connaissances traditionnelles

✓ Promouvoir la mise en à niveau des femmes agricultrices

Conclusion

Cette proposition du Burundi prend en considération les femmes, la jeunesse et les groupes vulnérables étant donné que les conséquences du changement climatique affectent d'une manière significative ces groupes sociaux.

Paper no. 2: Japan

Japan's views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries

Japan welcomes the opportunity to submit its views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries.

Japan recognizes that agriculture is one of the most essential sectors for addressing issues such as food security, poverty eradication and sustainable rural development.

It goes without saying that adaptation is essential, when considering the relationship between agriculture and climate change. It is because agriculture is one of the most vulnerable sectors to climate change. And even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades. Hence, adaptation is essential in agricultural sector.

Japan recognizes that, considering food security, rural development and so on, agricultural practices with co-benefit effects on both agricultural production and climate change are very important. Japan has worked on research and technology development on adaptation in agriculture, on the basis of the Fourth Assessment Report of IPCC, domestic climate change projections, high temperature phenomena and so on. A few examples of international cooperation on adaptation that Japan has supported are shown as follows.

・New Rice for Africa (NERICA) ; NERICA is a group of rice varieties developed by AfricaRice (the former : WARDA). Widely cultivated varieties of upland NERICA have short growth durations, so that they can be applied as rice varieties adapted to climate change such as droughts, and their yields are higher than local varieties. Furthermore, a new project is accelerating development and deployment of the next generation of elite rice varieties, "Advanced Rice for Africa (ARICA)".

・Assessments of Climate Change Impacts and Mapping of Vulnerability to Food Insecurity under Climate Change to Strengthen Household Food Security with Livelihood's Adaptation Approaches (AMICAF) ; The AMICAF is a FAO's project to assess climate change impacts on food security. The AMICAF analyzes climate change impacts on agriculture and food security and indicates food insecurity vulnerability by mapping, and then supports to design adaptation options in the region.

There are some examples of agricultural practices with co-benefit effects on both agricultural production and climate change in the case of mitigation. A few examples of mitigation that Japan has conducted are shown as follows.

・Mitigation of Methane Emission from Paddy Fields by Alternate Wet and Dry Irrigation (AWD) ; In Japan, we have practiced AWD for a long time, in order to increase rice yield by vitalization of rice roots with oxygen. This AWD also has mitigation effects to reduce methane emission from paddy fields and reduces the use of water resources and irrigation costs.

・Farm Household Biogas Project Contributing to Rural Development ; This project is a CDM project conducted in Viet Nam that reduces GHG emission and contributes to rural development. In this project, biogas digesters for treating farm wastes, sewage and so on were introduced to low-income communities to produce biogas, a renewable fuel that can be used as fuel wood and LP gas substitutes for heating and cooking purposes. This project has co-benefit effects on low-income households (by contributing to livelihood improvement) as well as climate change (by a reduction of GHG emission), although it does not have a direct benefit on agricultural production.

Above-mentioned examples show that there are some agricultural practices with co-benefit effects on both agricultural production and climate change in the case of mitigation. Hence, when considering the relationship between agriculture and climate change, it is necessary to consider agriculture that addresses climate change from not only the adaptation aspect but also the mitigation aspect. The reason why we should think about mitigation is that we should take consideration of the following issues with respect to the relationship between agriculture and climate change.

・Agriculture sector occupies 13.5% in the world total GHG emission.

・Reliance on adaptation alone could eventually lead to a magnitude of climate change to which effective adaptation is possible only at very high social, environmental and economic costs.

Considering these issues, it is very important to address both adaptation and mitigation with respect to agriculture and climate change.

Japan recognizes that the latest projections and impact assessments of climate change based on scientific analysis in the forthcoming Fifth Assessment Report of IPCC will be very important in order to address appropriate adaptation measures on various agricultural fields. In order to establish and conduct agricultural practices with co-benefit effects on both agricultural production and climate change, especially in the case of mitigation, it is necessary to consider them from the perspective of science and technology. Furthermore, the effectiveness of improved agricultural management practices depends on factors such as climate, soil type and farming system. Considering this agricultural characteristic, science and technology including on-site research and development need to be strengthened to establish those agricultural practices with co-benefit effects on both agricultural production and climate change, which are suited to various climate, soil types and farming systems. Japan finds it useful and effective to do collaborative research with developing countries in their lands, in cooperation with researchers and other relevant stakeholders in developing countries. Japan has contributed to doing some collaborative research, through programs such as Science and Technology Research Partnership for Sustainable Development (SATREPS).

Finally, it is important to establish a mechanism through which countries can share knowledge, technologies, activities and human networks on adaptation, mitigation and so on in the field of agriculture, in cooperation with the existing mechanisms. In this regard, accumulating reliable knowledge on emission, mitigation and sequestration is valuable as the basis of the effective approach, which has been discussed in the Global Research Alliance on Agricultural Greenhouse Gases, a voluntary framework established in 2011 and currently joined by 35 countries. Regarding financial resources, it is important to consider the linkage between the above-mentioned mechanism related to agriculture and various types of climate funds such as the Green Climate Fund and the Adaptation Fund, as well as, further availability of all other financial sources.

Paper no. 3: Kenya

Subject: **Views on the current state of scientific knowledge on how to enhance the Adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries| SBSTA**

Introduction

This submission is made by Kenya pursuant to paragraph 2 of FCCC/SBSTA/2013/L.20 as provided for in https://unfccc.int/documentation/submissions_from_parties/items/5901.php, in which the UNFCCC invited views from Parties and relevant organizations on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries, taking into account the diversity of the agricultural systems and the differences in scale as well as possible adaptation co-benefits.

Kenya welcomes this opportunity for submission and acknowledges the progress made in Bonn, and also looks forward to participating in the exchange of views at SBSTA 39. Kenya appreciates the fruitful discussions during SBSTA 38 in Bonn, reaffirms its conviction regarding the necessity of addressing issues related to agriculture under SBSTA and considers this submission of views an important initial step in the process of addressing issues related to agriculture under UNFCCC.

Background

Agriculture is expected to ensure the food security of an increasing number of people in a changing climate. This requirement means that agriculture has to change with the times and within the dictates of a changing climate. The situation will be made worse when this changing climate is coupled with environmental degradation, especially in the most vulnerable parts of developing country territories. This scenario makes adaptation of the agriculture sector imperative for survival and not just an option, especially in aspects like food security, development and poverty reduction as well as the management of synergies and trade-offs across intervention outcomes and adaptation co-benefits including methods for quantifying and accounting for these co-benefits, and integrated MRV methodologies that might be needed for this.

Agriculture in the UNFCC Convention

The UNFCCC has an important role to play in facilitating a global response to the adaptation challenges and opportunities presented by the agriculture sector.The Convention, in its Article 2, states that stabilization of greenhouse gas concentrations in the atmosphere should be within a timeframe, which ensures that "food production is not threatened". In Article 9, the Convention establishes the subsidiary body for scientific and technological advice (SBSTA) to provide the Conference of the Parties and, as appropriate, its other subsidiary bodies with timely information and advice on scientific and technological matters relating to the Convention.

Agriculture in Kenya

Agriculture plays a major in the economy of Kenya, directly contributing 24% of GDP and another 27% indirectly through industry, services and trade. The agricultural sector employs about 65% of the workforce in the country. It also provides valuable environmental stewardship and sustainable land management. The agriculture sector is very sensitive to climate change, meaning that agricultural systems will need to adapt to ensure provision of adequate food for a growing population. Kenya has in recent years had its share of climate-related impacts: prolonged droughts; frost in some of the productive agricultural areas; hailstorms; extreme flooding; receding lake levels; drying of rivers and other wetlands; among others leading to large economic losses and adversely impacting food security. Evidence is emerging that the frequency of droughts, floods, and other extreme climate events has increased in recent years.

Climate Hazards in Kenya include:

- Temperature – reduction in the number of reliable crop growing days
- Drought and dry spells – changes in precipitation patterns are likely to directly increase short-term crop failures and long-term production declines for rain-fed agriculture
- Floods and excessive rains – unpredictability in precipitation is already having negative consequences on rural livelihoods
- Salinization of soils and water due to saline intrusion/abstraction
- Inundation of coastal lowlands due to sea level rise
- Occurrence of windstorms and hailstones
- Incidences of frost
- Wildlife migrations
- Insect pests, diseases
- Invasive plants/weeds

Vulnerabilities in Kenya include:

- Poor state of natural resources and infrastructure – degraded
- High dependence on climate sensitive livelihoods and value chains
- Inflexible behavior in a changing environment
- The poverty/deprivation trap

A combination of these factors and many others increases Kenya's vulnerability to climate change.

Kenya recognizes the valuable and diverse role this sector plays in ensuring national food security, livelihood security, income generation and poverty reduction, as well as environmental benefits. However, Agriculture is one of the most vulnerable sectors of Kenya's economy. It is therefore critical that the UNFCCC facilitates the sector's response to climate change in terms of both adaptation and its co-benefits in a way that Kenya can benefit.

Proposals by Kenya to SBSTA

With this in mind, Kenya considers that work done in SBSTA on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security should include the following aspects:

Identify climatic factors that represent the greatest risk of compromising food security: Climate change is expected to impact agricultural production in Kenya. It is therefore important to anticipate effects of future climate change as accurately as possible and identify those climatic factors that represent the greatest risk of compromising food security and agricultural income security. Once these factors have been identified, appropriate and quantitatively informed adaptation strategies can be devised. However, little quantitative information is available on the extent and direction of these impacts. Without such quantitative information, however, developing appropriate adaptation strategies is difficult. SBSTA needs to provide scientific and technological advise on this not only for Kenya but for all countries.

Accurately assess climate change impacts in the agriculture sector: There is need for a comprehensive assessment of the evidence and impacts of climate change in Kenya, and a framework for impact monitoring.

Identify priority adaptation actions and methods to measure adaptation co-benefits: The adaptation interventions rely mainly on a range of assumptions about pertinent factors, with very high uncertainty. SBSTA needs to provide scientific and technological advice on priority adaptation actions to improve water management include increased domestic water supply and improved sewage systems, enhanced irrigation and drainage to increase agricultural and livestock production, effective trans-boundary water resources management, and flood mitigation schemes. These actions reduce the impact of droughts and floods on crop yields and livelihoods, and more irrigation-based agriculture reduces the reliance of crop production on rainfall. Many climate-smart agricultural practices that reduce climate vulnerability also reduce emissions and improve agricultural production potential. Methods to measure and quantity these co-benefits against adaptation initiatives will need to be developed. Further, SBSTA is requested to provide advice on:

- Pathways of ecological resilience and livelihood diversification for sustainable agriculture
- Initial and regular screening of farming community vulnerability to current climate – to prioritize response actions
- Capacity building for agro-meteorological information management
- Existing measures already being undertaken to adapt to climate change within the agricultural sector, with a view to sharing this information to increase the capacity of all countries to implement the strategies most suited to their national circumstances.
- What barriers exist to implementing adaptation & mitigation strategies in agriculture.

Downscale climate-crop/livestock models for focused interventions: Robust agricultural modelling requires detailed knowledge of a host of factors that influence agricultural systems, such as the crop variety planted, sowing densities, fertilization regimes etc. In particular the crop variety or livestock breed needs to be defined not only by name, but with a comprehensive set of attributes describing factors like timing of development stages in response to weather, growth rate etc. If all these factors are known and reliable weather and other information is available, productivity can be simulated quite reliably. Doing such an analysis is impaired by a striking shortage of necessary input data, especially in developing countries, among them Kenya. This means that even current climate cannot be reliably characterized, placing constraints on the accuracy with which the future can be projected. Observations of local weather are needed for calibrating climate models, and where no records are available, the accuracy of climate models is questionable. Similarly, soil information for these regions is scarce, yet soil data is an essential input into any agricultural model. Finally, information on what crop varieties farmers grow, how these respond to climate, and how exactly they are managed, is unavailable. Relying only on global data is too crude an approach for making site-specific decisions. SBSTA needs to provide scientific and technological advice on these aspects in a downscaled manner.

Provide advice on agricultural efficiency, resilience and productivity to respond to climate change: Kenya acknowledges that addressing climate change in the agriculture sector has challenges, but also it also presents opportunities. In that regards SBSTA needs to provide scientific and technological advice regarding actions which enhance efficiency, resilience, productivity and sustainability, including benefits to farmers and to the climate. It is within SBSTA's mandate to identify and promote development and transfer of innovative and efficient technologies and know-how. This should be done in relation to agriculture. Further, SBSTA should consider the identification of innovative agricultural technologies, practices, processes and know-how and advice on the ways and means of promoting the development and/or transfer of such technologies. Through identifying existing technologies and emerging developments and aligning these with identified priorities for adaptation in agriculture, it will be possible to implement effective responses to climate change in the agriculture sector. Technological responses which encourage the best use of available resources, increasing the efficiency of food production whilst decreasing resource intensity and protecting biodiversity, should be explored. Opportunities to share and apply this technology, taking into account local and cultural specific conditions, should be maximized.

Paper no. 4: Lithuania and the European Commission on behalf of the European Union and its member States

SUBMISSION BY LITHUANIA AND THE EUROPEAN COMMISSION ON BEHALF OF THE EUROPEAN UNION AND ITS MEMBER STATES

This submission is supported by Albania, Bosnia and Herzegovina, Iceland, the Former Yugoslav Republic of Macedonia, Montenegro and Serbia.

Vilnius, 2 September 2013

Subject: Issues relating to agriculture

General remarks

In line with the conclusions by the SBSTA chair[1], the EU welcomes this opportunity to provide views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while also promoting productivity and co-benefits of adaptation, taking into account the diversity of agricultural systems. The EU would also like to reemphasise the views expressed in its previous UNFCCC submission on agriculture in March 2012[2].

The objective of the convention (article 2) states: "The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner". It is therefore clear that agriculture has a central role to play to achieve the objective of the Convention while promoting food production, food security, livelihoods and rural development at local, national, regional and global level.

Europe is already facing climate impacts which vary in severity and nature between the different regions[3]. The ability to cope and adapt also differs across EU countries depending on different variables (e.g. farm scale, agro-ecological and socioeconomic conditions). What is clear is that climate change will add to the many economic and social challenges already being faced by European agriculture, with crop yields, livestock management and location of production likely to be affected.

Agriculture work under the UNFCCC to date and current state of scientific knowledge

The EU recognises that while useful work on agriculture mitigation has been carried out to date under the UNFCCC[4], this work did not adequately address adaptation and the close relationship

1 FCCC/SBSTA/2013/L.20

2 FCCC/SBSTA/2012/MISC.1

3 http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012.

4 FCCC/SBSTA/2010/10, FCCC/TP/2008/8, FCCC/SBSTA/2008/12

between adaptation and mitigation in agriculture and in particular the synergies between them. This work also needs to be updated to include the latest scientific and technological advice.

Although no explicitly titled agricultural adaptation work has been conducted under the UNFCCC, a considerable number of the adaptation outputs[5] from the Nairobi Work Program include a significant agricultural component[6]. This work should be taken into account in our SBSTA work.

Increasingly, agriculture is also prominently featured in many NAMAs and NAPs[7]. Mitigation actions in the agricultural sector are mentioned in 40 per cent of the NAMA submissions to the UNFCCC Secretariat. They all focus on the potential synergies of mitigation, resilience or adaptation, and on food security, while most of the measures in the NAPAs (National Adaptation Programme Actions) are, in fact, directly related to the agriculture sectors (see Figure 1 below).

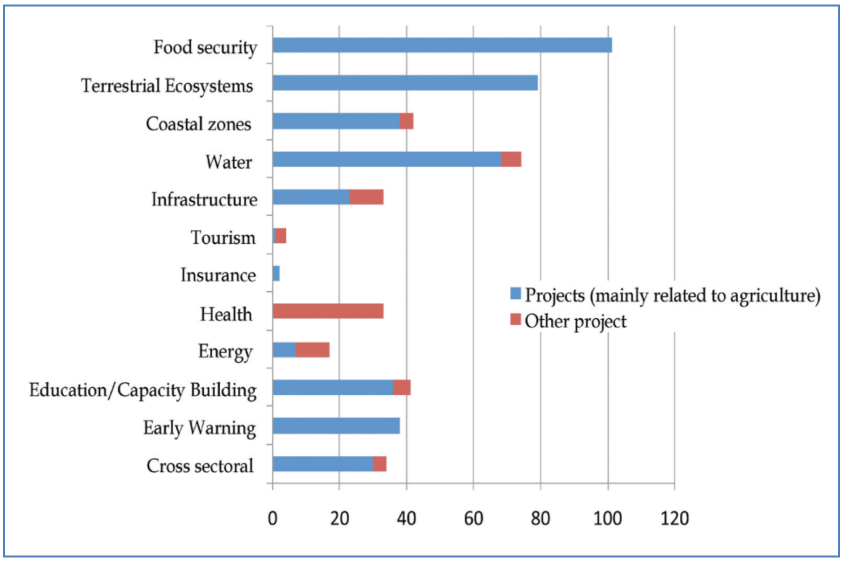

Figure 1: NAPAs priority projects *mainly related to agriculture* in each of the 12 UNFCCC categories (Source: FAO[8])

Many international organisations, research institutes, farmer organisations, private companies and NGO's worldwide are actively developing new scientific knowledge and advice and promoting the implementation of this knowledge on the ground. International organisations such as FAO[9], OECD[10], IFAD, World Bank[11], EU[12], African Union[13] and others have set up large programs to this end. Resilience has also become central to the European Commission's reflection on development, particularly in the context of reducing small producers' vulnerability to food crises. For example,

5 FCCC/SBSTA/2007/7, FCCC/SBSTA/2007/15, FCCC/SBSTA/2009/7, FCCC/SBSTA/2010/9

6 Please see annex 1

7 Hansel G. 2012. Paving the way for nationally appropriate mitigation actions in the agricultural sector.

8 http://www.fao.org/docrep/017/i3084e/i3084e13.pdf

9 http://www.fao.org/climatechange/en/

10 http://www.oecd.org/tad/sustainable-agriculture/agricultureandclimatechangeimpactsmitigationandadaptation.htm

11 http://www.worldbank.org/en/topic/climatechange/brief/climate-smart-agriculture-world-bank-facts

12 http://ec.europa.eu/agriculture/climate-change/index_en.htm

13 http://pages.au.int/caadp

the ACP-EU Technical Centre for Agricultural and Rural Cooperation recently organised the 30th Brussels Development Briefing to discuss the importance of Agricultural Resilience in the Face of Crises and Shocks[14].

It is clear that scientific and technological advice is needed to guide those national actions and programs. Further work on agriculture under the UNFCCC, especially looking at agriculture in a holistic fashion, should contribute to reaching the objective of the Convention. It should build on current scientific knowledge and existing research programs. Agriculture features prominently in the IPCC assessment reports, with the 5th assessment report to cover interactions between mitigation and adaptation in the same chapter for the first time.
The EU has set up a Joint Programming Initiative[15] on Agriculture, Food Security and Climate Change (FACCE-JPI) which brings together 21 countries who are committed to building an integrated European Research Area addressing the interconnected challenges of sustainable agriculture, food security and impacts of climate change. EU research organisations are also collaborating with worldwide partners in the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)[16]. In addition, 10 EU countries are members of the Global Research Alliance (GRA), collaborating to increase knowledge on ways to reduce GHG in agriculture while producing more food and also increasingly considering possible cobenefits for adapting to climate change. Outcomes of all this work can contribute to the UNFCCC work under SBSTA.

In addition to scientific advancement, the EU and its individual member states, are contributing significantly to the implementation of actions on adaptation in agriculture at both regional[17] and global level[18]. This includes the financial contributions to the implementation of the Nairobi Work Program, as acknowledged during SBSTA38[19].

Rationale for SBSTA work on enhancing agricultural adaptation, while also sustainably increasing the productivity of agricultural systems

Further addressing and improving the understanding of scientific, technical and socio-economic issues on the interface between agriculture and climate change, can enhance the contribution of the sector to many critical objectives. These include sustainable development, poverty alleviation and preservation of biodiversity and ecosystem services as well as contributing to achieving the 2°C objective.

Many adaptation actions can be implemented within the agricultural systems. These include e.g. agroforestry, improved protection and enhancement of soil organic matter, restoring degraded land, integrated land and water resources management including safe reuse of water, use and development of drought, heat and flood-resilient as well as salt-resilient locally adapted crop

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14 http://brusselsbriefings.files.wordpress.com/2007/12/br30_highlights_eng_agricultural-resilience-rev4.pdf
15 http://www.faccejpi.com/
16 http://ccafs.cgiar.org/
17 http://www.eea.europa.eu/publications/adaptation-in-europe
http://www.circle-era.eu/np4/%7B$clientServletPath%7D/?newsId=432&fileName=BOOK_150_dpi.pdf
18 http://ec.europa.eu/europeaid/climate-change-actions/
19 UNFCCC/SBSTA/2013/L.9

varieties, improved livestock management (e.g. forages, pastures, water), early warning and early reaction systems for weeds, pests, and diseases, access to climate services[20], insurance schemes and reduction of pre and post-harvest losses (including food losses).

Combining such actions can contribute to improving the efficiency and productivity of agricultural systems in a sustainable manner, if implemented in a locally appropriate manner, considering the diversity of the agricultural and social systems. It can therefore have a positive mitigation impact and will contribute to increased food production at local, national, regional level thus contributing towards global food security.

There is a need to ensure that mitigation co-benefits are achieved as a component of adaptation actions as well as to ensure adaptation is not threatened by, but rather included as a component of any mitigation actions and that both approaches can support enhanced food security at local, national, regional and global level. A common scientific understanding of the synergies between adaptation, mitigation and food security is therefore required, according to the variety of agricultural and social systems, practices, techniques and technologies.

It is also necessary to increase agricultural production and efficiency in the context of decreasing availability and declining quality of natural resources, often exacerbated by climate change. In parallel to food waste and loss reduction, production must increase in a sustainable way, taking into account in an integrated vision all the environmental challenges (e.g. deforestation, biodiversity, soil, air and water), while promoting socio-economic development and safeguarding livelihoods for people in rural areas (e.g. access to land, water, credit and markets). The wide diversity of agricultural systems worldwide, as well as specific national and regional development priorities, objectives and circumstances mean that a one size fits all approach does not apply for agriculture in relation to climate change.

It is therefore crucial that farmers' organizations and farmers, especially smallholders and subsistence farmers, are closely involved and supported through exchange of scientific and traditional knowledge and advice, extension services, access to financial mechanisms and agricultural markets.

Conclusions and ways forward

While farmers successfully have adapted production systems over thousands of years, the recent impacts of climate change (droughts and extreme weather events) presents a serious challenge for billions of people to produce and secure their access to food. This is therefore also a matter of global food security. Science can contribute to addressing these challenges. UNFCCC decisions on agriculture could help foster local, national, regional and international initiatives to address the challenges of agriculture and climate change.

The complex nature of agriculture and the wide variety of productions systems and climatic conditions requires a considerable amount of work by the UNFCCC to ensure that Parties and farmers are best equipped to respond to the challenges of agriculture and climate change, to ensure that food production is not threatened.

[20] http://www.gfcs-climate.org/

Therefore to commence this work, the EU proposes that the secretariat:

1. Invites the IPCC to make a presentation at an in-session workshop at SBSTA39, to discuss the findings of the IPCC 5th Assessment report and its implications towards agriculture.
2. Prepares a technical report on previous UNFCCC work on agricultural adaptation conducted under the Nairobi work programme.
3. Revise the 2008 UNFCCC technical paper[21] to include the latest science and also to incorporate synergies and trade-offs between mitigation and adaptation.

Finally, it is the view of the EU and its Member States that further discussions of SBSTA on agriculture should not be limited to the scope of this submission, but rather maintain room for discussing further aspects of agriculture in relation to climate change and the UNFCCC.

[21] FCCC/SBSTA/2010/10, FCCC/TP/2008/8, FCCC/SBSTA/2008/12

Annex 1. UNFCCC Nairobi Work program outputs relevant to Agriculture

UNFCCC Output	Relevance for Agriculture
Workshop on Climate Related Risks and Extreme Events (FCCC/SBSTA/2007/7)	Discussions focused on experience with assessment, prediction and management of climate-related risks and impacts, including those related to extreme events, in the agriculture and food security, coastal zones and health sectors.
Workshop on adaptation planning and practices (FCCC/SBSTA/2007/15)	Discussions at the workshop focused on sector-specific adaptation planning and practices in the areas of agriculture and food security, water resources, coastal zones and health.
Technical workshop on increasing economic resilience to climate change and reducing reliance on vulnerable economic sectors, including through economic diversification (FCCC/SBSTA/2009/7)	The workshop was divided into two parts. The first part focused on understanding existing approaches, measures and tools for increasing economic resilience to climate change and reducing reliance on vulnerable sectors, in particular from the perspective of the agriculture and food security sector.
Technical Workshop on costs and benefits of adaptation options (FCCC/SBSTA/2010/9)	The second day was organized into three breakout groups: group 1 focused on agriculture, and ecosystems and biodiversity; group 2 discussed water resources and health; while group 3 discussed coastal zones, settlements and infrastructure.
NWP Adaptation Practices Interface (FCCC/SBSTA/2006/11)	Includes practices in agriculture and food security
NWP Local Coping Strategies database (http://maindb.unfccc.int/public/adaptation/)	Includes practices in agriculture and food security (i.e. loss of crops, low survival/productivity of livestock)
Database on Ecosystem Based Approaches to adaptation (http://unfccc.int/adaptation/nairobi_work_programme/ knowledge_resources_and_publications/items/6227.php)	Includes experiences in agriculture and food security
NWP Compendium on Methods and tools (http://unfccc.int/adaptation/nairobi_workprogramme/ knowledge_resources_and_publications/items/5457.php)	Tools include i.e. Agro-ecological Zones Methodology, AFRC-Wheat, Agricultural Catchments Research Unit, Agro-climatic Water Stress Mapping, Agro-Met-Shell, Aqua-Crop,
Relevant Publications: • Climate Change and Freshwater Resources Technical Paper: Water and Climate Change Impacts and Adaptation Strategies • Compilation of Information: Ecosystem-based Approaches to Adaptation (http://unfccc.int/adaptation/nairobi_work_programme/ knowledge_resources_and_publications/items/4628.php)	Direct links with agriculture
Partner Database	100 Partners in Food Security, Agriculture, Forestry and Fisheries

Paper no. 5: Malawi

This submission is made by Malawi on issues related to agriculture in response to the invitation by SBSTA to make submissions based on paragraph 2 of its conclusion contained in document FCCC/SBSTA/2013/L.20 on current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security taking into account the diversity of the agricultural systems and the differences in scale as well as possible adaptation co-benefits.

Preamble

Agriculture in Malawi is the key sector to food security, economic growth, and wealth creation. More than 80 per cent of the country's population is directly or indirectly employed in the agricultural sector, which also accounts for nearly 90 percent of foreign exchange earnings and 39 per cent of gross domestic product (GDP). Two main sub-sectors are recognised - the smallholder sub-sector that contributes more than 70 per cent, and the estate sub-sector that contributes less than 30 per cent to agricultural GDP (GoM, 2007). The Smallholder subsector cultivates food crops while estates focus on high value cash crops for export.

Despite the importance, the agriculture sector faces a number of challenges including i) over dependence on rain fed farming system ii) limited absorption of improved technologies iii) weak private sector engagement, and iv) lack of investment capacity in mechanization. About 99 per cent of Malawi agriculture land is under rain fed cultivation and 69 percent is cultivated by the smallholders. Smallholder farmers cultivate small and fragmented land holdings under customary land tenure with yields lower than those in the estate sector. In addition, smallholders and rural populations in particular face a plethora of production and market constraints, poor access to information as well as serious lack of public services in rural areas which adversely affect their welfare and employment opportunities. Beside these challenges, Malawi is susceptible to the impacts of climate change and has experienced extreme weather events, such as droughts and floods, which have negative impacts on production. This makes adaptation a priority area, as climate change impacts disproportionately affect those least able to bear them.

While climate change negatively affects the agriculture sector, Malawi recognizes that agriculture activities also contribute to GHG emissions. The Second National Communication for Malawi indicates that the sector produced significant non-CO_2 emissions. The total emissions consisted of 49 Gg of CH_4 mainly from enteric fermentation (30 Gg) and rice cultivation (15 Gg). The other emissions consisted of 7 Gg of N_2O from agricultural soils, 2 Gg of NO_X and 72 Gg of CO from prescribed burning of savannah and field burning of agricultural residues. Thus, while the country recognizes the great need for adaptation in the agriculture sector, promotion of mitigation through better agriculture practices to reduce GHGs emissions is equally acknowledged. However, gaps still exist in data collection, expertise to analyse the data, and lack of local or regional models.

As a country, there is increased recognition of sustainable agricultural land management to enhance soil-water conservation, improve fertility and reduce vulnerability of the sector to the impacts of climate change. Agricultural carbon sequestration can help increase agricultural productivity and enhance farmers' capacity to adapt to climate change. Increased soil carbon improves soil structure, with corresponding reduction in soil erosion and nutrient depletion. Soils with increased carbon stocks retain water better, thereby improving the resilience of agricultural systems to drought. These positive biophysical impacts of soil carbon sequestration lead directly to increased crop, forage, and plantation yields and land productivity. However, technical support in monitoring and verification of the increased storage and the permanence of the carbon sequestration need to be improved.

Vulnerability and Adaptation

In the efforts to address the challenges of climate change in agriculture, the government developed its NAPA that highlights some of the adaptation activities being implemented in agriculture such as promotion of conservation agriculture and agro forestry, rainwater harvesting, crop diversification, irrigation, livestock production and sustainable land resource management, improved early warning systems, recommended improved livestock breeds, and improved crop and livestock management practices. Droughts and floods are the major climatic hazards affecting the fisheries sector, and have been responsible for the declining, or even drying up, of water bodies resulting in low fish production and loss of biodiversity. The proposed interventions include: (i) fish breeding to restock the lakes, rivers and dams, (ii) improving knowledge and understanding on how temperature profiles in the lake disrupt fish breeding and survival, (iii) establishing climate observations or monitoring systems on Lake Malawi, and (iv) mainstreaming climate change into fisheries strategies.

Malawi has a lot of inadequacies in its agriculture sector and systems such as paucity in the science and knowledge of current and future impacts of climate change on agriculture, weak **i**nstitutional and inadequate technical capacities**,** limited technological innovation and low adoption as well as poor infrastructure. While the interventions proposed in the NAPA could make a difference among vulnerable communities, they remain limited in scope. The lack of technical and financial support remains a challenge to up-scaling the interventions.

Priority Areas that SBSTA should address

Despite efforts that the government is undertaking in building capacity to enhance existing scientific knowledge, there are gaps that relate to three major areas that needs strengthening. These include;

1. Research & Development

- Strengthening national technical support in modeling and downscaling of Global Circulation Models to regional and national scales to enhance current and future understanding of the impacts of climate change on agricultural production.
- Assessment, development and identification of research & technological options, tools, methods and practices for agricultural adaptation and adaptation co-benefits.
- Improving the application of tools and methods for measuring climate change adaptation co-benefits in agricultural systems.
- Continuous assessment of vulnerability and impacts of climate change on food security across different climate zones, shared watersheds, ecosystems and land uses is very important for Malawi.

2. Information and Knowledge Management

- Improving the national systems for agricultural data collection and development of research using scientific and technical platforms to accelerate vertical and horizontal sharing of information and provide advice on adaptation research priorities and needs such as management of risks and tools for development.
- Support documentation that will enhance integration of indigenous and traditional knowledge and Scientific based knowledge

- Reviewing the adequacy of current climate change data, information, and analysis systems to support decision-making in the agricultural sector will be of significant importance to Malawi.
- Strengthening of national and local institutional capacities to generate, package and communicate climate information, products and support services for different end users;

3. Technology Development and Transfer

- Strengthening national and regional research programs through international cooperation to improving cultivars that will adapt to climate variability and change, improving conservation technologies and practices to enhance resilience to climate variability and change in agriculture.
- Promoting the development and transfer of relevant adaptation technologies and practices and their adoption.

The IPCC will soon release the Working Group I report, “The Physical Science Basis” of its Fifth Assessment Report as such it will be useful if IPCC could highlight its current findings relevant to agriculture in its report.

Paper no. 6: Mali on behalf of the Like-minded Developing Countries

Submission by LMDC on Agriculture, including Fisheries

Submitted by Mali on behalf of the LMDC

A. Background and Mandate

SBSTA 38 invited Parties to submit their views on "*the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries. This should take into account the diversity of the agricultural systems and the differences in scale as well as possible adaptation co-benefits*." (FCCC/SBSTA/2013/L.20)

The SBSTA conclusions call for an in-session workshop at SB 39 in Warsaw, with a report on the workshop to be considered at SB 40 in June 2014. Therefore the consideration of the results of the workshop to be held at COP will need to be discussed by Parties next year.

B. Context within the Convention and General Principles

The agricultural sector is particularly vulnerable to the effects of climate change. In view of the need to feed a growing world population in the next decades, it will be necessary to increase the adaptive capacity of the sector and to improve the productivity of the agricultural systems.

*A*daptation must be pursued cognizant of the fundamental role of agriculture in food production and food security, the interests of small and marginal farmers, indigenous and or traditional knowledge and practices, and the role of women in agriculture. In particular, it must be recognised that in developing countries a large proportion of the population depends on agriculture for its livelihood, and that agriculture is of critical importance for social and economic development and for poverty eradication of those countries.

Work related to agriculture must be governed and guided by the principles and provisions of the Convention, in particular the principles of common but differentiated responsibilities. *Also, it should be* taken into account that the developed countries shall assist, according to Article 4 of the Convention, developing countries that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.

C. Promoting rural development, sustainable development and productivity of agricultural systems and food security in developing countries

There is a need for an assessment of the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts, while promoting rural development, and productivity of agricultural systems and food security, particularly in developing countries. This should take into account the diversity of the agricultural systems, and the differences in scale, as well as possible adaptation co-benefits.

Further, responses to climate change should be coordinated with social and economic development in an integrated manner with a view to avoiding adverse impacts on the latter taking into full account the legitimate priority needs of developing counties for the achievement of sustained economic growth and the eradication of poverty. It is important to recognise the specific economic and social circumstances and needs of developing countries and their specific regional, national and local contexts.

D. Current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change

A 2°C world is likely to have unacceptable consequences for agricultural production in most parts of the developing world. Food production is already threatened by the temperature rise of the last century, and the committed warming due to greenhouse gas emissions of the last decades. A doubling of the warming seen to date – to 1.5°C – will mean crops in some regions will fail too often for crop producers to maintain that livelihood strategy. Pastoralists in many areas will be forced to migrate distances too far and too frequently for water and pasture to remain pastoralists. Fisheries will be affected by the triple threat of temperature rise, sea level rise, and ocean acidification. Two degrees of warming will have implications affecting millions of livelihoods based on agriculture and fisheries – in such instances, adaptation in many areas will simply not be an option due permanent damage to agricultural systems.

In its Fourth Assessment Report, the IPCC projects that crop productivity would increase slightly at mid- to high latitudes for local mean temperature increases of up to 1-3oC (depending on the crop) (Easterling et al., 2007). However, at lower latitudes, especially in the seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2oC). In some African countries, yields from rain-fed agriculture, which is important for the poorest farmers, could be reduced by up to 50 percent by 2020 (IPCC, 2007). Further warming above 3oC would have increasingly negative impacts in all regions.

Recent studies suggest the IPCC may have significantly understated the potential impacts of climate change on agriculture. New research by Stanford University, for example, suggests that production losses across the continent of Africa in 2050 (consistent with global warming of around 1.5oC) are likely to be in the range of 18 to 22 percent for maize, sorghum, millet and groundnut, with worst-case losses of up to 27 percent to 32 percent (Schlenker and Lobell, 2010).

The International Food Policy Research Institute (IFPRI) suggests that rice production in South Asia, one of the most affected regions in terms of crop production, could decline by 14.3 to 14.5 percent by 2050, maize production by 8.8-18.5 percent and wheat production by 43.7 to 48.8 percent, relative to 2000 levels. IFPRI concludes that unchecked climate change will have major negative effects on agricultural productivity, with yield declines for the most important crops and price increases for the world's staples – rice, wheat, maize and soybeans (Nelson et al., 2009).

Recent research strongly suggests that observed rising temperatures in the second half of the 20th century and early years of the 21st century, and accompanying changes in precipitation, have already had demonstrable and varying effects on agriculture across the globe (Lobell et al., 2011). There are dramatic regional differences in the recent past (1980-2008) in terms of change in growing season temperature: small changes are found in North America whereas large increases are found in other parts of the world, particularly Europe and China. This translates into different changes in yields. Models that link yields of the four largest commodity crops to weather indicate that global maize and wheat production declined by 3.8 and 5.5 percent, respectively, relative to a counterfactual without climate trends. In particular, there is much research needed to understand the severity of slow onset impacts on agriculture and adaptation strategies required to address those impacts as limits to adaptation are breached.

Further research is needed on adaptation in agriculture to impacts of climate change and the workshop at COP 19 could pose a range of questions that must be addressed along these lines.

Questions that could be framed for further SBSTA consideration:

1. What further knowledge is needed on potential climate change impacts on agriculture?

In order to understand how to enhance the adaptation of agriculture to climate change impacts, it is essential to know what impacts are anticipated. The entire spectrum of adaptation options is broad, complex, and diverse. A good understanding is needed of the range of impacts that are to be expected, under which timeframes, and the degree of severity of those impacts. For this, a system for early identification of climate change manifestations and impacts on agricultural ecosystems designed in a manner that addresses concerns of interested developing countries could be a useful tool to enhancing knowledge.

Impacts on agriculture will have significant consequences for rural development, sustainable development, and food security. For example:

- In the tropics and sub-tropics climate change could cause crop yields to fall 10-20 percent or more between now and 2050 — even as population and demand for food increases;
- Entire regions face a shift to a different climate type and the geographic range for many crops will shift accordingly;
- Steadily rising temperatures are predicted to reduce yields of all the world’s staple crops: maize, wheat, rice, and potato. For example potatoes (world’s fourth largest food crop – accounting for more than half of global production from developing countries like India and China) are suited to cooler climates, and massive production shifts are likely.
- With the increase of temperatures, crops are requiring more water and regions such as the Arabian Peninsula are depleting their underground reservoirs and as a consequences the water will become salinized. This will cause lack of both drinking water and the main source of water used for agriculture.
- Water shortage and extreme events like flood and drought have significant impacts on crop production and livestock management.

Reviewing this background knowledge is essential to understand how to enhance adaptation and is within the SBSTA mandate (Article 9.2(a)): “to assess the state of scientific knowledge relating to climate change and its effects.” It is key to understand the state of knowledge on staple crops and on crops, livestock, and fisheries resources that are important for the food security of the most vulnerable.

2. What is the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts?

Because the range of impacts is not well understood, the current state of scientific knowledge is incomplete. In particular, as emphasis has been placed on adaptation, insufficient attention has been paid to relevant temperature and precipitation thresholds that require changes on the conventional approach to adaptation.

Additionally, SBSTA could review the effectiveness of and provide advice on the development of necessary systems, technologies and institutions, ranging from agro-meteorological forecasting and early warning systems to other approaches to manage risk.

SBSTA also has a mandate (Article 9.2(d)) "to provide advice on scientific programmes, international cooperation in research and development related to climate change, as well as on ways and means of supporting endogenous capacity-building in developing countries."

The SBSTA could carry out a process of identifying research, capacity and technology needs, associated cost, deployment and upscaling of technology and practices, technical and priorities for international cooperation in research and development related to both climate impacts on agriculture and how to enhance adaptation to those impacts. The workshop could address a range of suggestions for research needs and priorities.

3. Collapse in agricultural systems due to climate change slow onset impacts

As noted above, insufficient attention has been paid to the situations that will require addressing conditions beyond feasible adaptation (i.e. where biophysical barriers limit options for adapting or where the cost of adaptation is beyond what developing countries are supported to do), and possible impacts on food security of billions with livelihoods dependent on agriculture, including livestock and fisheries, when there is no possibility for adequate and effective adaptation and when climate variability overtakes the ability of systems to cope.

According to recent academic research, particular cropping systems that look especially vulnerable are maize in most locations across the globe, wheat in Central and South Asia, and rice throughout South and East Asia. Slow onset temperature rise is already having and will continue to have serious consequences for farmers, pastoralists, and fisherfolk. The workshop at COP19 should consider the significant and widespread assessment of impacts from increasing temperatures on agricultural yields, food production, and the livelihoods of those dependent on agricultural and fisheries production. SBSTA should consider options for assessing impacts and possible means to compensate for losses and damage in the agriculture sector.

SBSTA should as a priority with regard to agricultural adaptation address the research and other needs related to adaptation and the impacts of climate change that may transform food systems. For example, water availability plays a crucial role in agricultural production, given the very high percentage of cropping systems that are rainfed or fed from underground water, and the dependence of livestock on both pasture and water supplies.

Further activities to continue addressing adaptation needs related to slow onset impacts and limits to adaptation could include:

- A technical paper on projected climate impacts, including slow onset temperature rise on agricultural yields, food and fisheries production, and livelihoods of those dependent on agricultural and fisheries production. There could be an analysis of different scenarios of climate change impacts on agriculture, considering the characteristics and the diversity of agricultural systems, as well as the known capacity at national level for awareness and dissemination of various relevant technical information to farmers.
- Identify in the workshop at COP19 scientific, technical, data collection and systematic observation gaps and needs regarding impacts of climate change on agriculture, including for the development and transfer of technologies.
- Support the establishment of a clearing house mechanism on adaptation action to assist Parties to obtain the appropriate tested technology for implementation of adaptation
- Encourage Parties to have national sustainable agricultural policies, including adequate provision for research and development in respect to adaptation in the sector with respect to the impacts of climate change

E. Support for the development and transfer of appropriate adaptation technologies and practices

Adaptation must be a key priority for technology transfer. In this respect, there is a need to ensure effective technology transfer to developing countries, in particular those technologies and practices which could contribute to increasing the adaptive capacity of agricultural systems. It is important to help developing countries to develop their endogenous capacities in relation to technologies for the adaptation of agriculture to the impacts of climate change. Technologies need also to be considered in relation to the different agricultural systems and climates and specific national, regional and local contexts.

Additionally, intellectual property rights on plant and animal varieties will be a stumbling block to the breeding efforts necessary for agriculture to keep pace with changing climates. The growing interest of multinational agribusiness is reflected in increased bio-prospecting in developing countries and accompanying IPR activity. An opposition to patents on any life forms is warranted in this regard. Protection of new plant varieties as required under the WTO TRIPS Agreement should be carefully considered to not result in depriving developing countries of their rights over their plant resources for continuous breeding and cultivation. All flexibilities and safeguards related to IPRs should be maintained and implemented fully.

F. Capacity needs

Agricultural challenges over the coming decades clearly necessitate additional support for capacity building at many levels. Such capacity building should be assessed in the workshop at COP19 and could include, but is certainly not limited to:

- Capacity in the meteorological sector, for early warning systems, data collection and interpretation. Early warning systems can provide seasonal rainfall information that can be useful to farmers in their planting decisions.
- Capacity to communicate seasonal weather information and possible responses with farmers. Meteorological information is of little value if there are not dissemination systems in place to communicate with farmers and pastoralists in rural areas.
- Conservation, breeding and seed multiplication capacity: climate-change-focused conservation and breeding programs, farmer-breeder linkages, seed multiplication systems at the local level are all necessary. As climates rapidly change, it will be difficult to keep pace with breeding for novel climates. Local, regional, and national, and systems of breeding and seed exchange are urgently needed.
- Promotion of agroforestry systems to reduce vulnerability to drought or excess rainfall, loss of soil, soil degradation and disaster risk reduction
- Appropriate systems for sharing of traditional and contemporary agricultural practices . Many agricultural practices that increase the adaptive capacity are in use across the developing world, but these must be disseminated more widely. Capacity in farmer-to-farmer knowledge sharing will be key to this effort.

Paper no. 7: Nepal on behalf of the least developed countries

Submission by Nepal on behalf of the Least Developed Countries Group on Agriculture

This submission is made by the Least Developed Countries Group (LDC Group) in response to the SBSTA 38 conclusions that invited Parties to submit views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems, and food security in all countries, particularly in developing countries …. taking into account the diversity of agricultural systems and the differences in scale as well as possible adaptation co-benefits (Document FCCC/SBSTA/2013/L.20 para 2).

Recognizing that agriculture holds the key to LDC's sustainable and rural development, a top priority on the global agenda now is how to feed the projected world population of nine billion by 2050. This task is especially formidable in LDCs, where close to 75% of the small scale farmers directly or indirectly rely on rain-fed agriculture and livestock as a source of livelihood. LDCs' capacity to produce food is likely to be challenged by the combined effects of natural resource degradation, limited knowledge, information and skill, limited access to appropriate and climate change-friendly technologies and increasing adverse effects of climate change and climate variability. Thus, ensuring food security in LDCs requires urgent actions to improve the productivity and promote climate-resilience of agriculture including livestock and to enhance the food value chains to ensure adequate nutrient-rich, pollutants-free and affordable food supplies.

From the global perspective, it is noted that due to uncertainties in climate projections and other factors (including greenhouse gas emissions, high fertilizer application, socio-economic development pathways, differential adaptive capacities of LDCs to climate change, etc.) climate change impacts on agriculture are not spatially explicit and they (the impacts) depend heavily on scenario assumptions that fail to mimic the future climate conditions. Limited studies have been conducted on the effects and impacts of climate change on agriculture in LDCs with several limitations. The major constraints could be attributed to the gaps in the scientific knowledge of climate change impacts on agriculture that have hitherto not been modeled either due to data limitations or to shortcomings in conceptualizing the problem.

For example, there is limited knowledge on: (1) the direct impact of climate change on pastoralism and agricultural farming and livestock rearing systems in the LDCs; (2) the prevalence and impact of pests and diseases in changing climate; (3) the socio-economic, including the gender differentiated impact of extreme weather and climate events as current GCM scenarios do not account for such events and yet they are increasingly becoming common in LDCs; (4) the costs and benefits of adaptation response measures and coping strategies by small scale farmers; (5) type and availability of adaptation technologies; and (6) impacts of climate change on factors of agricultural production and agro-ecological environment. This is further constrained by inadequate data, technical, and institutional capacities that hinder effective application of climate modeling to inform national development planning and decision-making at different levels.

Furthermore, with respect to dry-land ecosystems (covering over 40% of the earth's land surface), there is insufficient understanding of how pastoral food production systems use mobility not only as a way of coping with a difficult environment, but more importantly as a strategy to harness environmental instability for food production.

Effects of climate change on agriculture take place through:

1. direct effect on the crops' and livestock's physiology through changes in temperature, precipitation, humidity, etc.;
2. direct effect on the factors of production of crops and livestock (land degradation, pasture degradation, adverse effects on water resources, air composition, etc.) and changing in agro-environment; and
3. change in the environment of pests and diseases.

The effects are further aggravated by low adaptive capacity in case of LDCs in regard to:

1. limited access to technologies for adaptation;
2. limited skill, knowledge and awareness for adaptation;
3. lack of resources especially financial resource to respond to the adverse effects of climate change; and
4. inability of climate models to produce downscaled scenarios for adaptation at local levels.

In light of the foregoing facts, the LDC Group has identified three priority areas that the international community through SBSTA could support LDCs so that it could have the most current state of knowledge that would enhance LDCs' adaptive capacities to address climate change impacts and build climate-resilient agriculture sector. These are:

1. *Capacity building on the development and application of tools and methods for addressing adverse effects of climate change, climate monitoring, modeling, uncertainty analysis, downscaling, early warning and updatability for climate change:* The LDCs are vulnerable to several climate change-related challenges and impacts that are tied closely to the LDCs' geographical diversity, economy, and population patterns. Since there is paucity of necessary historical climate and agricultural data in LDCs, there is need to study, in detail, the indicators of exposure, sensitivity, and adaptive capacities. In addition, it is imperative for the international community to put in place a programme of work on agriculture, with emphasis on capacity building, development and application of various tools and methods, particularly for climate monitoring, modeling, downscaling and early warning for developing countries, especially LDCs, with a view to building the requisite technical capacityof systems and relevant

stakeholders, especially subsistence farmers of which women are the majority, and strengthening institutional infrastructure.

2. *Assessment, development and identification of research, technological options, and practices for agricultural adaptation and adaptation co-benefits, including understanding positive impacts and monitoring systems for adaptation (e.g. lessons from pastoralism's capacity to harness climate variability to improve livestock productivity):* The motivation for research and technological options is the need to develop innovations tailored to the local scale that directly and indirectly enhance adaptive capacities of LDCs' agriculture systems in a changing climate. Enhanced adaptive action and research in different agro-climatic zones, including competitive research funding and better-managed programmes, is critical for innovation to improve agricultural productivity that could alleviate global poverty and hunger.

3. *Identification of approaches to enhance integration of indigenous, traditional, and science-based knowledge and practices:* Indigenous knowledge plays a critical role in decision-making by LDC small-scale farmers in their quest to manage climate-related risks, including extreme weather events and coping with the impacts. Such coping strategies and indigenous knowledge and traditional practices vary by sub-region or country and to a great extent are localized. On the other hand, science-based knowledge systems, such as weather forecasting, though useful, need downscaling for them to be meaningfully applied at the local scale. Therefore, to be more effective in dealing with the increasing challenges of climate change impacts on the agriculture systems of LDCs, it is imperative to integrate indigenous knowledge, traditional practices, and science-based knowledge and systems.

Finally, we note that it would be helpful for SBSTA to welcome the participation of the IPCC at the workshop as it will have released the Working Group I Report, "The Physical Science Basis" of its Fifth Assessment Report (AR5).

Paper no. 8: New Zealand

September 2013

Context

The thirty-eighth session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) invited Parties and admitted observer organisations to submit to the secretariat their views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries, taking into account the diversity of agricultural systems and the differences in scale as well as possible adaptation co-benefits.

2. This submission will focus on work done in New Zealand on agricultural adaptation. The New Zealand Government has financed two major assessments of climate change impacts on agriculture in New Zealand. In addition, many smaller studies have also been conducted on more discrete aspects of impacts and adaptation. This submission will share New Zealand's experiences and lessons learned and conclude with suggestions for further work on issues related to agriculture under the SBSTA.

Key points

3. New Zealand's understanding of the impacts of climate change on New Zealand agriculture has progressed from a focus on macro-level impacts to a second stage of modelling the effectiveness of farm-level adaptations.

4. Climate change adaptation occurs locally, is enterprise specific and requires value decisions made by land managers on what is best for their particular system in response to climate change, and their particular environmental, cultural, economic and social context.

5. There are many areas where future work is needed to reduce scientific uncertainty. A key area for New Zealand will be understanding climate change adaptation constraints and synergies in a future where farmers may face changing market or regulatory conditions.

6. New Zealand finds the SBSTA submissions process an especially useful way to share our experiences and lessons learned, and learn from the experiences of other Parties. New Zealand looks forward to participating in the workshop on this topic at COP19. In New Zealand's view the SBSTA should build on this work by having further targeted submission processes and workshops on other areas of interest within the agenda item 'Issues relating to agriculture', and by advancing the work on these issues through further SBSTA special events.

Background to New Zealand climate and agriculture

7. New Zealand's climate is complex and varies from warm subtropical in the far north, to a cool temperate climate in the far south, with alpine conditions in the mountainous areas. Mountain chains extending the length of New Zealand provide a barrier for the prevailing westerly winds,

dividing the country into dramatically different climate regions. These diverse climatic zones result in a diverse range of climate change impacts and therefore means of adaptation to a changing climate.

8. New Zealand's agriculture sector is market-based and export-oriented. Economic reforms during the 1980's in New Zealand removed virtually all subsidies, including agricultural subsidies. New Zealand now has the lowest level of agricultural support of any OECD country (less than one per cent). The market-based nature of New Zealand's agricultural sector influences the approach to climate change adaptation, including the role of government in agricultural adaptation in New Zealand.

9. The market-based and export-oriented nature of New Zealand's agricultural sector reduces barriers to land use change. In many other countries, land use change (for example switching land use from rice to corn production) may not be a simple decision, due to local culture and food demand. To an extent, New Zealand farmers are experienced with adapting production systems and changing land use in the face of changing market demands. For example, due to favourable market conditions dairy land use has increased 68 percent since 1990 and wine production has doubled since 2005. The ability to change land use has influenced our approach to adaptation research, in that New Zealand research often assumes farmers will change land use and/or production system if it is profitable to do so.

Climate change adaptation in New Zealand

10. The New Zealand economy depends heavily on biologically-based industries. Around the world agriculture is already experiencing the impacts of climate change, and New Zealand's awareness of these impacts has been sharpened by the severe droughts of the 2007-08 and 2012-13 southern hemisphere summers.

11. Science, research and modelling is essential to help inform decisions but cannot be a sole basis for decisions. The role of government in New Zealand agriculture is to ensure land managers, rural advisors and industry organisations have access to the knowledge needed to guide decision-making, but ultimately, farm adaptation decisions are made by private land managers. Appropriate policy settings at national and regional levels ensure that adaptation by land managers can occur effectively.

12. New Zealand has developed scientific capacity to identify and analyse drought risk. In recent years the consequences of changes in drought risk and agricultural production under climate change have been more clearly identified. However, it has been recognised that there is a need to progress this further, to understand secondary and tertiary impacts of climate change, and the role management or adaptation can play in reducing the negative impacts of climate change.

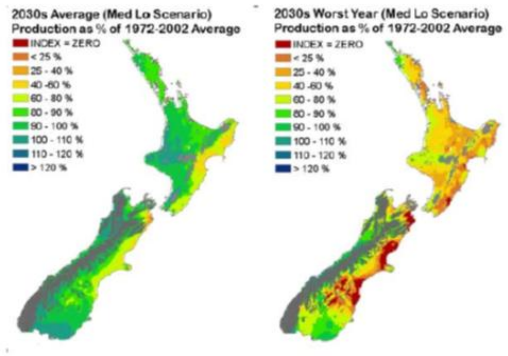
13. Understanding impacts and looking for viable adaptation options provides a constructive approach to managing both current climate variability and changes in future variability. Managing variability has always been a feature of the New Zealand production environment and many of the techniques to address climate variability will provide a degree of resilience to future climate change.

Current state of New Zealand scientific knowledge on how to enhance the adaptation of agriculture to climate change

14. To prepare for the impacts of climate change on agriculture, the initial need of agricultural policy makers in New Zealand was to understand the long-term macro-level impacts of climate change. This included assessments of the change in average production and also variability in production for the purpose of macro-level policy decisions. These assessments enabled policy makers to understand the economic risk posed by climate change, the value of new infrastructure projects (such as irrigation schemes) and the pressures placed on current infrastructure. New Zealand conducted a large-scale study in 2007 that assessed these broad impacts.[1]

15. The research found that: the projected changes to pasture production are small when averaged; winter production will increase while summer production will fall; and, production will increase in some areas while decreasing in others (Figure 1, left). Projections also indicate a more variable climate in the future with droughts becoming increasingly severe. For example, the worst drought during the reference period 1972-2002 decreased the pasture growth for the 1977-78 season by 29 per cent, while the study projected the worst drought in the period 2030-2049 would be expected to decrease a season's pasture growth by 48 per cent (Figure 1, right).

Figure 1: Relative production projections for the 2030s



Source: EcoClimate Report

Climate change adaptation to maintain and enhance agricultural productivity, rural development and food security

16. The second phase of research has been focused on providing relevant information for individual land managers. A second major study was completed in 2012 which applied a bottom-up approach by modelling the impacts of climate change on a range of sample farms. This study then looked at a variety of farm manager responses and assessed the economic and productivity consequences of the adaptation measures. A technical report was produced for the science community and a stakeholder report was produced for the farming community.[2,3] The stakeholder report has been particularly well received.

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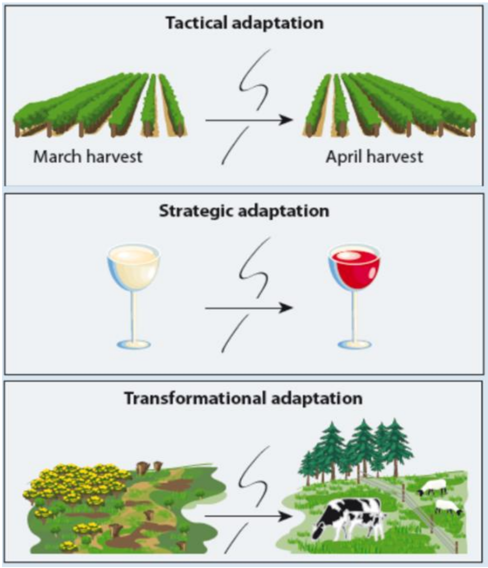
1 *The EcoClimate Report: Climate change and agricultural production*, Ministry of Agriculture and Forestry, 2007. Available at http://docs.niwa.co.nz/library/public/ecoclimate.pdf

2 *Impacts of climate change on land-based sectors and adaptation options: Technical Report*, Ministry for Primary Industries, November 2012.

3 *Impacts of climate change on land-based sectors and adaptation options: Stakeholder Report*, Ministry for Primary Industries, November 2012. Available at: http://www.mpi.govt.nz/Default.aspx?TabId=126&id=1581

17. New Zealand's land based sectors have a comprehensive choice of adaptation options. They are well positioned to meet the challenges ahead and, at times, also capture potential opportunities. Adaptations were considered to range from 'tactical', to 'strategic', to 'transformational' (Figure 2). Tactical adaptations include the adjustment of current practices. For example, increasing the rate of rotation used for pasture grazing. Strategic adaptations include the use of existing technologies that were not previously suited to the location of the farm, for example, shifting pasture to a more drought resistant species. Transformational adaptations were considered to be where new production systems, infrastructure or technologies were needed in order to adapt land to climate change.

Figure 2: Adaptation Categories

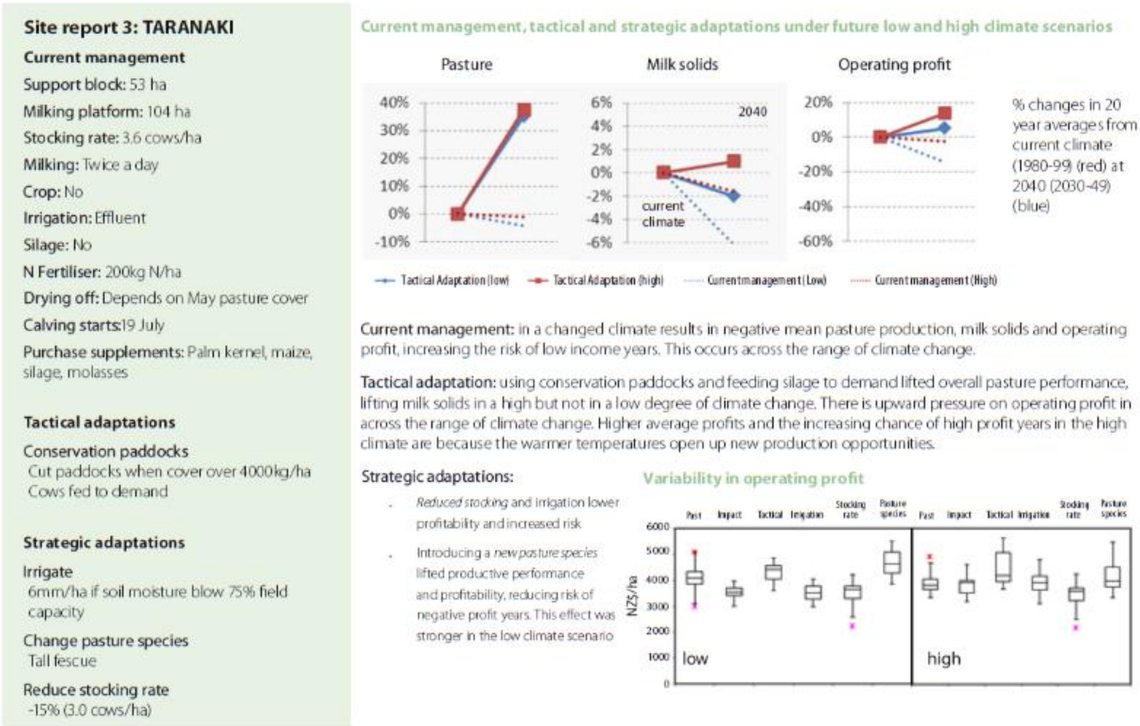


18. While tactical adaptations can be implemented in the short-term, they are more suitable for small to moderate levels of climate change. Transformational adaptations are more appropriate where climate change is severe, but will take time and funds for land managers to implement.

19. Policy-makers found that a key benefit of this work was the level of engagement from farmers. Farmers were able to relate the work done to their own farm circumstances and management choices.

20. Figure 3 shows an example of bottom-up farm level modelling results. For this example the existing production system would have experienced moderate reductions in operating profit under a high and low climate forecast for the 2030-49 period. With tactical adaptations however the production could be maintained and profit could be increased above previous levels. Strategic adaptations offered only mixed results for the period analysed, but may have been more profitable under a longer-term scenario.

Figure 3: Site report for Taranaki dairy farm



21. Increased variability is a key theme of climate change research. Figure 4 shows the change in gross margin for a model New Zealand (Hawkes Bay) sheep and beef farm in moving from a 1990 to a 2030-2049 climate. While the adaptations modelled have the potential to preserve the current average gross margin under a changing climate, the variability in gross margin is increased. The cumulative impact of back-to-back climatic events is little understood but is potentially a large challenge for land managers and rural communities.

Figure 4: Box-plot of gross margin for Hawkes Bay Sheep and Beef farm

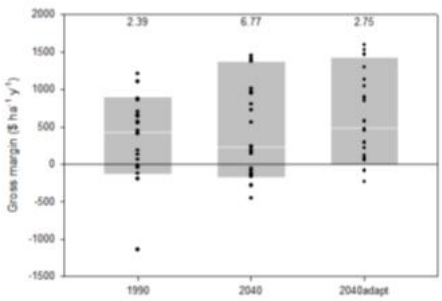


Figure 4.14. Boxplots of the gross margins for Hawke's Bay using the high climate change projections for the current farming system in the time period 1980 – 1999 (labelled '1990'), the current farming system with projected pasture growth for 2030 – 2049 ('2040') and an adapted farming system with projected pasture growth for 2030 – 2049 ('2040adapt'). The bottom boundary of the box indicates the 10th percentile, the line within the box marks the 50th percentile (median), and the upper boundary of the box indicates the 90th percentile. The individual annual gross margins are also shown and the variability indices for each period are shown above the boxplots (see text for details).

Climate change adaptation in the context of sustainable development

22. Sustainable development, including greenhouse gas mitigation and reducing nitrate loss from agricultural land, is currently an area of focus for government, agriculture sector organisations and farm managers in New Zealand. The impact of agriculture on water quality has been a recent area of particular focus.

23. It should be noted that potential future constraints on greenhouse gas emissions and nutrient losses may potentially constrain the options farmers have for adaptation. This link between sustainable development and climate change adaptation, in New Zealand, is an area that requires further research. A holistic approach to climate change issues, both adaptation and mitigation, will allow policy makers to ensure that sustainable development and climate change adaptation are approached in harmony.

24. Measures to improve efficiency and productivity will often improve sustainability and assist farmers to be more resilient in the face of a changing climate, while at the same time managing greenhouse gas emissions. For example, in New Zealand sheep farmers have emphasised the breeding of ewes that will produce twins rather than a single lamb. As a result New Zealand has increased lamb production while reducing the size of the sheep flock by 47% since 1990. This reduction in the size of the flock needed for lamb production will ensure farmers are more resilient through extreme events as fewer sheep are needed to maintain lamb production.

25. There are both areas of commonality and trade-offs between the actions that farmers will take to specifically adapt to climate change and the actions New Zealand farmers are taking to mitigate greenhouse gas emissions and reduce nitrate leaching. The implications of a single farm management decision will often result in a complex series of outcomes, with varied implications for greenhouse gas mitigation and climate change adaptation.

For example:

i. As an adaption to a series of recent droughts, many northern New Zealand dairy farmers have installed feed pads to allow increased use of supplementary feed during dry periods (pasture continues to provide over 90 per cent of average total dietary needs).

ii. Increased use of supplementary feed will have greenhouse gas emissions implications depending on, amongst other things, the carbon footprint of the feed used.

iii. Farmers find that feed pads can also be utilised during high rainfall events as stand-off pads to reduce pasture and soil damage, reducing direct excretion to pasture and resulting in more effluent entering a management system rather than deposited directly to pasture.

iv. Reducing direct excretion to pasture, especially while soils are saturated and during winter months, will reduce nitrous oxide emissions and nitrate leaching, however storing effluent may result in increased methane emissions.

26. Increased atmospheric carbon dioxide (CO_2) concentrations have been shown to increase carbohydrate levels and decrease protein content of C_3 plants (non-tropical grasses). Currently the protein content of most New Zealand pastures is generally greater than animal requirements. Increased carbohydrate levels due to elevated CO_2 could potentially lead to increased nitrogen efficiency and productivity and decreased nitrous oxide emissions and nitrate leaching (however, associated changes in soil microbial populations, pasture plant species composition, soil water

dynamics and partitioning of ingested plant protein in animals under elevated CO_2 makes the direction of these system changes difficult to predict, and this remains an area of on-going research).

27. Meanwhile, increasing temperatures will see the continued southward movement in New Zealand of sub-tropical grasses and weeds. A spread of tropical grasses and weeds will reduce pasture digestibility and likely increase greenhouse gas emissions (per unit of production).

28. Adaptation measures focused on limiting the spread of tropical grasses, weeds and pests will result in avoided emissions increases. While measures to maintain non-tropical grasses in the presence of increased CO_2 concentrations may further reduce greenhouse gas emissions, creating a synergy between adaptation and mitigation efforts. Again, more research is needed here.

Conclusions and next steps

29. New Zealand is pleased to have this opportunity to share our experiences and lessons learned in this important area. The process of compiling this submission has also been useful for the New Zealand Government in understanding its own current capacity. In New Zealand's view Parties should make this submission process, and the upcoming workshop, the first step in a broader discussion on climate change issues related to agriculture.

30. New Zealand also suggests that the SBSTA build on this first step, which has had an adaptation focus, with a similar process to understand the current state of the science on agricultural greenhouse gas emissions and measures to improve emissions efficiencies (per unit of production, or from business-as-usual levels). Such work should of course take into account, amongst other things, interactions with individual party development needs, the socio-economic importance of agriculture, and the need to increase food production in the face of growing global populations.

31. This submission process is only one step in understanding agricultural adaptation to climate change. More work is needed to progress this work to more tangible outcomes for farmers in regions around the world. The next phase of SBSTA work could include, amongst other things, organisation of expert meetings and reports; IPCC special reports; and SBSTA special events, taking into account relevant work under the Nairobi work programme.

32. Work under the SBSTA should take care to focus on both the macro-level impacts of climate change on agriculture and the farm level responses. The diversity of global farm systems must be taken into account. It is also important that this work takes into account co-benefits and trade-offs with sustainable development needs, such as greenhouse gas mitigation and enhancing rural development. Interactions with resilience and social, economic, environmental and cultural adaptation options need to be taken into account.

33. New Zealand looks forward to discussions with Parties at the up-coming SBSTA workshop. New Zealand would welcome the opportunity to make a presentation building on the information in this submission at this upcoming workshop.

Paper no. 9: South Africa

6 September 2013

South Africa welcome the opportunity to submit its views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries, taking into account the diversity of the agricultural systems and the differences in scale as well as possible adaptation co-benefits.

There is no doubt that climate change remains a top priority for most developing countries, particularly in Africa where agriculture is key to the livelihoods of many people. South Africa, in its climate change response strategy, recognises the importance of adaptation in agriculture and the need to achieve food security and the importance of technology transfer. By focusing on reducing vulnerability and increasing resilience, key issues of strategic national, regional and international importance such as food security, sustainable development, eradication of poverty, job creation and sustainable livelihoods will be addressed.

It is critical for developing countries like South Africa to focus primarily on reducing vulnerability to the impact of climate change, on enhancing resilience, and encouraging adaptation actions that take into account the diversity of the agricultural systems and the differences in scale as well as possible adaptation co-benefits. Adaptation actions must be aimed at increasing resilience, and take into account the concerns of vulnerable groups, particularly rural people, women, youth and children. Therefore, there is a need to develop a gender sensitive disaster and vulnerability risk reduction, and to include vulnerable groups from planning to implementation of adaptation strategies such as ecosystems management approaches that can provide multiple benefits. These vulnerable groups and communities must be afforded opportunities to develop and implement their own indigenous strategies as well as participate in the discussions and development of national and international adaptation policies for agriculture.

South Africa has identified the following critical areas that SBSTA needs to address in order to support and assess the current state of scientific knowledge on how agriculture responds to climate change. This must take into account the need to promote rural development, and the sustainability and productivity of agricultural systems and food security. This applies to all countries, but developing countries also need to take into account the diversity of their agricultural systems and the differences in scale, as well as possible adaptation co-benefits

- Assessment of future research needs;
- Assessment of adaptation needs at regional, national and local scale;
- Assessment of possible adaptation co-benefits at regional, national and local scale;
- Assessment of current adaptive capacity (stress testing, early warning systems, national planning, disaster response, institutional capacity, infrastructure maintenance, risk and vulnerability assessments, pests and diseases, research, etc);
- Assessment of technological needs relating to adaptation and the promotion of technology transfers;
- Development of institutional arrangements for proper coordinated response;
- Adaptation actions must be country driven and be aligned with national developmental goals and objectives;
- Capacity building:
    - Provide access to information and means of implementation of agricultural adaptation (especially finance and new technologies), particularly for developing countries;
    - Recognise the role of rural and poor people especially women and youth in implementing adaptation programmes and activities at local levels;
    - Recognise the importance of traditional and indigenous knowledge systems and skills in regard to sustainable practices, and ensure that indigenous knowledge be valued and widely disseminated.

In conclusion, there is a need to build on community resilience to enhance adaptation strategies, as well as to share knowledge and experiences that will be an investment towards enhanced productivity and sustainability. It is therefore critical that public-private partnerships be encouraged and supported to enhance the response of agriculture to climate change.

Paper no. 10: Swaziland on behalf of the African States

AFRICA GROUP

SBSTA SUBMISSION ON ISSUES RELATING TO AGRICULTURE

This submission is made by the Africa Group in response to the SBSTA 38 conclusions that invited Parties to submit views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries ….taking into account the diversity of agricultural systems and the differences in scale as well as possible adaptation co-benefits (Document FCCC/SBSTA/2013/L.20 para 2).

Recognizing that agriculture holds the key to Africa's sustainable and rural development, a top priority on the global agenda is how to feed the projected nine billion people by 2050. This task is especially formidable in Africa, where more than one-third of the world's poor and malnourished people live, with close to 80% small scale farmers directly or indirectly relying on rain-fed agriculture as a source of livelihood. Africa's capacity to produce food is likely to be challenged by the combined effects of resource degradation and increasing adverse impacts climate variability and change. Thus, ensuring food security in this region requires urgent actions to improve the productivity and climate resilience of agriculture and an increased attention to climate risk management tools, including safety nets and insurance, to ensure adequate and affordable food is available for the most vulnerable. The priority for the agriculture sector in Africa is to ensure food security, eradication of poverty and socio-economic development, environmental and livelihood sustainability, with special attention to small-scale farmers and fishers, under a changing climate. To achieve this goal, adaptation will be necessary, including adaptation options where mitigation co-benefits may also be possible

From the global perspective, it is appreciated that due to uncertainties in climate projections and other factors, including carbon dioxide fertilization (i.e., photosynthetic CO_2 fixation), socio-economic development pathways and the differential adaptive capacities of countries in the region, projections of the impacts of climate change on agriculture are not spatially explicit and depend heavily on scenario assumptions that fail to mimic the future climate conditions. Various studies have been conducted on the impacts of climate change on agriculture in Africa amidst several limitations, yet despite limitations most scenarios, including the most recent analysis of the World Bank, indicate significant impacts on agriculture production across the African continent. The major constraints could be attributed to the gaps in the scientific knowledge of climate change impacts on agriculture that have hitherto not been modeled due to data limitations. For example, there is limited understanding of: (1) direct impact of climate change on pastoralism and African agricultural and livestock farming systems; (2) the prevalence and impact of pests and diseases in changing climate; (3) the socio-economic impact of extreme weather and climate events, and loss and damage associated with extreme and slow onset events, as current GCM scenarios do not account for such events and yet they are increasingly becoming common in Africa; and (4) effectiveness of adaptation response measures and coping strategies by small scale farmers and on gender, taking into consideration the types of impacts that are likely to be felt in Africa, in particular temperature rise, increased variability of precipitation, drought, and long-term drying. This is further constrained by inadequate data, technical and institutional capacities that hinder effective application of climate modeling to inform national development planning and decision making at different levels.

In light of the foregoing, the Africa Group has identified four priority areas that the international community through SBSTA could support Africa so that it could have the most current state of knowledge that would enhance Africa's adaptive capacity to address climate change impacts and build climate resilient agriculture sector. These are:

1. **Capacity building on the development and application of tools and methods for climate monitoring, modeling, uncertainty analysis, downscaling, early warning and updatability for climate change:** Africa is vulnerable to several climate change related challenges and impacts that are tied closely to the region's geographical diversity, economy and population patterns. Since there is paucity of accurate historical climate and agricultural data in Africa, there is need to study in detail the indicators of exposure and sensitivity. Also needed is data relevant to slow onset changes that will affect agriculture, fisheries, and food security, such as temperature rise, long-term drying, sea level rise, and ocean acidification. Improved national data collection and retrieval systems is very important for Africa , including data from earth observing systems to improve micro climate modeling to enable more accurate interpolation. In addition, it is imperative for the international community to put in place a Programme of Work on capacity building on development and application of various tools and methods, particularly for climate monitoring, modeling, downscaling that would lead to improved regional temperature and precipitation simulations, so that they can be used as direct inputs into agricultural impact models and early warning for developing countries, especially Africa with a view to building the requisite technical capacity and strengthening institutional infrastructure.

2. **Assessment, development and identification of research and technological options and practices for agricultural adaptation and adaptation co-benefits, including understanding positive impacts, limits to adaptation, and monitoring systems for adaptation:** The motivation for research and technological options is the need to develop innovations tailored to the local scale that directly and indirectly enhance adaptive capacity of Africa's agriculture in a changing climate including assessment and monitoring of climate impacts for adaptation (impacts on key staples and natural resources, how rainfall, temperature and carbon dioxide concentrations will interact in relation to agricultural productivity, changes in the incidence, intensity and spatial distribution of important weeds, pests and diseases and help to identify limits so as to identify when transformational approaches to adaptation are necessary and help to identify limits so as to identify when transformational approaches to adaptation are necessary, such as when diversification options dwindle for agropastoral or artisanal fishing systems. Moreover, there is little information on the relationship between agricultural adaptation and adaptation co-benefits (i.e., adaptation actions and practices that have mitigation benefits). Thus, enhanced research, including competitive research funding and better-managed programs, are critical for innovation to improve agricultural productivity to alleviate global poverty and hunger, as well as to identify adaptive limits and implications for regional food security.

3. **Assessment of technological needs relating to adaptation and promotion of technology transfer:** It is critical to assess technology needs relating to adaptation and the transfer of these technologies particularly to the most vulnerable communities in developing countries, especially Africa. This will enable these communities to adapt quickly and increase resilience. Africa is of the view that there is need for technology needs assessment relating to adaptation and the transfer of these technologies in agriculture particularly to the most vulnerable communities in developing countries. The assessment of technologies (and policies) will have to be done in relation to multiple objectives and multiple temporal/spatial scales in order to: Evaluate trade-offs and synergies between the development outcomes of increased food security, enhanced rural livelihoods for poverty reduction and addressing climate change, Evaluate the costs and benefits of adaptation options at different spatial scales and understanding short-term and long-term gains obtained from technology options and how they affect adoption. Promoting the transfer of relevant adaptation technologies and implementation of adaptation practices for which enabling means (investment/financing, capacity building) inclusive of and suitable for agriculture will be necessary.

4. **Identification of approaches to enhance integration of indigenous and science-based knowledge:** Indigenous knowledge (IK) plays a critical role in decision making by Africa's small scale farmers in their quest to manage climate related risks, including extreme weather events and to cope with the impacts. Such coping strategies and indigenous knowledge vary by sub-region or country and to a great extent are localized. On the other hand, science-based knowledge systems such as weather forecasting, though useful, need downscaling for them to be meaningfully applied at the local scale. Therefore, to be more effective in dealing with the increasing challenges of climate change impacts in Africa, it is imperative to explore ways of integrating indigenous knowledge and science-based knowledge systems.

Finally, we note that it would be helpful for SBSTA to welcome the participation of the IPCC at the workshop as it will have released the Working Group I report, "The Physical Science Basis" of its Fifth Assessment Report (AR_5) and will be well-advanced in the preparation of the report of Working Group II on " ***Impacts, Adaptation, and Vulnerability***".. In particular, it may be useful to have a presentation on the global and regional climate projections, as well as the findings on ocean acidification that might have an impact on agriculture, livestock and fisheries. It may also be beneficial to invite some form of participation from FAO and the CCAFS programme of the CGIAR, which have made major contributions to international work on agriculture and climate change.

Paper no. 11: United States of America

5 September 2013

At the thirty-eighth session of the Subsidiary Body for Scientific and Technological Advice held in Bonn, Germany from June 3-14, 2013 on Agenda item 9, Issues relating to agriculture, the Draft conclusions proposed by the Chair reads, in part, "The SBSTA invited Parties and admitted observer organizations to submit to the secretariat, by 2 September 2013, their views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries. This should take into account the diversity of the agricultural systems and the differences in scale as well as possible adaptation co-benefits."

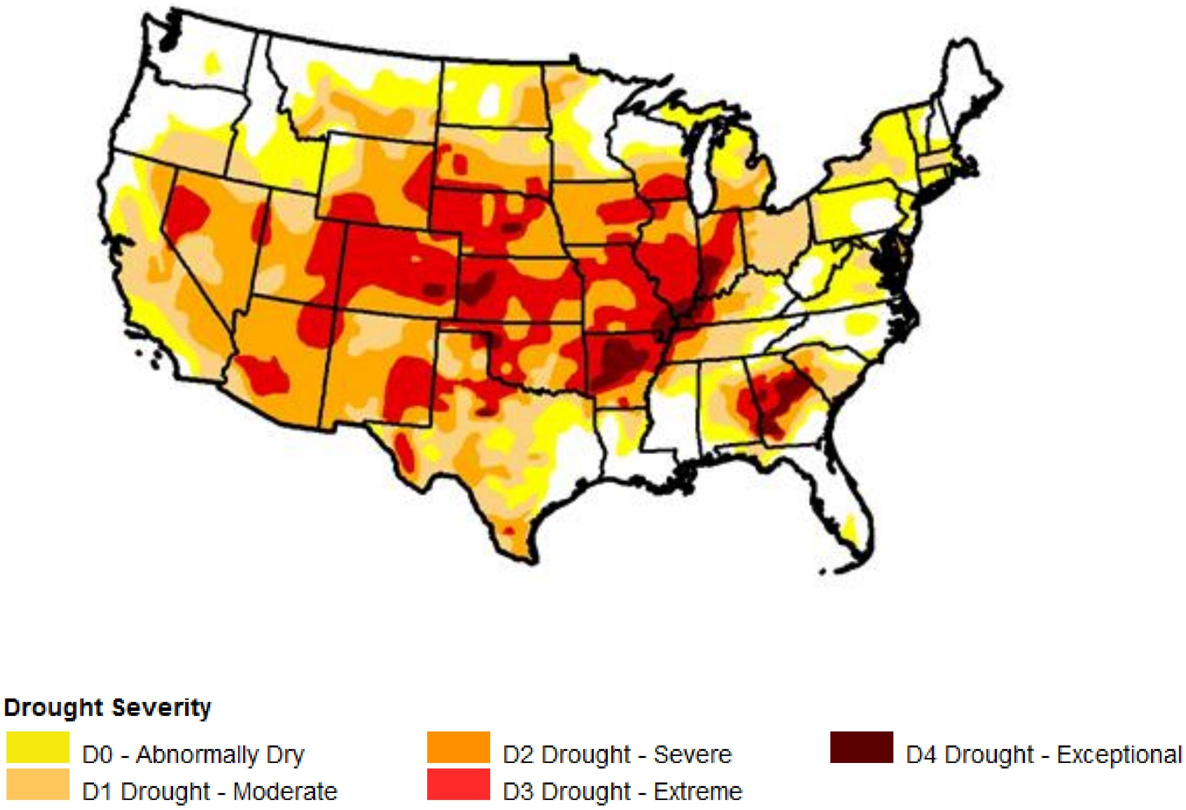
Introduction: 2012 Drought and Impacts

The United States welcomes the opportunity to submit, pursuant to FCCC/SBSTA/2013/L.20, its views and experiences on the adaptation of agriculture to climate change. The issue of extreme weather events, including drought, is becoming even more critical to climate change adaptation strategies for many countries. This submission will review some ways in which U.S. farmers adapted to the 2012 drought, as the lessons learned may be applicable to others.

The 2012 United States drought ranked among the most costly weather-related disasters in U.S. history. Precipitation deficits for the period May through August 2012 were the highest since official measurements began in 1895, eclipsing the driest summers of 1934 and 1936 that occurred during the height of the Dust Bowl. The United States Department of Agriculture designated 2,245 counties in 39 states as disaster areas due to drought, or 71 percent of the land area of the contiguous United States. By July 2012, 64 percent of the contiguous U.S. was in moderate to exceptional drought. More than 56 percent of the wheat crop and 60 percent of livestock were within drought-affected areas. Corn yield was reduced by 27 percent.

Despite these conditions, producers used a variety of practices and technologies to prevent even greater losses. Conservation practices such as cover crops and careful water management technologies ameliorated the effects of the drought. Producers' experiences also highlighted the need for geographically specific information and drought prediction and warning.

Drought Map of the Contiguous 48 United States on July 24, 2012
Source: U.S. Drought Monitor



Conservation Practices

Conservation programs are important means of addressing natural resource concerns associated with drought including diminished water availability for crop and livestock production, deteriorating plant conditions for grazing, decreased water quality, decreased plant cover resulting in increasing erosion, and diminished soil quality. Cover crops, crop rotation, conservation tillage, and other soil carbon building conservation practices can increase the available water holding capacity of the soils, while strategic water application and efficient irrigation can improve water management. These conservation practices fall into three major groups:

- Water management: efficient irrigation systems and management, water storage, strategic water application, livestock watering facilities
- Land management: prescribed grazing, conservation tillage or no-till, buffer and filter strips near water sources

- Crop management: crop rotations, drought tolerant crops, shift to less water-dependent cropping, cover cropping to enhance soil carbon and available water holding capacity

In Indiana, cover crops and no-till had significant benefits in 2012, nearly doubling yield compared to similar fields. Elsewhere, cover crops increased yields, in some cases from 30 bushels per acre to 180 bushels per acre. These practices increase soil biology, moisture, organic matter, and aggregate stability over time.

Experiences from the 2012 drought showed that some conditions can make conservation assistance more effective. These include:

- Building on existing partnerships that deliver conservation assistance
- Incentivizing, promoting, and advocating for conservation on the ground
- Providing flexibility to accommodate variability across field, farm, and county boundaries
- Researching, with producer engagement, the effects of conservation practices at the local level

Technology

New technologies played an important role in reducing the impact of the drought. A recent study found that if 1988 seed and management technologies had been used in 2012, the drought would have caused a 37 percent loss in corn production across the US[1]. The actual loss that occurred in 2012 was closer to 13 percent, and corn yields were 41 percent higher in 2012 than in 1988. Relevant technologies include:

- Tillage systems: Increased adoption of conservation tillage or no-till to reduce evaporative losses, to increase the water holding capacity of the soils, and to promote deeper penetration of moisture into soil profile
- Better equipment: Wider availability of improved equipment for soil-bed preparation, planting, harvesting and application of crop chemicals
- Water management: Better management of water, advanced drainage systems, and some increases in irrigated acres
- Planting changes: Earlier planting dates and/or higher plant populations

[1] Elliott, et al., 2013: http://papers.ssrn.com/sol3/cf_dev/AbsByAuth.cfm?per_id=1655092

- Crop protection chemicals: Continued development and introduction of more effective crop protection chemicals and improved application methods that preserve yield in the presence of increased weed, pest, and disease pressure

- New technologies for higher yields: New diverse, broadly adapted and widely-tested germplasm help maintain yield potential under environmental stress

Drought-tolerant crops and water management particularly show how technology can help during drought, although not indefinitely. Drought-optimized varieties produce higher yields as a result of physiological traits such as increased root growth. The tradeoff is that such plants often have lower yields than conventional varieties when there is sufficient water, although careful application of conservation practices may help new seeds under better conditions.

Likewise, irrigation has expanded areas where crops can be grown, has reduced variability, and can help farmers manage drought risks. Irrigation is most effective as a year-round, holistic practice. During the growing season in the drought, farmers practiced triage (abandoning a portion of the crop while watering the most favorable area), managing drought-related pests, and continuously monitoring to address water needs in a timely manner. In the off season, farmers increased irrigation efficiency and/or uniformity, switched to crop mixes that require less water, reduced tillage, and reduced the irrigated area through fallowing or crops with different life cycles. Despite these efforts, many irrigation systems could not provide sufficient water to offset the impacts of the 2012 drought. This suggests that reducing irrigated acreage may be necessary over the long term in drought-prone areas.

Information and Technology Needs

Producers need relevant information to apply conservation practices in their areas. For example, producers who use conservation practices such as cover crops need a tracking system in which they can enter their parameters to compare the most efficient ways to manage cropping. In the case of cover crops, a system would include the type of cover crop, the time when the cover crop is killed, the cash crop, the yield, precipitation during the growing season, irrigation (if any), and applied nutrients.

Improved drought preparedness is another requirement for coping with future drought. This includes forecasting, early warning, and preparedness, as well as research. Forecasting predictions issued from a single source would improve producers' decision-making abilities. Forecasting tools should rely on real-time data at a farm-level scale in order to inform planting decisions. Accurate weather forecasting is necessary to ensure that appropriate seeds are available across the country. In seasons when drought is predicted, seed producers must anticipate demand for drought-tolerant seed varieties in an effort to produce enough to meet that demand. Drought mitigation includes actions taken in advance of a drought that reduce potential drought-related impacts on crop. Early information provided by an early warning system is vital to reducing damage from drought impacts.

In the years just before the 2012 drought, scientific improvements allowed the United States to better monitor drought in real time, which in turn provided better forecasting and allowed policymakers to plan further in advance. These efforts include:

- National Integrated Drought Information System: NIDIS is an interagency, interstate effort to establish a national drought early warning information system with improved coordination of monitoring, forecasting, and impact assessment efforts. As a proactive effort, NIDIS provides a better understanding of how and why droughts affect society by working with communities and existing networks on drought assessments, drought early warning systems, climate outlook forums, education and outreach, and preparedness.
- The United States Drought Monitor synthesizes indices and inputs from 270 experts across the country on a weekly basis. This representative scientific consensus helps inform the public and decision-makers. The Drought Monitor is currently used as a trigger mechanism for both State and Federal drought response measures.

Research is ongoing both to improve the ability to predict droughts and to predict at smaller scales. These efforts include:

- Improved understanding of drought development mechanisms
- Improved assessment of drought monitoring based on verification metrics
- Impacts of decadal scale variations on seasonal forecast reliability
- Improved satellite estimates of snow cover (e.g. snow-water equivalent)
- Improved satellite estimates of soil moisture

Further development and dissemination of other technologies will also yield valuable adaptation strategies to address increasingly variable growing conditions. These range from simple on-farm practices like treating corn stover with quicklime to increase its feed value to more expensive technologies. For example, Landsat satellites provide free, globally available data at subfield resolutions, thus facilitating drought monitoring of individual crops and fields. However, Landsat is the only source of data at this scale, and it provides data only every 16 days. Additional sources of data would enhance early detection plant stress conditions develop and would allow earlier implementation of drought management strategies.

Broadly, producers, planners, and policy makers will all need more information about water availability as growing conditions continue to vary. Technologies that will provide more information about where water is coming from, how much is available, and how to reduce its use while maintaining adequate production will be required.

Summary of Observations and Lessons Learned

- Although the 2012 drought had serious negative impacts for crop production, those impacts were in many ways less severe than expected, particularly when comparing the 2012 drought to the 1988 drought. Two of the most important factors contributing to reduced drought impacts were improved soil health as a result of appropriately applied conservation practices and technological advances such as improvements in crop breeding. Together, these improved soil moisture holding capacity and the ability of major crops to use that soil moisture even when it was present in limited quantities.

- Voluntary, incentive-based conservation practices are widely viewed as an important way to engage in drought preparedness, to respond to certain drought impacts, and to mitigate long-term drought impacts. Increasing technical assistance for adaptation will help farmers prepare for drought and weather fluctuations expected to occur as climate variability increases. Adaptation practices are important not only from a risk-management perspective, but also from a natural resource management perspective.

- Technology and conservation practices have interacted in important ways to reduce drought vulnerability. Newer seeds are well-positioned to take greater advantage of healthier soils. Newer seeders allow farmers to plant seeds more precisely, leading to greater viability, even with greater residue left on the fields.

- Although collecting and calibrating on-the-ground data is a challenge, this information is necessary to improve prediction accuracy. It is important that programs and authorities continue to be empowered to provide funding for this type of research, observation, and data management.

- Increasing and improving available data is critical. Coordinating data provides a national perspective on weather trends, technology and policy needs. Consolidating this data in central locations would greatly improve ease of access and use.

- Improving the way farm-level data are collected, recorded and used in research and on-farm research trials is necessary to refine predictions, to encourage farmer-led actions to improve crop outcomes, and to inform policy approaches to natural resource and adaptive management in a variable climate. While collecting these data requires farmers' participation, farmers will also benefit from the research they support.

Paper no. 12: Uzbekistan

Opinion of Republic of Uzbekistan on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impact while promoting rural development, sustainable development and productivity of agricultural systems and food security according to document FCCC/SBSTA/2013.L20, paragraph 2

Republic of Uzbekistan occupies the territory of 448,9 km^2 the major part of which is covered with the desert plains. Historically, the water resources and agriculture are the basic motivation for the social-and-economical and geopolitical transformations which have taken place on the territory of Central Asia during the last century. The region is characterized with rather arid climate, that is why for the provision of the irrigation in agriculture only small water resources are available – the basins of Syrdarya and Amudarya rivers. These river basins are transboundary resources 90% of which are formed on the territory of boundary states – Kyrgyzstan and Tajikistan. Uzbekistan is the main user of water resources in the region as the agriculture in the republic is almost fully based on irrigation using about 90% of water intake from the surface. Half of the republic population lives in rural areas. Agriculture comprises38% of Gross Domestic Product and 44% of able-bodied population works in agriculture.

According to estimations of vulnerability of sectors of economy and nature resources it follows that in future water resources and agriculture depend on climate change most of all. Thus, irrigated farming is the most vulnerable to climate warming. The farmers whose farms are in the end of irrigation network will suffer the first. Besides, the climate change will result most probably, in the decrease of the pastures yield which are the main source of the forage for the livestock.

Productive yield of farms depends mainly, on technical provision, fertilizers, seeds, veterinary service and dissemination of the best practices and knowledge.

Possible change of agroclimatic resources due to the increase of summer and autumn temperature during the nearest decades will not influence much on the crop yield in the regions of irrigated and non-irrigated farming. Only up to 2050-2080 this effect will be manifested.

Thus, all adaptation actions taken by the government are aimed, mainly at strengthening the sustainability of the irrigated farming regarding the high vulnerability of this sector of economy to climate change.

Nevertheless, in practice, adaptation measures are still limited by the one-time measures or actions implemented mainly in experimental or pilot projects.

Undoubtedly, for elaboration and implementation of the relevant adaptation measures it is needed to define sensitivity and to assess the vulnerability of natural or anthropogenic systems and to determine the ability of these systems for adaptation to climate change.

Regarding the previous information, Uzbekistan identifies several priority areas where the international community could provide support to the enhancement of knowledge in adaptation area of agricultural sector of Uzbekistan and creation of climate-resistance and climate-flexible agriculture via SBSTA. These are as follows:

1. **Improvement of hydrometeorological monitoring**

Creation of scenarios for the development of climate change and its impact on agricultural sector sometimes is hampered by the absence or incompleteness of data. For the solution of this problem it is needed to extend the surface network of Hydrometeorological observations including the foreign mountain territory, development and application of remote monitoring methods, reconstruction of observations of the upper atmosphere layers.

2. **Studies and development and definition of the positive on adaptation of agriculture to climate change.**

It is necessary to motivate the studies directed to the elaboration of methods of assessment of adaptation and risks at the national, regional and community level; identification and mapping of the maximum risk zones; elaboration of system for the early drought warning; capacity building in the field of the direct and indirect strengthening and building of adaptive capacity in agricultural sector of Uzbekistan. Further capacity building in the area a of studies and development of adaptive mechanisms for sustainable development of agricultural production including the financial mechanisms and programs managed in the most beneficial way will facilitate the improvement of life conditions of the poorest population.

3. Improvement of the land-and-water resources management at the national and transboundary level:

As the water resources of Uzbekistan are mainly transboundary, it is concerned with the problem of the capacity building in the management of transboundary water resources, search and determination of the best world practices and methods for solution of the problems of water resources deficit and their rational use with account of climate change. It is also important to develop the programs and action plans on the irrigated lands amelioration, complex assessment of the land use change, salinization and of the types of land degradation, optimization of the crops location over the territory with account of climate change (use of the laser land planning), elaboration of long-term programs/plans of development of the agriculture and water economy, improvement of monitoring of the state of seeds planting and pastures, improvement of information collection, processing and exchange between the countries of the region.

4. Improvement of knowledge at all levels (from the local communities to the decision makers) with regard of specific features of the local experience of adaptation to climate change.

The experience of farmers plays an important role in making the decisions on agriculture adaptation and climate risks management (including climate disasters). The territory of the country is diverse from the deserts to the upper mountains, that is why the combating strategies and local experience are also diverse. The approaches based on scientific knowledge need detalization and this is not always possible because of the existing limitations. They are as follows:

Methodical. Lack of specialists using the up-to-date analysis methods and instruments and also acquire knowledge in specific, non-traditional areas – assessment of climate change impact, elaboration and introduction of mitigation and adaptation measures. The main difficulties and limitations are related to the use of tested and recommended methods and instruments: creation of social-and-economic scenarios; assessment of ecological and social-and-economic risks; analysis of measures, alternative ways of development and policy elaboration.

Financial. Often the research projects which got financing are not able to purchase the needed equipment, to organize the field studies, to participate in republic and international training workshops or conferences. The overhead costs – keeping and maintenance of buildings and administration of organizations where the expert who got grants for conduction of research works work are high.

Requirements for the development of studies. The involvement of different research institutions, agencies, representatives of economy sector, agriculture, social sector to the problem of climate change, especially in the vulnerability assessment, development and introduction of adaptation and mitigation measures to agriculture management. The most efficient way is an active participation in international research programs and projects which provide for coordination of activities at national and international levels.

That is why for the successful realization of knowledge and experience the coordination and joint introduction of the research knowledge and local experience to the processes of adaptation of agriculture to climate change is necessary.

Paper no. 13: Zambia

This submission is made by Zambia in response to the SBSTA 38 conclusions that invited Parties to submit views on the current state of scientific knowledge on how to enhance the adaptation of agriculture to climate change impacts while promoting rural development, sustainable development and productivity of agricultural systems and food security in all countries, particularly in developing countries ….taking into account the diversity of agricultural systems and the differences in scale as well as possible adaptation co-benefits (Document FCCC/SBSTA/2013/L.20 para 2).

Recognizing that agriculture holds the key to Zambia's rural and sustainable development, and emphasizes that agriculture is central to the economic and social development of its people. The priority for Zambia and other African countries in the agriculture sector is to enhance socio-economic development, ensure food security, eradicate poverty, ensure environmental and livelihood sustainability with special attention to small-holder and marginal farmers and fishers through adapting to the effects of climate change with the identification and maximization of the potential of adaptation co-benefits. . Zambia's capacity to produce food is likely to be challenged by the combined effects of resource degradation and increasing adverse impacts climate variability and change. Thus, ensuring food security in this region requires urgent actions to improve the productivity and climate resilience of agriculture and an increased attention to climate risk management tools, including safety nets and insurance, to ensure adequate and affordable food is available for the most vulnerable..

From the global perspective, it is appreciated that due to uncertainties in climate projections and other factors, including carbon dioxide fertilization, socio-economic development pathways and the differential adaptive capacities of countries in the region, projections of the impacts of climate change on agriculture are not spatially explicit and depend heavily on scenario assumptions that fail to mimic the future climate conditions. Some studies conducted on the impacts of climate change on agriculture in Zambia amidst several limitations, indicate significant impacts on agriculture production. The major constraints could be attributed to the gaps in the scientific knowledge of climate change impacts on agriculture that have hitherto not been modelled due to data limitations. For example, there is limited understanding of: (1) direct impact of climate change on pastoralism and African agricultural and livestock farming systems; (2) the prevalence and impact of pests and diseases in changing climate; (3) the socio-economic impact of extreme weather and climate events, and loss and damage associated with extreme and slow onset events, as current GCM scenarios do not account for such events and yet they are increasingly becoming common in Zambia; and (4) effectiveness of adaptation response measures and coping strategies by small scale farmers. This is further constrained by technical and institutional capacities that hinder effective application of climate modeling to inform national development planning and decision making at different levels.

In light of the foregoing, the Zambia has identified three priority areas that the international community through SBSTA could support Zambia so that it could have the most current state of knowledge that would enhance Zambia's adaptive capacity to address climate change impacts and build climate resilient agriculture sector. These are:

1. **Capacity building on the development and application of tools and methods for climate monitoring, modelling, uncertainty analysis, downscaling, early warning and updatability for climate change: Zambia just like the rest of** Africa is vulnerable to several climate change related challenges and impacts that are tied closely to the Country's geographical diversity, economy and population patterns. Since there is paucity of accurate historical climate and agricultural data in Africa, there is need to study in detail the indicators of exposure and, sensitivity. Also needed is data relevant to slow onset changes that will affect agriculture, fisheries, and food security, such as temperature rise, long-term drying. In addition, it is imperative for the international community to put in place a programme of work on capacity building on development and application of various tools and methods, particularly for climate monitoring, modelling, downscaling and early warning for developing countries, especially Africa with a view to building the requisite technical capacity and strengthening institutional infrastructure.

2. **Assessment, development and identification of research and technological options and practices for agricultural adaptation and adaptation co-benefits, including understanding positive impacts (opportunities), challenges to adaptation, and monitoring systems for adaptation:** The motivation for research and technological options is the need to develop innovations tailored to the local scale that directly and indirectly enhance adaptive capacity of Zambia's agriculture in a changing climatic environment so as to identify when transformational approaches to adaptation are necessary.. Enhanced research, including competitive research funding and better-managed programmes is critical for innovation to improve agricultural productivity to alleviate global poverty and hunger, as well as to identify adaptive limits and implications for regional food security.

3. **Identification of approaches to enhance integration of indigenous and science-based knowledge:** Indigenous knowledge (IK) plays a critical role in decision making among the Zambian small scale farmers in their quest to manage climate related risks including extreme weather events and cope with the impacts. Such coping strategies and indigenous knowledge vary by province or district and to a great extent are localized to sub-district levels. On the other hand, science-based knowledge systems such as weather forecasting, though useful, need downscaling for them to be meaningfully applied at the local scale. Therefore, to be more effective in dealing with the increasing challenges of climate change impacts in Zambia, it is imperative to integrate indigenous knowledge and science-based knowledge systems.

Finally, we note that the IPCC would have released the Working Group I report, "The Physical Science Basis" of its Fifth Assessment Report (AR_5) and therefore, would welcome their participation at this workshop. In particular, it may be useful to have a presentation on the global and regional climate projections.
