FINAL REPORT:

Stage 2 - Supporting Climate Resilient Value Chains

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The Adaptation Knowledge and Tools programme is a DFID-funded programme intended to maximise the effectiveness of UK and international investment in climate change adaptation and resilience. The knowledge and tools generated through this programme are expected to promote greater understanding of what constitutes best practice in adaptation, as well as better international cohesion and coordination around adaptation. Through these entry points the programme expects to increase the quality of international and UK adaptation programming and reduce its risk.

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List of Acronyms

ACCRA	Africa Climate Change Resilience Alliance
ACP	African Caribbean and Pacific
ADB	Asian Development Bank
AFCA	Africa Fine Coffee Association
AL	Awami League
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCI	Better Cotton Initiative
BMZ	Federal Ministry for Economic Cooperation and Development
BNP	Bangladesh Nationalist Party
BTB	Bangladesh Tea Board
CBA	Collective Bargaining Agreement
CCIOU	Climate Change and International Obligations Unit
CDM	Clean Development Mechanism
CEIL-PEAKS	Climate, Environment, Infrastructure and Livelihoods Professional Evidence and Applied Knowledge Services (DFID)
CIA	Central Intelligence Agency
CIAT	International Center for Tropical Agriculture
CIF	Cost, insurance and freight
CLCV	Cotton leaf curl virus
CmiA	Cotton made in Africa
CO2	Carbon Dioxide
CRGE	Climate Resilient Green Economy
CSR	Corporate Social Responsibility
CTC	Crush, tear, curl
CWS	Coffee washing station
DFID	Department for International Development (UK)
DMF	Design and Monitoring Framework
DNA	Designated National Authority
DoE	Department of Environment
DRC	Democratic Republic of Congo
DRM	Disaster Risk Management
EACC	Economics of Adaptation to Climate Change
EATTA	East African Tea Trade Association
ECGA	Eastern cotton growing area
ECX	Ethiopian Commodity Exchange
EPA	Environmental Protection Authority
EPZ	Export Promotion Zone
ETP	Ethical Tea Partnership
EU	European Union
FAO	Food and Agricultural Organisation (of the World Bank)
FD	Forest Department
FFV	Fresh fruit and vegetables
FLO	Fairtrade Labelling Organisation
FOB	Free on board

GAP	Good Agricultural Practices
GCF	Gatsby Charitable Foundation
GCM	Global Climate Model
GCM	Global Circulation Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gases
GI	Geographical indicators
GIZ	German Agency for International Cooperation
GLOBALGAP	Global Partnership for Good Agricultural Practice
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (German Technical Cooperation)
HIES	Household Income and Employment Survey
HIPC	Heavily Indebted Poor Country
IARI	Ilonga Agricultural Research Institute
ICA	International Cotton Association
ICAC	International Cotton Advisory Committee
ICO	International Coffee Organisation
IDRC	Canadian International Research Development Centre
IFC	International Finance Corporation
IIED	International Institute for Environment and Development
IITA	International Institute of Tropical Agriculture
ILO	International Labour Organisation
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ISCC	International Sustainability and Carbon Certification
ITB	Indian Tea Board
ITC	International Tea Committee
ITC	International Trade Centre
KETEPA	Kenya Tea Packers Limited
KPAWU	Kenya Plantation & Agricultural Workers' Union
KTDA	Kenya Tea Development Agency
KTGA	Kenya Tea Growers Association
LDC	Least Developed Country
LGA	Local Government Authority
LTP	Lawrie Tea Processor
LSC	Levi Strauss & Company
LZARDI	Lake Zone Agricultural Research Development Institute
MAGICC	Model for the Assessment of Greenhouse Gas Induced Climate Change
MNC	Multinational corporation
MLPG	Micro-level Perspectives of Growth
MoARD	Ministry of Agriculture and Rural Development
MoEF	Ministry of Environment and Forests
NAPA	National Adaptation Programme of Action
NEMC	National Environment Management Council
NGO	Non-governmental Organisation
NIE	National Implementing Entity
NMA	National Meteorological Agency
Norad	Norwegian Agency for Development Cooperation
NRI	National Resources Institute
NTC	National Tea Company

N2O	Nitrous Oxide
OCIR	Office Nationale des Cultures Industrielles
OCIR CAFÉ	Rwanda Coffee Development Authority
ODI	Overseas Development Institute
PCCC	Pakistan Central Cotton Committee
PLCTC	Primary Level Coffee Transaction Centre
PO	Producer Organisation
PPP	Public-Private Partnership
PRECIS	Providing Regional Climates for Impact Studies
PSCI	Pakistan Sustainable Cotton Initiative
PSI	Policy Support Instrument
RA	Rainforest Alliance
RED	Renewable Energy Directive (of the EU)
REMA	Rwanda Environment Management Authority
RNFE	Rural non-farm economy
RPF	Rwandan Patriotic Front
RSPO	Round Table on Sustainable Palm Oil
RTD	Ready to Drink
RWF	Rwandan Franc
SAN	Sustainable Agriculture Network (a consortium of NGOs)
SCENGEN	Regional and global Climate SCENario GENerator
SCTF	Sustainable Cotton Task Force
SEZ	Special Economic Zone
STF	Sustainable Task Force
SME	Small and medium sized enterprise
SNC	Second National Communication
SRES	Special Report on Emissions Scenarios
STTF	Sustainable Tea Task Force
TACOGA	Tanzania Cotton Growers Association
TBK	Tea Board of Kenya
TBS	Tanzania Bureau of Standards
TCA	Tanzania Cotton Association
TCB	Tanzanian Cotton Board
TCC	Tropical Commodity Coalition
TOR	Terms of Reference
TOSCI	Tanzania Official Seed Certification Institute
TPRI	Tropical Pesticides Research Institute
TRFK	Tea Research Foundation of Kenya
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
URT	United Republic of Tanzania
USAID	United States Agency for International Development
WARPO	Water Resource Planning Organisation
WB	World Bank
WCGA	Western cotton growing area
WTO	World Trade Organisation
WWF	World Wildlife Fund

Executive Summary

Introduction
This Climate, Environment, Infrastructure and Livelihoods Professional Evidence and Applied Knowledge Services (CEIL PEAKS) study into "Supporting Climate Resilience in Value Chains" is part of the Department for International Development's (DFID) ongoing work in ensuring collaboration and partnership with the private sector to foster investment in the adaptation of agricultural value chains and reduce the negative impact of climate change. The Stage 1 study report was submitted to DFID in January 2013, and approved by them in February 2013.

This report covers Stage 2 of the study and addresses the following specific Terms of Reference (TOR):

A. An examination, in depth, of the following commodity supply/value chains, determined by DFID, following submission and assessment of the Stage 1 study report:

1 Coffee in Ethiopia and Rwanda;
2 Tea in Kenya and Bangladesh;
3 Cotton in Tanzania and Pakistan.

The above selected value chains will be examined in terms of:

(i) Current trends in the value chain, including baseline trajectories for production, considering whether they will grow or will face challenges due to physical climate effects under a range of scenarios;
(ii) Whether there are any particular strategies that should be undertaken in such a context, to either grow the sector even more, sustain them, and/or to manage their decline over time to derive maximum economic benefits for the economy, while recognising the impact of climate change on the industry.

B. Suggestions on ways in which private sector firms can invest in making the value chain more climate resilient, or how development institutions such as DFID can work with developing country governments to design policies that reduce the impact of climate change on the supply/value chain, and those who rely on it for their income, employment, profit or revenue.

The report is structured in six sections: Section 1: Introduction includes the background to the study, approach and methodology, notes on the Intergovernmental Panel on Climate Change (IPCC) climate change scenarios, and the United Nations Framework Convention on Climate Change (UNFCCC) sponsored National Adaptation Programmes of Action (NAPAs); Sections 2, 3 and 4 cover the coffee, tea and cotton sectors respectively; Section 5 summarises the report's key findings and recommendations for climate resilient coffee, tea and cotton value chains; and Section 6 contains 12 Annexes.

SUMMARY OF KEY FINDINGS

Need for detailed sub-regional studies on long term weather forecasting
Most of the outcomes of global studies on climate change are at continental levels, while the details at regional and sub-regional levels, which strongly influence the economics, are

inadequate. Coffee, tea, and cotton production systems are basically regional to sub-regional; hence there is a need for detailed studies. As early as 2000, the IPCC categorically stated in its assessment report the need for more comprehensive studies to be carried out at the regional/sub-regional production system level, as the climate is strongly influenced by local topography, location and proximity to sea and oceans. Studies by various agencies have used numerous approaches to conceptualise climate change in a specific region and its impacts on the various commodity production systems together with economic sectors in that region. Most of these studies, however, suggest the need for:

(i) Detailed analysis of long term weather and productivity information to quantify the specific changes in weather conditions that have occurred over the period; and
(ii) Studies on how the current and future weather, affects the productivity and economic activities/returns from the specific region (to include information on impacts alongside probabilities of those impacts)[1].

Current impact of climate change on selected commodity value chains
Scientific research and participatory assessments show that many of the current coffee-, tea- and cotton-growing regions are already suffering from more severe and frequently occurring extreme weather events. These have severe consequences, not only for farmers, but for all actors in the respective commodity value chains, thus affecting, particularly, yields, production costs, prices, and, in macroeconomic terms, a country's balance of payments, growth, employment and standards of living. Whilst farmers report changing weather patterns, particularly longer drought periods, shorter rainy seasons and greater fluctuations in temperature during the year, no long term trend in production decline can be discerned. Further statistical analysis is needed to draw definitive conclusions on the quantitative impact of climate change on volumes.

The need for greater commodity value chain efficiency
The study focuses on commodity value chain resilience to climate change, and in this context for each selected commodity/country, the value chain has been described and shown diagrammatically. Generally, the shorter the value chain the more efficient it is. An efficient value chain structure will work to the greater advantage of farmers in coping with the negative impacts of climate change as it will assist in more easily identifying actual and potential problems related to declining yield, production and quality caused by changing temperature and rainfall patterns. Many of the initiatives described in the report are increasing their focus on contract farming, direct communication between farmer and retailer/primary processor, and institutional reform and capacity building, which will shorten the value chain and make it more transparent.

Climate change impact assessment on commodity value chains
An analysis of the impact of climate change on each selected commodity value chain/country was undertaken using forecasted parameters for temperature increases causing surface air warming in the 21st century, based on the IPCC Special Report on Emissions Scenarios (SRES, 2000). The IPCC Fourth Assessment Report- Climate Change 2007, used emission scenarios as developed in the SRES, 2000. These emissions scenarios were used in climate model experiments, which in turn were used to generate climate scenarios used in modeling of impacts, adaptation, and vulnerability. The IPCC Fourth Assessment Report - Working Group III: Mitigation of Climate Change, Chapter 3.1, Emissions Scenarios (http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch3s3-1.html) stated that the evolution of future greenhouse gas (GHG) emissions and their underlying driving forces is highly uncertain, as reflected in the wide range of future emissions pathways across (more than 750) emission scenarios in the literature. This literature is referred to as

[1] Food and Agricultural Organisation (FAO), INTERGOVERNMENTAL GROUP ON TEA INTERSESSIONAL MEETING, Washington DC, USA, 17-18 September 2012 - Working Group on Climate Change.

"post-SRES" scenarios and focuses especially on new multi-gas baseline scenarios produced since the publication of the SRES in 2000. A report from an IPCC expert meeting, which was held on 19–21 September 2007 at Noordwijkerhout, The Netherlands, and submitted by the Co-chairs of the Steering Committee, detailed further work on new scenarios or analysis of emissions, climate change, impacts, and response strategies[2]. The development of scenarios for the Fifth Assessment Report of the IPCC, scheduled for release in 2013 or 2014, is being undertaken by the scientific community. More recent information on the next generation of scenarios for climate change research and assessment is detailed in the publication Nature (Perspectives - Vol 463 11 February 2010)[3].

In the absence of new emission scenarios, officially sanctioned by the IPCC, the SRES 2000 forecasted temperature parameters increases have continued to be used in this report. It should be noted that the time frame for the use of these temperature parameters is from the current date until 2050, unless subsequently changed by IPCC.

The analysis indicated the following results:

Coffee

As both the selected coffee-producing countries, viz, Ethiopia and Rwanda, are located in the East African highlands, with similar growing conditions, the climate change scenario analysis is also similar and is given below:

(i) **Low-range climate change:** Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), with no serious long term drought conditions during the growing season, and only slight changes to rainfall levels and patterns, the following impact may be expected:

- Slightly declining overall annual production and yields, without improved agricultural practice, including conservation farming techniques, the International Institute of Tropical Agriculture (IITA) report, (see Footnote 12) forecasts a reduction of 100 kg/ha for every 1°C rise in temperature;
- Possible reduction in quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario the optimum policy is to maintain, at least existing levels of production, and where possible expand production through:

- Farmer training and capacity building in climate change resilience, including conservation and organic farming techniques (provided the quality premium/loss of yield equation is positive, i.e. benefits equal or exceed effects);
- Considering inter-planting of coffee with bananas (a cash crop) as a shade tree, as recommended by the IITA report (see footnote 12), which may reduce the temperature of the under storey plants (coffee) by 2°C or more;
- Institutional reform, particularly to improve agricultural extension delivery to farmers;
- Shortening the value chain through fostering contract farming and forward and backward linkages between farmers and retailers/certification compliance;

2 http://www.ipcc.ch/meetings/session28/doc8.pdf

3 *Nature*, Perspectives, 2010, 'The Next Generation of Scenarios for Climate Change Research and Assessment', Richard H. Moss, Jae A. Edmonds, Kathy A. Hibbard, Martin R. Manning, Steven K. Rose, Detlef P. van Vuuren, Timothy R. Carter, Seita Emori, Mikiko Kainuma, Tom Kram, Gerald A. Meehl, John F. B. Mitchell, Nebojsa Nakicenovic, Keywan Riahi, Steven J. Smith, Ronald J. Stouffer, Allison M. Thomson, John P. Weyant & Thomas J. Wilbanks. Available at: http://cmaps.cmappers.net/rid%3D1KJHRBBS9-X1Y02G-RJT/nature08823.pdf

- Identifying and assessing new areas suitable for planting coffee at higher altitudes, as temperatures increase;
- Investing in research on drought resistant and heat resilient coffee varieties;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with occasional long term drought conditions during the growing season, and frequent changes to rainfall levels and patterns including shorter rainy seasons, the following impact may be expected:

- Declining overall annual production and yields, at significant levels in some lower altitude areas, (see (i) above);
- A reduction in overall quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario, the optimum policy is to prepare for the management of likely declining production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Considering the inter-planting of coffee with bananas (see (i) above);
- Considering research into inter-planting coffee with shade trees, which may not give annual cash income, but perhaps a long term commercial benefit, e.g. as timber when felled, and will reduce the temperature of the under storey crop (coffee);
- Institutional reform (see (i) above);
- Small-scale sub-surface drip irrigation in selected areas to improve yield and maintain quality through nutrigation[4];
- Shortening the value chain (see (i) above);
- Consider the commercial planting of robusta coffee in lower altitude areas;
- Introducing crop diversification in the most vulnerable areas;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

(iii) **High-range climate change:** Under conditions of high average temperature rises (4.0°C with a likely range of 2.4 to 6.4°C), with regular long term drought conditions during the growing season, and erratic rainfall levels and patterns including much shorter rainy seasons, and regular extreme weather events, there will be serious negative results on the coffee industry and the following impact may be expected:

- Overall declining production due to heat stress and inadequate timely rainfall;
- Substantial loss of quality rendering significant production uneconomic to sell on world markets;
- High, perhaps unsustainable, crop maintenance and harvesting costs;
- Significantly large growing areas will become uneconomic for the production of coffee, and perhaps, other perennial and annual commercial cash crops.

Under this scenario, the optimum policy is geared to managing the decline of the coffee industry through:

[4] Netafim, *Drip Irrigation Doubles Coffee Production in Africa*, Guy Rayev. Available at: http://www.eafca.org/wwc/downloads/AFCCE10/presentations/Drip%20Irrigation%20To%20Boost%20Coffee%20Yields%20In%20Africa.pdf [Accessed 23 April 2013].

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Considering introducing furrow irrigation and small-scale sub-surface drip irrigation[5] in those areas that remain commercially viable;
- Shortening the value chain (see (i) above);
- Introducing crop diversification throughout the coffee growing regions of the country;
- Fostering non-farm rural enterprises, e.g. marketable handicrafts and small scale village manufacture; whilst a desirable alternative income option for farmers studies on the rural non-farm economy (RNFE)[6] have highlighted the difficulties in developing suitable viable enterprises in the this context . Particular attention needs to be paid to capital including microfinance, education and capacity building, and access to markets in order for rural enterprises to succeed.
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

Tea

The two selected tea producing countries, viz, Kenya and Bangladesh, have different characteristics. Kenya is a preeminent exporter with a small static domestic consumption market, while Bangladesh is a smaller producer, in terms of quantity, with a growing domestic market, and a declining negligible export market. However, growing conditions and location at high altitude are similar in both countries, as is the impact of climate change. Policy requirements differ in terms of Kenya's need to maintain its position as the leading tea exporter in the world, and Bangladesh's need to satisfy its growing large domestic market. However, overall impact and policy imperatives are similar, therefore, to avoid repetition, in this report summary only Kenya's impact analysis is given hereunder:

(i) **Low-range climate change:** Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), with no serious long term drought conditions during the growing season, and only slight changes to rainfall levels and patterns, the following impact may be expected:

- Slightly declining overall annual production and yields, without improved agricultural practice, including conservation farming techniques;
- Possible reduction in quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario, the optimum policy is to maintain production, at existing levels through:

- Farmer training and capacity building in climate change resilience including conservation and organic farming techniques (provided the quality premium/loss of yield equation is positive, i.e. benefits equal or exceed effects);
- Considering the extension of inter-planting of tea with shade trees which may reduce the temperature of the under storey plants (tea). The use of shade trees was historically ubiquitous in the tea industry, particularly in the sub-continent of India, however, modern practice has been to reduce cover – perhaps policy needs re-examining in the light of climate change;
- Institutional reform, particularly to improve agricultural extension delivery to farmers;

5 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

6 *The Rural Non-farm Economy: Prospects for Growth and Poverty Reduction*, Steven Haggblade, Peter B.R. Hazell and Thomas Reardon. Available at: http://fsg.afre.msu.edu/responses/Haggblade_World_Dev_forthcoming.pdf

- Shortening the value chain through fostering contract farming with black tea factories and forward and backward linkages between farmers and retailers/certification compliance;
- Identification and assessment of new areas suitable for planting tea at higher altitudes, as temperatures increase;
- Investment in research on drought resistant and heat resilient tea varieties;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with occasional long term drought conditions during the growing season, and frequent changes to rainfall levels and patterns including shorter rainy seasons, the following impact may be expected:

- Declining overall annual production and yields, at significant levels in some lower altitude areas, (see (i) above);
- A reduction in overall quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario the optimum policy is to endeavour to prepare for the management of likely declining production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Considering the inter-planting of tea with shade trees (see (i) above);
- Institutional reform (see (i) above);
- Small-scale sub-surface drip irrigation in selected areas to improve yield and maintain quality;
- Shortening the value chain (see (i) above);
- Introducing crop diversification in the most vulnerable areas; studies (see the Centre for Tropical Agriculture (CIAT) study, Footnote 25) have indicated that cabbage, peas, passion fruit and bananas (also as a shade tree) would be suitable income generating enterprises for farmers;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

(iii) **High-range climate change:** Under conditions of high average temperature rises (4.0°C with a likely range of 2.4 to 6.4°C), with regular long term drought conditions during the growing season, and erratic rainfall levels and patterns including much shorter rainy seasons, and regular extreme weather events, there will be serious negative results on the tea industry, and the following impact may be expected:

- Overall declining production due to heat stress and inadequate timely rainfall;
- Substantial loss of quality rendering significant production uneconomic to sell on world markets;
- High, perhaps unsustainable crop maintenance and harvesting costs;
- Significantly large growing areas will become uneconomic for the production of tea, and perhaps, other perennial and annual commercial cash crops.

Under this scenario the optimum policy is geared to managing the decline of the coffee industry through:

- Farmer training and capacity building (see (i) above);

- Institutional reform (see (i) above);
- Considering introducing furrow irrigation and small scale sub surface drip irrigation[7] in those areas that remain commercially viable;
- Shortening the value chain (see (i) above);
- Introducing crop diversification throughout the tea growing regions of the country;
- Fostering non-farm rural enterprises[8] e.g. marketable handicrafts and small-scale village manufacture.

Cotton

Whilst the growing conditions for cotton in the two selected countries, viz, Tanzania and Pakistan, are similar, Pakistan's industry relies hugely on irrigation from the river Indus and its tributaries, which are dependent on melt water from the Himalayan glaciers, while Tanzania's cotton production area is primarily in the region of Lake Victoria. Therefore, the impact analysis for both countries is given separately below.

Tanzania

(i) **Low-range climate change:** Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), no serious drought conditions during the growing season, and given that the area planted to cotton annually remains basically constant the following impact may be expected:

- Slightly declining overall annual production and yields, without improved agricultural practice, including conservation farming techniques;
- Possible reduction in quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario, the optimum policy is to maintain, at least existing levels, and where possible expand production through:

- Farmer training and capacity building in climate change resilience including conservation and organic farming techniques (provided the quality premium/loss of yield equation is positive, i.e. benefits equal or exceed effects)[9];
- Institutional reform, particularly to improve agricultural extension delivery to farmers;
- Introducing small-scale sub-surface drip irrigation in vulnerable selected areas;
- Shortening the value chain through fostering contract farming and forward and backward linkages between farmers and retailers/certification compliance;
- Identification and assessment of new areas suitable for planting cotton;
- Investment in research on drought resistant and heat resilient cotton seed varieties;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport. It is suggested that agribusiness small and medium sized enterprises (SMEs) are encouraged, and supported, to install small scale renewable energy capacity, mainly for own consumption within the agricultural business as a way to help to combat climate change and improve business viability. The following are the types of technologies and or equipment that could by supported: (a) small scale wind turbines, (b) hydro-electric turbines, (c) solar panels, (d) automated wood fuel boilers, (e) heat pumps, (f) solar water heating, (g) anaerobic digestion equipment using slurry and other agricultural by-products in the

7 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

8 FAO (undated) *Rural non-farm income in developing countries*, Tom Reardon. Available at: http://siteresources.worldbank.org/DEC/Resources/ruralNonfarmIncomeinDevelopingCountries.pdf

9 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

production of energy, (h) biofuel for use in transporting commodities. These types of interventions have been adopted in recent agribusiness project designs undertaken by the Asian Development Bank (ADB)[10] and the European Union (EU), and are believed to assist in compensating for reductions in crop productivity due to the negative impact of climate change. Quantitative analysis of the impact is not yet available from the examples given. These comments are equally applicable to the recommendations under the coffee and tea sections of the executive summary and the report.

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with occasional drought conditions and periods of less than optimal rainfall during the growing season, the following impact may be expected:

- Periodic loss of soil moisture leading to declining production;
- Loss of quality;
- Increased costs on pest and disease control, and weeding;
- Some growing areas will be become commercially unviable for the production of cotton.

Under this scenario, the optimum policy is to endeavour to maintain overall production at existing levels, but also to prepare for the management of likely declining production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Introducing large scale furrow irrigation and small scale sub surface drip irrigation in selected areas (drip irrigation brings better results in cotton lint per hectare yield, but tends to be more expensive and needs cost/benefit analysis)[11];
- Shortening the value chain (see (i) above);
- Identification and assessment of new areas suitable for planting cotton outside the Lake Zone;
- Investment in research on drought resistant and heat resilient cotton seed varieties;
- Introducing crop diversification in the most vulnerable areas;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

(iii) **High-range climate change:** Under conditions of high average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with frequent drought conditions and periods of less than optimal rainfall during the growing season, and regular extreme weather events, there will be serious negative results on the cotton industry, and the following impact may be expected:

- General loss of soil moisture leading to declining overall production;
- Substantial loss of quality rendering significant production uneconomic to sell on world markets;
- High, perhaps unsustainable, planting, crop maintenance and harvesting costs;
- Significantly large growing areas will be become uneconomic for the production of cotton, and perhaps, other commercial cash crops.

10 http://www.aec-fncci.org/_pdf/RISMFP-%20Project.pdf / http://eeas.europa.eu/delegations/vanuatu/projects/overview/index_en.htm

11 E.R. Norton and J.C. Silvertooth, *Evaluation of a Drip Vs. Furrow Irrigated Cotton Production System*. Available at: http://ag.arizona.edu/pubs/crops/az1224/az12245b.pdf

Under this scenario, the optimum policy is geared to managing the decline of the cotton industry through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Introducing large-scale furrow irrigation and small scale sub surface drip irrigation[12] in those areas that remain commercially viable (see (ii) above);
- Shortening the value chain (see (i) above);
- Introducing crop diversification throughout the Lake Zone and cotton growing areas in the east of the country;
- Fostering non-farm rural enterprises[13] e.g. marketable handicrafts and small-scale village manufacture;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

Pakistan

(i) **Low-range climate change:** Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), no serious shortage of water availability of good quality for irrigation during the growing season, only occasional disruption to level and pattern of rainfall, the following impact may be expected:

- A slight decline in overall annual production and yields, without improved agricultural practice, including conservation farming and improved irrigation techniques;
- Possible reduction in quality due to slight heat stress;
- Possible increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs of irrigation.

Under this scenario the optimum policy is to maintain production at least at existing levels through:

- Farmer training and capacity building in climate change resilience techniques including conservation agriculture and improved irrigation techniques including sub-surface drip irrigation;
- Institutional reform, particularly to improve agricultural extension delivery to farmers;
- Shortening the value chain through fostering contract farming and forward and backward linkages between farmers and ginners;
- Investment in research on drought resistant and heat resilient cotton seed varieties;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with regular shortages of water availability of good quality for irrigation during the growing season, frequent disruption to the level and pattern of rainfall, and occasional extreme weather events such as floods, the following impact may be expected:

12 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

13 FAO (undated) *Rural non-farm income in developing countries*, Tom Reardon. Available at: http://siteresources.worldbank.org/DEC/Resources/ruralNonfarmIncomeinDevelopingCountries.pdf

- Regular loss of soil moisture leading to declining yields and overall production;
- Loss of quality, particularly in boll size, due to heat stress;
- Increased costs on pest and disease control, weeding and irrigation;
- Some growing areas, particularly at further distances from the Indus River and its tributaries, will become commercially unviable for the production of cotton;
- Periodic very poor crops due to flooding.

Under this scenario the optimum policy is to prepare for the management of likely declining production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Extension of large-scale furrow irrigation and small-scale sub-surface drip irrigation in vulnerable areas;
- Shortening the value chain (see (i) above);
- Investment in research on drought resistant and heat resilient cotton seed varieties;
- Introducing crop diversification in the most vulnerable areas;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

(iii) **High-range climate change:** Under conditions of high average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with regular and large scale shortages of water availability of water for irrigation during the growing season, erratic rainfall levels and seasonal patterns and regular extreme weather events such as droughts and flooding, there will be serious negative impacts on the cotton industry, and the following may be expected:

- Overall loss of soil moisture leading to a major decline in overall production;
- Substantial loss of quality rendering significant production uneconomic to the domestic textile market;
- High, perhaps unsustainable, planting, irrigation, crop maintenance and harvesting costs;
- Significantly large growing areas will be become uneconomic for the production of cotton, and perhaps, other commercial cash crops;
- Some areas in Sind, close to the Indus estuary, could suffer from secondary salination of groundwater, leading to production of cotton being abandoned.

Under this scenario, the optimum policy is geared to managing the decline of the cotton industry and research into other agricultural and non-agricultural enterprises, through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Introduction of large scale furrow irrigation and small scale sub surface drip irrigation[14] in those areas that remain commercially viable;
- Shortening the value chain (see (i) above);
- Introducing crop diversification throughout the cotton growing of the country;
- Fostering non-farm rural enterprises[15] e.g. marketable handicrafts and small-scale village manufacture;

14 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

15 FAO (undated) *Rural non-farm income in developing countries*, Tom Reardon. Available at: http://siteresources.worldbank.org/DEC/Resources/ruralNonfarmIncomeinDevelopingCountries.pdf

- Considering resettlement schemes, if appropriate areas exist, for those rural populations whose likely livelihoods are most affected by climate change;
- Fostering the use of renewable energy sources throughout the value chain, particularly processing and transport.

RECOMMENDATIONS

The key recommendations to DFID for future action in the promotion and fostering of climate resilient coffee, tea and cotton value chains cover the following intervention strategies.

1. Sustainable Task Forces (STFs)[16]: Setting up multi-stakeholder STFs in the coffee, tea and cotton sectors, under the auspices and hosting of ministries of agriculture. It is recommended that STFs focus, as a prime responsibility, on initiatives at the government policy level aimed at giving incentives to stakeholders in the sustainable coffee, tea and cotton sectors, with an emphasis on achieving optimum sustainable production under a low carbon and green economy. In undertaking its mandate in this connection, the STF should work in collaboration with other relevant public and private sector organisations on (i) identification and investigation of the feasibility of applying a broad range of macro-economic incentives (ii) the implementation of sustainable coffee, tea and cotton promotion (iii) the identification of donor and private sector funding to enable the commissioning of research and feasibility studies on coffee, tea and cotton sustainability issues.

2. International sustainability certification compliance: Assistance to private sector led and facilitated certification of standards schemes for export commodities. This is the main way in which the private sector, along the value chain, can invest in making the value chain more resilient to climate change.

3. Capacity building: Training of stakeholders in (i) climate resilient value chain strategies, including conservation and organic farming techniques and furrow and drip irrigation methods and (ii) crop diversification (iii) non-farm rural enterprises.

4. Public-Private Partnership (PPP) pilot projects: Feasibility studies for PPP pilot projects on sustainable agribusiness focused on coffee, tea and cotton[17]. The proposed PPP pilot concept entails the incorporation of a holistic approach to sustainable PPP commodity development pilot projects using the following broad themes (i) the enhancement of the role of smallholders in the achievement of optimum sustainability and profitability (ii) the promotion of GHG reduction techniques (iii) the promotion of fiscal and other incentives to the achievement of low carbon and green economy agribusiness

The following are examples of other PPP pilot projects in the coffee, tea and cotton sector, with potential for scaling up, including those arising from agricultural commodity sustainability certification schemes:

1. AdapCC – Adaptation to climate change for smallholders of coffee and tea (2007-2010): PPP between GTZ and Cafédirect/Teadirect UK. Key findings are given in Section 2.4.
2. Rainforest Alliance (RA) – Carbon Coffee: A PPP between RA and the International Finance Corporation (IFC), a member of the World Bank Group; Ecom Agroindustrial Corp, the third-largest coffee trading company in the world, non-governmental organisations (NGOs) and coffee farmers in Mexico and Nicaragua. Key findings are given in Section 2.4.
3. FAO (Intergovernmental Group on Tea) - Project on the impact of climate change on global tea production (2012+): Key findings are given in Section 3.4.

16 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).
17 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

4. Project to expand the Ethical Tea Partnership's (ETP) tea climate adaptation programme: PPP between ETP, Marks and Spencer Ltd, the UK retailer, and the Kenya Tea Development Agency (KTDA). Key characteristics of the PPP are given in Section 3.7.6.
5. Better Cotton Initiative – Sustainable cotton production (from 2010): Eco-labeling PPP between global apparel/textile manufacturers and NGOs, farmers associations and cotton institutions in producing countries. Key characteristics of the PPP are given in Section 4.4.

* Draft outline TOR for 1 and 4 above are included in detail in Annex 12.

Specific commodity value chain/country recommendations are based on the above recommendations and are summarised as follows:

Coffee – Ethiopia and Rwanda

- Set up multi stakeholder STFs;
- Promote the expansion of the geographic labelling systems, using geographic indicators (GI) and trademarks as a method of certifying sustainability of coffee exports;
- Capacity building and training for smallholders and other stakeholders;
- Feasibility studies on PPP sustainability pilot projects.

Tea – Kenya and Bangladesh

- Work with Tea Board of Kenya and Tea Board of Bangladesh on developing their planned Sectoral Working Group on Climate Change;
- Work with the ETP on extending their current programme development and delivery of training courses/programmes for smallholder farmers and farmer groups in Kenya, and hopefully Bangladesh;
- Feasibility studies on PPP sustainability pilot projects.

Cotton – Tanzania and Pakistan

Unlike coffee and tea, which are perennial tree crops, cotton is grown commercially as an annual crop, therefore, farmers can be more flexible in deciding whether to grow cotton, or diversify into more profitable alternative crops. Recommendations for future action by DFID to support climate change resilient cotton value chains in Tanzania and Pakistan are similar as climate change predictions, under their respective NAPAs, indicate that both countries should plan for maintaining current levels of production, or, even, managing a decline and substituting cotton with other suitable and viable crops.

- Work with the Government and NGOs on crop diversification, away from cotton, in those cotton areas that will be most badly affected by climate change in terms of reduced production and yields. Studies in cotton growing countries suggest that suitable crops, for diversification away from cotton, include, particularly, fresh fruit and vegetables (FFV) and spices[18], particularly taking into account the use of irrigation systems. FFV tend to be high value crops, vital to food security and nutritional improvement, but less suitable for export due to difficulties in preservation of freshness;

[18] Canadian International Research Development Centre (IDRC) (2008) *Diversifying Tanzanian Agricultural Exports: Opportunities for Smallholder Farmers*, Dr Longinus Rutasitara, University of Dar Es Salam, Micro-level Perspectives of Growth (MLPG), Policy Brief. Available at: http://www.ebpdn.org/download/download.php?table=resources&id=2299

- Work with a broad range of stakeholders, e.g. Government/Cooperatives/privately owned ginneries and oil mills on developing and delivering training courses/programmes for smallholder farmers and farmer groups on adaptation strategies for coping with the negative impact of climate change on the cotton value chain;
- Feasibility studies on a PPP pilot project, on sustainable cotton production.

SECTION 1

Introduction

1.1 Background to the study

This Climate, Environment, Infrastructure and Livelihoods Professional Evidence and Applied Knowledge Services (CEIL-PEAKS) study on "Supporting Climate Resilience in Value Chains" is part of the UK Department for International Development's (DFID's) on-going work on providing information, leadership, incentives and ensuring collaboration and partnership with the private sector in fostering investment in the adaptation of agricultural value chains to the negative impact of climate change. The objective of the study is to (i) identify the most valuable commodity supply chains to developing countries, in terms of their contribution to gross domestic product (GDP) and employment; (ii) assess the extent to which those supply chains are resilient to the impacts of climate change in 2030 and 2050; and (iii) propose investments and policies needed to improve resilience along those chains.

The Stage 1 Study Report was submitted to DFID in January 2013, and approved by them in February 2013. The report reviewed the literature on climate resilient commodity supply chains in developing countries, and identified the 20 most valuable supply chains, in DFID focus developing countries, based on (i) its contribution to GDP and (ii) share of employment, using global databases such as World Development Report Indicators and FAOSTAT, in addition to country and regional economic strategies. The full terms of reference (TOR) covering the overall study were included under Annex 1 of the Stage 1 Study Report.

This report covers Stage 2 of the study and addresses the following specific TOR:

(a) An examination, in depth, of the following commodity supply/value chains, determined by DFID following submission and assessment of the Stage 1 Study Report:

1. Coffee in Ethiopia and Rwanda.
2. Tea in Kenya and Bangladesh.
3. Cotton in Tanzania and Pakistan.

The above selected supply/value chains will be examined in terms of:

(i) Current trends, including baseline trajectories for production, under a range of physical climate scenarios, while recognising the impact of climate change on the industry, to identify particular strategies to either grow the sector, sustain it, and/or to manage its decline over time, in order to derive maximum economic benefits for the economy.

(b) Suggestions on ways in which private sector firms can invest in making the supply/value chain more climate resilient, or how development institutions, such as DFID, can work with developing country governments to design policies to reduce the impact of climate change on the supply/value chain, and those who rely on it, for their income, employment, profit or revenue.

1.2 Approach and methodology

Stakeholder consultation and literature review

The study is desk based, however, a limited number of "face to face" interviews were conducted with key informants and organisations in London. Additionally, contact was made with key stakeholders via email and telephone. A list of key stakeholders/resource persons and literature and secondary documentation, which highlights specific coffee, tea, and cotton publications consulted, is included under Annex 1 to this report. The list does not repeat reference works included in Annex 2 of the Stage 1 Study Report, unless they are particularly relevant.

Approach and methodology

(i) Examination of the minimum, median, maximum, and optimum conditions for the successful growth of each selected commodity in each target country. Growing conditions in terms of temperature, rainfall and altitude are based on information provided by the Food and Agricultural Organisation's (FAO's) ECOCROP database[19] and the established authoritative crop literature cited in Annex 1.

(ii) When assessing *current trends in the value chain, including baseline trajectories for production and considering whether they will grow or will face challenges due to physical climate effects under a range of scenarios* (TOR), the forecasts given in the IPCC SRES 2000[20] have been taken into account. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report - Climate Change 2007, used emissions scenarios as developed in the Special Report on Emissions Scenarios (SRES) 2000. These emissions scenarios were used in climate model experiments, which in turn were used to generate climate scenarios used in modelling of impacts, adaptation, and vulnerability. The IPCC Fourth Assessment Report - Working Group III: Mitigation of Climate Change, Chapter 3.1, Emissions Scenarios[21] stated that the evolution of future greenhouse gas (GHG) emissions and their underlying driving forces is highly uncertain, as reflected in the wide range of future emissions pathways across (more than 750) emissions scenarios in the literature. This literature is referred to as "post-SRES" scenarios and focuses especially on new multi-gas baseline scenarios produced since the publication of the SRES in 2000. A report from an IPCC expert meeting, which was held on 19–21 September 2007 at Noordwijkerhout, The Netherlands, and submitted by the Co-chairs of the Steering Committee, detailed further work on new scenarios or analysis of emissions, climate change, impacts, and response strategies. The development of scenarios for the Fifth Assessment Report of the IPCC, scheduled for release in 2013 or 2014, is being undertaken by the scientific community. More recent information on the next generation of scenarios for climate change research and assessment is detailed in the publication Nature (Perspectives - Vol 463 11 February 2010). In the absence of new emissions scenarios, officially sanctioned by the IPCC, the SRES 2000 forecasted temperature parameters increases have continued to be used in this report.

A summary of the scenarios devised by the IPCC is included in Annex 2. An assessment of the impact of climate change on each selected commodity value chain/country has been undertaken following a "three scenario" approach, viz, (a) low-range (b) mid-range (c) high-range, with forecasted parameters for temperature increases causing surface air warming in the 21st century as follows:

19 FAO ECOCROP database. Available at: http://ecocrop.fao.org/ecocrop/srv/en/home

20 Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) (2000) Available at: http://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf [Accessed 22 February 2013].

21 http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch3s3-1.html

a) Low-range scenario: The best estimate is for an average temperature increase of 1.8°C with a likely range of 1.1 to 2.9°C.
b) Mid-range scenario: The best estimate is for an average temperature increase of 3.2°C with a likely range of 1.75 to 4.7°C.
c) High-range scenario: The best estimate is for an average temperature increase of 4.0°C with a likely range of 2.4 to 6.4°C.

The IPCC SRES 2000 also forecasts the following with regard to sea level rises, and extreme weather events:

Sea level rises: Based on multiple models that all exclude ice sheet flow due to a lack of basis in published literature, it is estimated that sea level rise will be:

- In a low-range scenario 18 to 38 cm.
- In a mid-range scenario 22 to 48 cm.
- In a high-range scenario 26 to 59 cm.

Extreme weather events: (a) it is very likely that there will be an increase in frequency of warm spells, heat waves and events of heavy rainfall, and (b) that there will be an increase in areas affected by droughts, intensity of tropical cyclones (which include hurricanes and typhoons) and the occurrence of extreme high tides.

It should be noted that predictions of temperature and water variability can vary enormously; therefore caution is advised in forecasting the direction of commodity production in terms of growth, stagnation or decline. The degree of climate change and its impact remain uncertain, particularly regarding equilibrium and transient climate sensitivity to rising GHG emissions[22].

(iii) Assessment of the current and proposed mitigation and adaptation techniques in each case.

(iv) Recommendation of future action for DFID.

(v) Whilst the TOR refers specifically to the impact of climate change on coffee, tea, and cotton value chains, the approach taken in the study suggested that future action by DFID takes a holistic approach and targets overall agricultural sustainability in commodity value chains. Coping with the impact of climate change, particularly the promotion of GHG emissions reduction techniques, is a major element in agribusiness sustainability, together with other issues such as prevention of land degradation under farm and plantation management, the destruction of forests for agricultural expansion, destruction of the habitats of endangered flora and fauna species, the avoidance of social conflicts and compliance with international labour rules and regulations. These issues are the concern of increasingly influential international standards and quality certification agencies for the export of agricultural commodities, e.g. the Rainforest Alliance (RA) and the Ethical Tea Partnership (ETP), described in Sections 2 and 3 of this report.

Agribusiness value chains and supply chains: The TOR uses both the expression value chain and supply chain; these terms are often used interchangeably as they are closely related and it should be noted that an integral component of the value chain is the agricultural supply chain. The integration of the value chain, enabling forward and backward linkages between farmer and consumer, is an important tool in the improvement of both

[22] *The Economist*, 'A sensitive matter', 30 March 2013.

marketing efficiency, and adapting to climate change, particularly to the benefit of farmers. Basically, the value chain is a connected string of companies, groups and other actors, including farmers, working together to satisfy market demand for a particular product or group of products. At each stage of the value chain, from farmer through to consumer, monetary value is added to the original cost production, representing actual transaction costs plus profit margins for each actor in the chain. As the TOR states "Supporting Climate Resilience in Value Chains" the term **value chain** has been used throughout this report.

Finally, it is noted that climate change is a global phenomenon and meaningful mitigation policies and strategies require joint global responses. Whilst admirable in itself unilateral mitigation action to reduce GHG emissions by individual countries, and particularly smaller developing countries are unlikely to have much impact on the slowing of climate change globally. Even the most aggressive stabilisation targets being discussed imply acceptance of a global average temperature rise of 1 to 3^{0}C[23]. This will lead both to more frequent and severe climate-related disasters (including droughts, flooding and storms) and to longer-term stresses (including changing rainfall patterns, ecosystem degradation, reduced biodiversity and higher sea levels).

These changes will affect poorer countries disproportionately: not only are they typically reliant on climate sensitive industries like agriculture and forestry, but poverty, poor health and limited capacity and resources increase their vulnerability.[24] For these reasons, the report focuses on recommendations for adaptation to climate change rather than mitigation.

1.3 National Adaptation Programmes of Action (NAPAs)

For the purpose of this report, the identification of government policy and strategy for coping with the impact of climate change in each selected country uses the respective National Adaptation Programmes of Action (NAPAs). Under the United Nations Framework Convention on Climate Change (UNFCCC)[25] NAPAs have been developed to provide a process for Least Developed Countries (LDCs) to identify priority activities that respond to their urgent and immediate needs to adapt to climate change. The NAPAs focus on urgent and immediate needs, i.e. those for which further delay could increase vulnerability or lead to increased costs at a later stage. NAPAs are based on existing information and no new research is needed. They must be action-oriented and country-driven and be flexible and based on national circumstances. Finally, in order to effectively address urgent and immediate adaptation needs, NAPA documents should be presented in a simple format, easily understood both by policy-level decision-makers and by the public. To date, the UNFCCC secretariat has received NAPAs from 47 LDCs, including Ethiopia, Rwanda, Kenya, Bangladesh, Tanzania and Pakistan (under preparation), viz, those countries selected for this study. Support to countries preparing NAPAs is given by the Global Environment Facility (GEF) providing financial support through the United Nations Environment Programme (UNEP).

23 IPCC 2007

24 Key Elements of a Global Deal

25 United Nations Framework Convention on Climate Change (UNFCCC) website: http://unfccc.int/national_reports/napa/items/2719.php

SECTION 2

Coffee

2.1 Introduction

This section reviews the global coffee market, with particular reference to **Ethiopia** and **Rwanda**, and assesses the impact of climate change on the coffee value chain. A supplementary note on the world coffee trade, describing coffee growing and processing, global production, further details of the value chain, trading systems and production and price trends, is included under Annex 3. The coffee genus, Coffea Arabica L. (Arabica Coffee) is native to the tropical forests of East Africa, and Coffea Canephora Pierre (Robusta Coffee) is native to the dense, lowland, equatorial rainforest forests of the Congo River basin, extending up to Lake Victoria in Uganda, where it developed as a mid-storey tree. Arabica and robusta types of the perennial coffee tree dominate, economically, the world coffee trade, accounting for about 99% of world production. **Ethiopian** and **Rwandan** coffee production is primarily arabica.

2.2 Coffee value chains and marketing systems

The components of the coffee value chain vary with the unique institutional framework of each origin country. Whilst the specific supply chains for **Ethiopia** and **Rwanda** are given in Sections 2.6 and 2.7 below, under Figures 1 and 2, the following simple common components may be identified:

- Farmer/large farms/plantation/cooperative groups sell coffee cherry at ex farm price to trader/agent;
- Trader/agent sells coffee cherry to green coffee processing mills at delivered mill price;
- Coffee mill sells green coffee, to domestic roasters, or exporters, either direct or through a coffee auction centre or futures and options market;
- Exporter sells green coffee to overseas buyers at free on board (FOB) or cost, insurance and freight (CIF) price;
- Overseas buyers sell green coffee to roasters/blenders/packers in destination countries;
- Roasters/blenders/packers sell to supermarkets and other retailers, who sell on to consumers.

Notwithstanding the impact of climate change at the coffee cherry and green coffee production stages above, it should also be noted that along the chain transport (road, rail, sea and sometimes air for premium gourmet packaged coffee) is involved which results in the emission of greenhouse gases (GHGs). The world coffee trading system is extremely complex, however, it should be noted that in coffee trading, as in other mainstream commodities with futures and options (terminal) markets (e.g. coffee, cocoa, grains, sugar and oils), there is a clear distinction between the physical (also known as the actual or cash market) and futures and options markets. The physical market deals in specific grades and origins of coffee at quantities, qualities, delivery times, packaging, and price and payment conditions to be negotiated privately between buyers and sellers. The physical market is open to anyone who has the means, opportunity and willingness to enter it and has access to it. The futures and options market, however, is a restricted market, at a specific location,

e.g. New York Coffee Exchange, where an individual or company must use an intermediary to buy and sell coffee and has, often, substantial financial resources to meet contractual obligations. It should be noted that futures and options markets are used both to hedge against price risks and to speculate. Both the physical and actual markets are inextricably entwined in determining the level of coffee prices.

2.3 Coffee and climate change[26]

Whilst coffee production systems are basically regional to sub-regional as the climate is strongly influenced by local topography, location and proximity to sea and oceans, some generalised possible effects and potential impacts of climate change on coffee production have been suggested in recent research and are described hereunder. The impact, of climate change on coffee production, in terms of low, mid and high-range climate change scenarios is assessed under the **Ethiopia and Rwanda** sub-sections 2.6.5 and 2.7.5 below.

Possible effects of climate change on coffee production

Optimum growing conditions: Arabica coffee grows at altitudes ranging from 1,500 metres (m) to 2,800 m, between the latitudes of 4°N and 9°N. In these regions air temperature shows little seasonal fluctuation, with a mean annual air temperature between 18°C to 22°C. Rainfall is well distributed, varying from 1,600 millimetres (mm) to more than 2,000 mm per annum, with a dry season lasting three to four months, which coincides with the coolest period of the year. Robusta coffee needs an annual mean temperature ranging from 23°C to 26°C, without large oscillation, and abundant rainfall of above 2,000 mm, distributed over a 9 to 10 month period.

Climatic variability and change, particularly in temperature and rainfall, is the main factor responsible for changes in global coffee yields and quality, and hence profitability and farmers' incomes. Though adverse air temperatures, solar radiation and relative humidity influence many of the physiological processes of the coffee tree, temperature and rainfall conditions are considered to be the most important factors in defining potential yield. The relationships between climatic parameters and the agricultural production are complex, because environmental factors affect the growth and the development of the plants in different ways during the phenological phases of the coffee growth. Agro-meteorological models, related to growth, development and productivity, can supply information for the monitoring of soil water and yield forecasts, based on the air temperature and water stress derived by a soil/water balance during different crop growth stages. Thus the effect of the available soil/water balance on the decrease in the final yield can be quantified. The process of photosynthesis becomes limited when water stress occurs, due to the reduction in the physiological activities of the plant. Other climatic factors can reduce productivity, such as adverse air temperatures during different growth stages. A study was conducted aimed at the development of an agro-meteorological model (Camargo et al, 2009)[27] that monitors and assesses the quantitative influence of climatic variables, such as air temperature and soil water balance on the coffee crop phenology and yield for different Brazilian regions. This kind of model could be an efficient tool to assess the environmental effects of new technologies and future climate change scenarios.

Besides the direct impacts of high temperatures on the coffee crop, the increase of pests and diseases is a consequence of increasing temperatures. Scientists at the Brazilian

[26] Key sources for this section: International Coffee Organisation (ICO) (2009) *Climate Change and Coffee*; and Natural Resources Institute (NRI) (2012) *Coffee and Climate Change: Impact and Options for Adaptation in Brazil, Guatemala, Tanzania and Vietnam*, Jeremy Haggar and Kathleen Schepp.

[27] Marcelo Bento Paes de Camargoe (2009) *Impact of Climatic Variability and Climate Change on the Arabica Coffee Crop in Brazil,* Centro de Ecofisiologia e Biofísica, Instituto Agronômico, Caixa Postal 28, 13012-970 Campinas (SP). Bolsista de Produtividade Científica do CNPq.

Agricultural Research Corporation (Embrapa) have studied the impact of climate change on the distribution of nematodes and leaf miner and expect an increasing occurrence.

Much less literature is available concerning the impacts of temperatures and rainfall distribution on robusta. This may also have led to less concern about the impacts of climate change on robusta, but could also be due to the lower trading volume on the world's coffee market (30%) compared to arabica (70%). A factor that is not well understood is the response of coffee to the increased carbon dioxide (CO2) concentrations involved in climate change. Many plants respond favourably to increased CO2 concentrations which can contribute to increased water use efficiency. This may partially offset some of the negative consequences of increased water stress related to changing temperature and rainfall. Researchers in Brazil are initiating research to elucidate the real potential for the amelioration of the negative effect of climate change on coffee growth from increased CO2 concentrations.

The International Trade Centre (ITC), Geneva, has made the following recent comments on the possible effects and impact of climate change and the coffee sector in its Coffee Guide (2011)[28].

Quality: As temperature rises, coffee ripens more quickly leading to a fall in inherent quality. This statement is supported by the fact that low grown arabica from tropical areas with higher temperatures mostly show less "quality" compared to the same coffee grown at higher altitudes. The beans are softer and may well be larger but, lack the "quality" characteristic. If by the end of the 21st century temperatures rise by 3°C (some experts believe an increase of up to 5°C is possible), then the lower altitude limit for growing good quality arabica may rise by some 5 metres per annum, meaning that over time areas that are currently too cold for coffee could become suitable. But it is uncertain whether land at higher altitudes would in fact become available, or be rendered suitable, for coffee production.

Yield: If climatic events such as overly high temperatures occur during sensitive periods of the life of the crop, e.g. during flowering or fruit setting, then yields will be adversely affected, particularly if accompanied by reduced rainfall.

Pests and diseases: Higher temperatures will not only favour the proliferation of certain pests and diseases, but will also result in these spreading to regions where they were not normally present. Research suggests that the incidence of pests and diseases such as coffee berry borer, leaf miner, nematodes, coffee rust and others will increase as future temperatures rise. The consequent need for more control will make coffee production both more complicated and more expensive.

Irrigation: Areas currently not requiring this may do so in the future due to increased evaporation that reduces the soil's moisture content. Other areas may experience increases in both rainfall and the variability thereof.

Complexity and uncertainty make it hard to be precise; however, there is a real possibility that fewer parts of the world will be suitable for growing coffee. If so, then the already evident growth in the geographical concentration of production could become even more pronounced. This in turn could make global production more prone to high fluctuations, as any severe disruption in output from one of the major producers would drastically curtail global output. Secondly, the cost of production will increase more than would have been the case without global warming and thirdly, competition from other crops for available arable land may increase. It should be noted that current initiatives to reduce the extent of global

[28] http://www.intracen.org/coffee-guide/climate-change-and-the-coffee-industry/the-coffee-sector-and-climate-change/

warming are mostly aimed at limiting further warming, not to reverse it rapidly. This means everyone in the coffee value chain needs to adapt by taking actions to minimize and adapt to the seemingly inevitable negative effects of climate change.

2.4 Climate change impact initiatives in the coffee sector

Overview: Climate change initiatives in the coffee sector include specific multi and bilateral donor projects, multinational corporations (MNCs) and public-private partnerships (PPPs), and coffee certification schemes, which include compliance with environmental standards. Small-scale farmers in the developing world dominate production for many agricultural commodities, such as coffee, and the need for information, knowledge and capacity building in coping with climate change by this key group of stakeholders is acknowledged as being paramount. Small-scale farmers face particular challenges in building their livelihoods from agriculture, including geographical dispersion, contributing to high transport and transaction costs, a lack of market information, and limited access to affordable credit and inputs. Furthermore, small-scale farmers capture a low and declining share of the final purchase price of their produce, and often face problems of environmental sustainability, including coping with the impact of climate change[29].

Coffee certification schemes to ensure sector sustainability, led by the private sector, have their genesis in consumer pressure and the marketing strategy of the major brand leaders and retailers, particularly supermarkets, in developed countries. Furthermore, such schemes are geared to the export market, and tend to ignore the interests of domestic consumers in producing countries, who are surely entitled to the same safeguards regarding standards as those in the developing world. The costs of compliance with certification fall mainly on actors along the value chain in producing countries, particularly growers, processors and internal transporters. It is also acknowledged that these schemes have had a beneficial effect on, or at the very least, have not harmed, the health, safety, and working conditions of employees in the coffee industry, together with having a positive impact on environmental issues, including climate change. However, it is considered that there is room for additional sustainability initiatives, with greater focus on value chain climate change adaptation involving both public sector involvement in producing countries, and the private sector. The above comments apply equally to the certification schemes in the tea and cotton sectors, and reference is made to ways and means of achieving progress in this regard in the recommendations for future action given in Section 4.

Some relevant global selected climate change initiatives in the coffee sector are described below.

AdapCC – Adaptation to climate change for smallholders of coffee and tea: The project, implemented between April 2007 and February 2010, supported coffee and tea farmers in developing strategies to cope with the risks and impacts of climate change. The pilot initiative was implemented between April 2007 and February 2010 as a PPP by the leading British fairtrade company for hot beverages Cafédirect and German Technical Cooperation (GTZ). Financing of the project was shared by Cafédirect (52%) and the PPP programme (48%). The project has focussed on six pilot regions in Latin America and East Africa, viz, Mexico, Peru, Nicaragua (coffee farmers) and Uganda, Tanzania, Kenya (tea farmers). The successful pilot project will be extended and continued by Cafédirect and several regional and international public and private institutions. The key findings of the project identified the following key climate change adaptation principles:

[29] International Institute for Environment and Development (IIED) (2012) *Pro-poor certification: Assessing the benefits of sustainability certification for small-scale farmers in Asia*, Emma Blackmore and James Keeley with Rhiannon Pyburn, Ellen Mangus, Lu Chen and Qiao Yuhui.

- Strengthening the resilience of a farmer's plantation by applying sustainable agriculture practices is the first step to mitigate the risk of being affected.
- Diversifying farmers' income and food production reduces their dependence on monocultures and spreads the risk of yield and income loss.
- Diversification with cash crops suitable for future production beyond climate change turns climate change losers into the winners of climate change.
- Increasing the efficient use of natural resources like forests, biodiversity, water, and soil increases farmers' productivity in the long run and in a sustainable way.
- Selecting more resistant crop varieties could be an option to adapt coffee and tea production.
- Adopting the technologies for processing helps farmers to conserve the quality of the products and earnings.
- Building farmers' capacity through providing access to information and knowledge empowers them to take action and make decisions.
- Building partnerships between different public and private actors helps farmers to benefit from improved framework conditions to cope with climate change.
- Receiving income from climate friendly certified products or credits for reduced greenhouse gas emissions could be an option to finance adaptation measures.

The Rainforest Alliance (RA): The RA based in the USA, with regional offices in Central and South America, Europe, West Africa and South East Asia, works to conserve biodiversity and ensure sustainable livelihoods by transforming land-use practices, business practices and consumer behaviour. The Alliance aims to arrest the major drivers of environmental destruction in areas such as timber extraction, agricultural expansion, cattle ranching and tourism. The Alliance's approach is to endeavour to give consumers a reliable way to identify responsibly produced goods and services through the RA Certified seal and RA Verified mark. The alliance is involved in the certification of both coffee and tea production, and has a growing focus on the adaptation and mitigation of the impact of climate change on agricultural commodity supply chains. Two initiatives, introduced by the RA, are described below.

1. Rainforest Alliance – Carbon Coffee: Climate change is recognised as contributing to biodiversity loss, desertification, forced human migrations, water shortages, weather related disasters and poverty, and coffee farmers can play an important role in mitigating these changes. In this context the RA collaborated with the International Finance Corporation (IFC), a member of the World Bank Group; Ecom Agroindustrial Corp., the third-largest coffee trading company in the world; and coffee farmers in Mexico and Nicaragua to develop a credible methodology for measuring and verifying carbon stored on coffee farms**.** To help farmers participate in efforts that alleviate the impact of climate change the two-year project, which concluded in 2009, worked to:

    - Help combat climate change by promoting reforestation.
    - Allow coffee growers to earn additional income by planting and growing trees on their farms and selling the carbon absorbed by those trees.
    - Select a methodology that can be used in other regions and sectors.
    - Avoid the high transaction costs normally associated with carbon-offset projects.

    The benefits of reforesting coffee lands**:** Climate scientists regard reforestation, especially in the tropics, as one of the most practical and least expensive ways to ameliorate the negative impact of climate change. By planting trees to shade their coffee plants, farmers can draw CO2, the GHG most responsible for climate change, from the atmosphere and store it in trees. The RA envisions that the carbon credits resulting from the implementation of reforestation projects, guided by the following

process, will be sold in two ways, viz, (i) via an "aggregation model," where a number of farmers can consolidate their carbon credits to sell to a buyer, and (ii) via a "coffee plus carbon model," where individuals or small groups of farmers can earn additional income by selling carbon credits through the conventional coffee value chain.

Methods for Monitoring Carbon**:** In 2009, the RA tested the methodology in Mexico and Nicaragua to ensure that it was suitable for reforestation carbon projects on Central American farms. However, with additional information, the methodology can be applied using the tools developed by the RA in all of the world's coffee and cocoa producing regions. The coffee industry and consumers support the concept, and the combination of carbon-offset initiatives with existing conservation efforts offers clear benefits for the industry, farmers and the planet. Besides helping to slow the effects of climate change, reforestation contributes to biodiversity conservation by providing critical wildlife habitat, helps coffee farmers improve the quality of their beans, supplies firewood, construction materials, fruit and other forest goods, and protects the watersheds that provide drinking water. The carbon credit market, currently valued around $120 billion, continues to expand, even with carbon prices currently at record lows the United Nations (UN) believes that the carbon offset market has a long future in helping the world curb man-made GHG emissions[30]. As companies seek to offset their emissions voluntarily and compensate for those emissions they cannot eliminate, carbon conservation, through activities such as, reforestation, has the potential to yield significant economic benefits for farmers who can generate credits to sell on the carbon market. Some farmers are already receiving modest payments for carbon offsets, watershed protection and other "environmental services." The roadblock to giving more farmers access to the lucrative carbon market is the cost of the vital studies and monitoring that are required by carbon credit buyers. Without such guarantees, investors cannot know that the trees were really planted and that they continue to grow.

2. Rainforest Alliance - Coffee Farm Certification**:** Under this scheme, farms undergo rigorous annual audits, which verify their compliance with the stringent criteria for social, environmental and economic sustainability set by the Sustainable Agriculture Network (SAN), a consortium of non-governmental organisations (NGOs). If auditors could measure the carbon sequestered by trees planted to earn carbon credits at the same time that these farms are being audited to the SAN standards, the carbon monitoring costs would be low and the credibility of the results would be high. The SAN standards already require and monitor reforestation, but trees planted for carbon reforestation projects must be additional to those already existing to help farms meet the SAN standards. As a result of this project, eligible groups of farms, coffee traders and associations, and other project developers now have guidance on how to implement a widely regarded, but highly technical methodology for small-scale agroforestry activities that will allow them to participate in the global carbon market.

Utz Certified: The Utz Certified system is based on the idea of Good Agricultural Practices (GAP), as specified by the Global Partnership for Good Agricultural Practice (GLOBALGAP). Its primary emphasis is on traceability and production practices and processes. It offers producers access to high-specification traceability technologies. It does also incorporate some social and environmental criteria such as abiding by International Labour Organization (ILO) conventions regarding wages and working hours and responsible use of agrochemicals.

[30] Reuters, 19 July 2012, statement by the Chairman of the UN Clean Development Mechanism (CDM).

CAFÉ Practices: The CAFÉ Practices system is a corporate ethical sourcing scheme which evaluates the sustainable production of cherry and green coffee. It prioritises quality and economic accountability. The scheme is designed and managed by Starbucks, though it is verified by a third party, viz, Scientific Certification Systems. Product quality and economic accountability are prerequisites for participation in the scheme, although the standard also includes social responsibility and environmental leadership criteria, including climate change issues.

Geographic labelling: Geographic labelling is a potentially useful complement or alternative to sustainability certification. It has been successful for Colombian and Jamaican Blue Mountain coffee, Darjeeling tea and tequila, for example, and appears to be offering some benefits for **Ethiopian** coffee. Use of geographical indicators (GIs) is one approach to geographic labelling; another is to use trademarks or collective trademarks, as has been done in **Ethiopia**. Trademarks can be a useful approach where the state does not have the capacity to enforce a GI, but they will not necessarily result in more value returning to producers in the region. The use of geographic labels has been favoured by the developed world and particularly the European Union. It is likely to be easier for developed countries to use intellectual property rights such as trademarks and GIs because they are better able to absorb the costs associated with creating, promoting and enforcing geographic labels. Those opting for a geographic label-based development strategy may find there are many unforeseen costs to this approach. GIs require considerable investment from the state to ensure adequate enforcement. It may be useful to build up the reputation of a GI locally before reaching out to overseas markets. Indeed, long-term investments in marketing will need to be made in order to generate added value in a GI. Products will generally need to be of a high quality and have distinctive characteristics associated with the place and method of production.

Fairtrade certification: Fairtrade is defined as an alternative approach to conventional trade that aims to improve the livelihoods and wellbeing of small producers. Its emphasis is on fairness and building livelihoods through its minimum prices and social premium. Fairtrade regards environmental sustainability, and in particular awareness of climate change mitigation and adaptation strategies, as necessary to underpin sustainable livelihoods.

Organic certification: Organic certification is technically challenging, knowledge and labour intensive, but likely to deliver environmental benefits including climate change awareness[31]. Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It emphasises a knowledge-intensive rather than input intensive farming system. It is regarded as a technically challenging certification that requires learning new skills and is typically associated with high quality products. It is made more challenging by the fact that there is no single system for organic certification, with different standards existing for Japanese, US and European markets. A major problem with organic certification is that the cost of certification, and the cost of implementing organic practice, e.g. eradication of agricultural chemicals, may exceed the current organic premium available on the market.

2.5 Global coffee production and price trends

The 5 year global trend in coffee production indicates that production should continue to increase in the medium to long term, notwithstanding the possible negative impact of climate change on overall global production volumes. World coffee production over the past 22 years, according to official International Coffee Organisation (ICO) statistics for crop years 1990 to 2012, has increased from 92.253 million 60 kg bags to 144.061 bags, an increase of around 54%. Whilst the overall trend over this period is for world production to increase, it is interesting to note that production dipped in 1992, 1994, 1996, 2000, 2003, 2005, and 2007.

[31] IFOAM EU Group (2009) *Organic Agriculture, A Guide to Climate Change and Food Security.*

It is very difficult to ascertain the extent to which climate change has had an impact on production levels during this period. However, although production is influenced by other factors as well as climate, particularly, political unrest, end season stock levels, price trends, consumption trends and farmers' harvesting intentions, it is acknowledged by coffee industry experts including ICO statistical analysts, that the vagaries of climate usually have the major influence on the annual levels of production. It should be noted that production levels over the past 6 years have risen from 116.612 million bags to 144.061 million bags, a rise of around 27%.

This scenario is similar for the selected countries of Ethiopia and Rwanda. Whilst farmers report changing weather patterns, particularly longer drought periods, shorter rainy seasons and greater fluctuations in temperature during the year, no long term trend in production decline can be discerned. Further statistics will be needed to draw definitive conclusions on the quantitive impact of climate change on volumes.

The medium term outlook is for prices to remain stable to higher (ICO). However, predicting prices in the volatile coffee market is notoriously difficult, as a recent article from the commodity analysts, Agritrade (http://agritrade.cta.int/en) indicates. The article is included under Annex 2, Coffee – supplementary note.

2.6 The Ethiopian coffee sector

2.6.1 Introduction

Annex 4 contains a map of Ethiopia, general economic information, and further details of the country's coffee sector. Ethiopia claims to be the birthplace of the arabica coffee tree and the industry is vital to the country's cultural and socio-economic life, providing livelihoods for over 15 million of its inhabitants, including an income source from casual labour for poor rural people. The Ethiopian economy is highly dependent on coffee which contributes over 25% of its foreign exchange earnings, and represents 31.5% of all merchandise exports, and 2.59% of gross domestic product (GDP). In 2010/11 Ethiopia exported coffee to 53 destination countries, with a total volume and value of 196,117 mt and US $ 841.65 million respectively, an increase over the previous annual figure of 13.9 % and 59.3% respectively.

2.6.2 Ethiopian coffee production

The Ethiopian coffee production system may be classified as follows[32]:

Forest and semi-forest coffee: 45% of Ethiopia's coffee is either semi-forest coffee (30-35%) or forest coffee (8-10%), found in the south-west and in Bale (south-east). The coffee trees in these regions are often very tall as they have to fight the other forest trees to reach the light, and for this reason their productivity is usually low. The difference between forest and semi-forest coffee is that the former is totally wild, while the latter is harvested from semi-wild plants in smaller patches of forest (often near roads or settlements) where farmers thin the upper canopy and annually slash the undergrowth to aid production.

Garden coffee: Around 50-55% of coffee produced in Ethiopia is classified as garden coffee, grown on small plots of land around rural people's homes. Most Ethiopians live in rural locations obtaining their livelihoods primarily from farming small plots of land, growing both cash crops, such as coffee, and food for their own consumption. In coffee growing areas, coffee is the main cash crop, covering around 0.5 ha to 1.5 ha of land, usually planted

[32] Mercanta Ltd, http://www.coffeehunter.com/contact and Ethiopian Government Ministry of Trade.

alongside a second cash crop, often a large-leafed tree, which also is a shade provider for coffee, and known as “false banana” used to produce both a nutritious flour and a fermented paste that are staple food ingredients (particularly across southern Ethiopia).

Plantation coffee: Only a very small proportion (5-6%) of Ethiopian coffee is grown on estates. These large plantations, averaging some 2,800 ha, are based in west of the country, mostly in the lower altitude growing regions. Until recently, these estates were exclusively state-owned, however new legislation has sanctioned private ownership, which may increase the proportion of plantation coffee in the future.

2.6.3 The Ethiopian coffee value chain and marketing

The system of marketing coffee in Ethiopia is described in detail under Annex 4, and the supply chain is illustrated in Figure 1 below, and comprises the following key transaction stages:

Primary Level Coffee Transaction Centres (PLCTC): Located near to coffee farms where coffee farmers and suppliers buy and sell coffee. Currently there are about 979 primary coffee marketing centres in the country.

Ethiopian Commodity Exchange (ECX): This is the secondary level of the chain where coffee is traded. There are currently ECX warehouses located at 8 different locations of the country, viz, DireDawa, Hawasa, Dilla, Sodo, Bonga, Dijimmah, Bedele and Gimbi. Trading is carried out by open outcry at the ECX in Addis Ababa.

International coffee market: This is third level of the chain where exporters sell coffee to international importers.

2.6.4 National climate change policy

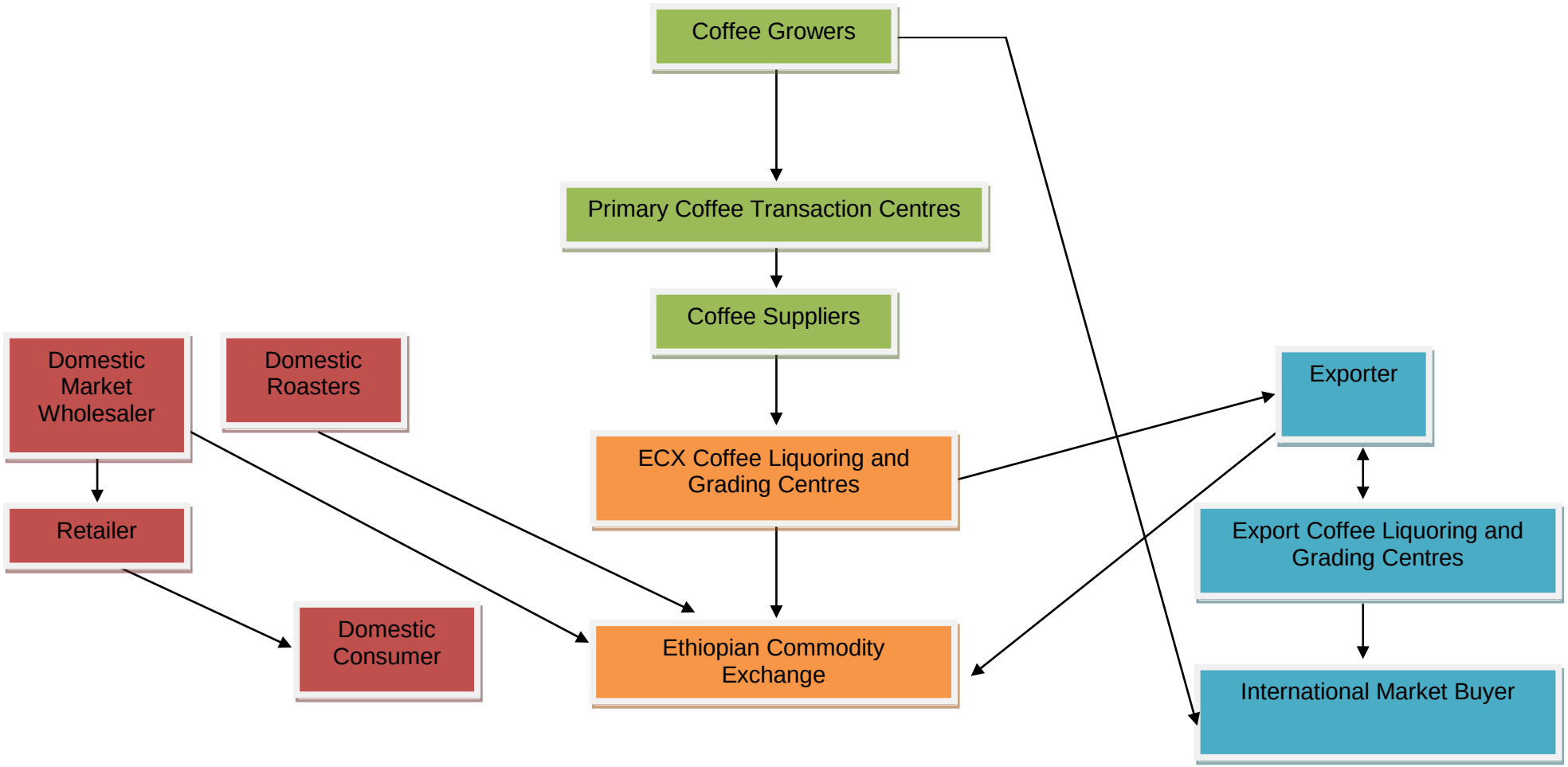
Ethiopia has been identified as one of the most vulnerable countries to climate variability and change, and is frequently faced with climate-related hazards, commonly drought and floods. Climate related hazards documented as affecting Ethiopia include drought, floods, heavy rains, strong winds, frost and high temperatures (National Adaptation Programme of Action (NAPA) 2007). The most significant hazards are drought and floods. The cause of exceptional vulnerability to climate change hazards in Ethiopia is due to much of Ethiopia’s population being dependent on small-scale rain-fed agriculture, such as coffee production, and livestock production. Therefore, the national economy and the livelihoods of its people are highly vulnerable to climate change. The Federal Democratic Republic of Ethiopia has put in place policies, strategies and programmes that enhance the adaptive capacity and reduce the vulnerability of the country to climate variability and in 2012 the Climate Resilient Green Economy (CRGE) initiative was launched to protect the country from the adverse effects of climate change and to build a green economy that will help realise its ambition of reaching middle income country status before 2025. The CRGE initiative builds on the NAPA of Ethiopia, being implemented under the auspices of the Ministry of Water Resources, and, originally, the National Meteorological Agency[33], but now the responsibility has been transferred to the Environmental Protection Authority (EPA).

[33] United Nations Development Programme (UNDP)/Global Environment Facility (GEF) (2007) *Preparation of National Adaptation Programme of Action for Ethiopia* for the Ethiopian National Meteorological Agency (NMA).

2.6.5 Impact of climate change on coffee production

For the Intergovernmental Panel on Climate Change (IPCC) mid-range (A1B) emission scenario, the mean annual temperature will increase in the range of 0.9 - 1.1°C by 2030, in the range of 1.7 - 2.1°C by 2050 and in the range of 2.7 - 3.4°C by 2080 over Ethiopia compared to the 1961-1990 normal. A small increase in annual precipitation is also expected over the country. Projected climate change over Ethiopia has been generated using the software MAGICC/SCENGEN (Model for the Assessment of Greenhouse-gas Induced Climate Change)/(Regional and Global Climate SCENario GENerator) coupled model (Version 4.1) for three periods centred around the years 2030, 2050 and 2080.

Figure 1 Ethiopia Coffee Value Chain



A recent study by the International Institute of Tropical Agriculture (IITA) in collaboration with those from the Colombian-based International Centre for Tropical Agriculture (CIAT), on coffee-based livelihoods in the East African highlands, including Ethiopia and **Rwanda**, found that the areas suitable for growing arabica coffee will drastically decrease in the future leading to losses in the region that may exceed US$100 million annually[34]. The researchers interviewed farmers in the region who said the climate was already changing, with droughts becoming longer, rainfall becoming more erratic, and the rainy seasons becoming shorter, which negatively affected the flowering of coffee and reduced the sizes of the coffee cherries. Furthermore, farmers had also observed that pests and diseases such as leaf miners, coffee berry borers, mealy bugs, and leaf rust were on the rise.

Impact of climate change on coffee production under a low, mid and high-range scenario

Coffee is Ethiopia's most important agricultural crop and significant effort should be applied to maintain its role in the economy. Coffee is grown throughout the highlands of Ethiopia. Whilst the expected different impact of levels of climate change is described below, some results and policy options will be common to all three scenarios.

(i). **Low-range climate change:** Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), with no serious long term drought conditions during the growing season, and only slight changes to rainfall levels and patterns, the following impact may be expected:

- Slightly declining overall annual production and yields, without improved agricultural practice, including conservation farming techniques, the IITA report, (see Footnote 12) forecasts a reduction of 100 kg/ha for every 1°C rise in temperature, which may be somewhat pessimistic;
- Possibly reduction in quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario the optimum policy is to maintain, at least existing levels, and possibly expand production through:

- Farmer training and capacity building in climate change resilience including conservation and organic farming techniques (provided the quality premium/loss of yield equation is positive, i.e. benefits equal or exceed effects);
- Consider the inter-planting of coffee with bananas (a cash crop) as a shade tree, as recommended by the IITA report, (see Footnote 12) which may reduce the temperature of the under storey plants (coffee) by up to 2 °C or more;
- Institutional reform, particularly to improve agricultural extension delivery to farmers;
- Shortening the value chain through fostering contract farming and forward and backward linkages between farmers and retailers/certification compliance;
- Identification and assessment of new areas suitable for planting coffee at higher altitudes, as temperatures increase;
- Invest in research on drought resistant and heat resilient coffee varieties;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

[34] International Institute of Tropical Agriculture (IITA) (2013) *Banana can protect coffee from the effects of climate change*. Available at: http://www.iita.org/bananaplantain-asset/-/asset_publisher/9zYD/content/banana-can-protect-coffee-from-the-effects-of-climate-change?redirect=%2Fbanana-and-plaintain [Accessed 29 April 2013].

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with occasional long term drought conditions during the growing season, and frequent changes to rainfall levels and patterns including shorter rainy seasons, the following impact may be expected:

- Declining overall annual production and yields, at significant levels in some lower altitude areas, (see (i) above);
- A reduction in overall quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario the optimum policy is to endeavour to prepare for the management of likely declining production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Consider the inter-planting of coffee with bananas (see (i) above);
- Consider research into inter-planting coffee with shade trees, which may not give annual cash income, but perhaps a long term commercial benefit, e.g. as timber when felled, and will reduce the temperature of the under storey crop (coffee);
- Institutional reform (see (i) above);
- Small scale sub surface drip irrigation in selected areas to improve yield and maintain quality through nutrigation[35];
- Shortening the value chain (see (i) above);
- Consider the commercial planting of robusta coffee in lower altitude areas;
- Introduce crop diversification in the most vulnerable areas;
- Foster the use of renewable energy sources throughout the value chain particularly processing and transport.

(ii) **High-range climate change:** Under conditions of high average temperature rises (4.0°C with a likely range of 2.4 to 6.4°C), with regular long term drought conditions during the growing season, and erratic rainfall levels and patterns including much shorter rainy seasons, and regular extreme weather events, there will be serious negative results on the coffee industry, and the following impact may be expected:

- Overall declining production due to heat stress and inadequate timely rainfall;
- Substantial loss of quality rendering significant production uneconomic to sell on world markets;
- High, perhaps unsustainable crop maintenance and harvesting costs;
- Significantly large growing areas will be become uneconomic for the production of coffee, and perhaps, other perennial and annual commercial cash crops.

Under this scenario the optimum policy is geared to managing the decline of the coffee industry through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Consider introducing furrow irrigation and small scale sub surface drip irrigation[36] in those areas that remain commercially viable;

[35] Netafim, *Drip Irrigation Doubles Coffee Production in Africa*, Guy Rayev. Available at: http://www.eafca.org/wwc/downloads/AFCCE10/presentations/Drip%20Irrigation%20To%20Boost%20Coffee%20Yields%20In%20Africa.pdf [Accessed 23 April 2013].

- Shortening the value chain (see (i) above);
- Introduce crop diversification throughout the coffee growing regions of the country;
- Foster non-farm rural enterprises[37],e.g. marketable handicrafts and small scale village manufacture;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

2.6.7 Ethiopia - findings and recommendations

The consensus of opinion amongst experts is that, even relative minor increases in temperatures and fluctuations in precipitation due to climate change will affect, negatively, the Ethiopian coffee trade in terms of yield, quality and cost of production. As the current trend is for increased production under stable world price, it is essential that the country maintains its position as one of the top ten coffee exporting countries and the first exporter in Africa, in order to maintain and improve rural incomes and coffee's contribution to the economy. The Government should continue its existing strategy (see sub-section 2.6.4 above) for sustaining and growing the agricultural sector including the coffee sub sector and other non-agricultural sectors such as tourism, manufacturing, minerals and mining.
It is recommended that the Department for International Development (DFID) consider the following options for future action in addressing climate change resilience in Ethiopia:

1. Work with the Government on:

    - Setting up a multi stakeholder Sustainable Coffee Task force, under the auspices of the Ministry of Agriculture;
    - Promoting the expansion of the Geographic labelling system as using GIs and trademarks as a method of certifying sustainability of coffee exports (see sub-section 2.4 above).

2. Work with a broad range of stakeholders, e.g. Government/Cooperatives/privately owned large plantations, on developing and delivering training courses/programmes for smallholder farmers and farmer groups on adaptation and mitigation strategies for coping with the negative impact of climate change on the coffee value chain.

3. Commission a feasibility study on a PPP pilot project, involving Government agencies, Cooperatives, private sector agribusiness, on sustainable coffee production and export.

Options 2 (training) and 3 (pilot project) above have common elements with recommendations to be suggested for climate change resilient coffee and tea value chains, both perennial tree crops with similar growing condition requirements, and, further details regarding basic Terms of Reference (TOR) for these initiatives are described in Annex 12.

2.7 The Rwandan coffee sector

2.7.1 Introduction

Annex 5 contains a map of Rwanda, general economic information, and further details of the country's coffee sector. The Rwandan coffee industry has undergone a remarkably successful transformation by positioning its coffee as an appreciated and recognized brand

36 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).
37 FAO (undated) *Rural non-farm income in developing countries*, Tom Reardon. Available at: http://siteresources.worldbank.org/DEC/Resources/ruralNonfarmIncomeinDevelopingCountries.pdf

in the international premium coffee market, which has created a high value for Rwanda's economy.

2.7.2 Rwanda coffee production

Coffee was introduced to Rwanda in 1904 and first exported in 1917, becoming a major source of income benefiting from strong political support from the Belgian colonial authorities. Following independence in 1962, the Ministry of Agriculture established a regulating agency in 1964, viz, Office Nationale des Cultures Industrielles (OCIR), and in 1974, the ministry established a parastatal agency, the Rwanda Coffee Development Authority (OCIR CAFÉ), with monopolistic powers, responsible for organising smallholders, purchasing their crops in the form of "café parch", contracting private factories to process the *parche* into green coffee ("café marchand"), and selling the final product on the international market. Market liberalisation was introduced after the 1994 genocide with the licensing of several private coffee exporters and the installation of several private parchment mills, changing the coffee value chain from a central monopoly to a free market. OCIR CAFÉ is now a promotion, regulation and monitoring agency and private traders are now allowed to purchase parchment coffee from smallholder growers, and sell to the hulling companies. Exports are increasingly carried out by private enterprises, acting as agents or paying a fee to OCIR CAFÉ.

The production of commercial green coffee dropped from 40,000 mt (1985 - 1992) to 15,000 - 20,000 mt (1996), during the genocide period and due additionally, to (i) the average age of the country's coffee trees, which exceeded 20 to 25 years, the limiting age for economically optimal exploitation (ii) low coffee prices encouraging farmers to diversify towards the cultivation of food crops (iii) the abandonment of good agricultural practices by farmers due to social unrest. In response to the steady decline in coffee production, quality, and export earnings, and in view of the recognized potential contribution that the sector could make to increased economic growth, the Government of the Republic of Rwanda adopted the *Rwanda National Coffee Strategy 2008-2012.* Key points of this strategy included:

- Increasing production through the dissemination of improved varieties, the adoption of better crop husbandry practices, appropriate and timely use of inputs, and by supporting grower associations to assume progressively greater responsibility for production activities;
- Improving coffee quality through producer education, improved infrastructure, investment in washing stations, and strengthened cooperative and association management;
- Promoting greater equity in value distribution through producer participation in coffee marketing.

The strategic plan for coffee has been subsequently updated with the following quantitative aims (i) production of 44,160 mt of commercial coffee, including 28,000 mt of fully washed coffee with the establishment of 107 operational washing stations throughout the country (ii) establishment of Rwanda's name in the global specialty/gourmet coffee market; prior to 2001, Rwanda was unknown to premium markets (iii) achievement of an average yield of 1,500kg/ha. Some progress has been made as in recent years green coffee production has improved from 13,440 mt in 2007 to 24,000 in 2012 crop year (ICO statistics).

2.7.3 The Rwandan coffee value chain and marketing

Before the liberalization of coffee marketing in 1995, all coffee was sold to the Government owned RWANDEX, either directly through their field agents or through middlemen. Producer prices were fixed by OCIR CAFÉ at the beginning of the production season, based on price expectations of the international market and estimations of transaction costs throughout the

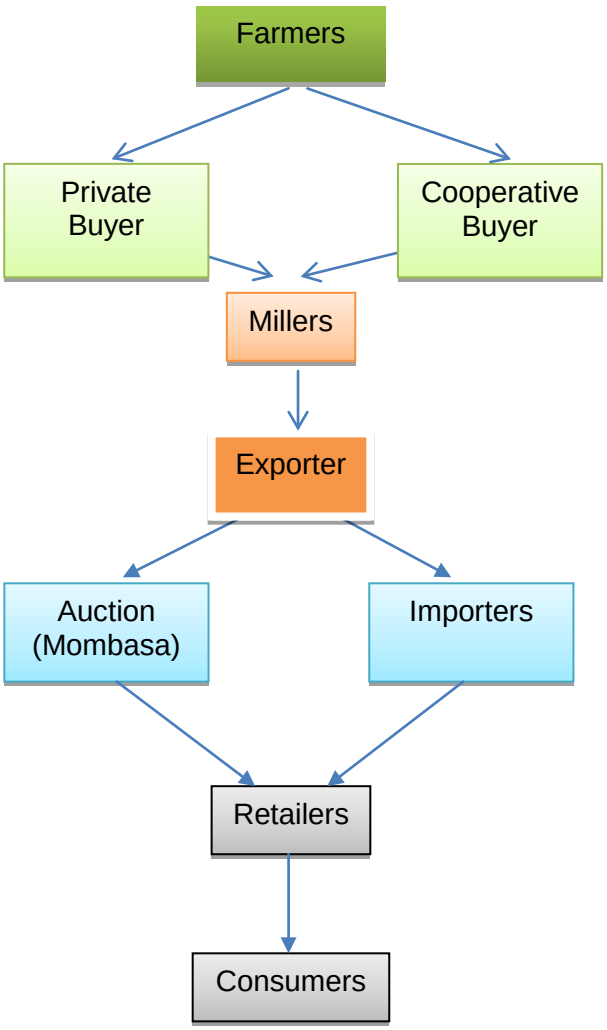
value chain, from farmer to exporter. RWANDEX then dry milled the coffee in one of their two large milling complexes at Kigali and Gisenyi. No price differential was accorded to quality. In 1995, the new government opened the coffee market to competition. New exporters established operations. Some of the exporting firms are partially owned by European coffee importers, mainly from Belgium, which facilitated value chain management. Exporters directly finance middlemen, thereby shifting bank credit risk from middlemen to the more financially solvent exporting firms.

Today, the government is less directly involved in the coffee sector. Farmers have more choice about what to grow, whom to sell their beans to, and how to market their product. Rather than dictate a single price for the entire season OCIR CAFÉ, sets a minimum weekly reference price, in consultation with stakeholders, a basis from which a sales price per kilo may be negotiated.

Private traders/exporters handle about 70% of the volume exported with 30% being handled by the Cooperatives[38]. The Rwanda coffee value chain is illustrated in Figure 2 below.

Figure 2 Rwanda Coffee Value Chain

[38] United States Agency for International Development (USAID) (2010) *Rwanda coffee industry value chain analysis - profiling the actors, their interaction, costs and opportunities,* Chemonics International Ltd.



2.7.4 National climate change policy

The Government of Rwanda has recently commissioned the development of a National Climate Change and Low Carbon Development Strategy for Rwanda and a report by consultants was submitted in 2011[39]. The strategy aims to:

- Develop a roadmap for future climate resilient and low carbon economic growth in Rwanda;
- Build on existing climate change initiatives and opportunities that are currently being undertaken in relative isolation in Rwanda;
- Provide a framework around which detailed sectoral studies and implementation plans can be built;
- Develop local capacity in sourcing, applying for and obtaining international climate change funding.

Rwanda has been engaged in climate issues since 1992 and has made good progress with national policy and environmental strategies. The following timeline summarises Rwanda's progress:

39 Department for International Development (DFID) (2011) *National Strategy on Climate Change and Low Carbon Development for Rwanda - Baseline Report,* Smith School of Enterprise and the Environment, Oxford, UK.

2006 - National Adaptation Programme of Action (NAPA) completed.
2009 - Climate Change and International Obligations Unit (CCIOU) established within the Rwanda Environment Management Authority (REMA), overseeing its Designated National Authority (DNA) to coordinate carbon market activities.
2010 - Second National Communication (SNC) completed, including a stand-alone mitigation strategy, the Carbon Policy and an updated emissions inventory.
2010 - National Implementing Entity (NIE) application submitted to access international resources under the United Nations Framework Convention on Climate Change's (UNFCCC's) Adaptation Fund under the SNC, priority sectors.

Current policy is enshrined in the Rwanda NAPA, which identifies the following climate change related hazards: flooding (flash)/drought and low flows/landslides/intense rainfall/extreme temperatures/heat waves.
The main human vulnerabilities and livelihood impacts are identified by the NAPA as follows: reduced agricultural production/water shortage and/or groundwater depletion/flooding/food security/income generation.

The following are identified as Priority Adaptation Projects:

1. Integrated water resource management.
2. Set up information systems for hydro agro-meteorological early warning system and rapid intervention.
3. Promotion of income generating activities.
4. Promotion of intensive agriculture and animal husbandry.
5. Introduction of crop varieties resistant to environmental conditions.
6. Development of alternative energy sources (to firewood).

2.7.5 Impact of climate change on coffee production

Impact of climate change on coffee production under a low, mid and high-range scenario
Coffee is Rwanda's most important agricultural crop and significant effort should be applied to maintain its role in the economy. Coffee is grown throughout the highlands of Rwanda. Conditions for coffee production in Rwanda are similar to those in other East African highland countries, and consequently scenario analysis is the same as for Ethiopia. Whilst the expected different impact of levels of climate change is described below, some results and policy options will be common to all three scenarios.

(i) **Low-range climate change:** Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), with no serious long term drought conditions during the growing season, and only slight changes to rainfall levels and patterns, the following impact may be expected:

- Slightly declining overall annual production and yields, without improved agricultural practice, including conservation farming techniques, the IITA report, (see Footnote 12) forecasts a reduction of 100 kg/ha for every 1°C rise in temperature, which may be somewhat pessimistic;
- Possibly reduction in quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario the optimum policy is to maintain, at least existing levels, and possibly expand production through:

- Farmer training and capacity building in climate change resilience including conservation and organic farming techniques (provided the quality premium/loss of yield equation is positive, i.e. benefits equal or exceed effects);
- Consider the inter-planting of coffee with bananas (a cash crop) as a shade tree, as recommended by the IITA report, (see Footnote 12) which may reduce the temperature of the under storey plants (coffee) by up to 2°C or more;
- Institutional reform, particularly to improve agricultural extension delivery to farmers;
- Shortening the value chain through fostering contract farming and forward and backward linkages between farmers and retailers/certification compliance;
- Identify and assess new areas suitable for planting coffee at higher altitudes, as temperatures increase;
- Invest in research on drought resistant and heat resilient coffee varieties;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with occasional long term drought conditions during the growing season, and frequent changes to rainfall levels and patterns including shorter rainy seasons, the following impact may be expected:

- Declining overall annual production and yields, at significant levels in some lower altitude areas, (see (i) above);
- A reduction in overall quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario the optimum policy is to endeavour to prepare for the management of likely declining production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Consider the inter-planting of coffee with bananas (see (i) above);
- Consider research into inter-planting coffee with shade trees, which may not give annual cash income, but perhaps a long term commercial benefit, e.g. as timber when felled;
- Institutional reform (see (i) above);
- Small scale sub surface drip irrigation in selected areas to improve yield and maintain quality through nutrigation[40];
- Shortening the value chain (see (i) above);
- Consider the commercial planting of robusta coffee in lower altitude areas;
- Introduce crop diversification in the most vulnerable areas;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

(iii) **High-range climate change:** Under conditions of high average temperature rises (4.0°C with a likely range of 2.4 to 6.4°C), with regular long term drought conditions during the growing season, and erratic rainfall levels and patterns including much shorter rainy seasons, and regular extreme weather events, there will be serious negative results on the coffee industry, and the following impact may be expected:

[40] Netafim, *Drip Irrigation Doubles Coffee Production in Africa*, Guy Rayev. Available at: http://www.eafca.org/wwc/downloads/AFCCE10/presentations/Drip%20Irrigation%20To%20Boost%20Coffee%20Yields%20In%20Africa.pdf [Accessed 23 April 2013].

- Overall declining production due to heat stress and inadequate timely rainfall;
- Substantial loss of quality rendering significant production uneconomic to sell on world markets;
- High, perhaps unsustainable crop maintenance and harvesting costs;
- Significantly large growing areas will be become uneconomic for the production of coffee, and perhaps, other perennial and annual commercial cash crops.

Under this scenario the optimum policy is geared to managing the decline of the coffee industry through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Consider introducing furrow irrigation and small scale sub surface drip irrigation in those areas that remain commercially viable;
- Shortening the value chain (see (i) above);
- Introduce crop diversification throughout the coffee growing regions of the country;
- Foster non-farm rural enterprises[41],e.g. marketable handicrafts and small scale village manufacture;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

2.7.6 Rwanda - findings and recommendations

As for the other selected coffee country, Ethiopia, it is recommended that DFID consider the following options for future action in addressing climate change value chain resilience in Rwanda.

1. Work with the Government on:

   - Setting up a multi stakeholder Sustainable Coffee Task Force, under the auspices of the Ministry of Agriculture;
   - Promote the expansion of the Geographic Labelling system, using geographic GIs and trademarks as a method of certifying sustainability of coffee exports.

2. Work with a broad range of stakeholders, e.g. Government/Cooperatives/privately owned large plantations on developing and delivering training courses/programmes for smallholder farmers and farmer groups on adaptation and mitigation strategies for coping with the negative impact of climate change on the coffee value chain.

3. Commission a feasibility study on a PPP pilot project, involving Government agencies, Cooperatives, private sector agribusiness, on sustainable coffee production and export.

[41] FAO (undated) *Rural non-farm income in developing countries*, Tom Reardon. Available at: http://siteresources.worldbank.org/DEC/Resources/ruralNonfarmIncomeinDevelopingCountries.pdf

SECTION 3

Tea

3.1 Introduction

This section reviews the global tea market and assesses the impact of climate change on the tea value chain, with particular reference to the **Kenya** and **Bangladesh** tea industries, which are discussed in detail under sub-sections 3.6 and 3.7. An overview of the world tea trade is included under Annex 6, which describes in detail tea growing and processing methodology, global production, exports, imports and consumption, further information on the value chain, trading systems and production and price trends. Tea is grown throughout the hot and humid tropical and sub-tropical regions of the world with 80% of current global tea output produced in five key tea countries, viz; China, excluding Taiwan, India, **Kenya**, Sri Lanka, and Vietnam. **Kenya's** and **Bangladesh's** production represented about 8.8% and 1.4% of global production respectively. It should be noted that all types of tea are produced from the same plant and the differences between them result from the different processing methods used in producing the tea. The green leaf of the perennial tea plant (Camellia Sinensis) is processed, in its fermented state, into black tea, or, in its unfermented or semi fermented state, into green and oolong teas. Tea is predominantly marketed internationally as black tea, which, in volume terms accounts for about 78% of global tea production and 85% of global trade. This report focuses on black tea.

3.2 Tea value chains and marketing systems

The components and players in the tea value chain vary with the unique characteristics and tea institutional framework of each origin country. While the specific tea value chains for **Kenya** and **Bangladesh** are given in sub-sections 3.6.3 and 3.7.3 below, under Figures 3 and 4, the following simple common components and actors may be identified:

- Smallholder farmers/small plantations, approximately under 75 ha/cooperative groups sell tea green leaf at ex farm gate net prices to green leaf traders/agents; or direct to black tea manufacturing factories at delivered factory net prices;
- Traders/agents transport and sell green leaf to black tea factories at delivered factory net prices;
- Black tea factory owners transport processed black tea to, either an auction centre's authorised warehouse, or an export warehouse (in the case of a direct sale overseas outside the auction system), usually located at a producing country's port town;
- Exporters sell black tea to overseas buyers at free on board (FOB) or cost, insurance and freight (CIF) prices;
- Overseas buyers sell black tea to blenders/packers in destination countries;
- Blenders/packers sell to supermarkets and other retailers who sell on to consumers.

Notwithstanding the impact of climate change at the green leaf and black tea production and primary processing stages above, it should be noted also that along the value chain, warehouse and transport facilities (road, rail, sea) are also involved which result in the emission of greenhouse gases (GHGs) and consequent climate change.

The tea value chain is characterized by very strong vertical integration with around 85% of global production being sold by just a few multinationals, and direct links between tea

packers and blenders and producers is common. In this context the UK Dutch company Unilever and India's Tata Tea control around 16% of the global consumer market for packeted tea.

Tea is traded primarily by direct negotiation between buyers and sellers, and, through the long established auction system, which has resulted in the trade being focused on spot or nearby sales, with long term forward commitments being rare. The global trade in bulk black tea is therefore still characterized by its overwhelming dependence on the auction system, with its long established network of individually identified producer sellers, selling (and sometimes also buying) brokers, with a broad representation of both domestic and export buyers. Another key characteristic of the tea trade is its requirement for sales to be on the basis of individual lot samples, a cumbersome and costly exercise, but considered necessary to ensure quality.

The Auction System**:** Table 1 below shows the main auction centres and their relative importance in terms of average prices, with changes over the last five years:

Country	2011	2010	2009	2008	2007
Kenya	2.72	2.54	2.29	2.18	1.66
Sri Lanka	3.25	3.28	3.15	2.83	2.51
India	2.23	2.29	2.18	2.00	1.62
Indonesia	1.97	1.82	1.80	1.51	1.33
Malawi	1.61	1.58	1.58	1.37	1.05
Bangladesh	2.14	2.61	1.98	1.62	1.17

Source: International Tea Committee (ITC) statistics

Table 1 Average international tea prices (US cent/kg), 2007-2011

The auctions, which act as price determinant points and as transparent and reliable market places, have served the tea trade well over its long history and continue to be supported by the majority of market participants. However, the system has a number of disadvantages in a modern trading environment, such as the lack of hedging facilities for both producers and blenders/packers; the dominance of spot ex-warehouse/ex-estate contracts which lack flexibility for overseas buyers; and, the pricing of many auction teas in the currencies of the producing countries, whereas the international trade in tea is conducted, primarily, in US dollars. Notwithstanding the above comments, and the growing popularity of direct sales, in the absence of a futures market for tea, the auction system will continue to play a pivotal role the tea market. Whilst the Mombasa auction in **Kenya** attracts teas for sale from nearby African countries, particularly Rwanda, Uganda, and Tanzania, none of the existing centres offer a complete international market place serving all the major global tea origins. To an extent, this role used to be performed by the London auction, which was the only truly international tea trading centre, but had been in decline for many years and finally closed in 1998. Around 70% of tea production passes through the auction system.

The following possible trends and developments, in the marketing of tea, linked particularly to globalization, should be noted:

- More direct sales and disintermediation;
- The development of international tea trading centres using freely convertible international currencies, e.g. the US dollar and the Euro;
- The possible development of tea futures and options markets;
- The development of information technology and automation connected to the digital revolution, e.g. automated and "on line" auctions, and, customized software trading packages;

- Greater value addition into packing and blending for export at origin.

3.3 Tea and climate change

Tea production systems are basically regional to sub-regional as the climate is strongly influenced by local topography, location and proximity to sea and oceans. Therefore, the possible effects, and potential impact, of climate change on tea production is assessed under the **Kenya** and **Bangladesh** sub-sections 3.6.5 and 3.7.5. In this context impact is discussed in terms of low, mid and high-range climate change scenarios.

Optimum climatic and geographic conditions required for tea growing[42]
The tea plant is highly adaptable, and can grow in a broad range of conditions, however, to achieve optimum yields and quality it needs a hot, moist climate requiring temperatures ranging from 10-30°C, in areas with an average yearly rainfall of 2,000 mm. Tea can survive in a light frost and even snow, but not heavy frosts or prolonged cold winters. The seasonality of rainfall is important in influencing the quality of tea, and tea leaves harvested at different times will produce a finished product with vastly different characteristics. Seasonality is thus an asset in tea production, which explains why most of the well-known tea producing regions have strong seasonal climates. Seasonality can include a simple wet-dry pattern like the Asian south-west and north-east monsoon, e.g. as in **Bangladesh**, or a bimodal precipitation pattern, with two distinct wet seasons and two distinct dry seasons in each year which occur in parts of sub Saharan Africa such as **Kenya**.

Tea is grown, commercially, within a certain range of altitudes, ideally at a level of between 600-2000 metres above sea level. Although high-grown teas often exhibit many desirable characteristics there is a point beyond which conditions become too cold for tea production, with the highest commercial tea plantings around 2,400 metres. In regions further from the equator, and into colder and drier climates, the highest possible elevation at which the tea plant can be grown becomes lower. It should be noted that altitude is one of the key local or regional influencers of climate, and at higher elevation, temperatures become more variable, and rainfall generally becomes higher, but with lower humidity. Therefore, in various climate change scenarios being examined in this report, viz, low-range, mid-range and high-range, it is important to assess the effect on yield and quality and whether a traditional tea growing area can continue to produce, and if new areas, previously unsuitable for tea can be brought into production.

3.4 Climate change impact initiatives in the tea sector

Overview:
Climate change impact initiatives in the tea sector have tended to be considered as part of overall social, economic and environmental issues, and viewed as part of tea production sustainability impact. Table 2 below summarises key sustainability issues and stakeholders primarily affected.

[42] More detailed information regarding tea growing conditions is given in Annex 5, Section 6.

	Estate and factory workers	Small-scale farmers
Social Issues	• ***High discrimination, gender inequality*** • ***Low representation of workers in union forums and committees*** • ***Poor living conditions on estates***	• ***High reliance on tea for livelihood*** • ***Low level of farmer organization*** • ***Lack of land title deeds***
Economic Issues	• ***Low wages*** • ***High level of casual/temporary labour*** • ***Uneven value distribution***	• ***Lack of market information, market access & (technical) training*** • ***Low productivity and low prices versus high production costs*** • ***Uneven value distribution***
Environmental Issues	*Small-scale farmers and estate and factory workers* • ***<u>Climate change impact on production levels</u>*** • ***Deforestation/loss of biodiversity due to conversion of forests into tea farms*** • ***Soil erosion, low soil fertility*** • ***Agrochemical use*** • ***Pollution and energy inefficiency in processing tea***	

Source: Tropical Commodity Coalition (TCC) 2010 - http://www.teacoffeecocoa.org/

Table 2 Overview of tea social, economic and environmental issues

Private sector initiatives[43]

Private sector initiatives are focused on sustainable certification of tea production, the standards of which contain environmental targets including in some cases climate change parameters such as reduction of GHGs.

A summary of the main tea certification schemes is shown in Table 3 below.

Scheme	Key attributes and objectives
Ethical Tea Partnership (ETP)	• Non-commercial alliance of over twenty international tea packers. • Vision of a socially just and environmentally sustainable tea sector. • Not a certification body itself, but works closely with key certification bodies, including Fairtrade, Rainforest Alliance (RA), Certified, and UTZ Certified. • Fundamental principles are those of the Ethical Trading Initiative's Base Code.
Rainforest Alliance (RA) Certified	• Environmental, social and economic standards set by the Sustainable Agriculture Network (SAN). • The SAN standards have a special emphasis on workers and wildlife. • Began working with tea farmers in 2006. • Industry-producer partnership which has recently expanded its certification program to the tea sector.
UTZ Certified	• Aims to provide an assurance of responsible production and sourcing. • Independent certification against the UTZ Certified code of conduct. • Focus on traceability, using a Track and Trace system and Chain of

[43] Sustainable Trade Initiative (2011) *Tea Sector Overview*, Michael Grooseman. Available at: http://www.biriz.biz/cay/raporlar/caysektoru2019vizyonu.PDF [Accessed March 2013].

Scheme	Key attributes and objectives
Organic	Custody criteria. • Set of standards which define what farmers can and cannot do • Strong emphasis on the protection of wildlife and the environment. Pesticides are severely restricted and artificial chemical fertilizers, animal cruelty, genetically modified feed and routine use of drugs and antibiotics are all disallowed. • Often dual certified, matching organic with other certification schemes.
Fairtrade	• Focus on poverty reduction and sustainable development. • Aims to create opportunities for producers and workers who have been economically disadvantaged or marginalized by the conventional trading system.

Source: Fairtrade 2010, Standards websites

Table 3 Overview of attributes and objectives of main tea certification schemes

RA is the dominant certification system, as it is used by the three largest global brand owners, Unilever, Tata Tea and Twinings, who account for around 16% of the global market and certify tea production in a number of diverse tea producing origins, e.g. Kenya, Tanzania, Rwanda, Turkey, Indonesia and Sri Lanka. The market share of certified teas has grown steadily over the last 5 years from only 1% in 2007 to 6% of global production in 2010; however, all certifiers expect demand to increase with Unilever claiming that by 2020, 100% of their tea, including loose tea, will be sustainably sourced.

As noted above certified tea still only accounts for a small part of global tea production and the main challenge ahead lies in reaching the huge domestic markets of large producing countries such as India, China and Turkey (ETP). Domestic markets of large producing countries however face considerable sustainability challenges. On the one hand, promoting tea sustainability from the demand side is not straightforward in India, since it is difficult to demonstrate sustainability in a non-branded, commodity type market. In addition, market research shows that consumers of branded-tea in India have little interest in how the tea is produced. On the other hand, promoting tea sustainability from the supply side is also challenging. Producers do not perceive sustainability to be leading to benefits such as improved yields, safety of products and economic improvement of local communities. Another challenge lies in reaching and certifying the millions of smallholders, and in this context, certification in Kenya has proven to be successful largely due to:

- Identifying and using local partners able to quickly and effectively reach out to a large base of smallholders and engage them in the certification process, and;
- Kenya already had the required scale for a quick roll-out, as smallholders are well organized through the Kenyan Tea Development Agency (KTDA) around black tea factories.

An in depth assessment of private sector tea certification schemes and other initiatives regarding the impact of climate change on tea production are considered under sub-section 3.6 regarding the Kenyan tea sector.

Other climate change impact initiatives

A major international initiative on the impact of climate change on tea production is being undertaken and led by the Food and Agricultural Organisation (FAO). At the twentieth session of the FAO Intergovernmental Group on Tea, held in Colombo, Sri Lanka on 30 January - 1 February 2012 a global initiative on the impact of climate change on tea production was proposed, to be implemented primarily by India, **Kenya**, Sri Lanka, China, **Bangladesh** and Malawi. The following action points were agreed:

- Review concepts and methods of climate change impact assessment;
- Evaluate the analyses carried out on the impact of climate change on the tea sub-sector in selected countries and determine methodologies to measure the impact of climate change on the tea economy;
- Evaluate suitable technologies that could be adapted for mitigation and adaptation strategies for the tea economy;
- Identify climate change databases and models to support analysis related to the tea sub-sector and agree on collection and collation of available research data on climate change in member countries;
- Define the scope of the Proposed Working Group on Climate: identify/suggest mitigation and adaptation strategies;
- Develop appropriate long-term technologies for mitigation/adaptation and agree on an Immediate Action Plan.

At a "follow up" intersessional meeting of the Tea Group's Working Group on Climate Change[44] held in Washington in September 2012 the following long and short term objectives of the initiative were submitted by India and approved by the meeting:

Long term objectives

- To develop a decision support system for contingency tea crop planning by using an interactive tea production specific methodology/technique for systematic analysis of scaled (spatial/temporal) and geo-referenced data/information which will allow for the sustainability of logical niches based (area specific and broadly weather based) tea production system (garden level-cluster), independent of conditioning variables (policy, infrastructure, markets, ethno-demographics) and climate resilient.

Short term objectives

- Development and analysis of a scaled and geo-referenced database of historical local (niche based) weather, soil, disease/pest incidence and tea yield in tea growing regions of Assam;
- Assessing future climate scenarios by downscaling global circulation models (GCMs) to regional level by using regional model PRECIS (*Providing Regional Climates for Impact Studies*);
- Integration of satellite data with regional weather data and creation of a spatial gridded database (1 km resolution) and use of this information in ecosystem model to generate Operational Weather Forecasts (short and medium range);
- Development of decision support framework/toolkit for Contingency Crop Planning for efficient management of tea plantations and make them climate resilient;
- Dissemination of specific weather based advisories to individual tea plantations, through a global climate model (GCM) network, using a *"Cluster Approach".*

To achieve these objectives, databases need to be prepared using historical, current and simulated future data. Further, surface statistical/satellite and climate data need to be integrated with simulation models to plan for a climate resilient tea production system. However, the most important feature of the entire exercise will be the selection/use of appropriate models and accuracy of the analysis suiting to the tea growing region under study. The following can be the possible key elements of analysis:

- Trend detection and attribution;

[44] INTERGOVERNMENTAL GROUP ON TEA INTERSESSIONAL MEETING, Washington DC, USA, 17-18 September 2012, Working Group on Climate Change.

- Vulnerability indication;
- Scenarios and scenario development;
- Biophysical inputs projections;
- Economic inputs projections;
- Bifurcation of the impacts of climate change impacts on individual sectors;
- Regional forecasts and nowcasts;
- Development of decision support framework/toolkit and crop planning based on weather advisories.

Further progress reports on this key initiative are awaited during the course of 2013.

3.5 Global tea production and price trends

Production

The five year production trend for tea (please refer to details under Annex 5) is almost uniformly upwards. Global production has increased between 2007 and 2011 by around 12%, due, primarily, to higher yields through replanting with improved clonal material and better husbandry practices, rather than an expansion in the overall global mature planted area. This upward global trend is expected to continue, notwithstanding the negative long term impact of future climate change, and adverse weather conditions, political conditions and labour unrest in producing countries. This scenario is similar for the selected countries of **Kenya** and **Bangladesh**. Whilst farmers report changing weather patterns, particularly longer drought periods, shorter rainy seasons and greater fluctuations in temperature during the year, no long term trend in production decline can be discerned. Further statistical analysis will be needed to draw definitive conclusions on the quantitive impact of climate change on volumes.

Prices

The global tea industry is forecast to face short supply in 2013. Key tea producing countries are expected to have a production drop in the range of 1% to 5% in 2013, while demand is set to grow by 3%. With consumption in India and China outpacing domestic production, reduced exports and rising prices are expected for both markets.

3.6 The Kenyan tea sector

3.6.1 Introduction

Annex 7 contains a map of Kenya, general economic information, and further information on the country's tea sector. Currently, tea, as the leading cash crop in Kenya, makes a significant contribution to the economy, representing about 26% of total export earnings, and about 6.5 % of gross domestic product (GDP). An estimated 3 million Kenyans (about 10% of the total population) derive their livelihoods from the tea industry. The crop also contributes significantly to the development of rural infrastructure, and directly contributes to environmental conservation through enhanced water infiltration, reduced surface erosion, and mitigation of global warming through carbon sequestration[45].

3.6.2 Kenyan tea production

Kenya is the fourth largest producer of black tea after India, China and Sri Lanka; however, Kenya currently competes with Sri Lanka for the position of leading tea exporter in the world.

[45] Tea Research Foundation of Kenya (TRFK) (2009) *Strategic Plan, 2005-2010*. Available at: www.tearesearch.or.ke [Accessed March 2013].

Tea production has expanded tremendously from 18,000 mt at independence in 1963 to over around 380,000 mt in 2011. Smallholder tea production accounts for around 65% of the area and about 62% of production. Notably, among all of Kenya's other export crops, only tea has maintained this upward trend in production and export earnings. Against this performance in tea production, quality and income earnings, the tea sub-sector has to contend with several challenges threatening its survival. These include heavily concentrated markets in which Egypt, the United Kingdom and Pakistan account for around 80% of Kenya's exports. Demand in Egypt and Middle Eastern countries has remained strong for many years, however the market potential of Kenyan tea remains under exploited. The United Kingdom remains the single most important destination for Kenya tea.

The challenges facing the Kenyan tea industry include:

- A stagnating demand in most of the main traditional markets;
- Increased production in Kenya could have a negative effect on prices as the country's output influences world tea prices;
- High transaction costs and inefficiencies in tea factories together with the seasonally impassable roads, that affect green leaf collection, are important factors that influence tea earnings and thus determine the industry's future viability;
- External challenges posed by overseas buyers, e.g. importers, particularly those from the West have increasingly been demanding that the tea value chain complies with environmental standards, including climate change adaptation and best practices in employee social and welfare standards;
- In the smallholder tea sector, the environment is characterised by deforestation, exacerbated by the continual cultivation of land, the use of wood for the factory, exhaust fumes from trucks and the increased use of generators and coal at factories polluting green leaf.

Whereas, larger private sector tea companies, particularly multi-national corporations (MNCs) such as Unilever and James Finlay Ltd have environmental strategies, covering coping with the impact of climate change, which includes research and development for sustainability, the reduction of GHG emissions, extension of renewable energy sources, fostering good husbandry practices, and the growth of trees on an 8-year rotational basis for firewood.

3.6.3 The Kenyan tea value chain and marketing

Value chain

The Kenya tea value chain is illustrated in Figure 3 below. The oval shapes indicate the price determination levels along the chain, where value is added to prices ex-tea factory, FOB and CIF. Further value is added to the product at destination as actual costs plus profit margins are added to the CIF price, through storage, transport, blending, packing and retailing to end consumers. The value chain comprises those stakeholders involved in converting green leaf into a packaged product available for sale to consumers. At each stage along the chain value is added to green leaf through various activities such as, the cost of conversion to black tea, factory packing, internal transport, warehousing, sales charges (auction and direct), freight, insurance, interest, blending and packaging and retailers' sales costs. Additionally, stakeholders along the chain should have an economic role to play and must include an adequate profit margin to ensure an acceptable return on their business activities. Four main categories of primary stakeholders in the tea industry have been identified, and they are involved in the following general activities:

- Green leaf production
- Green leaf collection

- Black tea manufacturing
- Tea consumption

There are also secondary stakeholders, not directly involved in the above, e.g. brokers, traders, shipping companies, warehousemen, bankers, but nevertheless affected by, or having an effect on the activities of primary stakeholders. Kenya's value chain structure is relatively efficient, although institutional reform within the public sector is desirable.

Marketing system
The institutional structure of the Kenya tea trade is very important to the overall marketing system as it facilitates the producer and processor in complying with international standards, such as those of the ETP, RA Certified and overseas buyers. The Kenya tea institutional framework is described in detail under Annex 5, and is summarised hereunder.

Kenya Tea Development Agency (KTDA): The KTDA was incorporated under the Companies Act as an independent and private enterprise, owned by all of Kenya's small-scale tea farmers through their respective factory companies. It manages the tea factories on behalf of farmers and charges a management fee.

Tea Board of Kenya (TBK): The TBK is a State Corporation under the Ministry of Agriculture, established in 1950; it has a mandate to regulate the tea industry.

Kenya Tea Growers Association (KTGA):The KTGA, which is a private and voluntary grouping, promotes the interests of large and medium private tea growers in Kenya.

Kenya Plantation & Agricultural Workers' Union (KPAWU): The KPAWU is the national trade union body representing unionised workers in the coffee, tea, sisal and horticultural industries.

East African Tea Trade Association (EATTA): The EATTA is a voluntary association bringing together tea producers, brokers and buyers of tea in East Africa. The Association's rules and regulations facilitate auction and direct tea sales and regulate the international trade in Kenya and other East African teas. The association comprises tea producers, buyers, brokers and other interested tea traders within the East African region.

Tea Research Foundation of Kenya (TRFK): TRFK was established in 1980 as a company limited by guarantee to carry out the investigation and research into all matters relating to the tea industry. It was a successor to the Research Institute of East Africa. Its guarantors are the Ministry of Agriculture and TBK.

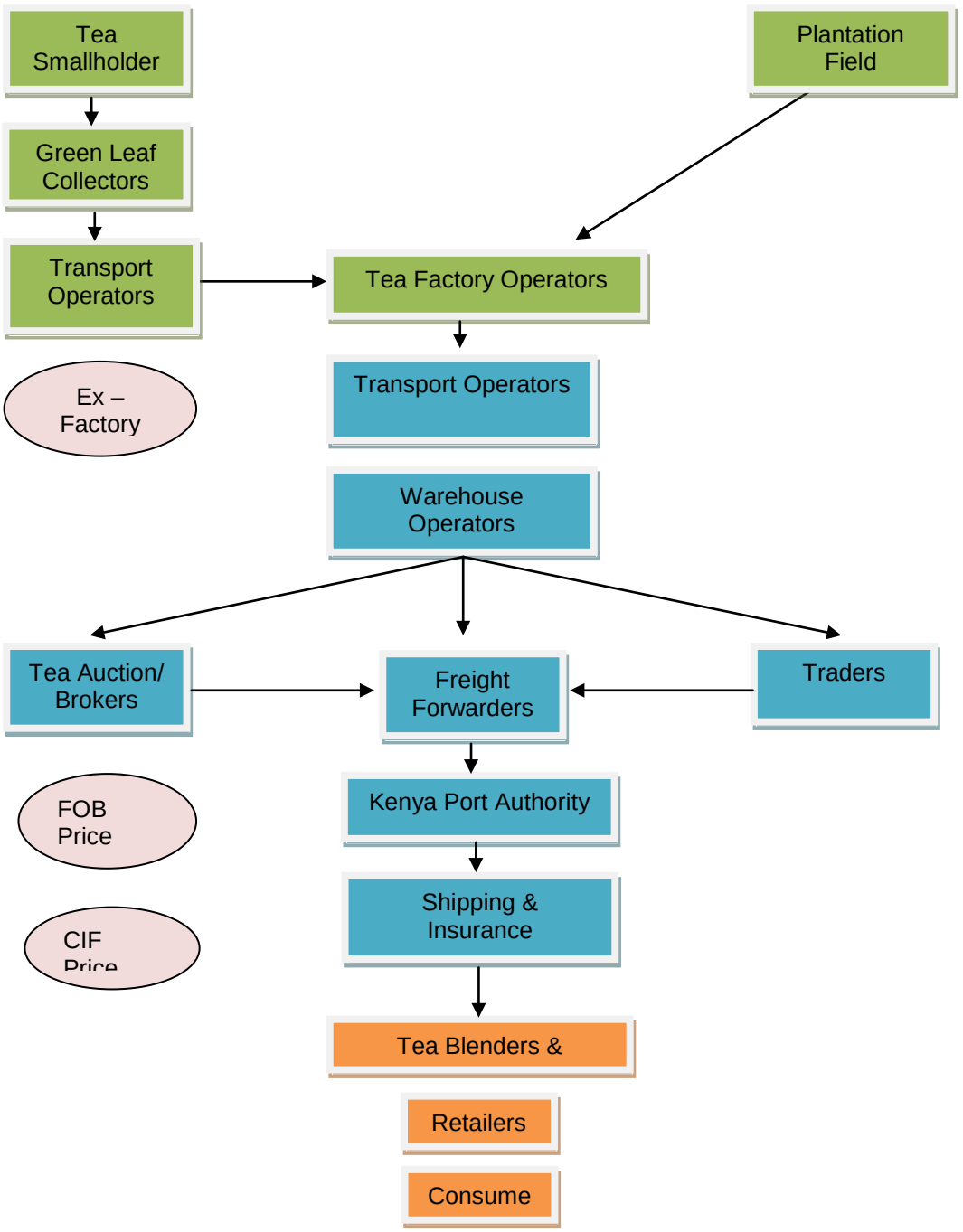
Tea Brokers, the tea auction and direct tea sales: The tea trade is primarily conducted by brokers appointed by tea producers. The brokers guarantee the sale of tea by negotiating between the producer and the tea trade buyers, including direct sales. Most Kenyan tea is sold through the weekly Mombasa Auction; when tea is ready for sale, the tea brokers are notified so that they can collect tea samples from the warehouse, some of which they send to buyers for liquoring and determining quality before the auction. It is the responsibility of the tea broker to follow up the payments from the tea buyers and remit the money to the selling companies. Tea sold through the auction attracts a brokerage fee on the sales. Direct tea sales are normally an outlet for premium tea grades in the Mombasa auction.

3.6.4 National climate change policy

The urgent need for a well-defined climate change policy is indicated by the following statement from the Government of Kenya's website: "Kenya has at least 90 national policies and laws that are relevant to climate change with yet additional regulations, by-laws and

other statutory instruments extending down to the local level. Almost all these policy instruments have no provisions that directly or indirectly have considerations for climate change adaptation and mitigation. Moreover, perverse incentives, unclear jurisdictions and regulatory gaps could prohibit effective implementation of priority adaptation and mitigation options" (Kenya's Climate Change Action Plan Enabling Policy and Regulatory Framework – Government of Kenya, Ministry of Environment and Mineral Resources, 2012). In this context a recent study entitled Climate Change Vulnerability and Adaptation Preparedness in Kenya, by the Heinrich Böll Foundation, Nairobi[46], highlights the current challenges in this context.

Figure 3 Kenya Tea Value Chain



46 http://www.ke.boell.org/downloads/Kenya_Climate_Change_Adaptation_Preparedness.pdf

3.6.5 Impact of climate change on Kenya tea production under three scenarios

Some recent research results

Recent research by the International Center for Tropical Agriculture (CIAT) for the Ethical Tea Partnership (ETP) and the German Agency for International Cooperation (GIZ), on "Future Climate Scenarios for Kenya's Tea Growing Areas"[47] examined the impact of climate change on Kenyan tea production in the main growing regions located in the central region around Mount Kenya and between the Rift Valley and Nyanza in the west. The research used the following scenarios over a time scale to 2020 and 2050:

(i). Low to mid-range climate change conditions resulting in:

- Rainfall increases from 1,658 mm to 1,732 mm in 2050 passing through 1,694 mm in 2020;
- Temperatures increase and the average increase is 2.3ºC passing through an increment of 1.0ºC in 2020;
- The mean daily temperature range keeps constant on 14.8ºC in 2050;
- The maximum number of cumulative dry months keeps constant at 3 months.

(ii). High-range climate change conditions resulting in:

- The maximum temperature of the year increases from 26.6ºC to 29ºC while the warmest quarter gets hotter by 2.3ºC in 2050;
- The minimum temperature of the year increases from 8.9ºC to 11.1ºC while the coldest quarter gets hotter by 2.5ºC in 2050;
- The wettest month gets wetter with 308 mm instead of 304 mm, while the wettest quarter gets wetter by 20 mm in 2050;
- The driest month stays constant with around 58 mm while the driest quarter gets wetter by 13 mm in 2050.

Overall, in both of the above scenarios, the climate becomes less seasonal in terms of temperature and precipitation variability throughout the year, which inevitability has an impact on the yield and quality of a crop such as tea (please refer to Annex 6, Section 6, Tea Growing and Processing). The research made the following conclusions, including proposing crop diversification as a key adaptation strategy for the areas which will become unsuitable for commercial tea production through the impact of climate change:

- In Kenya the yearly and monthly rainfall will increase and the yearly and monthly minimum and maximum temperatures will increase by 2020 and will continue to increase progressively by 2050;
- The implications are that the distribution of suitability within the current tea-growing areas in Kenya for tea production in general will decrease quite seriously by 2050;
- The optimum tea-producing zone is currently at an altitude between 1,500 and 2,100 metres and will by 2050 increase to an altitude between 2,000 and 2,300 metres;
- Compared with the current situation, by 2050 areas at altitudes between 1,400 and 2,000 metres will suffer the highest decrease in suitability and the areas around 2,300 metres the highest increase in suitability;
- A comparison of potential diversification crops recommended by the project shows that coffee performs similarly to tea and would not be a good alternative crop.

[47] International Center for Tropical Agriculture (CIAT) (2011) *Future Climate Scenarios for Kenya's Tea Growing Areas*, Dr. Peter Laderach and Anton Eitzinger, Cali, Colombia. Available at: http://www.fao.org/fileadmin/templates/est/Climate_change/kenya/CIAT_Future-Climate-Scenarios-for-tea-growing-areas2011.pdf

Summary of climate change impacts and adaptation strategies under three different scenarios

It should be noted that tea and coffee are similar beverage crops, grown under similar conditions and at high altitudes, therefore the analysis of different climate change scenarios has similar results as for those for coffee under sub-sections 2.6 and 2.7 above.

Tea is Kenya's most important agricultural crop and export and significant effort should be applied to maintain its role in the economy. Although Government policy is to grow the tea industry further, in view of climate change, and given Kenya's already pre-eminent position in the global tea trade, it may be prudent to endeavour to maintain the status quo in terms of production and quality while looking for alternative sources of growth elsewhere. Whilst the expected differentiated impact of levels of climate change is described below, some results and policy options will be common to all three scenarios.

(i) **Low-range climate change:** Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), with no serious long term drought conditions during the growing season, and only slight changes to rainfall levels and patterns, the following impact may be expected:

- Slightly declining overall annual production and yields, without improved agricultural practice, including conservation farming techniques;
- Possible reduction in quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario the optimum policy is to maintain production, at existing levels through:

- Farmer training and capacity building in climate change resilience including conservation and organic farming techniques (provided the quality premium/loss of yield equation is positive, i.e. benefits equal or exceed effects)[48];
- Consider the extension of inter-planting of tea with shade trees which may reduce the temperature of the under storey plants (tea); the use of shade trees was historically ubiquitous in the tea industry, particularly in the sub-continent of India, however, modern practice has been to reduce cover – perhaps policy needs re-examining in the light of climate change;
- Institutional reform, particularly to improve agricultural extension delivery to farmers;
- Shortening the value chain through fostering contract farming with black tea factories and forward and backward linkages between farmers and retailers/certification compliance;
- Identify and assess new areas suitable for planting tea at higher altitudes, as temperatures increase;
- Invest in research on drought resistant and heat resilient tea varieties;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with occasional long term drought conditions during the growing season, and frequent changes to rainfall levels and patterns including shorter rainy seasons, the following impact may be expected:

[48] A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

- Declining overall annual production and yields, at significant levels in some lower altitude areas (see (i) above);
- A reduction in overall quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario the optimum policy is to endeavour to prepare for the management of likely declining production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Consider the inter-planting of tea with shade trees (see (i) above);
- Institutional reform (see (i) above);
- Small scale sub surface drip irrigation in selected areas to improve yield and maintain quality;
- Shortening the value chain (see (i) above);
- Introduce crop diversification[49] in the most vulnerable areas; studies (see the CIAT study, Footnote 37) have indicated that cabbage, peas, passion fruit and bananas (also as a shade tree) would be suitable income generating enterprises for farmers;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

(iii) **High-range climate change:** Under conditions of high average temperature rises (4.0°C with a likely range of 2.4 to 6.4°C), with regular long term drought conditions during the growing season, and erratic rainfall levels and patterns including much shorter rainy seasons, and regular extreme weather events, there will be serious negative results on the tea industry, and the following impact may be expected:

- Overall declining production due to heat stress and inadequate timely rainfall;
- Substantial loss of quality rendering significant production uneconomic to sell on world markets;
- High, perhaps unsustainable crop maintenance and harvesting costs;
- Significantly large growing areas will become uneconomic for the production of tea, and perhaps, other perennial and annual commercial cash crops.

Under this scenario the optimum policy is geared to managing the decline of the tea industry through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Consider introducing furrow irrigation and small scale sub surface drip irrigation[50] in those areas that remain commercially viable;
- Shortening the value chain (see (i) above);
- Introduce crop diversification throughout the tea growing regions of the country;
- Foster non-farm rural enterprises[51] e.g. marketable handicrafts and small scale village manufacture;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

49 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

50 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

51 FAO (undated) *Rural non-farm income in developing countries*, Tom Reardon. Available at: http://siteresources.worldbank.org/DEC/Resources/ruralNonfarmIncomeinDevelopingCountries.pdf

3.6.6 Climate change impact initiatives in Kenya

The Ethical Tea Partnership (ETP)[52]

The ETP was formed in 1997 when a number of large, mainly UK based, tea buying companies took the decision to work together to monitor and assure their own value chains. At that time the organization was called the Tea Sourcing Partnership, and focused on certification of suppliers of tea in producing countries. The name was changed to the ETP in 2004. The ETP now has over 20 international member companies from Europe, North America and Australasia, including well known tea brand owners such as Tetley and Twining. The ETP's partners include growers at origin, certification programmes such as those of the Rainforest Alliance and Fairtrade Labelling Organisation (FLO), technical experts, development non-governmental organisations (NGOs), tea boards and associations, and donor funding organisations. The ETP's activities cover all the major tea producing regions and the organisation has, currently, 5 regional managers based in Kenya, India, Indonesia, Sri Lanka and China that support their programmes. The main activities of the ETP are:

Monitoring and certification of members' tea supply chains: The ETP Global Standard (2810) covers areas to help protect the environment as well as social and labour provisions. It aligns with the standards of the main certification programmes. To increase its impact and to reduce the audit burden for producers ETP has entered into collaborative agreements with the RA and Utz Certified (2009), and Fairtrade (2010).

Producer Support: This is a wide-ranging training programme that tackles a number of key issues which producers commonly face. This programme directly helps producers to raise their performance against the ETP Global Standard (2810) and helps in areas crucial to achieving certification.

Strategic Sustainability: In 2010 the ETP committed itself to tackling a number of wider problems affecting tea sustainability. The first two Strategic Sustainability Initiatives of this kind were in response to **the effects of climate change**.

Climate change as a result of GHG emissions from human activity is one of the biggest threats to sustainable agriculture and because tea is primarily a rain-fed crop tea production will be particularly affected unless early efforts are made to help farmers adapt. A change in climate will lead to many adverse effects on the tea sector including the following:

- Unpredictable rainfall patterns;
- Delayed rain and drought;
- Destructive rain including flooding and soil erosion (especially on steep contoured sites);
- Warmer temperatures and scorching effects on crops;
- Increased instances of pests and disease;
- Strong destructive winds and gales.

The ETP have entered a number of strategic partnerships that will provide information on climate change and its effects, and support producers and smallholder farmers to increase their resilience to the changing conditions. It's estimated that this project work will reach up to 50,000 smallholder farmers. The following are some of the projects being undertaken under the auspices of the ETP:

[52] Ethical Tea Partnership (ETP), http://www.ethicalteapartnership.org/

Project to help smallholder farmers prepare for the effects of climate change:

In Kenya the effect of climate change is already being witnessed e.g. in 2009 a drought in the Rift Valley was responsible for a fall in production of up to 30%. Smallholder farmers, which account for over 60% of tea harvested in Kenya, are particularly vulnerable. Consequently many of them may struggle to continue to make a sustainable living from tea unless they adopt new practices.

The ETP and the GIZ have a 3 year, €390,000 public-private partnership (PPP) that will give smallholders the tools and training to help smallholders to improve their farming practices and become more resilient to climate change. The ETP is working with the KTDA and using their training structures to promote farmers and help the smallholder tea farming communities.

At the start of the project climate modellers from CIAT mapped Kenya's tea producing regions (based on climate alone) to predict which areas would be most affected by climate change in 2020 and 2050. Using this information 5 KTDA tea factories and the smallholders that supply them were selected for inclusion in the project. Using KTDA's extension officers, promoter farmers (peer to peer learning) and farmer field schools, smallholders will learn about good practice tea farming and the practical measures they can take to adapt to climate change in the following disciplines:

- Pruning and plucking techniques;
- Soil management & fertility;
- Gap filling & planting new varieties of drought and disease resistant tea bushes;
- Conserving biodiversity to increase the resilience of ecosystems;
- Promoting energy efficiency to help reduce deforestation;
- Introducing kitchen gardens to secure food supply and new income.

Project to expand ETP's tea climate adaptation programme in collaboration with Marks and Spencer Ltd

Leading UK retailer Marks and Spencer Ltd has commissioned ETP to run training workshops to help tea producers and farmers in their supply chains prepare for climate change. Training workshops will reach smallholder farmers from 4 cooperatives, 3 of which supply tea to KTDA factories. The participatory workshops will support smallholders to:

- Assess their own vulnerabilities to climate change that could potentially inhibit their ability to grow tea sustainably;
- Develop locally appropriate adaptation solutions using the ETP/GIZ adaptation toolkit;
- Work with local stakeholders to implement the key initiatives they have identified.

Project with the Fairtrade and Rainforest Alliance (RA) certification programmes

The ETP have been commissioned by the International Trade Centre (ITC), Geneva, to develop resources that will support Kenyan tea farmers to manage climate change impacts. The project, which builds on climate change work with GIZ, is in partnership with the RA and the FLO, and will support farmers to adapt to climate change. This collaborative approach will also help to ensure the climate change principles are aligned for all the standards operating in the tea sector.

Unilever Group

Unilever (owners of the Lipton and Brook Bond tea brands) claimed to be the first major tea company, in 2007, to commit to sustainable sourcing of tea on a large scale. By 2015

Unilever aim to have the tea in all Lipton tea bags sourced from RA Certified estates. By 2020 100% of Unilever's tea, including loose tea, will be sustainably sourced. 57% of Lipton tea bag blends contained sustainable tea at end 2011 and 25% was fully RA Certified, and 32% contained a proportion of RA Certified tea en route to full certification. Overall, 28% of the tea purchased for all Unilever brands was sourced from RA Certified farms. The company's policy is dependent on changing farming practices among their tea producers. In Kenya 250,000 farmers have now undertaken training in farmer field schools. By the end of 2011 they had also trained nearly 50,000 more tea farmers in Rwanda, Sri Lanka, Indonesia and Turkey.

FAO Project on Climate Change and the Tea Sector in Kenya:
The FAO[53] held a workshop on 7-8th February 2012 at Cathay Hotel in Nakuru, Kenya which brought together stakeholders in the Kenyan tea industry and representatives of the FAO with an aim of formulating a road map and determining the required framework for undertaking an integrated impact assessment of climate change on the tea industry in Kenya. Pursuant to the FAO initiative, Kenya tea industry stakeholders led by the TBK in collaboration with the TRFK, KTDA and the Ministry of Agriculture, have formed a Sectoral Working Group on climate change to coordinate the formation of a thematic secretariat on climate change within the tea industry. This group is expected to work with all the other interested parties on climate change in order to have an organized approach to the challenge for a unified strategy.

3.6.7 Kenya - findings and recommendations

Concern on the likely impact of climate change on the Kenya tea industry has set stakeholders on a deliberate path towards seeking sustainable adaptation measures. Observed climate change trends in the last few years have revealed worrying events, including extreme temperature increase, decreased/irregular rainfall, melting and retreat of mountain glaciers, increased frequency of extreme climatic events such as droughts, frost and hailstones. Decreased and irregular rainfall is of particular concern to the tea industry in Kenya in view of the fact that tea growing is rain-fed. Therefore the unreliability and inadequate rainfall occasioned by climate change is bound to impact on the production levels[54].

The consensus of opinion is that despite the threat from climate change the Kenya tea industry can continue to grow and remain a key element in the country's economic development. However, whilst there are a number of donor, private sector and Government initiatives already underway to combat and adapt to the negative impact of climate change DFID can also have a valuable role to play. Therefore, it is recommended that DFID consider the following options for future action in addressing climate change resilience in the Kenya tea value chain:

1. Work with the TBK, and if acceptable to them, on developing their planned Sectoral Working Group on Climate Change, which appears to be an exclusively public sector initiative, into a multi stakeholder Sustainable Tea Task Force (STTF), involving the full involvement of the private sector.
2. Work with the ETP on extending their current programme development and delivery of training courses/programmes for smallholder farmers and farmer groups on

53 FAO (2012) *Report for Inception Workshop for FAO Project on Climate Change and the Tea Sector in Kenya: Economic and Social Impact Assessment*, organised by FAO in collaboration with Ministry of Agriculture. Available at: http://www.fao.org/fileadmin/templates/est/Climate_change/kenya/kenya_inception_workshop_proceedings_report.pdf

54 Tea Board of Kenya (TBK) (2012) *Tea Industry seeks mitigation on climate change impact*. Available at: http://www.teaboard.or.ke/news/2012/31aug12.html

adaptation and mitigation strategies for coping with the negative impact of climate change on the tea value chain.

3. Commission a feasibility study on a PPP pilot project, involving Government agencies, Cooperatives, private sector agribusiness, on sustainable tea production and export.

The above options have common elements with recommendations to be suggested for climate change resilient coffee value chains, as both tea and coffee are perennial tree crops with similar growing condition requirements, and, further details regarding these initiatives are described in Section 5.

3.7 The Bangladesh tea sector

3.7.1 Introduction

Annex 8 contains a map of Bangladesh, general economic information, and further information on the country's tea sector.

3.7.2 Bangladesh tea production

History of the Bangladesh tea industry dates back to 1840 when a pioneer tea garden was established on the slopes of the hills in Chittagong, with the first commercial tea garden established in 1857 at Mulnichera in Sylhet. Today, tea is grown in the eastern hilly parts of the country, primarily in the greater district of Sylhet, which accounts for about 90% of the tea growing area and production. The greater district of Chittagong is the second largest tea growing area, while some tea is also grown in Rangamati in the Chittagong Hill Tracts. During recent years tea has also been grown successfully in Panchagarh district in the extreme north western part of the country. Table 4 below shows the growth of the Bangladesh tea industry since the Second World War in terms of estate units, area planted to tea, pluckable (mature) area, production and yield. Up to date statistics since 2008/09 are not available from Bangladesh official sources, however, ITC statistics indicate that production has stabilised at around 59/60 million kg p.a. The area planted to tea is also stable at around 50,000/55,000 ha, and yield at around 11/1200 kg/ha.

Year	Number of Tea Estates	Area Under Tea (ha)	Pluckable Area (ha)	Production (million kg)	Yield (Kg/ha)
1947	103	28,734	28,734	18.36	639
1950	103	31,890	28,734	23.77	827
1955	127	30,274	28,734	23.87	831
1960	127	31,418	30,744	19.01	618
1965	151	36,500	32,335	27.13	839
1970	153	42,685	39,308	31.38	798
1975	153	42,685	39,308	29.09	740
1980	153	43,528	43,201	40.04	927
1985	156	44,609	44,330	43.29	976
1990	158	47,385	44,759	46.16	1,031
1995	158	47,938	43,998	47.67	1,084
2000	160	50,470	46,344	53.15	1,147
2002	161	50,226	44,717	53.62	1,199
2003	162	50,896	44,916	58.30	1,298
2004	162	51,264	45,083	56.00	1,242
2005	163	52,317	45,366	60.14	1,326

Year	Number of Tea Estates	Area Under Tea (ha)	Pluckable Area (ha)	Production (million kg)	Yield (Kg/ha)
2006	163	52,407	45,505	53.41	1,174
2007	163	53,368	46,926	58.19	1,240
2008	163	54,106	47,377	58.66	1,238
2009	N/A	N/A	N/A	60.00	N/A
2010	N/A	N/A	N/A	59.27	N/A
2011	N/A	N/A	N/A	59.32	N/A

Source: International Tea Committee (ITC) statistics and Bangladesh Tea Board (BTB)

Table 4 Bangladesh tea industry 1947 – 2011, units, area, production and yield

Whereas tea exports have declined from 18.10 million kg in 2000 to 1.45 million kgs in 2011), domestic consumption has risen in the same period from 38.79 million kg to 53.74 million kg (Annex 8 Tables 1 and 2).

3.7.3 The Bangladesh tea value chain and marketing system

Structure of the tea industry

The Bangladesh Tea Board (BTB): The BTB is a statutory body constituted under the Tea Ordinance 1977 to regulate, control and promote the cultivation and sale of tea in Bangladesh.

Ownership/different categories of tea management: While three Sterling, i.e. non-Bangladeshi, foreign owned tea companies, originally UK registered, own 28 estates, Bangladeshi companies and individuals own the rest of the tea gardens. The three foreign companies are Duncan Brothers, Deundi Tea Company and The New Sylhet Tea Estate. The country's 163 tea estate units operating in 2008 were managed by five different categories of managements as follows[55]:

1. Sterling companies
2. National Tea Company (NTC)
3. Bangladesh Tea Board
4. Bangladeshi Private Limited Companies (Deshi Company)
5. Bangladeshi Proprietary owners

Table 5 shows the management, land use and production of the various categories of tea ownership in Bangladesh. The up to date situation regarding, particularly foreign/sterling ownership of tea estates needs to be investigated further as there have been some estate sales and changes recently, but no details were available at the time of preparing the report.

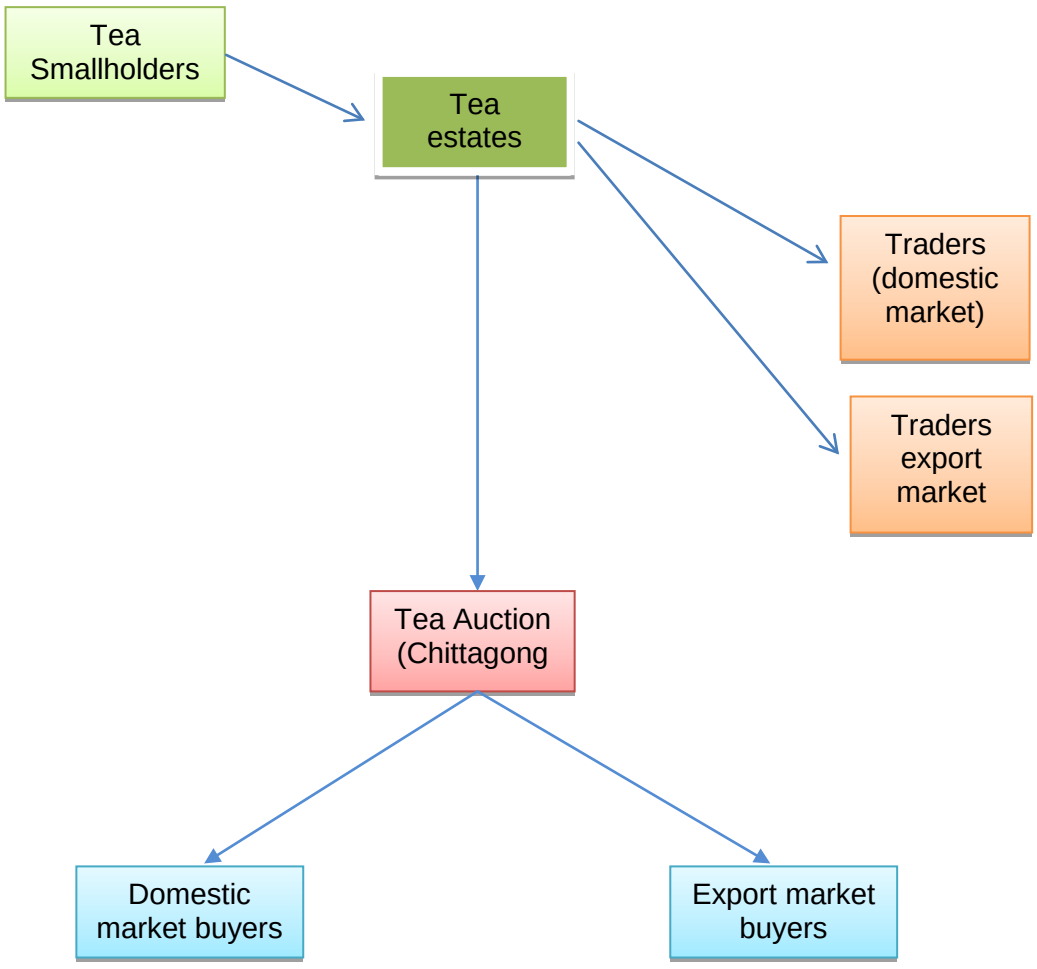
[55] Bangladesh Tea Board (BTB).

Category of Management	No. of Tea Estates	Grant Area (ha)	Tea Area (ha)	Land Use[56] (%)	Production (2006) 000' mt	Yield (kg/ha)
Sterling co.	28	39,386.02(34%)	20,219.16	51%	24,028 (45%)	1,188
BTB	3	2,559.39(2%)	1,445.55	57%	1,536 (3%)	1,063
NTC	13	11,279.95(10%)	5,583.66	50%	4,760 (9%)	852
Deshi Co	61	40,652.05(35%)	15,716.65	39%	15,816 (30%)	1,006
Proprietary	58	21,656.00(19%)	9,345.85	43%	7,205 (13%)	771
Total	163	115,553.41(100%)	52,310.87	45%	53,345	1,020
Smallholders		96.35	96.35	100%	63	650
Grand Total	163	115,629.76(100%)	52,407.22	45%	53,408 (100%)	1,019

Source: Bangladesh Bureau of Statistics (BBS), 2009

Table 5 Bangladesh – Tea management, land use and production (2009)

Figure 4 Bangladesh tea value chain



It is well known that shorter value chains are more efficient. The above chain is very traditional in the tea trade, and as Bangladesh's industry is geared to the domestic market it would be prudent to examine improved backward and forward linkages between farmers and retailers, and institutional reform in the public sector.

[56] The percentage land use is that planted to tea out of the organisation's total land grant area.

Export market
Since 1971 tea has been one Bangladesh's major exportable items and had a captive export market in some countries of the Asian region, particularly Pakistan and India and the former USSR. This scenario has changed in recent years due to market liberalisation and globalisation, the emergence of new entrants in the world market with low priced tea, such as Vietnam, and most importantly, the rapid increase of internal demand in Bangladesh itself. The Government of Pakistan has allowed duty free entry of 10.00 million kg of tea per year from Bangladesh since October 2002 and has offered to increase the quota up to 15.00 million kg, but Bangladesh has not been able to use the quota fully, as increasing internal demand pushes the price levels up in the local auction and discourages exports. Other tea producing countries such as India, Sri Lanka, Indonesia, Vietnam, Kenya and some other African countries have a comparative advantage over Bangladesh, in terms of cost of production and quality, which makes the export market extremely competitive for Bangladesh tea[57]. Given the rising internal demand, linked to population increase, and the fact that tea is a staple beverage in the country; it is most unlikely that a resurgence of the tea export market will occur in the foreseeable future.

3.7.4 National climate change policy

The Climate Action Plan published in 2011 builds on the NAPA and describes a ten-year programme to build the capacity and resilience of the country to meet the challenge of climate change over the next 20-25 years. The Climate Change Action Plan is built on the following six pillars:

1. Food security, social protection and health
2. Comprehensive disaster management
3. Infrastructure development
4. Research and knowledge management
5. Mitigation and low carbon development
6. Capacity building and institutional strengthening

Climate change policy and strategy is enshrined in the NAPA prepared by the Ministry of Environment and Forests (MoEF), Government of the People's Republic of Bangladesh[58], published in 2005. Climate change policy, under the NAPA focuses on the potential damage caused by the rise of water levels in the Bay of Bengal due to expected rising temperatures. Whilst tea is grown primarily in the hill country of eastern Bangladesh, the tea value chain, which includes the transportation of tea from growing areas to the auction in the coastal town of Chittagong, and distribution throughout Bangladesh along the road system, is also vulnerable. The Bangladesh NAPA has listed a number of priority projects, together with a description of the type of project, implementing agency and initial cost forecast.

A selection of these projects, with particular relevance to the agriculture sector, is given below; a full list of projects is included under Table 3 in Annex 8. It should be noted that tea is not specifically mentioned, and that the emphasis is on maintaining food security, in the most vulnerable plain areas.

1. Climate change and adaptation information dissemination to vulnerable communities for emergency preparedness measures and awareness-raising on enhanced climatic

[57] Tasnuba Nasir (Lecturer, Faculty of Business Administration), University of Science and Technology Chittagong (2011) *Bangladesh tea production, consumption and exports in global and Bangladeshi perspective*.

[58] United Nations Environment Programme (UNEP)/Global Environment Foundation (GEF) (2005) *National Adaptation Programme of Action (NAPA), Final Report*, prepared by the Government of People's Republic of Bangladesh, Ministry of Environment and Forests (MoEF).

disasters, (Awareness and Capacity Building), implemented by the MoEF - Full project: USD7 million.

2. Mainstreaming adaptation to climate change into policies and programmes in different sectors (water, agriculture, health and industry) focusing on disaster management, implemented by the Department of Environment (DoE) - Full project: USD 1 million, Design phase: USD 25,000.
3. Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future, implemented by Bangladesh Agricultural Research Council (BARC) - Full project: USD 5 million, Design phase: USD 50,000.

3.7.5 Impact of climate change on Bangladesh tea production under three scenarios

The country is vulnerable, both spatially and temporally, because of its regional connectivity through geo-physical and hydrological features and economically, due to the reliance of livelihoods on agriculture and trade. Various studies estimated that in the event of about a one metre rise of sea level by the year 2100 (the studies have found that there is a 50% probability of a one metre rise in sea level), a substantial area of Bangladesh will go under water; a one metre rise of sea level will inundate approximately 17% of the coastal area of Bangladesh, and affect 7% of the GDP of Bangladesh. Due to the impact of climate change the following consequences are likely:

- A greater share of the population to be congested into smaller areas and will force migration;
- Inundation of wetlands and lowlands;
- Accelerated coastal erosion, and increased salt water intrusion into rivers, agricultural and coastal forest lands and into groundwater;
- Multiple problems in coastal urban areas;
- Damage to port facilities and coastal embankments/structures;
- Destruction of agricultural land, dislodgement of mangroves and fisheries;
- Pressure on cyclone and storm surge protective measures in coastal areas.

Summary of climate change impacts and adaptation strategies under three different scenarios

Tea is an important agricultural crop and is an increasing affordable beverage of choice for the country's rapidly growing population, therefore, reasonable effort should be applied to maintain its role in the economy, in food security and rural employment.

(i) **Low-range climate change**: Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), with no serious long term drought conditions during the growing season, and only slight changes to rainfall levels and patterns, the following impact may be expected:

- Slightly declining overall annual production and yields, without improved agricultural practice, including conservation farming techniques;
- Possible reduction in quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs;
- Rising sea levels in the Bay of Bengal will cause problems with maintaining infrastructure, particularly the roads on which tea is transported to urban centres for domestic consumption.

Under this scenario the optimum policy is to maintain tea production at existing levels through:

- Farmer training and capacity building in climate change resilience including conservation and organic farming techniques (provided the quality premium/loss of yield equation is positive i.e. benefits equal or exceed effects)[59];
- Consider the extension of inter-planting of tea with shade trees which may reduce the temperature of the under storey plants (tea); the use of shade trees was historically ubiquitous in the tea industry, however, modern practice has been to reduce cover – this policy may need re-examining in the light of climate change;
- Institutional reform, particularly to improve agricultural extension delivery to farmers;
- Shortening the value chain through fostering contract farming with black tea factories and forward and backward linkages between farmers and domestic retailers e.g. supermarkets;
- Identify and assess new areas suitable for planting tea at higher altitudes, as temperatures increase;
- Invest in research on drought resistant and heat resilient tea varieties;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with occasional long term drought conditions during the growing season, and frequent changes to rainfall levels and patterns including shorter rainy seasons, the following impact may be expected:

- Declining overall annual production and yields, at significant levels in some lower altitude areas (see (i) above);
- A reduction in overall quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs;
- Rising sea levels in the Bay of Bengal will cause problems with maintaining infrastructure, particularly the roads on which tea is transported to urban centres for domestic consumption.

Under this scenario the optimum policy is to endeavour to prepare for the management of likely declining tea production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Consider the inter-planting of tea with shade trees (see (i) above);
- Institutional reform (see (i) above);
- Small scale sub surface drip irrigation in selected areas to improve yield and maintain quality;
- Shortening the value chain (see (i) above);
- Introduce crop diversification[60] in the most vulnerable areas; studies (see the CIAT study, Footnote 37) have indicated that cabbage, peas, passion fruit and bananas (also as a shade tree) would be suitable income generating enterprises for farmers;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

59 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

60 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

(iii) **High-range climate change:** Under conditions of high average temperature rises (4.0°C with a likely range of 2.4 to 6.4°C), with regular long term drought conditions during the growing season, and erratic rainfall levels and patterns including much shorter rainy seasons, and regular extreme weather events, there will be serious negative results on the tea industry, and the following impact may be expected:

- Overall declining production due to heat stress and inadequate timely rainfall;
- Substantial loss of quality rendering significant production uneconomic to sell on world markets;
- High, perhaps unsustainable crop maintenance and harvesting costs;
- Significantly large growing areas will become uneconomic for the production of tea, and perhaps, other perennial and annual commercial cash crops;
- Rising sea levels in the Bay of Bengal (see (ii) above).

Under this scenario the optimum policy is geared to managing the decline of the tea industry through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Consider introducing furrow irrigation and small scale sub surface drip irrigation[61] in those areas that remain commercially viable;
- Shortening the value chain (see (i) above);
- Introduce crop diversification throughout the tea growing regions of the country;
- Foster non-farm rural enterprises[62] e.g. marketable handicrafts and small scale village manufacture;
- Foster the introduction of renewable sources of energy.

3.7.6 Bangladesh - findings and recommendations

Bangladesh is one of the world's most vulnerable countries to the negative effects of climate change. Each year, roughly a fifth of Bangladesh is flooded and flooding in the country is set to increase by up to 40 per cent this century as global temperatures rise, the latest climate models suggest. However, it would seem that the tea industry, due to its production location in hilly areas, is less vulnerable to climate change than other agricultural sub-sectors such as rice and maize which are grown extensively in the flood plains. However, a threat to the tea value chain remains from changing temperatures, and climate change resilience strategies should be pursued by the industry if the tea sector is to maintain its current level and importance to the economy, employment, and the domestic beverage market. It should be noted that the Bangladesh tea industry has become primarily a supplier to the domestic market, with an insignificant volume of exports. Therefore, it is unlikely to be a priority origin for the private sector controlled certification agencies and facilitators, such as RA and the ETP. Therefore, it is recommended that DFID consider the following options for future action in addressing climate change resilience in the Bangladesh tea value chain.

1. Suggest to the Tea Board of Bangladesh that training programmes on the climate resilient tea value chain for smallholders, tea estate owners and key stakeholders are designed and delivered through workshops and famer schools. It is possible that the ETP may be interested in being involved in this initiative in an advisory capacity, bearing in mind their current experience in this area in Kenya.

61 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

62 FAO (undated) *Rural non-farm income in developing countries*, Tom Reardon. Available at: http://siteresources.worldbank.org/DEC/Resources/ruralNonfarmIncomeinDevelopingCountries.pdf

2. Commission a feasibility study on a PPP pilot project, involving Government agencies, Cooperatives and private sector agribusiness, on sustainable tea production and export.

The above options have common elements with recommendations to be suggested for climate change resilient coffee value chains, as both tea and coffee are perennial tree crops with similar growing condition requirements, and, further details regarding these initiatives are described in Section 5.

SECTION 4

Cotton

4.1 Introduction

This section reviews the global cotton market and assesses the impact of climate change on the cotton value chain, with particular reference to the **Tanzania** and **Pakistan** cotton industries, which are discussed in detail under sub-sections 4.6 and 4.7. An overview of the world cotton trade is included under Annex 9, which describes in detail cotton growing and processing methodology, global production, further information on the value chain, trading systems and production and price trends.

Cotton is essentially produced for its fibre, which is universally used as a textile raw material. Cotton is a soft, fluffy staple fibre that grows in a boll, or protective capsule, around the seeds of cotton plants of the genus Gossypium, and is a perennial plant by nature, but has long been grown as an annual crop. Varieties grown commercially today belong to four species of Gossypium. Gossypium hirsutum, or Upland cotton, produces the bulk of cotton worldwide. Cotton is grown commercially in more than 70 different countries, mostly in the longitudinal band between 37°N and 32°S, and is especially adapted to semi-arid and arid environments, where it is either grown rain-fed or through irrigation. About 53% of the world's cotton growth areas and 73% of all fibre growth areas benefit from full or supplementary irrigation. With worldwide annual production of some 22 million mt (2009/10) of cotton fibre, cotton is among the most important commodities in international trade. The Food and Agricultural Organisation (FAO) estimates that nearly 100 million rural families directly depend on cotton production. 90% of all cotton worldwide is of the gossypium hirsutum cotton species. In 2009, overall world production of cotton amounted to some 100 million bales (1 bale = 500 lbs or 226.8 kg). The largest cotton producers are China, India and the USA, followed by **Pakistan** and Uzbekistan.

4.2 Cotton value chains and marketing systems

The components and players in the cotton value chain vary with the unique characteristics and cotton institutional framework of each producing country, and whether the country is developed or less developed. Whilst the specific value chains for **Tanzania** and **Pakistan** are given in Sections 4.6 and 4.7 below, under Figures 5 and 6, the following general characteristics may be identified:

The cotton sector value chain beyond the on-farm cultivation of cotton includes all associated activities such as the transport of seeds, inputs and crop, ginning of the seed cotton, baling of cotton fibre and cottonseed, pressing of the cottonseed for oil, and transport of cotton fibre, cottonseed oil and cottonseed cake to the buyer. International fuel-based transport is important because at least one-third of global cotton fibre is exported from its country of origin. Greenhouse gas (GHG) emissions from cotton production vary greatly across countries. Countries with high incomes and high yields tend to rely upon intensive production systems that depend heavily on carbon-based fuels for irrigation, field operations, fertilizers and pesticides. In low-income countries, in turn, labour and cattle are generally used for field operations instead of carbon-based fuel driven equipment, fertilizers and pesticides, thus limiting GHG emissions per hectare and per product.

4.3 Cotton and climate change[63]

Optimum cotton growing conditions

Cotton needs favourable growing conditions with respect to temperature, sunshine and soil moisture. A marked dry season is also essential for the bolls to open properly and for harvesting. The cotton plant, once established, rapidly develops a vertical tap root that provides resilience against drought during the growing season and gives the plant access to more lower soil layers and nutrients than those cereal crops, such as maize, sorghum or millet, can access. Consequently, cotton is a particularly useful plant in crop rotation systems. However, the vertical tap root also makes cotton sensitive to stress from waterlogging after floods or heavy rains. Cotton requires a total of 105 to 125 days of sufficient soil moisture to grow and in tropical regions, 2 to 4 mm of water is needed daily at the beginning and the end of the growing period, while at the height of flowering 5 to 7 mm is required daily, therefore, about 500 to 700 mm of water is sufficient for the crop to develop fully. Rain-fed cotton, however, can, in practice, only be grown in regions where average annual rainfall is 700 mm or more, since inter-annual and intra-annual rainfall variability, and the amount of resulting run-off, has to be taken into account. Cotton is resilient to sub optimal growing conditions, and, for example, responds to loss of vegetation or fruiting parts (buds, flowers, bolls) through so-called “compensatory growth”.

Possible effects of climate change on cotton production

GHG emissions in the cotton value chain are derived mainly from the consumer use phase (30%–60%), and manufacture (20%–30%). Emissions from cotton production amount to only 5%–10% of the total emissions. Cotton production is both a contributor to, and, a victim of climate change. Cotton production contributes to between 0.3% and 1% of total global GHG emissions, and, particularly in the tropical regions of the world, looks set to suffer according to predicted rising temperatures, decreased soil moisture and more extreme weather events, such as those that cause flooding. Overall, the negative impacts of climate change on cotton production relate to the reduced availability of water for irrigation, in particular in Xinjiang (China), **Pakistan**, Australia and the western United States. Heat stress risks creating depressed yields in **Pakistan** in particular, while in other countries limited increases in temperatures could favour cotton plant growth and lengthen the cotton growing season. The crop is, however, sensitive to water availability, particularly at the height of flowering and boll formation. Rising temperatures favour cotton plant development; unless day temperatures exceed 32ºC. Limited increases in atmospheric carbon dioxide (CO2) also favour the cotton plant’s development.

Under Annex 9, Table 1 illustrates, in detail, the individual factors in cotton production that contribute to GHG emissions under low and high inputs for the various activities involved in the planting, growing, harvesting, transport and processing of cotton. The data shown in the table indicates that GHG emissions in cotton production, as in agriculture in general, are highly dependent upon human choices as to farm, field and crop management, e.g. “organic” versus “conventional”. Nitrous oxide (N2O) emissions contribute the most to cotton’s GHG emissions, followed by fertilizer and pesticide production, and energy for irrigation. Irrigated conditions produce more greenhouse gas emissions than dry land farming, particularly N2O emissions. This figure is similar to findings by Systain (2010)[64] who point out that during cotton cultivation, half of the GHG emissions are associated with N2O emitted when using mineral fertilizer, and the other half results from energy consumption, in particular for soil cultivation and ginning.

63 Main source for this sub section: International Trade Centre (ITC) (2011) *Cotton and Climate Change: Impacts and Options to Mitigate and Adapt*, Geneva, ITC, xii, 32 p. (Technical paper) Doc. No. MAR-11-200.E.

64 Systain (2010) A step in the right direction, *EcoTextilesNews*.

Tentative data quoted recently by the US Organisation, Cotton Incorporated[65], and other industry sources, suggests that cotton production might be considered a "carbon sink" through the use of conservation tillage systems; however, more research is required in this field.

Potential impact of climatic change on cotton production[66]

Cotton plants respond to changing environments depending on the plant's stage of development. Key stages in cotton plant development are: (i) conditions at the time of planting (ii) plant development in early season (iii) flowering (iv) boll formation and (v) conditions towards the end of the season.

Temperature: Climate change is leading to a rise in average temperatures, changes in the water cycle and precipitation patterns, and to an increase in extreme weather events. Depending on the growing region, higher temperatures may lead to a longer growing season and more rainfall, or to lower rainfall and a shorter growing season. Extreme weather events may affect the plants any time of the season, and are by definition hard to predict. Higher temperatures may affect different regions in different ways e.g. (i) low soil temperatures at planting time hamper timely planting of cotton in many countries and rising temperatures will benefit those countries and regions as they will be able to plant cotton much earlier than at present (ii) conversely, higher temperatures in cotton producing areas and regions already experiencing high temperatures could have a negative impact as a result of increased shedding of flower buds (iii) higher temperatures may have a positive effect on yields in those areas and regions where the effective fruiting period is squeezed between two phases of lower temperatures.

CO2 levels: Higher CO2 levels in the immediate surroundings of the cotton plant will increase photosynthetic activity. Cotton will grow more vigorously as the amount of CO2 in the air increases. Leaves will likely be larger; thereby giving plants a greater photosynthetic surface area, which subsequently facilitates growth. With more atmospheric CO2, greater numbers of branches and fruiting sites will likely develop, and this, in turn, should ultimately provide for higher lint yields. Another impact of higher atmospheric CO2 is that weeds will grow more vigorously, as when cotton is in the seedling stage, competition with weeds is critical, therefore, as cotton planting and development will start earlier as temperatures rise, the same development will be observed in weeds, thus increasing cost of production through weed prevention measures. Increases in atmospheric CO2 will also decrease the nutritional value of leaves for pests due to an increasing ratio of carbon to nitrogen in plant tissues.

Water availability: Cotton needs adequate water to grow and to maintain its temperature within an optimal range. Without water for cooling, plants may suffer heat stress. In many regions, irrigation water is used to maintain adequate growing and temperature conditions for cotton. The amount and timing of water availability during the growing season, through precipitation or irrigation, are critical for cotton. If water supply variability, due to climate change, increases, it will affect plant growth and cause reduced yields.

Pests and diseases: Insects are a recognized threat to cotton production throughout the world. As mentioned above, several studies have exhibited that global warming will influence the pest's metabolism and increase their population rate; therefore, pest control will become more critical in achieving optimal growth and yield. Furthermore, atmospheric CO2 levels and higher temperatures may also have an impact on the effectiveness of certain pest management tools currently in use, such as certain seed varieties or insecticides, thus increasing costs of production. The effect of global warming on living organisms is slow enough for cotton insects to adjust to rising temperatures and other changes accruing from

65 http://cottontoday.cottoninc.com/sustainability-about/ [Accessed 25 April 2013].

66 International Cotton Advisory Committee (ICAC) (2007) *Global warming and cotton production – Part 1.*

global warming.[67] Thus, the insects currently plaguing cotton are expected to continue to be live and possibly thrive in new environmental conditions. Global warming may also negatively affect disease control in three ways (i) through its effect on pathogens (i) by creating disease-propitiating environments, and (iii) by affecting host tissues. It is feared that a rise in temperature will affect some disease control methods as a result of changes in the pathogen emergence time. Chemical control methods may also become less effective due to the possibility of faster decomposition of chemicals under higher temperatures.

Options to adapt to climate change
Climate change is changing the economics of production, forcing rural cotton farming communities to consider multiple livelihood strategies including planting different crops and seeking alternative non-farm income streams. This entails complex and resource intensive responses from government and international aid flows. It should be noted particularly that irrigation allows half of today's cotton acreage (and three-quarters of production) to take place in areas where cotton could not normally be productively sustained. This makes cotton particularly vulnerable to the availability of freshwater or groundwater for irrigation.

Various studies have identified the following potential adaptation measures to sustain cotton production under the negative impact of climate change:

- Stop any unnecessary loss of nutrients for the farming system, preventing soil erosion and abandoning the burning of cotton crop residues where still applied;
- Favour a cropland design that has plant diversity and that favours soil fertility management; e.g. through the inclusion of cover crops or perennials;
- Adjust sowing dates to offset moisture stress during the warm period, to prevent pest outbreaks, and to make best use of the length of the growing season;
- Minimize the period that land lays bare, in order to slow down loss of organic matter and soil humidity, and soil erosion in general;
- Minimize soil tillage in order to prevent loss of soil organic matter, a natural source of soil fertility and a means of storing water for plant uptake;
- Breed cotton varieties that are more resistant to heat stress, drought spells, weeds, pests and diseases.

4.4 Climate change impact initiatives

An illustration of the climate change impact initiatives being undertaken by the private sector, and particularly multi-national corporations (MNCs) in cooperation with non-governmental organisations (NGOs), is the Levi Strauss & Company's (LSC) 2012 Climate Change Strategy[68]. The strategy focuses on the reduction of CO2 and other GHGs through maximising energy efficiency and using renewable energy in their manufacturing and distribution activities, and throughout the value chain. 95% of all LSC products are manufactured from cotton grown in the USA and developing countries such as **Tanzania** and **Pakistan**. In their climate strategy they have introduced, with other apparel brand owners and retailers, NGOs, and farmers' organizations, the Better Cotton Initiative (BCI)[69]. The initiative acknowledges that, as a result of climate change cotton farmers will face increasing land constraints and water scarcity, further exacerbating the need to influence how cotton is grown and harvested and the need to standardise more sustainable farming practices. The BCI aims to make all cotton production more sustainable particularly by

67 Ton (2011) *Cotton and Climate Change. Impacts and Options to Mitigate and Adapt*, International Trade Centre (ICT)/United Nations Conference on Trade and Development (UNCTAD)/World Trade Organisation (WTO), p.12.

68 http://levistrauss.com/sites/levistrauss.com/files/librarydocument/2012/10/2012-lsco-climate-change.pdf [Accessed 25 April 2013].

69 http://www.ecolabelindex.com/ecolabel/better-cotton-initiative [Accessed 25 April 2013].

reducing water and chemical use (including pesticides and fertilisers), protecting the health of the soil and promoting important labour standards including bans on child labour, thus improving the climate change resilience of the cotton value chain. BCI is complementary to other cotton sustainability/climate change initiatives such as Certified Organic, Fairtrade cotton and Cotton made in Africa (CmiA). The BCI Eco labelling system started in 2010 and in 2011 LSC incorporated the BCI in over two million pairs of its branded jeans around the globe and plans to increase that amount every year.

4.5 Global cotton production and price trends

World cotton area is projected to rise by 7% in 2011/12 to 36 million ha, the largest in 17 years, in response to record prices in 2010/11. Farmers are expected to expand cotton area in 2011/12 in all producing countries; expansion should be undertaken in a sustainable manner, by diversification away from other crops, or planting on land already logged in former forest areas and lying unutilised (given that it is preferable to make new plantings on land already in use, or used, for agroforestry purposes, rather than plant on virgin land which may be, for example, forests protecting natural habitats for flora and fauna). World cotton production is projected to increase by 9% to a record exceeding 27 million tons. Rising cotton supplies will feed rising demand in 2011/12. However, although prices are expected to decline from current record levels, it is likely that prices will stay substantially higher than the average that has prevailed during the past decade. However, higher prices, and competition from chemical fibres, are expected to limit growth in mill use during 2011/12 to 3%, to 25.4 million tons. The largest increases in mill use are projected for India, China, **Pakistan** and Turkey (International Cotton Advisory Committee (ICAC) statistics).

4.6 The Tanzanian cotton sector

4.6.1 Introduction

Annex 10 contains a map of Tanzania, general economic information, and further information on the country's cotton sector. Cotton has been grown in Tanzania for more than 120 years and is one of the country's major traditional crops; the others being coffee, tea, tobacco, cashew nuts, and sisal. Over the period 2005-2009, amongst the traditional cash crops, cotton generated the highest foreign exchange earnings, averaging US$ 92 million per annum, compared with US$ 89.7 million (tobacco), US$ 88.6 million (coffee), US$ 42.2 million (cashew nuts) and US$ 32 million (tea). Cotton is a source of employment and livelihood to about 40% of the population and a basis for considerable national fixed capital formation, and significant agricultural growth and earnings[70].

4.6.2 Tanzanian cotton production[71]

The key issues and challenges facing the Tanzanian cotton industry have been identified by the Tanzanian Cotton Board (TCB), in their Second Corporate Strategic Plan: 2010/11 - 2012/13 as follows:

- Persistent droughts;
- Numerous small-scale farmers with limited access to and knowledge in application of new and improved technologies on the farm;
- Poor infrastructure for inputs distribution and crop procurement;
- Inadequate research and extension services;

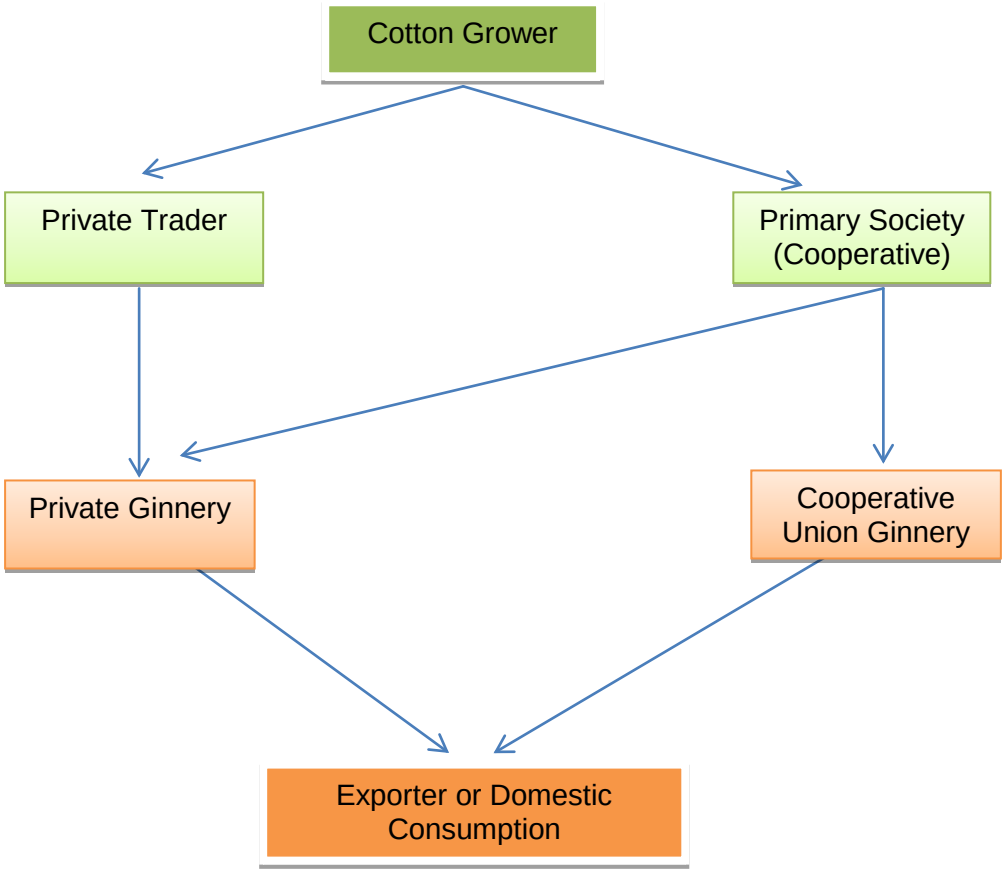
[70] United Republic if Tanzania (URT) (2009) *Economic Survey*, Dar es Salaam.
[71] Tanzania Cotton Board (TCB) (2010) *Second Corporate Strategic Plan: 2010/11 - 2012/13*.

- Rampant seed cotton and lint contamination reduces the quality of lint, lowers prices and the competitiveness of the crop, and leads to low yields and output volume of the crop;
- Expanding acreage, increasing yields and falling production costs in major producing and consuming countries reduce prices and markets for Tanzania cotton;
- Production and export subsidies in developed cotton producing countries lead to overproduction, unfair competition and lower cotton prices;
- Competition from man-made fibres reduces the market share for cotton;
- A historical tendency for cotton prices to decline leads to further reduced prices;
- Stakeholders are not properly organised to defend interests of cotton in a unified way;
- Conflict of interest and political interference in regulatory and monitoring role of TCB;
- Limited funding for cotton development activities, high commodity taxes and utility tariffs impinge on the operations of the cotton sector;
- Poor incentive and remunerative packages for employees;
- The emergence of alternative cash crops, especially green grams which are cheaper to grow, but fetch higher returns than cotton in the major cotton growing districts (e.g. Bariadi, Magu, Maswa and Meatu).

4.6.3 The Tanzanian cotton value chain and marketing

The basic traditional Tanzanian cotton value chain is illustrated in Figure 5 below.

Figure 5 Tanzanian cotton value chain



Cotton sector Stakeholders

The Cotton Farmers: Cotton is grown by 350,000 to 500,000 mostly small scale farmers. The number of farmers varies depending on weather conditions and cotton market price trends. Droughts and downward shifts in cotton prices in the international market place compel some of the farmers to switch to alternative crops, adversely affecting production volumes of both seed and lint.

Tanzania Cotton Board (TCB): The TCB was established on July 1, 2004 following the coming into effect of the Cotton Industry Act No. 2 of 2001 to replace the Tanzania Cotton Lint and Seed Board as set out by Act No. 19 of 1984 and as amended in 1993. TCB's major roles are regulation, promotion, monitoring, advisory, facilitation, coordination, development and representation in the cotton sector.

Cotton Research Institutes: Currently, there are two institutes, both Government owned, which directly deal with cotton research, (i) the Lake Zone Agricultural Research Development Institute (LZARDI), located in the western cotton growing area (WCGA), and (ii) the Ilonga Agricultural Research Institute (IARI) located in the eastern cotton growing area (ECGA). These institutes are constrained by limited funding for research and training; poor research infrastructure and other facilities, a staff ageing problem which is accentuated by difficulties in recruitment and retention of Researchers due to poor remuneration and inadequate other incentive packages.

Tanzania Cotton Association (TCA): While the TCA was formed in 1997 as an apex association of cotton stakeholders to articulate and promote the interests of the sector with a unified approach, in practice it has remained largely an association of ginners, traders, exporters; incorporating the Tanzania Cotton Growers Association (TACOGA). Currently the TCA has 50 members comprising 35 ginners, 1 exporter, 4 cooperative unions; 1 growers association (TACOGA), and 2 farmers. Some of the ginners also run oil mills. The TCA has played a crucial role in promoting self-regulation amongst its members and spearheading increased cotton output volumes and yields through supplying farmers with agricultural inputs and tractor hire services. In the WCGA there are a total of 62 ginneries equipped with 1,193 roller gins, and 85 saw gins. 21 of the ginneries are owned and operated by cooperatives. The remaining 41 are owned by private companies. All ginneries belonging to cooperatives are old – installed before 1970. The oldest are Ukerewe (1923) and Nassa (1924); and the newest are Chato and Ngasamo (1966) and Kahama (1967). Most of the private ginneries, with the exception of Manonga (1958), were constructed after 1995; and 17 of them were constructed after 2000. In the ECGA there are 8 ginneries; 7 of which are old and 1 is new.

Cooperatives: Currently, there are four area-based cooperatives with multifaceted problems which make them unable to compete effectively in the liberalized procurement, processing and marketing of cotton. Their market share which was 100% before liberalization in the early 1990s progressively dwindled and currently accounts for less than 3% of the market share for seed cotton.

Cotton Oil Millers: Most ginners have oil mills as important integral components of their cotton business operations. Currently 32 ginners have installed oil mills at their business premises, capable of processing 16,121 mt of cotton oil; representing only 14% of installed capacity which stands at 115,150 mt p.a. These oil mills also produce around 52,000 mt of cotton cake annually.

Cotton Spinners, Weavers and Textile Millers: This group of stakeholders comprises 21 mills, all of which are privately owned, producing annually 110m square metres of exclusive fabrics known as khanga and vitenge, dyed drill, linen and bed sheets. They utilize only about 20% of domestic lint, preferring to import the rest due to unfavourable prices and the

unacceptable quality levels of local fibres. They operate at 40 to 50% of installed capacity; and employ around 18,000 workers.

The Government: The cotton sub-sector is under the auspices of the Ministry of Agriculture, Food Security and Cooperatives. The Government provides subsidies for procuring cotton inputs and for funding the promotional and regulatory functions of the TCB. Together with the Farmers and Private Cotton Processors, it co-finances the operations of the Cotton Trust Fund. Other ministries whose work contributes to the cotton sub-sector, through cross-cutting issues, include the Vice President's Office, the Prime Minister's Office, Ministry of Finance, Ministry of Infrastructure Development, Ministry of Lands and Human Settlements, the President's Office - Planning Commission, Ministry of Industries, Trade and Marketing and Ministry of Internal Affairs. The list also includes Local Government Authorities (LGAs) which play a key role in the implementation stage of programmes at the district level.

Government Institutions: There are a number of Government institutions in the agricultural sector, which play a critical public role in various sectors including the cotton sub-sector, these include the Tanzania Official Seed Certification Institute (TOSCI), Tropical Pesticides Research Institute (TPRI), the National Environment Management Council (NEMC) and Tanzania Bureau of Standards (TBS).

Development Partners: Development partners include multilateral and bilateral organizations and agencies that support Government and communities in the agricultural sector in general, and cotton sub-sector in particular, through grants and soft loans. Development partners also provide technical support in the implementation of programmes and projects.

The basic Tanzanian cotton value chain is relatively efficient, however, greater backward and forward linkages between farmers and ginners are recommended together with institutional reform of public sector agencies involved in the industry.

4.6.4 National climate change policy

Tanzania's economic base is dependent on the use of natural resources, rain-fed agriculture and biomass for household energy. The economy is highly vulnerable to the adverse impacts of climate change and to extreme weather events. The impacts are already vivid, with recent temperature measurements from 21 meteorological stations in the country showing a steady increase in temperature for the past 30 years. Due to the increasing temperatures, the adverse impacts are now felt in all sectors of the economy and are threatening human life. Severe and recurrent droughts in the past few years have triggered the recent devastating power crisis. The extreme drop of water levels of Lake Victoria, Lake Tanganyika and Lake Jipe in recent years and the dramatic recession of 7km of Lake Rukwa in about 50 years, are associated, at least in part, with climate change, and are threatening economic and social activities. Eighty percent of the glacier on Mount Kilimanjaro has been lost since 1912 and it is projected that the entire glacier will be gone by 2025. The intrusion of sea water into water wells along the coast of Bagamoyo town and the inundation of Maziwe Island in Pangani District, off the Indian Ocean shores, are yet another evidence of the threats of climate change.

The Government's policy with regard to climate change is enshrined in its NAPA[72], which targets 14 selected projects activities, viz:

- Water efficiency in crop production irrigation to boost production and conserve water in all areas.

[72] UNEP/GEF (2007) *NAPA,* for Vice President's Office, Division of Environment.

- Alternative farming systems and water harvesting.
- Development of alternative water storage programs and technology for communities.
- Community based catchments conservation and management programs.
- Exploration and investment in alternative clean energy sources e.g. wind, solar, bio-diesel, etc. to compensate for lost hydro potential.
- Promotion of application of cogeneration in the industry sector for lost hydro potential.
- Afforestation programmes in degraded lands using more adaptive and fast growing tree species.
- Development of community forest fire prevention plans and programmes.
- Establishing and strengthening community awareness programmes on preventable major health hazards.
- Implementing sustainable tourism activities in the coastal areas and relocation of vulnerable communities from low-lying areas.
- Enhancement of wildlife extension services and assistance to rural communities in managing wildlife resources.
- Water harvesting and recycling.
- Construction of artificial structures e.g. sea walls, artificially placing sand on the beaches and coastal drain beach management systems.
- Establishment of a good land tenure system and facilitate sustainable human settlements.

During the National Adaptation Programme of Action (NAPA) preparation cotton was not selected for specific attention (maize and coffee were chosen in this context). However, Table 6 below indicates vulnerabilities to climate change and existing and potential adaptation strategies for the agricultural sector, including cotton.

Vulnerability	Existing Adaptation Activities	Potential Adaptation Activities
(1) **Cotton** yields could decrease by 10%-20% due to the impact of pests and diseases (2) Unpredictable rainfall, uncertainty in cropping patterns (3) Shifting in agro-ecological zones (4) Prolonged dry spells beyond normal patterns (5) increased weed competition with crops for moisture, nutrients and light (6) Ecological changes for pests and diseases (7) Decline of maize yields, the national food crop nationwide, by 33% due to temperature rise; highest decline reported for Dodoma and Tabora	• Small scale irrigation • R&D on drought tolerant • seed varieties • Agriculture extension activities • Diversification of • agriculture: growing • different types of crops on different land units • Water harvesting	• Alternative farming systems • Promotion of indigenous knowledge • Change in planting dates in some agro ecological zones • Increased irrigation to boost maize production in selected areas • Drip irrigation for specific regions • Reduce reliance on maize as staple food by growing short-season and drought tolerant crops such as sorghum and millet • Shift crop farming to more appropriate agro ecological zones • Change crop rotation practices • Integrated crop and pest management • Make better use of climate and weather data, weather forecasts, and other management tools • Create awareness of the

Vulnerability	Existing Adaptation Activities	Potential Adaptation Activities
		negative effects of climate change • Sustainable water management to boost food crop production • Strengthen early warning systems

Source: Tanzania NAPA

Table 6 Summary of vulnerabilities and adaptation activities (existing & potential) in the Tanzanian agricultural sector

4.6.5 Impact of climate change on cotton production under three scenarios

Overview

The climate of Tanzania varies from place to place in accordance with geographical location, altitude, relief and vegetation cover. Predictions, calculated under NAPA preparation, show that the mean daily temperature will rise by 3°C to 5°C throughout the country and the mean annual temperature by 2°C to 4°C. There will also be an increase in rainfall in some parts while other parts will experience decreased rainfall. Predictions further show that areas with bimodal rainfall pattern will experience increased rainfall of 5% – 45% and those with unimodal rainfall pattern will experience decreased rainfall of 5% – 15%.

Impact of climate change on cotton production under a low, mid and high-range scenario

Cotton is an important crop to Tanzania's GDP, foreign exchange earnings and to rural livelihoods, and reasonable/significant efforts should maintain its role in the economy even with expected climate change, providing that it takes place under the low-range scenario described in (i) below. Cotton is grown in seven western regions of Tanzania, and to a small extent in the east of the country. Over 90% of Tanzania's cotton farmers live in three regions: Mwanza, Mara and Shinyanga, the cotton growing "Lake Zone".

Whilst the expected different impact of climate change is described below, some results and policy options will be common to all three scenarios.

(i) **Low-range climate change:** Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), no serious drought conditions during the growing season, and given that the area planted to cotton annually remains basically constant the following impact may be expected:

- Slightly declining overall annual production and yields, without improved agricultural practice, including conservation farming techniques;
- Possible reduction in quality;
- Increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs.

Under this scenario the optimum policy is to maintain, at least existing levels, and possibly expand production through:

- Farmer training and capacity building in climate change resilience including conservation[73] and organic farming techniques (provided the quality premium/loss of yield equation is positive, i.e. benefits equal or exceed effects);
- Institutional reform, particularly to improve agricultural extension delivery to farmers;
- Introduce small scale sub surface drip irrigation in vulnerable selected areas;
- Shortening the value chain through fostering contract farming and forward and backward linkages between farmers and retailers/certification compliance;
- Identify and assess new areas suitable for planting cotton;
- Invest in research on drought resistant and heat resilient cotton seed varieties;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with occasional drought conditions and periods of less than optimal rainfall during the growing season, the following impact may be expected:

- Periodic loss of soil moisture leading to declining production;
- Loss of quality;
- Increased costs on pest and disease control, and weeding;
- Some growing areas will become commercially unviable for the production of cotton.

Under this scenario the optimum policy is to endeavour to maintain overall production at existing levels, but also to prepare for the management of likely declining production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Introduce large scale furrow irrigation and small scale sub surface drip irrigation[74] in selected areas (drip irrigation brings better results in cotton lint per hectare yield, but tends to be more expensive and needs cost/benefit analysis)[75];
- Shortening the value chain (see (i) above);
- Identify and assess new areas suitable for planting cotton outside the Lake Zone;
- Invest in research on drought resistant and heat resilient cotton seed varieties;
- Introduce crop diversification[76] in the most vulnerable areas;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

(iii) **High-range climate change:** Under conditions of high average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with frequent drought conditions and periods of less than optimal rainfall during the growing season, and regular extreme weather events, there will be serious negative results on the cotton industry, and the following impact may be expected:

- General loss of soil moisture leading to declining overall production;
- Substantial loss of quality rendering significant production uneconomic to sell on world markets;

73 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

74 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

75 E.R. Norton and J.C. Silvertooth, *Evaluation of a Drip Vs. Furrow Irrigated Cotton Production System*. Available at: http://ag.arizona.edu/pubs/crops/az1224/az12245b.pdf

76 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

- High, perhaps unsustainable, planting, crop maintenance and harvesting costs;
- Significantly large growing areas will be become uneconomic for the production of cotton, and perhaps, other commercial cash crops.

Under this scenario the optimum policy is geared to managing the decline of the cotton industry through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Introduce large scale furrow irrigation and small scale sub surface drip irrigation[77] in those areas that remain commercially viable (see (ii) above);
- Shortening the value chain (see (i) above);
- Introduce crop diversification throughout the Lake Zone and cotton growing areas in the east of the country;
- Foster non-farm rural enterprises[78] e.g. marketable handicrafts and small scale village manufacture;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

4.6.6 Climate change impact initiatives in Tanzania

Cotton Development Programme - Gatsby Charitable Foundation, UK (GCF): Since 2008, GCF has worked with the Tanzanian Cotton Board (TCB) to drive up productivity in Tanzania's cotton sector. Pilot initiatives, research and coalition-building have enabled the programme to reach a point where it can scale up to benefit a much greater number of smallholder cotton farmers. The programme has agreed co-funding with DFID and the Norwegian Agency for Development Cooperation (Norad). The Programme, managed by the Tanzanian Gatsby Trust in partnership with the TCB, addresses issues of sector sustainability, although an initial reading of programme documents has not revealed specific detailed climate change impact interventions, other than conservation agriculture promotion. A recent DFID paper entitled, "Business Case: the Cotton Sector Development Programme in Tanzania - Intervention Summary" proposes that the UK provides £7.32m over four years to GCF to support a £15.3m cotton sector development programme which will increase the incomes of 360,000 smallholder farmers living in the rural Lake Zone of Tanzania.

4.6.7 Tanzania - findings and recommendations

The cotton industry needs to plan for maintaining production at current levels, or, managing an overall decline over coming years. It is recommended that DFID consider the following options for future action in addressing climate change resilience in the Tanzanian cotton value chain.

1. Work with the Government on setting up a multi stakeholder Sustainable Cotton Task Force (SCTF), under the auspices of the Ministry of Agriculture Food Security and Cooperatives – see Annex 12 for suggested themes to be handled by the SCTF.
2. Work with the Government and Cooperative Unions on crop diversification, away from cotton, in those cotton areas that will be most badly affected by climate change in terms of reduced production and yields
4. Work with a broad range of stakeholders, e.g. Government/Cooperatives/privately owned ginneries and oil mills on developing and delivering training

[77] A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

[78] FAO (undated) *Rural non-farm income in developing countries*, Tom Reardon. Available at: http://siteresources.worldbank.org/DEC/Resources/ruralNonfarmIncomeinDevelopingCountries.pdf

courses/programmes for smallholder farmers and farmer groups on adaptation strategies for coping with the negative impact of climate change on the cotton value chain – see Section 5 for basic training course content.

4. Commission a feasibility study on a Public-Private Partnership (PPP) pilot project, involving Government agencies, Cooperatives, private sector agribusiness, on sustainable cotton production and export – see Annex 12 for suggested basic terms of reference (TOR).

4.7 The Pakistan cotton sector

4.7.1 Introduction

Annex 11 contains a map of Pakistan, general economic information, and further information on the country's cotton sector.

4.7.2 Cotton production

Pakistan is the world's 4th largest cotton producer and consumer, preceded by China, India and the USA. The cotton industry is an integral aspect of the economy, as is the textile sector on which the economy is heavily dependent. Production in 2007/08 totalled approximately 1.9 million tons, with an average yield of 620 kgs/ha. The cotton industry employs approximately 15 million people. Pakistan has been a net importer of cotton since the mid-1990s, due to the expansion in domestic demand, therefore, cotton exports have been declining to below 65,000 tons in recent seasons, whereas, imports are significantly higher. Pakistan is currently the 2nd largest importer of cotton, after China with 880,000 mt in 2007/08. Cotton trading is facilitated by the fact that the government has no quantitative restrictions or duties on imports and exports of cotton. The Pakistan economy is linked to the success of the cotton and textile sectors, which account for 8.2% of the value added in agriculture and 2% of GDP. Furthermore, the cotton and textile industries dominate exports, accounting for 55% of export value.

The major cotton producing areas in Pakistan are Punjab and Sindh with approximately 79% produced in Punjab and 20% in Sindh. According to recent figures, there are approximately 1.3 million cotton farmers, and 3 million ha currently allocated for cotton farming with an average farm size of 4 hectares. The cotton belt extends over about 1,200 km along the Indus River and its tributaries, between latitudes 23°N and 33°N, at altitudes from 153 metres in the North to 27 metres in the South. Soils vary from sandy loam to clay loam with clay dominant towards the South. Temperatures in May and June are as high as 40º C to 45º C, often reaching 50º C on individual days. Winter temperatures often fall below freezing in the Punjab and upper Sindh but the lower Sindh is frost free. There are two distinct cropping seasons for summer (Kharif) crops, from April to October, and winter (Rabi) crops, from October to April/May. Some short-season crops are sandwiched between these main cropping seasons. Due to very limited rainfall (150–750 mm according to zone), agriculture in the Indus Valley depends entirely on irrigation. Cotton takes the third biggest share of freshwater in Pakistan (World Wildlife Fund (WWF), 2005)[79]. Water is supplied on a weekly basis. Supply is regulated through a series of dams that store water until it is needed during relatively dry periods. Supply cannot be varied according to crop water requirements.

The average cotton fibre yield per hectare is higher in the Southern Sindh province (850 kg/ha) than in Punjab (692 kg/ha); however, both are low for irrigated cotton in general, which suggests that this is due to the very high average maximum and minimum

[79] World Wildlife Fund (WWF) (2005) *Pakistan Sustainable Cotton Initiative (PSCI).* Available at: WWF website.

temperatures in Pakistan as compared to other countries growing cotton in a hot climate. Boll weight in Pakistan (2–3 grams per boll) is less than half that in the United States, Egypt and Australia (each 5–6 grams per boll), and half that in Turkey (4–5 grams per boll).

In 2011 Pakistan produced a record cotton harvest of 14.01 million bales, up by 2.32 million from the 11.69 million bales produced in 2010. In 2011-12, the cotton area slightly increased from 3.1 million hectares in 2010-11 to 3.2 million hectares. The Pakistan Central Cotton Committee (PCCC), which is responsible for implementing the national "Cotton Vision 2015" aims to produce 19.1 million bales of cotton by 2015, a 74% increase over the five year period from 2010 to 2015. Therefore, cotton production is expected to increase in the medium to long term future, notwithstanding any adverse impacts of climate change. It is therefore imperative that the industry has the correct strategies to cope with climate change

Structure of the cotton industry: There are a number of government agencies and private initiatives that regulate and support the cotton sector. The Ministry of Food, Agriculture and Livestock, provincial Agriculture Departments and the Pakistan Cotton Central Committee are directly involved in the different aspects of cotton production. Similarly, there are organizations and research institutes related to improving cotton production and institutions responsible for the oversight of the textile industry, such as the Ministry of Textiles and the Textile Commissioner's Office.

Key issues facing the cotton sector: The cotton industry suffers from a variety problems. Although Pakistan is the 4th largest producer of raw cotton in the world it is still far behind in productivity per unit of area when compared with the yields being realized in some other major cotton growing countries. Yields are not increasing due to absence of virus resistant varieties, emergence of new insect pests such as mealy bug and cotton leaf curl virus (CLCV) and the limited adoption of better scientific cultivation methods.

4.7.3 The Pakistan cotton value chain and marketing

The Pakistan cotton value chain is illustrated in Figure 6 below. The role of the various actors in the chain, as shown in Figure 6, is described below.

1. Growers – small scale farmers cultivating cotton and selling ex-farm gate to marketing agents.
2. Marketing agents - they collect cotton from producers and sell to ginners. They acquire title to the cotton they sell and bear the risk. They may supply growers with agricultural inputs as well as credit.
3. Merchants – in principle buy the major part of their cotton from the poorest and smallest producers and the quantities purchased are more limited than those purchased by the marketing agents (2 above). They deliver cotton to the ginneries.
4. Cotton gins – located close to production sites and process raw cotton into fibres (cotton lint) and seeds.
5. Fibre is sold, usually through merchants, to spinners for yarn production, or to exporters, although most Pakistan production is currently used domestically in the textile industry.
6. Cotton seed is sold to oil mills for the production of cottonseed oil, to exporters for sale overseas as cottonseed, although this business has almost disappeared as seeds are crushed locally, or to growers for the planting of new cotton crops.

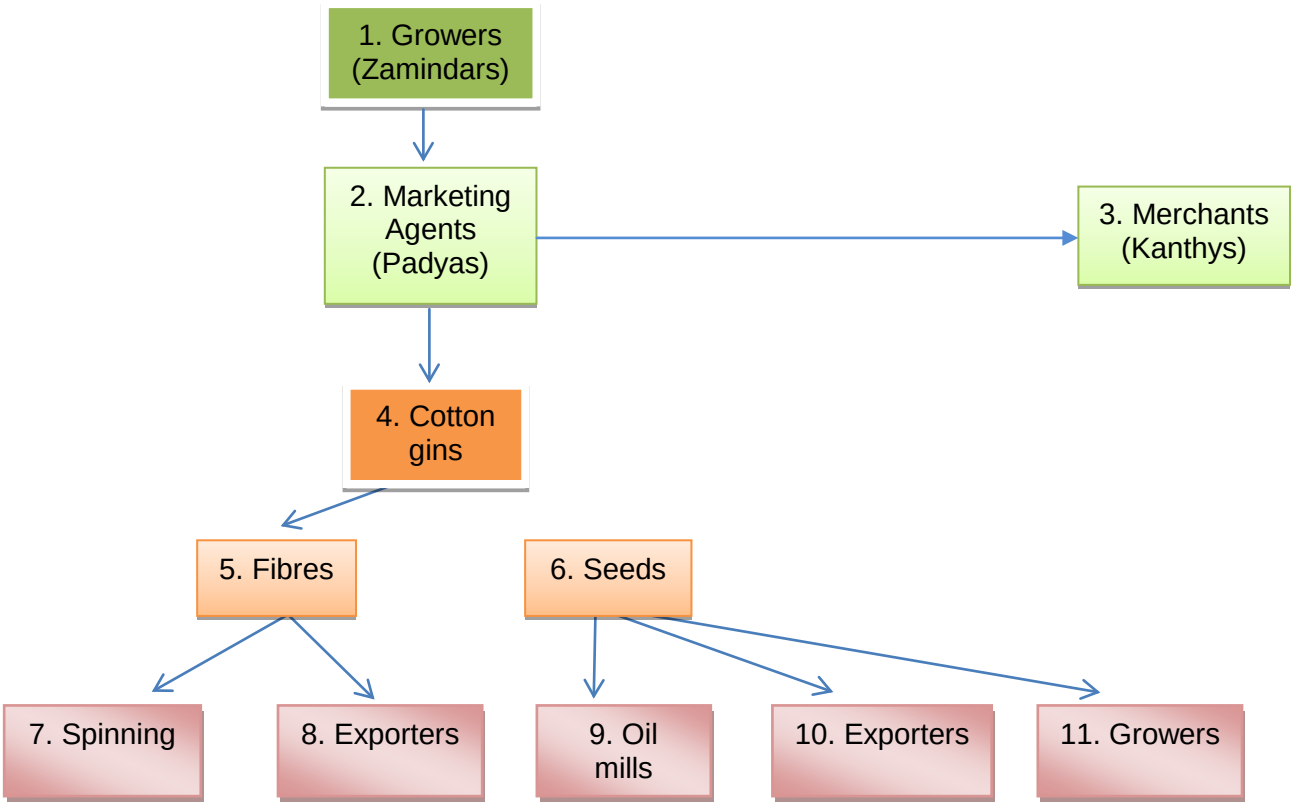
As is the case with most commodity value chains, the chain is too long and would benefit from institutional reform leading to shortening of the chain through greater backward and forward linkages between farmers and ginners, which in turn will improve marketing efficiency and give farmers more potential to retain a greater share of the value of cotton lint.

It is also recommended that institutional reform of public sector agencies involved in the industry should be investigated.

4.7.4 National climate change policy

Pakistan is currently developing a NAPA, focusing on marginalized groups for climate resilient development. Support is available for NAPA through the Least Developed Countries (LDCs) funding mechanism[80]. Adaptation to climate change is critical for Pakistan. There is a need for greater awareness among stakeholders on the changing risks, with Pakistan ranked 16th of 170 countries at risk as a result of climate change in 2010/11, moving up from 29th in the rankings in 2009/10. Pakistan now has "Highest Vulnerability" status and this needs to be stressed in climate change negotiations.[81]

Figure 6 The Pakistan cotton value chain



4.7.5 Potential impact of climate change on cotton production

Overview

Pakistan is forecast to suffer severely from climate change as far as agriculture and cotton production is concerned. Agriculture is mostly dependent on irrigation with water from the Indus River, which will carry less water as the Himalayan glaciers and snowfields diminish in size. The Indus River is very important to agriculture in Pakistan, and cotton production already takes place in sub-optimal conditions with respect to high temperatures. Further increases in temperature during the growing season will depress yields, as occurred

80 Government of Pakistan, (2011) Policy brief from the Ministry of Environment for delegation to United Nations Climate Change Conference (COP17) in Durban, South Africa, in November 2011.

81 Maplecroft (2011) *Climate Change Vulnerability Index (CCVI)*. Available at: http://maplecroft.com/about/news/ccvi.html

following the floods in Pakistan in 2010 which had a very significant impact on cotton production and prices.

The Indus River depends heavily on melt water because there is hardly any rainfall downstream if net irrigation water availability in the Indus valley decreases. Farmers are likely to switch to crops that demand less water than cotton, such as coarse grains, fruits and vegetables.

Maximum temperatures in summer exceed 40ºC in the central and southern parts of Pakistan. A future increase in temperature coupled with a decrease in rainfall would have a negative impact on the production of major crops. Irrigation requirements for crops vary by climatic zone. The increase in temperature coupled with changes in rainfall will increase net irrigation water requirements, particularly in the three main production systems: rice-wheat, maize-wheat and cotton-wheat. Furthermore, the increased use of poor quality groundwater would induce secondary salinisation. A study of the potential vulnerability of crops to heat stress under a climate change scenario of a rise in temperature of 0.3ºC per decade shows that all crops suffer heat stress, but crops like wheat, cotton, mango and sugarcane are more severely affected, while the prevailing maximum temperature is more than 10ºC higher than the optimal range. Any fractional rise in temperature would therefore have serious adverse effects on growth, maturity and productivity. Irrigation water requirements would increase to compensate for heat stress, with the cooling of crops becoming an essential element of the crop production system[82].

Potential impact of climate change on cotton production under a low, mid and high-range scenario

Cotton is an important crop to Pakistan's GDP, foreign exchange earnings and to rural livelihoods, and efforts should maintain its role in the economy under climate change, providing that it takes place under the low range scenario described in (i) below. Cotton is grown almost exclusively along the Indus River and its tributaries. Whilst the expected different impact of climate change is described below, some results and policy options will be common to all three scenarios.

(i) **Low-range climate change:** Under conditions of low average temperature rises (1.8°C with a likely range of 1.1 to 2.9°C), no serious shortage of water availability of good quality for irrigation during the growing season, only occasional disruption to level and pattern of rainfall, the following impact may be expected:

- A slight decline in overall annual production and yields, without improved agricultural practice, including conservation farming and improved irrigation techniques;
- Possible reduction in quality due to slight heat stress;
- Possible increased costs on pest and disease control, and weeding;
- Some areas may become commercially unviable due to the lowering of yields and increased costs of irrigation.

Under this scenario the optimum policy is to maintain production at least at existing levels through:

- Farmer training and capacity building in climate change resilience techniques including conservation agriculture and improved irrigation techniques including sub surface drip irrigation[83];

[82] International Trade Centre (ITC) (2011) *Cotton and Climate Change: Impacts and Options to Mitigate and Adapt*, Geneva, ITC, xii, p.32.

[83] A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

- Institutional reform, particularly to improve agricultural extension delivery to farmers;
- Shortening the value chain through fostering contract farming and forward and backward linkages between farmers and ginners;
- Investment in research on drought resistant and heat resilient cotton seed varieties;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

(ii) **Mid-range climate change:** Under conditions of medium average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with regular shortages of water availability of good quality for irrigation during the growing season, frequent disruption to the level and pattern of rainfall, and occasional extreme weather events such as floods, the following impact may be expected:

- Regular loss of soil moisture leading to declining yields and overall production;
- Loss of quality, particularly in boll size, due to heat stress;
- Increased costs on pest and disease control, weeding and irrigation;
- Some growing areas, particularly at further distances from the Indus River and its tributaries, will be become commercially unviable for the production of cotton;
- Periodic very poor crops due to flooding.

Under this scenario the optimum policy is to endeavour to prepare for the management of likely declining production in the most vulnerable areas through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Extension of large scale furrow irrigation and small scale sub surface drip irrigation in vulnerable areas;
- Shortening the value chain (see (i) above);
- Invest in research on drought resistant and heat resilient cotton seed varieties;
- Introduce crop diversification in the most vulnerable areas;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

(iii) **High-range climate change:** Under conditions of high average temperature rises (3.2°C with a likely range of 1.75 to 4.7°C), with regular and large scale shortages of availability of water for irrigation during the growing season, erratic rainfall levels and seasonal patterns and regular extreme weather events such as droughts and flooding, there will be serious negative results on the cotton industry, and the following impact may be expected:

- Overall loss of soil moisture leading to a major decline in overall production;
- Substantial loss of quality rendering significant production uneconomic for the domestic textile market;
- High, perhaps unsustainable, planting, irrigation, crop maintenance and harvesting costs;
- Significantly large growing areas will become uneconomic for the production of cotton, and perhaps, other commercial cash crops;
- Some areas in Sind, close to the Indus estuary, could suffer from secondary salination of groundwater, leading to production of cotton being abandoned.

Under this scenario the optimum policy is geared to managing the decline of the cotton industry and research into other agricultural and non-agricultural enterprises, through:

- Farmer training and capacity building (see (i) above);
- Institutional reform (see (i) above);
- Introduction of large scale furrow irrigation and small scale sub surface drip irrigation[84] in those areas that remain commercially viable;
- Shortening the value chain (see (i) above);
- Introduce crop diversification throughout the cotton growing areas of the country;
- Foster non-farm rural enterprises[85] e.g. marketable handicrafts and small scale village manufacture;
- Consider resettlement schemes, if appropriate areas exist, for those rural populations whose likely livelihoods are most affected by climate change;
- Foster the use of renewable energy sources throughout the value chain, particularly processing and transport.

4.7.6 Pakistan - findings and recommendations

The cotton industry needs to plan for maintaining production at current levels, or, managing an overall decline over coming years. It is recommended that DFID consider the following options for future action in addressing climate change resilience in the Pakistan cotton value chain.

1. Work with the Government on setting up a multi stakeholder SCTF, under the auspices of the Ministry of Agriculture – see Section 5 for suggested themes to be handled by the SCTF.
2. Work with the Government and provincial agencies on crop diversification, away from cotton, in those cotton areas that will be most badly affected by climate change in terms of reduced production and yields.
3. Work with a broad range of stakeholders e.g. Government/Cooperatives/privately owned ginneries and oil mills on developing and delivering training courses/programmes for smallholder farmers and farmer groups on adaptation strategies for coping with the negative impact of climate change on the cotton value chain.
4. Commission a feasibility study on a PPP pilot project, involving Government agencies, Cooperatives, private sector agribusiness, on sustainable cotton production and export – see Section 5 for suggested basic TOR.

84 A brief note on conservation agriculture is included under Annex 10 (Cotton – Supplementary note).

85 FAO (undated) *Rural non-farm income in developing countries*, Tom Reardon. Available at: http://siteresources.worldbank.org/DEC/Resources/ruralNonfarmIncomeinDevelopingCountries.pdf

SECTION 5

Summary of findings and recommendations

5.1 Key findings

1. Need for detailed sub regional studies on long term weather forecasting

Most of the outcomes of global studies on climate change are at continental levels, while the details at regional and sub-regional levels, which strongly influence the economics, are inadequate. Coffee, tea, and cotton production systems are basically regional to sub-regional; hence there is a need for detailed studies. In its assessment reports of 2000, the Intergovernmental Panel on Climate Change (IPCC) categorically stated the need for more comprehensive studies to be carried out at the regional/sub-regional production system level as the climate is strongly influenced by local topography, location and proximity to sea and oceans. Studies by various agencies have used a number of approaches to conceptualize the climate change in a specific region and its impacts on the different commodity production systems together with economic sectors in that region. Most of these studies, however, suggest the need for:

(i) Detailed analysis of long term weather and productivity information to quantify the specific changes in weather conditions that have occurred over the period; and

(ii) Studies of how the current and future weather is/would be affecting the productivity and economic activities/returns from that region (to include information on impacts alongside probabilities of those impacts)[86].

2. Current impact of climate change

Scientific research and participatory assessments show, that many of the current coffee, tea and cotton growing regions are already suffering from more severe and frequently occurring extreme weather events, which might have severe consequences, not only for farmers, but for all actors in the respective commodity value chains, thus affecting, particularly, yields, production costs, prices, and, in macroeconomic terms, a country's balance of payments, growth, employment and livelihoods. Whilst farmers report changing weather patterns, particularly longer drought periods, shorter rainy seasons and greater fluctuations in temperature during the year, no long term trend in production decline can be discerned. Further statistics will be needed to draw definitive conclusions on the quantitive impact of climate change on volumes.

3. The need for greater value chain efficiency

The study focuses on commodity value chain resilience to climate change, and in this context for each selected commodity/country the value chain has been described and shown diagrammatically. Generally, the shorter the value chain the more efficient it is. An efficient value chain structure will work to the greater advantage of farmers in coping with the negative impacts of value chains as it will assist in identifying actual and potential problems related to declining yield, production and quality caused by changing temperature and rainfall patterns. Many of the initiatives described in the report are increasing their focus on contract farming, direct communication between farmer and retailer/primary processor, and institutional reform and capacity building, which will shorten the value chain and make it more transparent.

[86] FAO, INTERGOVERNMENTAL GROUP ON TEA INTERSESSIONAL MEETING Washington, DC, USA, 17-18 September 2012 - Working Group on Climate Change.

5.2 Recommendations

The key recommendations to the Department for International Development (DFID) for future action in the promotion and fostering of climate resilient coffee, tea and cotton value chains cover the following intervention strategies.

1. Setting up multi stakeholder Sustainable Task Forces (STFs) in the coffee, tea and cotton sectors, under the auspices and hosting of Government agricultural ministries.
2. Cooperation and assistance to private sector led and facilitated certification of standards schemes for export commodities. This is the main way in which the private sector, along the value chain, can invest in making the value chain more climate resilient.
3. Training of stakeholders in (i) climate resilient value chain strategies, including conservation and organic farming techniques and furrow and drip irrigation methods and (ii) crop diversification (iii) non-farm rural enterprises.
4. Feasibility studies for public private partnership (PPP) pilot projects on sustainable agribusiness focused on coffee, tea and cotton.

Draft outline terms of reference (TOR) for the 1 and 4 above suggested interventions are included in detail in Annex 12.

Sustainable agribusiness (coffee, tea and cotton) task forces (STFs)
It is recommended that STF TORs focus, as a prime responsibility, on initiatives at the Government policy level aimed at giving incentives to stakeholders in the sustainable coffee, tea and cotton sectors with an emphasis on achieving optimum sustainable production under a low carbon and green economy. In undertaking its mandate in this connection the STF should work in collaboration with other relevant public and private sector organisations on (i) identification and investigation of the feasibility of applying a broad range of macro-economic incentives (ii) the implementation of sustainable coffee, tea and cotton, promotion (iii) the identification of donor and private sector funding to enable the commissioning of research and feasibility studies on coffee, tea and cotton sustainability issues.

PPP Pilot Projects on agribusiness sustainability

The Pilot Project Concept
The concept proposed entails the incorporation of a holistic approach to sustainable PPP commodity development pilot projects using the following broad themes (i) the enhancement of the role of smallholders in the achievement of optimum sustainability and profitability (ii) the promotion of greenhouse gas (GHG) reduction techniques (iii) the promotion of fiscal and other incentives to the achievement of low carbon and climate resilient agribusiness.

The following are examples of other PPP pilot projects in the coffee, tea and cotton sector, with potential for up-scaling, including those arising from agricultural commodity sustainability certification schemes:

1. AdapCC – Adaptation to climate change for smallholders of coffee and tea (2007-2010): PPP between the German Agency for International Cooperation (GIZ) and Cafédirect/Teadirect UK. Key findings are given in Section 2.4.
2. Rainforest Alliance (RA) – carbon coffee: PPP between RA and the International Finance Corporation (IFC), a member of the World Bank Group, Ecom Agroindustrial Corp, the third-largest coffee trading company in the world, non-governmental organisations (NGOs) and coffee farmers in Mexico and Nicaragua. Key findings are given in Section 2.4.

3. Food and Agricultural Organisation (FAO) (Intergovernmental Group on Tea) - Project on the impact of climate change on global tea production (2012+): Key findings are given in Section 3.4.
4. Project to expand the Ethical Tea Partnership's (ETP's) tea climate adaptation programme: PPP between ETP, Marks and Spencer Ltd, the UK retailer, and the Kenya Tea Development Agency (KTDA). Key characteristics of the PPP are given in Section 3.6.6.
5. Better Cotton Initiative – Sustainable cotton production (from 2010): Eco-labeling PPP between global apparel/textile manufacturers and NGOs, farmers associations and cotton institutions in producing countries. Key characteristics of the PPP are given in Section 4.4.

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Annex 2 Summary of the IPCC climate change scenarios

For purposes of predicting climate change, scientists from the IPCC have devised a set of scenarios of how the future might unfold, excluding so-called 'surprise' scenarios where drastic change takes place due to a completely unexpected factor. Four qualitative storylines of future possible worlds (A1, A2, B1 and B2) define four equally valid scenario families. The storylines describe developments in many different social, economic, technological, and environmental and policy dimensions.

The A1 storyline and scenario family are based on fast economic growth, slow population growth, and the swift introduction of new and more efficient technologies. Major underlying themes include convergence among regions, capacity-building and increased social and cultural interactions, with substantial declines in regional disparities in per capita income. The A2 storyline and scenario family are based on a very heterogeneous pattern of development. The emphasis is on self-reliance and the preservation of local identities. Population growth is high, since fertility patterns change very slowly. Per capita economic growth and technological change are more fragmented and less rapid than in other storylines.

The B1 storyline and scenario family are based on a convergent world, characterized by the same low population growth as in the A1 storyline, but with fast changes in economic structures towards a service and information economy, as well as the introduction of clean and resource-efficient technologies. Global solutions to economic, social, and environmental sustainability are emphasized, but without additional climate initiatives. The B2 storyline and scenario family are based on a world that emphasizes local solutions to economic, social, and environmental sustainability. This world is characterized by moderate population growth, intermediate economic development, and less speedy and more heterogeneous technological change than in the B1 and A1 storylines.

These four basic storylines are the basis for six scenario groups, A1F1 (fossil fuel intensive), A1B (balanced – i.e. not relying too much on any one source of energy), A1T (predominantly non-fossil fuel), A2, B1 and B2. In all, 40 different scenarios have been developed. Although all scenarios are equally valid and no probabilities of occurrence have been assigned, this study will focus on the four scenario groups that are most widely used, namely A1F1, A2, B1 and B2. These scenarios form the primary drivers for emissions scenarios, which can be generated through modelling studies and used to make projections of temperature changes. The idea is to use each of those four scenarios and predict how crops would respond to climate change. When dealing with agriculture, attention must be paid to potential changes in yields, prices, patterns or trade, and the number of farmers at risk of hunger, dislocation, natural disaster, sudden drop in income, disease, loss of crops, as well as the deterioration in crop quality due to changes in water availability, soil degradation and all the other possible climatic variables affecting agriculture.

The climate change policies and strategies of the countries selected for this report, viz, Ethiopia, Rwanda, Kenya, Bangladesh, Tanzania, and Pakistan have broadly applied the IPCC mid-range (A1B) emission scenario, i.e. balanced – not relying too much on any one source of energy.

Annex 3 Coffee – Supplementary Note

1. Introduction

Coffee is both a major traded commodity and the beverage of choice for millions of people worldwide. The following features of the world coffee market indicate its importance to the global economy:

- Coffee is the second largest commodity entering world trade, after petroleum, with annual current production around 8.6 million mt;
- An estimated 25 million people in developing countries rely directly or indirectly on coffee for their livelihoods;
- Coffee is a significant contributor to many developing countries' export earnings;
- Coffee is widely grown in tropical climates across Asia, Africa, and Latin America;
- Coffee tends to be a mono crop with farmers having few if any alternative means of income generation;
- Coffee has real development significance, with many initiatives currently underway by major donors, the International Coffee Organisation (ICO), non-governmental organisations (NGOs) and the private sector.

The coffea genus, Coffea Arabica L. (arabica coffee) and Coffea Canephora Pierre (robusta coffee) dominate, economically, the world coffee trade, accounting for about 99% of world production. Coffee cherry (comprising the inner coffee bean and the outer flesh) is largely grown as a smallholder crop, with cooperatives, small and medium (sized) enterprises (SMEs) and private sector companies operating processing mills, in producing countries, transforming the cherry into green bean, and larger international companies, including multinational corporations (MNCs), handling the international trade, secondary processing, grading and packaging, branding, distribution and retailing of the product to consumers.

2. Coffee growing and processing

Arabica coffee is native to the tropical forests of East Africa, and grows at altitudes ranging from 1,500 m to 2,800 m, between the latitudes of 4°N and 9°N. In this region, air temperature shows little seasonal fluctuation, with a mean annual air temperature between 18°C to 22°C. Rainfall is well distributed, varying from 1,600 mm to more than 2,000 mm per annum, with a dry season lasting three to four months, which coincides with the coolest period of the year. In this environment, arabica coffee originally became established as an under-storey shrub. Arabica coffee vegetates and fructifies very well in tropical highlands and is affected in its growth stages by environmental conditions, especially by photoperiodic variations and meteorological conditions, such as the distribution of rainfall and air temperature, which interferes with the crop's phenology (i.e. the relationship between periodic biological phenomena, e.g. flowering, and climatic conditions), and consequently in productivity and quality. Above 23°C the development and ripening of coffee cherries is accelerated, often leading to loss of quality, and continuous exposure to daily temperatures as high as 30°C could result not only in reduced growth but also in abnormalities such as yellowing of leaves. A relatively high air temperature during blossoming, especially if associated with a prolonged dry season, may cause abortion of flowers. It should be noted, however, that selected cultivars under intensive management conditions have allowed arabica coffee plantations to be spread to marginal regions with mean annual air temperatures as high as 24°C to 25°C with satisfactory yields, such as in the North Eastern and Northern regions of Brazil. Conversely, in regions with a mean annual air temperature below 18°C growth is significantly hampered, and the occurrence of frosts, even if sporadic, may strongly limit the economic viability of the crop.

Robusta coffee is native to the lowland forests of the Congo River basin, extending up to Lake Victoria in Uganda, and this species developed as a mid-storey tree in dense, equatorial rainforest, where the annual mean temperature ranges from 23°C to 26°C, without large oscillation, and abundant rainfall of above 2,000 mm is distributed over a 9 to 10 month period. High temperatures can be harmful especially if the air is dry, and robusta is much less adaptable to lower temperatures than arabica. Both leaves and cherry cannot withstand temperatures below 6°C or long periods at over 15°C. As altitude is related to temperature, robusta coffee can be grown between sea level and 800 m, whereas arabica coffee grows better at higher altitudes and is often grown in hilly areas. It should be noted that both the countries selected as case studies for this report, viz, **Ethiopia** and **Rwanda** are primarily producers of arabica and not robusta coffee.

The key activities involved in coffee cherry production are (i) planting/establishment (ii) on-going maintenance including, fertilising, pruning, weeding, control of pests and diseases, (iii) harvesting. Smallholders harvest the cherries from their coffee trees and deliver them, either directly, or through agents and traders, to green coffee processing units. Coffee cherry processing is either by the wet (washed), or dry method, described below.

The dry method (also called the natural method) is the oldest, simplest and requires little machinery and involves drying the whole cherry. The three basic steps, (i) cleaning, (ii) drying and (iii) hulling, are described below.

Firstly, the harvested cherries are usually sorted and cleaned, to separate the unripe, overripe and damaged cherries and to remove dirt, soil, twigs and leaves. This can be done by winnowing, which is commonly done by hand, using a large sieve. Any unwanted cherries or other material, not winnowed away, can be picked out from the top of the sieve. The ripe cherries can also be separated by flotation in washing channels close to the drying areas. The coffee cherries are spread out in the sun, either on large concrete or brick patios or on matting raised to waist height on trestles. As the cherries dry, they are raked or turned by hand to ensure even drying. It may take up to 4 weeks, depending on the weather conditions, before the cherries are dried to the optimum 12.5% maximum moisture content. On larger plantations, machine-drying is sometimes used to speed up the process after the coffee has been pre-dried in the sun for a few days. The drying operation is the most important stage of the process, since it affects the final quality of the green coffee. Coffee that has been over dried will become brittle and produce too many broken beans during hulling (broken beans are considered defective beans). Coffee that has not been dried sufficiently will be too moist and prone to rapid deterioration caused by the attack of fungi and bacteria. The dried cherries are stored in bulk in special silos until they are sent to the mill where hulling, sorting, grading and bagging take place. All the outer layers of the dried cherry are removed in one step by the hulling machine. The dry method is used for about 90% of the arabica coffee produced in Brazil, most of the coffee produced in **Ethiopia**, Haiti and Paraguay, as well as for some arabicas produced in India and Ecuador. Almost all robustas are processed by this method. It is not a practical process in very rainy regions, where the humidity of the atmosphere is too high or where it rains frequently during harvesting.

The wet method (also called the washed method) requires the use of specific equipment and substantial quantities of water. When properly done, it ensures that the intrinsic qualities of the coffee beans are better preserved, producing a green coffee which is homogeneous with few defective beans. Hence, the coffee produced by this method is usually regarded as being of better quality and commands higher prices. Even after careful harvesting, a certain number of partially dried and unripe cherries, as well as some stones and dirt, will be present among the ripe cherries. As in the dry method, preliminary sorting and cleaning of the cherries is usually necessary and should be done as soon as possible after harvesting. This operation can be done by washing the cherries in tanks filled with flowing water. Screens

may also be used to improve the separation between the ripe and unripe, large and small, cherries. After sorting and cleaning, the pulp is removed from the cherry. This operation is the key difference between the dry and the wet methods, since in the wet method the pulp of the fruit is separated from the beans before the drying stage. The pulping is done by a machine which squeezes the cherries between fixed and moving surfaces. The flesh and the skin of the fruit are left on one side and the beans, enclosed in their mucilaginous parchment covering, on the other. The clearance between the surfaces is adjusted to avoid damage to the beans. The pulping operation should also be done as soon as possible after harvesting to avoid any deterioration of the fruit which might affect the quality of the beans.

The pulped beans go on to vibrating screens which separate them from any unpulped or imperfectly pulped cherries, as well as from any large pieces of pulp that might remain. From the screens, the separated pulped beans then pass through water-washing channels where a further flotation separation takes place before they are sent to the next stage.

Because the pulping is done by mechanical means it normally leaves some residual flesh as well as the sticky mucilage adhering to the parchment surrounding the beans. This has to be completely removed to avoid contamination of the coffee beans by products resulting from the degradation of the mucilage. The newly pulped beans are placed in large fermentation tanks in which the mucilage is broken down by natural enzymes until it is dispersible, when it can be washed away. Unless the fermentation is carefully monitored, the coffee can acquire undesirable, sour flavours. For most coffees mucilage removal takes between 24 and 36 hours, depending on the temperature, thickness of the mucilage layer and concentration of the enzymes. The end of the fermentation is assessed by feel, as the parchment surrounding the beans loses its slimy texture and acquires a rougher "pebbly" feel.

When the fermentation is complete, the coffee is thoroughly washed with clean water in tanks or in special washing machines. The wet parchment coffee at this stage consists of approximately 57% moisture. To reduce the moisture to a maximum 12.5% the parchment coffee is dried either in the sun, in a mechanical dryer, or by a combination of the two. The sun-drying is done on extensive flat concrete or brick areas, known as patios, or on drying tables made of fine-mesh wire netting. The beans are laid out in a layer of 2cm to 10 cm, and turned frequently to ensure even drying. Sun-drying should take from 8 to 10 days, depending upon ambient temperature and humidity. Coffee dries more quickly if raised on tables because of the upward draught of warm air. The use of hot-air drying machines becomes necessary to speed up the process in large plantations where, at the peak of the harvesting period, there might be much more coffee than can be effectively dried on the terraces. However, the process must be carefully controlled to achieve satisfactory and economical drying without any damage to quality.

After drying, the wet-processed coffee, or parchment coffee as it is commonly known, is stored and remains in this form until shortly before export.

The final stages of preparation of the coffee, usually known as “curing” or “hulling”, usually take place at a special plant just before the coffee is transported for export. The coffee is hulled, to remove the parchment, then passes through a number of cleaning, screening, sorting and grading operations which are common to both wet and dry-processed coffee. Electronic sorting machines may be used to remove defective beans that cannot be distinguished by eye.

The wet method is generally used for arabica coffees, including those produced in **Ethiopia** and **Rwanda.** This processing method is rarely used for robusta coffees.

3. Global green coffee production

Total global coffee production for the ICO's crop year, which runs from 1 October to 30 September, 2012 was 144,061,000 bags of 60 kg[87] (8,643,660 mt), an increase of 24 % on the 2007 figure of 116, 612,000 bags (6,996.720 mt). The world's largest green bean coffee exporters are Brazil, Vietnam, Indonesia, Colombia and Peru. **Ethiopia** with a production in 2012 of 6,500,000 bags (390,000 mt), or 4.5% of global production is currently ranked 7th in the world and 1st in Africa. **Rwanda**, with a production of 400,000 bags (24,000 mt) in 2012, or 0.28% of global production, is ranked 6th in Africa. The bulk of coffee production is exported in green bean form, with the leading exporting countries coinciding with the major producers. However, a number of producing countries, notably Brazil, Colombia, PNG, Kenya, and Guatemala, have sought to increase export revenues by processing green coffee beans into finished (e.g. roasted, ground and packaged/soluble/instant coffee) products. The major markets for coffee are the USA, EU (UK, Spain, Italy, Germany, France, and Benelux) and Japan.

Table 1 below shows total world coffee production, based on ICO statistics, in 60 kg bags, for the crop year period 2007 to 2012. Producing and non-producing ICO members' production is differentiated by whether the country's dominant type of coffee production is arabica (A) or robusta (R), and the main crop months, i.e. annual harvesting period.

The 5 year global trend in coffee production indicates that global production should continue to increase in the medium to long term.

87 International Coffee Organisation (ICO) statistics are stated in 60 kg bags, and global coffee trading is primarily conducted in volumes denominated in 60 kg bags.

		Crop year	2007	2008	2009	2010	2011	2012
WORLD TOTAL			**116 612**	**128 523**	**122 599**	**133 470**	**134 401**	**144 061**
Producing Members			**109 317**	**120 504**	**115 533**	***125 572***	**124 954**	**135 278**
Bolivia	**(A)**	Apr/Mar	133	135	142	130	147	150
Brazil	**(A/R)***	Apr/Mar	36 070	45 992	39 470	48 095	43 484	50 826
Burundi	**(A)**	Apr/Mar	133	412	112	353	204	483
Cameroon	**(R/A)**	Oct/Sep	795	750	750	608	555	850
Central African Republic	**(R)**	Oct/Sep	43	60	93	95	86	100
Colombia	**(A)**	Oct/Sep	12 516	8 664	8 098	8 523	7 653	8 000
Costa Rica	**(A)**	Oct/Sep	1 771	1 287	1 304	1 392	1 462	1 616
Côte d'Ivoire	**(R)**	Oct/Sep	2 317	2 397	1 795	982	1 906	2 000
Cuba	**(A)**	Jul/Jun	7	12	22	26	38	100
Ecuador	**(A/R)**	Apr/Mar	1 110	691	813	854	1 075	1 000
El Salvador	**(A)**	Oct/Sep	1 505	1 450	1 075	1 850	1 163	1 420
Ethiopia	**(A)**	Oct/Sep	5 967	4 949	6 931	7 500	6 008	6 500
Gabon	**(R)**	Oct/Sep	0	1	1	1	0	1
Ghana	**(R)**	Oct/Sep	31	27	33	112	122	85
Guatemala	**(A/R)**	Oct/Sep	4 100	3 785	3 835	3 950	3 840	3 500
Honduras	**(A)**	Oct/Sep	3 640	3 351	3 403	4 280	5 705	5 400
India	**(R/A)**	Oct/Sep	4 319	3 950	4 794	5 033	5 233	5 258
Indonesia	**(R/A)**	Apr/Mar	4 474	9 612	11 380	9 129	8 620	10 950
Kenya	**(A)**	Oct/Sep	652	541	630	658	680	850
Liberia	**(R)**	Oct/Sep	7	12	13	9	7	10
Malawi	**(A)**	Apr/Mar	19	21	17	17	27	20
Mexico	**(A)**	Oct/Sep	4 150	4 651	4 109	3 994	4 546	5 160
Nicaragua	**(A)**	Oct/Sep	1 905	1 445	1 871	1 669	1 774	1 530
Panama	**(A)**	Oct/Sep	176	149	138	114	104	100
Papua New Guinea	**(A/R)**	Apr/Mar	968	1 028	1 038	870	1 415	1 200
Philippines	**(R/A)**	Jul/Jun	446	587	730	189	180	455
Rwanda	**(A)**	Apr/Mar	224	369	259	323	246	400
Sierra Leone	**(R)**	Oct/Sep	40	86	91	33	45	50
Tanzania	**(A/R)**	Jul/Jun	810	1 186	675	846	534	918
Thailand	**(R)**	Oct/Sep	650	675	795	829	823	850
Timor-Leste	**(A)**	Apr/Mar	36	48	47	60	44	75
Togo	**(R)**	Oct/Sep	125	138	204	161	142	150
Uganda	**(R/A)**	Oct/Sep	3 449	3 290	2 845	3 203	2 817	3 000
Vietnam	**(R/A)**	Oct/Sep	16 405	18 438	17 825	19 467	24 058	22 000
Yemen	**(A)**	Oct/Sep	198	220	135	160	158	200
Zambia	**(A)**	Jul/Jun	61	35	28	13	14	10
Zimbabwe	**(A)**	Apr/Mar	31	24	21	10	9	10
Producing non-members			**7 295**	**8 019**	**7 066**	**7 898**	**9 447**	**8 783**
Congo, Dem. Rep. of	**(R/A)**	Oct/Sep	416	422	346	305	350	450
Dominican Republic	**(A)**	Jul/Jun	465	645	352	378	682	550
Guinea	**(R)**	Oct/Sep	323	505	499	386	369	415
Haiti	**(A)**	Jul/Jun	359	359	351	350	349	325
Lao, People's Dem. Rep. of	**(R)**	Oct/Sep	393	406	434	541	468	550
Madagascar	**(R)**	Apr/Mar	614	728	457	529	603	575
Peru	**(A)**	Apr/Mar	3 063	3 872	3 286	4 069	5 581	4 750
Venezuela	**(A)**	Oct/Sep	1 520	932	1 214	1 202	901	1 000
Others			141	151	127	137	145	168

Source: ICO Statistics

*** (A) = Arabica, (B) = Robusta**

Table 1: Total coffee production (in 000' 60 kg bags), 2007 to 2012

4. The coffee value chain

At each stage along the chain monetary value is added to the original coffee cherries through various activities and transactions such as, the cost of conversion to coffee parchment, bagging, internal transport, warehousing, agents fees, profit on sales, sea freight, insurance, interest on working capital, product manufacture, packaging and retailers' sales costs. Stakeholders along the chain should have an economic role to play and must include an adequate profit margin to ensure an acceptable return on their business activities. The following main categories of coffee stakeholders can be identified, and are present in some form in most coffee producing countries.

- Coffee cherry and parchment producers (smallholder farmers/producer organisations (POs)/plantations);
- Green coffee producers (producers associations/plantations/independent mill operators);
- Local intermediaries (traders and agents);
- Local service providers (transporters, warehouse operators, quality inspection providers, insurance companies, credit providers);
- National public sector institutions serving the coffee industry;
- Licensed coffee exporters and overseas traders;
- Overseas service providers (shipping, insurance companies and banks);
- Coffee product (roast and ground/soluble/instant coffee) manufacturers;
- Coffee product retailers (e.g. supermarkets) and consumers.

5. Coffee trading systems

The world coffee trading system is extremely complex, however, it should be noted that in coffee trading, as in other mainstream commodities with futures and options (terminal) markets (e.g. coffee, cocoa, grains, sugar, and oils), there is a clear distinction between the physical (also known as the actual or cash market) and futures and options markets. The physical market deals in specific grades and origins of coffee at quantities, qualities, delivery times, packaging, and price and payment conditions to be negotiated privately between buyers and sellers. The physical market is open to anyone who has the means, opportunity and willingness to enter it and has access to it. The futures and options market, however, is a restricted market where an individual or company must use an intermediary to buy and sell coffee and have, often, substantial financial resources to meet contractual obligations. It should be noted that that futures and options markets are used both to hedge against price risks and to speculate. Both the physical and actual markets are inextricably entwined in determining the level of coffee prices.

6. Global coffee production trends

The 5 year global trend in coffee production indicates that production should continue to increase in the medium to long term, notwithstanding the possible negative impact of climate change on overall global production volumes. World coffee production over the past 22 years, according to official ICO statistics for crop years 1990 to 2012, has increased from 92.253 million 60 kg bags to 144.061 million bags, an increase of around 54%. Whilst the overall trend over this period is for world production to increase, it is interesting to note that production dipped in 1992, 1994, 1996, 2000, 2003, 2005, and 2007. It is very difficult to ascertain the extent to which climate change has had an impact on production levels during this period. However, although production is influenced by other factors as well as climate, particularly, political unrest, end season stock levels, price trends, consumption trends and farmers' harvesting intentions, climate will have probably had the major influence on the level of production. It should be noted that production levels over the past 6 years have risen from 116.612 million bags to 144.061 million bags, a rise of around 27%.

7. Coffee price trends.

Prospects for arabica coffee prices in 2013 (24 February 2013): *In 2012, arabica coffee lost 'more than one third of its value', according to Rabobank, this resulted in arabica coffee prices being 'down over 52% from the 2011 high'. This has been attributed to 'a strong Brazilian crop', boosting supplies and exerting a downward pressure on prices. According to Barclays, the Brazilian 'off year' (scheduled for 2013) production is projected to be only 5.9% down on 2012 (rather than the more normal 15.2%), and supplies from non-Brazilian producers are expected to be strong, so coffee prices are projected to recover only slightly in 2013.*

Rabobank's analysis of future coffee price trends broadly follows Barclays' projections, while Commerzbank and Société Générale both project stronger average price rises (20 and 15% respectively above the Barclays projections over 2013). The stronger Commerzbank price projections reflect their analysis of the high level of net short positions adopted by speculative financial investors, which are considered to 'have reached their highest level since May 2007', and a more pessimistic perspective on Brazilian production during the 'off season'.

A more pessimistic perspective on Brazilian coffee production in 2013 is confirmed by remarks from one of Brazil's largest coffee producer groups, which dismissed ideas of a rise in Brazilian coffee production in 2013 as 'absurd' This needs to be seen against the background of concerns among Brazilian government officials over speculation, which is seen as projecting unrealistically high levels of Brazilian production in 2013. This is thought to be depressing prices and allowing speculative financial investments in the market.

Société Générale for its part takes the view that 'coffee prices appear to be extremely undervalued from a fundamental perspective'. Currently, it is argued that macro-economic concerns, which are seen as depressing demand, are weighing down prices, but that current prices do not reflect 'how historically low inventories are', with this providing scope for price increases.

Table 2: Arabica coffee: Analysts' price projections for 2013 (US cents/lb, quarterly average price, New York front future contract)

	Barclays	*Commerzbank*	*Rabobank*	*Société Générale*
Q1	*165*	*170*	*160*	*188.14*
Q2	*170*	*200*	*170*	*196.69*
Q3	*173*	*220*	*175*	*199.47*
Q4	*176*	*220*	*170*	*202.68*
Average for 2013	*171*	*205*	*(168.75)*	*196.75*

Source: Agrimoney.com (see below)

'Arabica coffee prices - will they heat up in 2013?', 28 December 2012, Available at: http://www.agrimoney.com/feature/arabica-coffee-prices---will-they-heat-Agrimoney.com; *'Coffee prices to revive from 2-year low – Barclays',* 24 December 2012, Available at: http://www.agrimoney.com/news/coffee-prices-to-revive-from-2-year-low---Agrimoney.com; *'Brazil*

officials join attack on coffee speculators', 21 December 2012, Available at: http://www.agrimoney.com/news/brazil-officials-join-attack-on-coffee-spe...

Agritrade editorial comment:
The apparent lack of agreement on projected production forecasts for Brazil's coffee harvest, and the varying price projections, are an indication of the need to put in place systems that not only provide more accurate marketing information but also better projections of future production. In some African Caribbean and Pacific (ACP) regions this is seen as necessary to reduce speculative practices that may harm the industry in the long run. Such speculative practices can have a widespread impact on the entire global coffee trade, especially on smaller producers such as those in East Africa who have limited influence on international coffee prices. Information from the Coffee Board of Kenya shows that there have been some recent declines in all grades of coffee, but on average not big enough to be of major concern.

Given that Kenya produces good quality coffee that is used for blending with other coffees for high-end markets, it is not expected that predicted lower international coffee prices would impact heavily on Kenya's arabica coffee prices. However, lower prices could negatively affect future developments in the Kenyan coffee sector.

Due to rapid urbanisation, availability of high-quality land previously used for coffee production has been declining, and efforts are being made to encourage coffee production in other non-traditional areas where agronomic conditions favour production of robusta coffee. High and stable international prices are required for the sustainable expansion of coffee production into these areas. The current danger is that lower arabica prices could drag down robusta coffee prices.

Annex 4 Ethiopia – Supplementary Note

Ethiopia, located in the horn of Africa, covers a land area of 88,013,491 square km, and has a population of 88 million Ethiopia's economy is based on agriculture, which accounts for 46% of gross domestic product (GDP) and 85% of total employment. **Coffee** has been a major export crop. The agricultural sector suffers from poor cultivation practices and frequent drought, but recent joint efforts by the Government of Ethiopia and donors have strengthened Ethiopia's agricultural resilience, contributing to a reduction in the number of Ethiopians threatened with starvation. The banking, insurance, and micro-credit industries are restricted to domestic investors, but Ethiopia has attracted significant foreign investment in textiles, leather, commercial agriculture and manufacturing. Under Ethiopia's constitution, the state owns all land and provides long-term leases to the tenants; land use certificates are now being issued in some areas so that tenants have more recognizable rights to continued occupancy and hence make more concerted efforts to improve their leaseholds. While GDP growth has remained high, per capita income is among the lowest in the world.

Coffee growing areas:
It should be noted that there is only one main harvest a year in Ethiopia, which takes place in November and December across all of the country's growing regions. Different Ethiopian coffees are internationally known by their origin and characteristics of taste, and aroma. When assessing the impact of climate change on production it must be emphasised that the unique features and characteristics of coffees from different regions may be altered and premium prices may be eroded on domestic and international markets. The following are the main Ethiopian coffee types described by quality and place of origin.

Yirgacheffee coffee is an internationally known and recognized brand name which has an intense fine flavour known as flora, with a fine acidity and rich body. Many international coffee roasters are willing to pay a premium price for this origin.
Harar coffee has medium sized beans with a greenish-yellow colour, medium acidity and full body, with a distinctive mocha flavour. This origin is internationally known and recognized as Harar brand and is one of highest premium priced coffees in the world.

Sidama coffee has medium-sized beans, greenish-greyish in colour with fine acidity and good body, and is usually blended in gourmet and speciality coffees
Limmu coffee has a spicy and winy flavour, acidity and full bodied, with medium sized round beans which are greenish bluish in colour. This coffee attracts many roasters especially in Europe and USA, making washed Limmu coffee one of the world's best premium priced coffee.
Djimma coffee, grown at high altitude, has a heavy bodied cup with winy after taste.
Tepi coffee has low acidity but better body, there are commercially important reasons why it is used for special blends.
Bebeka coffee has low acidity but better body and is commercially important as a blend in speciality coffees.
Lekempti coffee has a medium sized bean and is known for its fruity taste, is greenish-brownish in colour with good acidity and body. Some coffee roasters put Lekempti in their blends because of its distinctive flavour, but this origin can also sold as an original gourmet or special origin flavour.

ICO Coffee data

ETHIOPIA	
COFFEE SECTOR	
ICO membership status	**Exporting Member**
ICO Contact	**Ministry of Agriculture and Rural Development**
Type of coffee produced	**Arabica**
Harvesting year	**October-September**
Method of processing	**Dry and Wet**
Total production (crop year) (000 bags)	**6 008**
Domestic consumption (crop year) (000 bags)	**3 383**
Per capita consumption (kg)	**2.40**
Exports of green coffee (60kg bags)	**2 675 381**
Exports of processed coffee (60kg bags GBE)	**38**
Gross stocks at start of crop year (000 bags)	**417**
Value of exports of all forms of coffee (mill US$)	**822.76**
Value of exports of all merchandise (mill US$)	**2 615**
Value of coffee as a percentage of all merchandise	**31.5%**
Value of coffee as a percentage of GDP	**2.59%**
Total area planted to coffee (ha)	
In production (crop year)	
In formation (crop year)	
Total number of trees (000)	
In production (crop year)	
New trees (crop year)	
Yield (crop year) (bags/ha)	**Not Available**
Density (crop year) (trees/ha)	
Retail tax on coffee (%)	
Additional taxes and levies	

Coffee marketing
Each year small producers must make a decision either to sell their coffee cherry to a cooperative or to a private buyer. In most areas the buyers operate side by side at the same collection station, where they will buy cherry from the local area and deliver them to their own processing facilities, usually serving around a thousand farmers. Generally, a private buyer will pay a higher spot price than a cooperative, but the latter will offer farmers access to additional benefits such as rural finance, in the form of a financial premium at the end of

the season if sales have been better than expected. The cooperative system is very important, institutionally, in the Ethiopian coffee trade, with individual cooperatives forming regional Unions, e.g. the Sidama Coffee Farmers Cooperative Union is made up of some 50 cooperatives, each with around 1000 members. These regional cooperative unions are, together with a handful of private plantations, the only organisations in Ethiopia allowed to export coffee directly to overseas buyers. Therefore, they can by-pass the Ethiopia Commodity Exchange (ECX) auction although they must still obtain official EXC grading certificates prior to export. However, the reality is that some 87.5% of Ethiopia's exports are via the ECX with 8% exported directly by cooperative unions, and 4.5% by private plantations.

Climate change policy

The revision of national development and disaster risk management (DRM) policies in 2010 is expected to lay a framework for the mainstreaming of climate change responsibilities throughout government and establish a decentralised DRM system. Despite these efforts, for now, DRM activities and responses to climate change remain fragmented and largely uncoordinated. Historical division of responsibility and the increasingly significant political profile of climate change issues led to three government institutions jostling to position themselves as leader on climate change.

Firstly, affiliated to the Prime Minister's office is the Environmental Protection Authority (EPA). The EPA is responsible for design and enforcement of environmental regulations, and is the focal point for Ethiopia's Kyoto Protocol and United Nations (UN) Africa Adaptation Program engagement. Recently the EPA was recognised as the governmental lead on climate change strategy. However it does not have ministerial status, is under-resourced and lacks capacity. Secondly, the National Meteorological Agency (NMA), within the Ministry of Water Resources. The NMA was historically the focal point for United Nations Framework Convention on Climate Change (UNFCCC) and National Adaptation Programme of Action (NAPA) processes. However, the lead on climate change has now been allocated to the EPA. Thirdly, as the sector most affected by climate change, the Ministry of Agriculture and Rural Development (MoARD), has been highly and increasingly engaged in climate change adaptation and mitigation[88].

[88] Africa Climate Change Resilience Alliance (ACCRA) (2010) *Ethiopia – Country Level Literature Review*, Amber Miekle. (Nb. ACCRA is a consortium initiative of Oxfam GB, Overseas Development Institute (ODI), Care International, Save the Children UK and World Vision International. ACCRA is funded by DFID).

Annex 5 Rwanda – Supplementary Note

In 1959, three years before independence from Belgium, the majority ethnic group, the Hutus, overthrew the ruling Tutsi king. Over the next several years, thousands of Tutsis were killed, and some 150,000 driven into exile in neighboring countries. The children of these exiles later formed a rebel group, the Rwandan Patriotic Front (RPF), and began a civil war in 1990. The war, along with several political and economic upheavals, exacerbated ethnic tensions, culminating in April 1994 in a state-orchestrated genocide, in which Rwandans killed up to a million of their fellow citizens, including approximately three-quarters of the Tutsi population. The genocide ended later that same year when the predominantly Tutsi RPF, operating out of Uganda and northern Rwanda, defeated the national army and Hutu militias, and established an RPF-led government of national unity. Approximately 2 million Hutu refugees - many fearing Tutsi retribution - fled to neighboring Burundi, Tanzania, Uganda, and Zaire. Since then, most of the refugees have returned to Rwanda, but several thousand remained in the neighboring Democratic Republic of the Congo (DRC, the former Zaire) and formed an extremist insurgency bent on retaking Rwanda, much as the RPF tried in 1990. Rwanda held its first local elections in 1999 and its first post-genocide presidential and legislative elections in 2003. Rwanda in 2009 staged a joint military operation with the Congolese Army in DRC to root out the Hutu extremist insurgency there and Kigali and Kinshasa restored diplomatic relations. Rwanda also joined the Commonwealth in late 2009.

Rwanda is a poor rural country with about 90% of the population engaged in (mainly subsistence) agriculture and some mineral and agro-processing. Tourism, minerals, **coffee** and tea are Rwanda's main sources of foreign exchange. Minerals exports declined 40% in 2009-10 due to the global economic downturn. The 1994 genocide decimated Rwanda's fragile economic base, severely impoverished the population, particularly women, and temporarily stalled the country's ability to attract private and external investment. However, Rwanda has made substantial progress in stabilizing and rehabilitating its economy to pre-1994 levels. GDP has rebounded with an average annual growth of 7-8% since 2003 and inflation has been reduced to single digits. Nonetheless, a significant percentage of the population still live below the official poverty line. Despite Rwanda's fertile ecosystem, food production often does not keep pace with demand, requiring food imports. Rwanda continues to receive substantial aid money and obtained International Monetary Fund (IMF)-World Bank (WB) Heavily Indebted Poor Country (HIPC) initiative debt relief in 2005-06. In recognition of Rwanda's successful management of its macro economy, in 2010, the IMF graduated Rwanda to a Policy Support Instrument (PSI). Rwanda also received a Millennium Challenge Threshold Program in 2008. Africa's most densely populated country is trying to overcome the limitations of its small, landlocked economy by leveraging regional trade.

Rwanda joined the East African Community and is aligning its budget, trade, and immigration policies with its regional partners. The government has embraced an expansionary fiscal policy to reduce poverty by improving education, infrastructure, and foreign and domestic investment and pursuing market-oriented reforms.

Energy shortages, instability in neighbouring states, and lack of adequate transportation linkages to other countries continue to handicap private sector growth. The Rwandan government is seeking to become regional leader in information and communication technologies. In 2010, Rwanda neared completion of the first modern Special Economic Zone (SEZ) in Kigali. The SEZ seeks to attract investment in all sectors, but specifically in agribusiness, including coffee, information and communications technologies, trade and logistics, mining, and construction. The global downturn hurt export demand and tourism, but economic growth has recovered, driven in large part by the services sector, but inflation has grown. On the back of this growth, government is gradually ending its fiscal stimulus policy while protecting aid to the poor.

The Rwandan economy is mainly based on agriculture, which accounts for 43% of GDP and sustains almost 90% of the population. Agricultural production in Rwanda can be grouped into two main categories: staple crops (leguminous, cereals, roots, tubers and bananas) and cash crops (coffee, tea, and pyrethrum). Since agricultural production in Rwanda depends almost exclusively on the quality of the rainy season and specific temperature ranges, it makes the country particularly vulnerable to climate variability and change. Moreover, the changing patterns of precipitation and the extreme events of storms and droughts lead not only to a decline in land productivity but also to an increase of plant disease incidences in the study area.

Extract from ICO Statistics on coffee - ICO 2007

RWANDA	
GENERAL INFORMATION	
Area (km²)	**26,338**
Population (million)	**10.94**
Currency	**Rwandan Franc (RWF)**
GDP (mill US$)	**6,377**
GDP per capita (US$)	**583**
Value of all exports (mill US$)	**789**
Value of all imports (mill US$)	**2,290**
Exchange rate (US$ 1)	**583.13**
Official languages	**Kinyarwanda, French, English**
COFFEE SECTOR	
ICO membership status	**Exporting Member**
ICO Contact	**OCIR-CAFÉ**
Type of coffee produced	**Arabica and some robusta**
Harvesting year	**April-March**
Method of processing	**Wet and some Dry**
Total production (crop year) (000 bags)	**244**
Domestic consumption (crop year) (000 bags)	**1**
Per capita consumption (kg)	**0.01**
Exports of green coffee (60-kg bags)	**272,904**
Exports of processed coffee (60-kg bags GBE)	**2,251**
Gross stocks at start of crop year (000 bags)	**13**
Value of exports of all forms of coffee (mill US$)	**94.0**
Value of exports of all merchandise (mill US$)	**464.0**
Value of coffee as a percentage of all merchandise	**20.27**
Value of coffee as a percentage of GDP	1,47
Total area planted to coffee (ha)	**Not available**
In production (crop year)	
In formation (crop year)	
Total number of trees (000)	
In production (crop year)	
New trees (crop year)	
Yield (crop year) (bags/ha)	**Available**
Density (crop year) (trees/ha)	
VAT on coffee (%)	
Additional taxes and levies	
On imports of green coffee	**Not available**
On imports of roasted coffee	
On imports of soluble coffee	
On exports of green coffee	
On exports of roasted coffee	
On exports of soluble coffee	

The main priority area for investments in the coffee sector is to put in place a system for improving the distribution, management, and monitoring of inputs – especially regarding pesticides use. Coffee washing stations should employ their own agronomists to spread best practices among farmers, as part of a wider coffee washing station (CWS) development programme. Further initiatives should include building the capacity of exporters, extending necessary infrastructure, and generally enhancing research and development in the coffee sector.

Annex 6 Tea – Supplementary Note

1. Introduction

Figure 1: Where tea is grown in the world

All types of tea are produced from the same plant and the differences between them result from the different processing procedures in producing the tea. The leaf of the evergreen tea plant (Camellia Sinensis) is processed, in its fermented state, into black tea, or, in its unfermented or semi-fermented state, into green and oolong teas. Tea is predominantly marketed internationally as black tea, which, in volume terms accounts for about 78% of global tea production and 85% of global trade. This note focuses on black tea.

2. Tea growing and processing

Tea growing: Climate and geography are the key factors in determining both where tea can be grown, and how the tea grown in a particular region tastes. However, the tea plant is highly adaptable, and can grow in a broad range of conditions. The tea plant can handle a light frost and even snow, but not heavy frosts or prolonged cold winters, and, unlike some plants, it does not require a period of cold dormancy. It can thus grow from sub-tropical climates to tropical climates, but generally requires a fair amount of humidity and rainfall during the growing season. Although it can grow in hot tropical climates if they are sufficiently humid, the highest quality teas mostly come from subtropical climates with some seasonality.

The seasonality of precipitation is important in influencing the quality of tea, and tea leaves harvested at different times will produce a finished product with vastly different characteristics. Seasonality is thus an asset in tea production, which explains why most of the well-known tea-producing regions have strong seasonal climates. Seasonality can include a simple wet-dry pattern like the Asian Monsoon, or a bimodal precipitation pattern, with two distinct wet seasons and two distinct dry seasons in each year which occur in parts of sub Saharan Africa such as Kenya.

The tea plant needs a hot, moist climate. It grows in temperatures ranging from 10-30°C, in areas with an average yearly rainfall of 2,000 mm and at a ground level of between 600-2,000 metres above sea level. A carefully chosen source plant can be used for creating new tea seedlings. The soft seedlings develop in a nursery for ten months, which protects them

from difficult weather conditions. After they have strengthened, the tea plants continue to develop in open fields that are sheltered by the shade of wide trees

The tea plant can often only be grown within a certain range of altitudes. Although high-grown teas often exhibit many desirable characteristics and sometimes fetch a higher price than their lower-altitude counterparts, in ascending to progressively higher altitudes, there is a point beyond which the conditions become too cold to grow the tea plant. The highest commercial tea operations are around 8,000 feet (about 2,400m) in elevation. As one travels farther from the equator, and into colder and drier climates, the highest possible elevation at which the tea plant can be grown becomes lower. Elevation or altitude is one of the largest local or regional influencers of climate. As one climbs to a higher elevation, temperatures become more variable, rainfall generally becomes higher, but humidity becomes lower. This is due to a number of processes, one of the most important of which is called orographic lift. Orographic lift describes the phenomenon of what happens when air rises. At higher altitudes, air pressure is lower, so air expands, and the process of expansion cools the air. The capacity for air to hold water vapour depends on temperature, and is lower at lower temperatures. Thus, as air rises, it expands and cools, and it cannot hold all its moisture, so this causes clouds to form, and often causes precipitation such as rain or snow. Orographic lift explains why the windward (wind facing) side of mountains has high rainfall and the leeward (on the other side of the wind's source) side of mountains tends to be dry, a phenomenon called rain shadow. Tea, a water-loving plant, tends to be grown on the windward sides of mountain ranges.

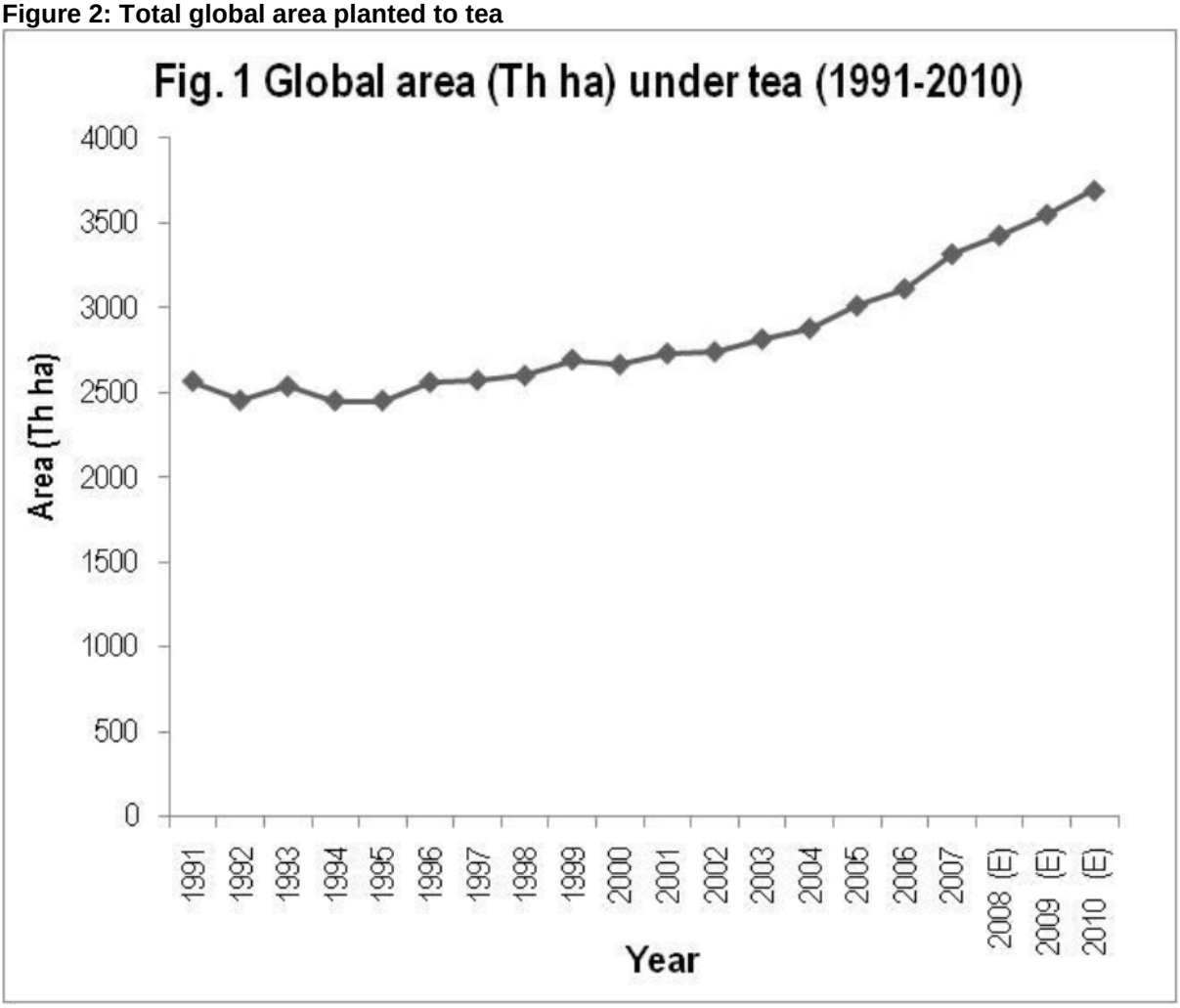
The key activities involved in tea production are (i) planting/establishment (ii) on-going maintenance including, fertilising, pruning, weeding, control of pests and diseases, (iii) harvesting (plucking of the green leaf). Smallholders or plantation labour pluck green leaf from the tea bushes and deliver them, either directly, or through agents and traders, to black tea processing units. Coffee cherry processing is either by the wet (washed), or dry method, described below.

Black tea manufacture: There are three main types of black tea manufacture, viz, (1) orthodox manufacture which makes use of rolling machines in a batch process and is the traditional method of processing green leaf, (2) crush, tear, curl (CTC) manufacture which uses contra-rotating rollers in a continuous process and was invented in India in the 1930's.The CTC process is dominant in India and Africa and produces a tea with a thicker liquor, smaller grade sizes, faster brewing characteristics and gives more cuppage than orthodox manufacture. CTC teas lend themselves particularly to use in tea bags, a growing trend in tea consumption worldwide, (3) Lawrie Tea Processor (LTP) manufacture which uses a hammer-mill disintegrator. LTP manufacture is not significant in global tea production.

3. Global tea plantings, production, exports and imports

Tea plantings: The last decade of 20th century saw a sluggish rate of increase in the total area under tea. In 1991, tea was cultivated globally under 2563.75 thousand ha which increased to 2661.88 thousand ha by 2000, with a compound growth rate of 0.42% during that period. With the advent of the 21st century the world tea industry saw a steady increase in the overall area under tea. In 2001 the area under tea was 2727.42 thousand ha which increased to 3691.89 thousand ha in 2010 with a compound growth rate of 3.42% during the period. In terms of the average area planted to tea during the last two decades (1991 – 2010), China has the largest number of hectares (45%), followed by India (21%), Sri Lanka (7%), **Kenya** (5%), and Vietnam (3%). The trend of a modest increase in planted area under tea is expected to continue, although significant increases in the overall global area planted with tea are not expected in the foreseeable future. Please see Figure 2 below.

Figure 2: Total global area planted to tea



Source: Indian Tea Board (ITB)

It should be noted that the available statistics must be treated with caution, as they are, in some cases incomplete. The area planted with tea refers to total planted area and does not differentiate between mature and immature stands of tea, or tea in plucking. This level of statistical information is not available on a global basis.

Tea production: Global production of tea in 2011 totaled 4,299,220 mt of which over 80% was produced in five key tea countries, viz; China, excluding Taiwan (1,623,210 mt), India (988,330 mt), Kenya (377,910 mt), Sri Lanka (328,630 mt), and Vietnam (178,000 mt). The above figures show a slight increase over the 2010 total of 4,170,200 mt. The five year production trend is almost uniformly upwards. Global production has increased between 2007 and 2011 by around 12%, due, primarily, to higher yields through replanting with improved clonal material and better husbandry practices, rather than an expansion in the overall global mature planted area. This upward global trend is expected to continue, notwithstanding the negative long term impact of future climate change, and adverse weather conditions, political conditions and labour unrest in producing countries. Kenya's production represented about 8.8% of global production, and Bangladesh's production of 59,320 mt represented around 1.4% of the world total.

Country	2011 (P)	2010	2009	2008	2007
China	1623.21	1475.06	1358.64	1257.60	1140.00
India	988.33	966.40	979.00	980.82	986.43
Kenya	377.91	399.01	314.20	345.82	369.61
Sri Lanka	328.63	331.43	289.78	318.70	304.61
Vietnam	178.00	170.00	175.00	166.38	148.27
Turkey	145.00	148.00	153.00	155.00	178.00
Indonesia	119.65	129.20	136.48	137.50	137.25
Bangladesh	59.32	59.27	60.00	58.66	58.42
Malawi	47.06	51.59	52.56	41.64	48.14
Uganda	54.18	59.14	50.98	42.75	44.91
Tanzania	32.78	31.65	32.09	31.61	34.86
Others	345.15	349.45	342.65	328.31	345.58
Total	**4299.22**	**4170.20**	**3944.38**	**3864.79**	**3796.08**

Source: ITC

Table 1: Global tea production, 2007 - 2011

Provisional

Tea exports: Global exports of tea in 2011 totalled 1,749,520 mt of which about 78% was exported by five countries, viz; Kenya (421,270 mt – 19%), China excluding Taiwan (322,580 mt – 18%), Sri Lanka (301,270 mt – 20%), India (192,870 mt – 14%) and Indonesia (100,180 mt – 7%). As a result of large stocks carried over by importing countries from the previous year exports in 2010 showed an annual decrease of only 2.6%, which is lower than the annual trend since 1995. The global export figure ten years ago was 1,154,795 mt and has remained relatively stable during the ten-year period from 1993 to 2002, fluctuating in a range of +/- 275,000 mt annually.

Overall global exports are expected to remain stable around current levels for the foreseeable future, with any increased production being primarily absorbed in domestic markets, particularly in India.

The figures quoted above refer to both green and black tea exports, but as mentioned above, black tea exports represent some 85% of global trade in tea. A breakdown of statistics between bulk tea and value added tea exports were not available.

Country	2011	2010	2009	2008	2007
Kenya	**421.27**	**441.02**	**342.48**	**383.44**	**343.70**
China	322.58	302.53	302.95	296.94	289.43
Sri Lanka	301.27	296.38	279.84	298.82	294.25
India	192.87	222.02	197.90	203.12	178.75
Vietnam	143.00	127.97	120.00	104.00	110.93
Indonesia	75.45	87.10	92.30	96.21	83.66
Argentina	86.20	85.35	69.19	77.23	74.88
Malawi	44.89	48.58	46.55	40.07	46.59
Uganda	46.15	53.18	47.92	42.39	43.64
Tanzania	27.11	26.13	21.51	24.77	29.13
Zimbabwe	8.57	8.50	7.54	5.65	7.60
Bangladesh	1.45	0.91	3.15	8.39	10.56
Others	78.71	79.02	73.77	75.08	69.14
Total	1749.52	1778.69	1605.10	1656.11	1582.26

Table 2: Global Tea exports

Tea imports: Tea consumption in 2010, as indicated in Table 4 below was 2,413,000 mt with net imports at 1,146,000 mt, an annual growth rate over the previous ten year period of

0.8% and 0.6% respectively. It should be noted that the major Asian tea producers, viz India, Indonesia, China, Bangladesh and Sri Lanka, have large domestic tea consumption markets.

In most of the developed world tea consumption has seen slow to static growth in recent years, and in some large traditional markets, such as the UK, consumption is declining. The reason for this situation is perceived as being tea's unexciting image particularly in the youth market, the increased use of tea bags (which are less wasteful to the consumer than loose tea) and competition from coffee, soft drinks and fruit juice. In order to counter competition from alternative beverages the industry is promoting alternative and differentiated tea based drinks such as "Ready to Drink" (RTD) products packaged in cans and bottles; instant teas; flavoured teas; and, "gourmet" brands, differentiated regionally, or by specific locality and character, in the manner of wine and many coffees. There is also growth potential in mature markets in the so called premium "sustainable" niche beverage markets where coffee is achieving significant success in organic, "bird friendly", and fairtrade products.

However, in the traditional market for black tea there is still very significant consumption growth potential, particularly in India, Pakistan, the Middle East, Central Asia and Russia and the Central Asian Republics.

	ACTUAL	**PROJECTED**	**GROWTH RATES**	
	2000	2010	1990 to 2000	2000 to 2010
	000 mt		Percent per year	
WORLD	**2 214**	**2 413**	**2.2**	**0.8**
Net imports	**1 077**	**1 146**	**2.5**	**0.6**
ASIA				
Pakistan	109	150	**0.7**	2.9
Japan	18	22	**2.2**	1.8
EUROPE				
United Kingdom	134	126	**-0.6**	-0.6
Germany	10	22	**-3.4**	7.4
France	9	7	**-2.2**	-2.3
Netherlands	15	17	**2.2**	1.1
Ireland	11	11	**-0.4**	0.0
Italy	4	4	**0.2**	0.0
Former USSR/CIS	224	315	**2.7**	3.1
NORTH AMERICA				
United States	81	94	**0.4**	1.4
Canada	15	19	**1**	2.2
OCEANIA				
Australia	14	11	**-1.5**	-2.2
Domestic consumption[2]	**1 137**	**1 267**	**1.9**	**1.0**
AFRICA				
Uganda	3	1	**3.9**	-9.5
Tanzania	1	1	**0**	0.0
Malawi	4	4	**0**	0.2

	ACTUAL	PROJECTED	GROWTH RATES	
	2000	2010	1990 to 2000	2000 to 2010
Kenya	28	29	**0.2**	0.3
ASIA				
India	617	919	**1.8**	3.7
Indonesia	33	51	**6.1**	4.0
China	37	31	**-1.1**	-1.6
Bangladesh	36	45	**2.4**	2.0
Sri Lanka	24	36	**2.6**	3.8

Source: FAO

Table 3: Black tea: actual and projected consumption

4. Tea trading systems

Tea is traded primarily by direct negotiation between buyers and sellers, and, through the long established auction system. Unlike other major soft commodities such as coffee, cocoa and sugar, the tea trade has not, for a variety of reasons, been able to develop futures and options exchanges as price determinant points and as price fluctuation risk hedging mediums for both buyers and sellers. The lack of an appropriate hedging medium in the tea trade has resulted in the trade being focused on spot or nearby sales, with long term forward commitments being rare. The global trade in bulk black tea is therefore still characterized by its overwhelming dependence on the auction system, with its long established network of individually identified producer sellers, selling (and sometimes also buying) brokers, with a broad representation of both domestic and export buyers. Another key characteristic of the tea trade is its requirement for sales to be on the basis of individual lot samples, a cumbersome and costly exercise, but considered necessary to ensure quality.

The Auction System: Table 4 below shows the main auction centres and their relative importance in terms of average prices, with changes over the last five years:

Country	2011	2010	2009	2008	2007
Kenya	2.72	2.54	2.29	2.18	1.66
Sri Lanka	3.25	3.28	3.15	2.83	2.51
India	2.23	2.29	2.18	2.00	1.62
Indonesia	1.97	1.82	1.80	1.51	1.33
Malawi	1.61	1.58	1.58	1.37	1.05
Bangladesh	2.14	2.61	1.98	1.62	1.17

Table 4: Average international tea prices (US cent/kg), 2007-2011

The auctions, which act as price determinant points and as transparent and reliable market places, have served the tea trade well over its long history and continue to be supported by the majority of market participants. However, the system has a number of disadvantages in a modern trading environment, such as the lack of hedging facilities for both producers and blenders/packers; the dominance of spot ex-warehouse/ex-estate contracts which lack flexibility for overseas buyers; and, the pricing of many auction teas in the currencies of the producing countries, when the international trade in tea is conducted, primarily, in US dollars. Notwithstanding the above comments, and the growing popularity of direct sales, in the absence of a futures market for tea, the auction system will continue to play a pivotal role the tea market.

Whilst the Mombasa auction attracts teas for sale from nearby African countries, particularly Rwanda, Uganda, and Tanzania, none of the existing centres offer a complete international market place serving all the major global tea origins To an extent, this role used to be performed by the London auction, which was the only truly international tea trading centre, but had been in decline for many years and finally closed in 1998. London's closure was due, mainly, to the lack of support from producing countries and the introduction and growth of US dollar auctions and direct sales in important origins such as Kenya, Malawi, and Indonesia. Consequently there is no longer one market place where price comparisons in a single currency, on the same sale terms, of a multitude of tea origins can be made.

5. Global tea market trends

The following possible trends and developments, in the marketing of tea, linked particularly to globalization, should be noted:

- More direct sales and disintermediation;
- The development of international tea trading centres using freely convertible international currencies, e.g. the USD and Euro;
- The possible development of tea futures and options markets;
- The development of information technology and automation connected to the digital revolution, e.g. automated and "on line" auctions, and, customized software trading packages.

Value Addition: Producing countries have traditionally exported black tea in bulk, and value added activities involving blending and packaging have been carried out in the traditional large consuming countries particularly the UK, Europe and North America. This situation continues to prevail, particularly for teas from African producing countries, however, there is a growing trend for value addition to be carried out at origin and Sri Lanka and India have had growing success in blending and packaging for export. Furthermore, tea blending and packing is a developing industrial activity in the Middle East and Eastern Europe.

Prices: The global tea industry is forecast to face short supply in 2013. Key tea producing countries are expected to have a production drop in the range of 1% to 5% in 2013, while demand is set to grow by 3%. With consumption in India and China outpacing domestic production, reduced exports and rising prices are expected for both markets.

However, when analysing the tea supply/demand balance for the purpose of price trend forecasts, the following variables should always be borne in mind:

- Long term production forecasts are based on normal growing conditions and adverse weather conditions, caused by climate change, can dramatically affect output;
- Historic data must be treated with caution as accurate figures from many smaller producers and consumers are difficult to obtain; furthermore statistical data from some larger market participants such as China and the former USSR must be treated with caution;
- There is a substantial volume of unrecorded imports, particularly into the former USSR, Afghanistan and Pakistan, which will reduce the surplus figures;
- Increasing domestic tea consumption in India (and **Bangladesh**), the world's largest producer, may also mitigate the potential for lower prices.

Annex 7 Kenya – Supplementary Note

Kenya is located in Eastern Africa, bordering the Indian Ocean, between Somalia and Tanzania. Kenya has been hampered by corruption and by reliance upon several primary goods whose prices have remained low. Low infrastructure investment threatens Kenya's long-term position as the largest East African economy. In the key December 2002 elections, Daniel Arap MOI's 24-year-old reign ended, and a new opposition government took on the formidable economic problems facing the nation. After some early progress in rooting out corruption and encouraging donor support, the KIBAKI government was rocked by high-level graft scandals in 2005 and 2006. In 2006, the WB and IMF delayed loans pending action by the government on corruption. The international financial institutions and donors have since resumed lending, despite little action on the government's part to deal with corruption. Unemployment is very high.

Value added % of GDP (Agriculture)	28
Agricultural commodities (top 3) export earnings % share of total export earnings	44
Agricultural commodities (top 3) export earnings % share of agricultural export earnings	71
Tea export earnings % share of total export earnings	26
Tea export earnings % share of agricultural export earnings	42
Tea export earnings as a % of GDP	6.5
Agricultural employment as a % of total	61
Tea exports (1000 Mt/value US$ millions)) - 2010	418 ($116.5)

Sources: (i) International Tea Committee (ITC) Annual Bulletin 2012 (ii) World Bank Development Indicators, 2012 (iii) FAOSTAT 2011.

Table 2: Tea economic indicators – Kenya

Black tea processing in Kenya
Black tea processing from smallholders green leaf includes the following stages:

- After production smallholder farmers carry the green leaf to a tea collection centre;
- Green leaf is weighed and recorded by a factory employed clerk;
- Green leaf is collected by factory owned Kenya Tea Development Agency (KTDA) managed lorries;
- Green leaf is delivered to the processing factory owned by farmers but managed by KTDA on their behalf;
- Tea is processed, packaged and dispatched through privately owned transporters;
- Black tea is warehoused in Mombasa from where most of it is sold through the Mombasa auction with a small amount through directly negotiated sales;
- Large-scale tea production and processing is integrated and green leaf from private plantations is plucked and processed in their own factories, then transported and warehoused for sale in the auction and under private arrangements;
- Most medium scale estates do not have factories of their own and their green leaf is processed by the large estate factories where they pay a management fee or more commonly sell their green leaf at a negotiated price per kg.

The tea marketing system and institutional framework

The institutional structure of the Kenya tea trade is very important to the overall marketing system as it facilitates the producer and processor in complying with international standards, such as those of the Ethical Tea Partnership (ETP), Rainforest Alliance (RA) Certified and overseas buyers.

Kenya Tea Development Agency (KTDA): The KTDA was incorporated under the Companies Act as an independent and private enterprise, owned by all of Kenya's small-scale tea farmers through their respective factory companies. It manages the tea factories on behalf of farmers and charges a management fee. The Agency took over in 2000 from its predecessor the Kenya Tea Development Authority. The authority had been instrumental in the introduction of tea production to smallholder producers and had managed tea factories on behalf of farmers since 1964. The agency assists the farmers by purchasing agricultural inputs such as fertiliser in bulk, and offering it to tea producers on credit, to be recovered after the tea is sold. The KTDA also offers extension services to smallholder tea producers and is involved in sourcing funds for factory construction and renovations. Notably, KTDA operates and manages factories, markets black tea internationally, buys green leaf from smallholders, paying them on a monthly basis and at the end of each financial year. The smallholders are paid total proceeds from the sale of black tea processed from their green leaf, less transportation, processing, handling and marketing costs. The KTDA does not employ agricultural workers.

Tea Board of Kenya (TBK): The TBK is a State Corporation under the Ministry of Agriculture, established in 1950; it has a mandate to regulate the tea industry. It licenses tea growers and factories, and regulates and controls tea cultivation and processing. It also scrutinises all the research activities of the Kenya Tea Research Foundation, promotes Kenyan tea in and outside the country, and collects and disseminates tea statistics. The TBK advises the Government on all policy matters regarding tea and Board representation is composed of Government officials, Kenya Tea Growers Association (KTGA), KTDA, and East African Tea Trade Association (EATTA).

Kenya Tea Growers Association (KTGA): The KTGA, which is a private and voluntary grouping, promotes the interests of large and medium private tea growers in Kenya. The association accounts for around 40% of tea production with the other balance of 60%

coming from small-scale farmers. The KTGA negotiates workers' social, welfare and employment conditions with the Kenya Plantation and Workers Union on behalf of the large scale tea growers.

Kenya Plantation & Agricultural Workers' Union (KPAWU): KPAWU is the national trade union body representing unionised workers in the coffee, tea, sisal and horticultural industries. It negotiates with the KTGA, which represents large tea growers, in order to develop the collective bargaining agreements (CBAs) for the tea industry. It also negotiates with KTDA on behalf of employees that are covered by the union.

East African Tea Trade Association (EATTA): The EATTA is a voluntary association bringing together tea producers, brokers and buyers of tea in East Africa. The Association's rules and regulations facilitate auction and direct tea sales and regulate the international trade in Kenya and other East African teas. The association comprises tea producers, buyers, brokers and other interested tea traders within the East African region.

Tea Brokers: The tea trade is primarily conducted by brokers appointed by tea producers. The brokers guarantee the sale of tea by negotiating between the producer and the tea trade buyers. The brokers' functions include receiving tea from producers and selling it at the best possible price, negotiating sales by private contract on behalf of the producers, receiving tea samples from producers, tasting, valuing and distributing samples to potential buyers, preparing and printing catalogues and effecting payment to the producers and factories. Brokers taste tea for the purpose of ascertaining the grade of tea in the auction and visit the tea factories informing the factory management on the quality of their tea. The brokers are not quality controllers, since quality management is an in-built process in tea production and manufacturing.

Tea Packers: The tea packers in Kenya are not organised into any association. Currently the single largest packer in local market is the Kenya Tea Packers Limited (KETEPA). Prior to October 1992, KETEPA had the monopoly of tea packaging and distribution in domestic market. With the repeal of the Price Control Act and complete liberation of tea trading, there are a multitude of registered tea packers who are free to blend and pack tea for local and export markets.

Tea Research Foundation of Kenya (TRFK): TRFK was established in 1980 as a company limited by guarantee to carry out the investigation and research into all matters relating to the tea industry. It was a successor to the Research Institute of East Africa. Its guarantors are the Ministry of Agriculture and Tea Board of Kenya. The Foundation has obtained funding for its research activities almost entirely from the tea industry through the Tea Board of Kenya.

Tea auction and direct tea sales: Most Kenyan tea is sold through the weekly Mombasa Auction. When tea is ready for sale, the tea brokers are notified so that they can collect tea samples from the warehouse, some of which they send to buyers for liquoring and determining quality before the auction. It is the responsibility of the tea broker to follow up the payments from the tea buyers and remit the money to the selling companies. Tea sold through the auction attracts a brokerage fee on the sales. Direct tea sales are normally an outlet for premium tea grades in the Mombasa auction.

Annex 8 Bangladesh – Supplementary Note

The area known as Bengal, primarily Hindu in the western section and mostly Muslim in the eastern half became part of British India. Partition in 1947 resulted in an eastern wing of Pakistan in the Muslim-majority area, which became East Pakistan. Calls for greater autonomy and animosity between the eastern and western wings of Pakistan led to a Bengali independence movement. That movement, led by the Awami League (AL), won independence for Bangladesh in 1971, with India's assistance and after the death of at least 300,000 civilians. The post-independence, AL government faced daunting challenges and in 1975 was overthrown by the military, triggering a series of military coups that resulted in a military-backed government and subsequent creation of the Bangladesh Nationalist Party (BNP). That government also ended in a coup in 1981, followed by military-backed rule until democratic elections in 1991. The BNP and AL have alternated in power since then, with the exception of a military-backed, emergency caretaker regime that suspended parliamentary elections planned for January 2007 in an effort to reform the political system and root out corruption. That government returned the country to fully democratic rule in December 2008 with the election of the AL and Prime Minister Sheikh HASINA. With the help of international development assistance, Bangladesh has made great progress in food security since independence, and the economy has grown at an average of about 6% over the last two decades.

Bangladesh is a small country[89] with a large population, located in the north east corner of the South Asian sub-continent. It is one of the poorest countries in the world with a per capita GDP of approximately $329 in constant 1995/96 prices, and $599[90] in current prices. The two major problems faced by the country are (i) the large population, estimated at 144.5 million in July 2008, with a current growth rate of 1.39% per annum[91] and a population

89 147,570 sq km in area, with 6.7% consisting of rivers and inland waterways. (K.B. Sajjadur Rasheed (2008) *Bangladesh: Resource and Environmental Profile*).

90 Bangladesh Bureau of Statistics (BBS) (2008)

91 Population is expected to rise to around 180 million by 2025, with a density of around 1,200 persons per sq km. (K.B. Sajjadur Rasheed (2008) *Bangladesh: Resource and Environmental Profile*).

density of 1,007 people per square km, and (ii) susceptibility to environmental hazards such as cyclones, floods, droughts, arsenic groundwater contamination and seismic activity. Bangladesh is also considered to be at particular risk from climate change particularly due to its low lying position on the edge of the Bay of Bengal. The country is predominantly an agrarian society with over 75% of the population directly or indirectly engaged in agriculture, with the incidence of poverty tending to be higher in rural farming areas than in urban centres.

Land and its cultivation is Bangladesh's most basic resource and is the mainstay of the country's primarily agricultural economy. Agriculture provides employment to 48.4% of the total labour force in the country[92], its staple food (rice) is consumed by virtually 100% of the population, 28.7% of total income emanates from agricultural outputs, and earnings from agricultural wages[93] accounts for 28.1% of the total income of rural households. The agricultural sector accounts for 20.87% of GDP at constant prices which shows a slightly decreasing trend, compared to the share of the other major sectors of the economy, viz, industry and services.

Tea marketing

In Bangladesh the marketing of tea is the process of selling manufactured black tea, in bulk, from tea estates to buyers, through the Chittagong Auction, from where it is bought for the local internal market or for export, either in bulk or in packets. Some teas are also sold at ex estate level, outside the auction system, with prior authorisation of the Bangladesh Tea Board (BTB) either directly to overseas buyers, or traders in the domestic market. Tea auctions are held weekly at Chittagong, which is a major port city, with sufficient warehouse and shipping facilities and is well connected by road, railways and air to the rest of Bangladesh and India. The weekly tea auction is organised by the Tea Traders Association of Bangladesh through the tea brokers appointed by the BTB.

Export market

Since 1971 tea has been one of Bangladesh's major exportable items and had a captive export market in some countries of the Asian region, particularly Pakistan and India and the former USSR. This scenario has changed in recent years due to market liberalisation and globalisation, the emergence of new entrants in the world market with low priced tea, such as Vietnam, and most importantly, the rapid increase of internal demand in Bangladesh itself. The Government of Pakistan has allowed duty free entry of 10.00 million kg of tea per year from Bangladesh since October 2002 and has offered to increase the quota up to 15.00 million kg but Bangladesh has not been able to use the quota fully, as increasing internal demand pushes the price levels up in the local auctions and discourages exports. Other tea producing countries such as India, Sri lanka, Indonesia, Vietnam, Kenya and some other African countries have comparative advantages over Bangladesh, in terms of cost of production and quality, which makes the export market extremely competitive for Bangladesh tea[94]. Given the rising internal demand, linked to population increase, and the fact that tea is a staple beverage in the country; it is most unlikely that a resurgence of the tea export market will occur in the foreseeable future.

92 BBS, 2008.

93 BBS (2005) *Household Income and Employment Survey (HIES)*.

94 Tasnuba NASIR (Lecturer, Faculty of Business Administration, University of Science and Technology Chittagong) (2011) *Bangladesh tea production, consumption and exports in global and Bangladeshi perspective*.

Year	Total tea exports (million kgs)	Value (million US dollars)
2000	18.10	20.76
2001	12.92	15.64
2002	13.65	18.28
2003	12.18	15.64
2004	13.11	15.98
2005	9.09	11.26
2006	4.79	6.69
2007	10.56	13.15
2008	8.39	14.29
2009	3.15	6.34
2010	0.91	N/A
2011	1.45	N/A

Source: ITC statistics

Table 1: Bangladesh tea exports, 2000 - 2011

Internal domestic market: Tea is supplied in the internal market in three ways (i) buying tea from the auction paying 15% VAT on the auction value known as internal account buying, (ii) buying tea from the auction for export at nil VAT known as external account buying and subsequently transferring to the internal account and (iii) tea supplied directly from the tea estates with prior permission of the Tea Board.

Table 7 below shows tea consumption in Bangladesh between 2000 and 2009, and these figures, coupled with the static production and declining export statistics shown in Tables 4 and 6 above, emphasise this trend.

Year	Total tea domestic consumption (million kgs)
2000	***38.79***
2001	***36.95***
2002	***41.50***
2003	***37.44***
2004	***43.32***
2005	***43.30***
2006	***40.51***
2007	***46.27***
2008	***52.12***
2009	***53.74***

Source: Bangladesh Tea Board

Table 2: Bangladesh domestic tea consumption, 2000 - 2009

	Project Title	Type of Project	Primary Implementing Agency	
1	Reduction of climate change hazards through Coastal afforestation with community participation	Intervention	Forest Department (FD)	Full project: USD 23 million Project design: 100,000
2	Capacity building for integrating climate change in planning, designing of infrastructure, conflict management and land-water zoning for water management institutions.	Capacity building	Water Resource Planning Organization (WARPO)	USD 2.0 million Project design: USD
3	Climate change and adaptation information dissemination to vulnerable community for emergency preparedness measures and awareness raising on enhanced climatic disasters.	Awareness and capacity building	Ministry of Environment and Forest (MoEF)	Full project: USD7 million Project design: USD
4	Exploring options for insurance to cope with enhanced climatic disasters.	Research	Department of Environment (DOE)	Full project : USD 0.2 million Project design: USD 25,000
5	Mainstreaming adaptation to climate change into policies and programmes in different sectors (focusing on disaster management, water, agriculture, health and industry).	Capacity building	Department of Environment (DOE)	Full project: USD 1 million Design phase: USD 25,000
6	Adaptation to agriculture systems in areas prone to enhanced flash flooding– North East and Central Region.	Intervention	Bangladesh Agricultural Research Institute (BARI)	Full project: USD6.5 million Project design: USD 50,000
7	Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change.	Intervention	NGO consortium	Full project: USD 5 million Design phase: USD 50,000
8	Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.	Research	Bangladesh Agricultural Research Council (BARC)	Full project: USD 5 million Design phase: USD 50,000

Source: Bangladesh NAPA, 2005

Table 3: Bangladesh NAPA – priority projects relevant to the agricultural sector

Annex 9 Overview of the world cotton trade

1. Introduction

Cotton is essentially produced for its fibre, which is universally used as a textile raw material. Cotton is an important commodity in the world economy. With worldwide annual production of some 22 million mt (2009/10) of cotton fibre grown in some 35 countries, cotton is among the most important commodities in international trade. The Food and Agricultural Organisation (FAO) estimates that nearly 100 million rural families directly depend on cotton production. For some countries in West Africa, cotton is the main driving force behind economic development, with cotton earnings accounting for 40-60% of GDP in countries like Burkina Faso, Benin, Mali, Chad and Senegal. 90% of all cotton worldwide is of the Gossypium Hirsutum cotton species. In 2009, overall world production of cotton amounts to some 100 million bales (1 bale = 500 lbs or 226.8 kg). The biggest producers are China, India and the USA, followed by Pakistan and Uzbekistan. The combined production of all West African countries currently accounts for only 4.7% of the world market. The United States and Africa are the largest exporters of seed cotton. Since 1980, Africa's share of the cotton trade has doubled. Neither the US nor most African countries have significant domestic textile industries.

2. Cotton growing and processing

Cotton is grown commercially in more than 70 different countries, mostly in the longitudinal band between 37°N and 32°S. Cotton is especially adapted to semi-arid and arid environments, where it is either grown rain-fed or through irrigation. About 53% of the world's cotton growth areas and 73% of all fibre growth areas benefit from full or supplementary irrigation.

Cotton is a soft, fluffy staple fibre that grows in a boll, or protective capsule, around the seeds of cotton plants of the genus Gossypium, and is a perennial plant by nature, but has long been grown as an annual crop. Varieties grown commercially today belong to four species of Gossypium. Gossypium Hirsutum, or Upland cotton, produces the bulk of cotton worldwide. G. Barbadense comes in second. It is associated with high staple length. Cotton is grown mainly in the longitudinal band between 37°N and 32°S. Cotton needs favourable growing conditions with respect to temperature, sunshine and soil moisture. A marked dry season is also essential for the bolls to open properly and for harvesting. The cotton plant, once established, rapidly develops a vertical tap root that provides resilience against drought during the growing season. The vertical tap root gives the plant access to lower soil layers and nutrients than cereal crops such as maize, sorghum or millet can access. This makes cotton a particularly useful plant in crop rotations. However, the vertical tap root makes cotton sensitive to stress from waterlogging after floods or heavy rains. Cotton requires a total of 105 to 125 days of sufficient soil moisture to grow. In tropical regions, 2 to 4 mm of water are needed daily at the beginning and the end of the growing period, while at the height of flowering 5 to 7 mm are required daily according to climatic zone. Thus 500 to 700 mm of water is sufficient for the crop to develop fully. Rain-fed cotton, however, can in practice only be grown in regions where average annual rainfall is 700 mm or more, since inter-annual and intra-annual rainfall variability, and the amount of resulting run-off, have to be taken into account. Cotton is resilient to sub optimal growing conditions. Cotton responds to loss of vegetation or fruiting parts (buds, flowers, bolls) through so-called "compensatory growth".

The stages of the ginning process, and cottonseed crushing, applicable in the cotton industry of most developing countries, including the countries selected for this report, viz, **Tanzania** and **Pakistan** is, basically, as follows:

- Delivery of seed cotton to the ginnery by farmers (by head loads and bicycles), or by agents (by pick-up trucks and lorries), where offloading and weighing takes place;
- Sorting and grading of the seed cotton (according to moisture/foreign matter/stones, sand etc./colour) into different grades and put into temporary storage;
- Pre cleaning and drying of the seed cotton;
- The seed cotton is transferred to elevated platforms;
- And fed into gin feeders where more foreign matter is removed;
- The ginning operation commences where the fibre/lint is separated from the seed, (i) lint is transported by conveyors to condensers where it is pressed (hydraulically) for baling and (ii) seed is transported by conveyor to the seed store;
- The lint is graded, and cleaned and baled, ready for sale.

The basic stages in the cottonseed milling process are as follows:

Unbagging of cottonseed / Decortication / Seed transportation to presses by elevator / Crude oil extraction by screw presses / Crude oil movement to the oil refinery stage / Neutralising / Bleaching / Deodorising/ Oil cooling / Oil blending if required / Storage packing and labeling.

	Low input			**High input**		
Operation of factory	Kg CO2e/ha	%	Comment for low input production	Kg CO2e/ha	%	Comment for high input production
Fertilizer and pesticide production	0	0%	If organic or unfertilized	1,263	31%	Based on application rates from International Cotton Advisory Committee (ICAC) (2008)
Tillage and planting (fuel for machines)	0	0%	Animal traction, unequipped production	119	3%	Few data sources; E.gs. from USA
Applications (fertilizers, pesticides)	0	0%	Organic production or unequipped	103	3%	Few data sources; E.gs. from USA
Irrigation pumps	0	0%	Rain-fed	642	16%	Few data sources; E.gs. from USA
Harvest (without ginning and transport)	0	0%	Hand-picked	89	2%	Few data sources; E.gs. from USA
Nitrous oxide emissions	150	0%	Rain-fed; low N rate	1,800	45%	Calculated from ICAC (2008) and Scheer et al.
Total emissions	150	100%		4,016	100%	

SEEP (2009) Report from the Expert Panel on Social, Environmental and Economic Performance.

Table 1. Individual factors in cotton production that contribute to GHG emissions

Table 1 above illustrates, in detail, the individual factors in cotton production that contribute to GHG emissions under low and high inputs for the various activities involved in the planting, growing, harvesting, transport and processing of cotton. The data shown in the table indicates that GHG emissions in cotton production, as in agriculture in general, are

highly dependent upon human choices as to farm, field and crop management, e.g. “organic” versus “conventional”. Nitrous oxide emissions contribute the most to cotton’s GHG emissions, followed by fertilizer and pesticide production, and energy for irrigation. Irrigated conditions produce more greenhouse gas emissions than dry land farming, particularly N2O emissions. This figure is similar to findings by Systain (2010)[95] who point out that during cotton cultivation, half of the GHG emissions are associated with nitrous oxide (N2O) emitted when using mineral fertilizer, and the other half results from energy consumption, in particular for soil cultivation and ginning.

According to Cotton Incorporated (2009), however, cotton production could even be considered a ‘carbon sink’. The amount of carbon stored in the fibre and soil exceeds the total GHG emissions that occur while growing and ginning the crop. In the cotton production process, more carbon dioxide (CO2) is sequestered in the fibre and soil than GHGs emitted into the atmosphere. It is clear from these tentative data that the establishment of the carbon footprint of cotton fibre from a certain country, region or production system is difficult to do in terms of definition, measurement and attribution. Further research is required to generate reliable, coherent and comprehensive data that allow a global comparative approach.

3. Note on conservation agriculture, organic farming, crop diversification and irrigation

Conservation agriculture
Conservation agriculture enables more sustainable and climate change-resilient farming (mostly through moisture conservation). Trials in the Gatsby Charitable Foundation (GCF) pilot in Tanzania under a range of climate conditions over three years have shown consistent benefits.

Organic agriculture

Crop diversification

Drip irrigation versus furrow irrigation
A paper, undated, entitled “Evaluation of a Drip vs. Furrow Irrigated Cotton Production System” by, E.R. Norton and J.C. Silvertooth came to the following conclusion: (http://ag.arizona.edu/pubs/crops/az1224/az12245b.pdf).

A newly installed subsurface drip system was compared to a conventional furrow-irrigated cotton production system in the Marana Valley in 2000.

Regular measurements included soil moisture, flower tagging, general plant growth and development measurements and lint yield. Results indicate that an increase in lint yield of approximately 250 lbs lint/acre was obtained under the drip irrigation system. Approximately 1/3 less irrigation water was used under the drip irrigation system. Pounds of lint produced per acre-inch of water applied provide the most dramatic results. In the furrow-irrigated system approximately 25 lbs of lint was produced per inch of water applied while the drip system ranged from 70-80 lbs.

[95] Systain (2010) A step in the right direction, *EcoTextilesNews*,

Annex 10 Tanzania – Supplementary Note

Tanzania is the largest country in East Africa, and borders the Indian Ocean, between Kenya and Mozambique. Shortly after achieving independence from Britain in the early 1960s, Tanganyika and Zanzibar merged to form the nation of Tanzania in 1964. One-party rule ended in 1995 with the first democratic elections held in the country since the 1970s. Zanzibar's semi-autonomous status and popular opposition have led to two contentious elections since 1995, which the ruling party won despite international observers' claims of voting irregularities. The formation of a government of national unity between Zanzibar's two leading parties succeeded in minimizing electoral tension in 2010.

Tanzania is one of the world's poorest economies in terms of per capita income; however, it has achieved high growth based on gold production and tourism. The economy depends on agriculture, which accounts for more than one-quarter of GDP, provides 85% of exports, and employs about 80% of the work force. The World Bank (WB), the International Monetary Fund (IMF), and bilateral donors have provided funds to rehabilitate Tanzania's aging economic infrastructure, including rail and port infrastructure that are important trade links for inland countries. Recent banking reforms have helped increase private sector growth and investment, and the government has increased spending on agriculture to 7% of its budget. Continued donor assistance and solid macro-economic policies supported a positive growth rate, despite the world recession. In 2008, Tanzania received the world's largest Millennium Challenge Compact grant, worth $698 million. Dar es Salaam used fiscal stimulus and loosened monetary policy to ease the impact of the global recession. GDP growth in 2009-12 was a respectable 6% per year due to high gold prices and increased production[96].

Production characteristics

Cotton is grown in 42 districts of 13 regions, respectively out of 127 districts and 21 regions of mainland Tanzania. More than 99% of the crop is produced in the western cotton growing area (WCGA), around Lake Victoria, covering Shinyanga, Mwanza, Mara, Tabora, Kigoma, Kagera and Singida regions. The balance crop is grown in the eastern cotton growing area (ECGA), which comprises Iringa, Kilimanjaro, Morogoro, Tanga, Manyara and Coast regions. Though this area currently produces less than 1% of the entire crop, it has greater potential for increased cotton production than the WCGA, which, due to continued cultivation, coupled with inadequate use of fertilizers, has generally become exhausted in terms of productivity. Current domestic cotton production averages 700,000 bales per annum, equivalent to 126,000 mt of cotton lint; with yields at around 760kg/ha of seed cotton, or 260 kg/ha of lint cotton.

Table 10 below shows the cotton production and yield trends between 2001/02 and 2008/09 which indicates that the ten year trend is for increased output, yield and cultivated area. More up to date figures were not available at the time of preparing the report but indications from the media indicate that this upward trend in cotton production is continuing.

[96] United Republic of Tanzania (URT) and sources Central Intelligence Agency (CIA) Fact sheet (2013).

Period	Acreage ('000 Hectares)	Yield (Kg/ha)	Production ('000 MT)
2001/02	392	161	63
2002/03	291	172	50
2003/04	459	257	117
2004/05	471	212	10
2005/06	450	214	96
2006/07	459	215	99
2007/08	410	163	67
2008/09	485	256	124

Source: International Cotton Advisory Committee (ICAC) seasonal statistics, 2009

Table 10: Tanzania - Cotton production and yield trends: 2001/02- 2008/09

Tanzanian cultivated cotton is of the American Upland type (Gossypium Hirsutum L) and is sold on the basis of "Grades", together with the corresponding staple length known as "Type". There are seven grades of cotton out of which five are determined by physical properties, and two are descriptive. The basic selling grade is Gany, as adopted by the International Cotton Association (ICA). Generally, Tanzania's cotton may be characterized as follows:

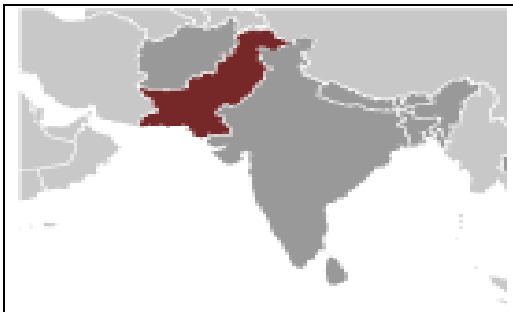
- Staple length ranges between 11/16" and 11/8";
- Over 82% of the grade is middling and above;
- More than 50% is roller ginned with low nep and short fibre content;
- Over 95% is within the prime micronaire range of 3.5 – 4.9;
- High uniformity ratio of 81 - 85% which is ideal for high speed spinning technology;
- Fibre strength ranges between 25 and 29 gms/tex which is also ideal for high speed spinning technology.

Organic Cotton Production: Organic cotton is grown in certain areas of WCGA, particularly in Meatu District on a project with more frequent extension services provision, and the application of better crop and farm management practices. Yields are, however, comparatively lower than on non-organic cotton farms. Being a unique niche market product, organic cotton fetches, on average, Tanzanian shillings 200/kg (0.12 US cents) higher than traditional types of seed cotton. However, this premium price does not fully compensate for the resulting low yields. Another recurring challenge in organic cotton farming is that it has few players, tends to be monopolistic, and is, essentially a buyers' market.

Annex 11 Pakistan – Supplementary Note

4. Country profile – Pakistan

4.1. Background and economic profile[97]



Pakistan is located in Southern Asia, bordering the Arabian Sea, between India on the east and Iran and Afghanistan on the west and China in the north.

The separation in 1947 of British India into the Muslim state of Pakistan (with West and East sections) and largely Hindu India was never satisfactorily resolved, and India and Pakistan fought two wars - in 1947-48 and 1965 - over the disputed Kashmir territory. A third war between these countries in 1971 - in which India capitalized on Islamabad's marginalization of Bengalis in Pakistani politics - resulted in East Pakistan becoming the separate nation of Bangladesh. In February 2008, Pakistan held parliamentary elections and in September 2008, after the resignation of former President MUSHARRAF, elected Asif Ali ZARDARI to the presidency. Pakistani government and military leaders are struggling to control domestic insurgents, many of whom are located in the tribal areas adjacent to the border with Afghanistan. In January 2012, Pakistan assumed a non-permanent seat on the UN Security Council for the 2012-13 term.

Decades of internal political disputes and low levels of foreign investment have led to slow growth and underdevelopment in Pakistan. Agriculture accounts for more than one-fifth of output and two-fifths of employment. Textiles account for most of Pakistan's export earnings, and Pakistan's failure to expand a viable export base for other manufactures has left the country vulnerable to shifts in world demand. Official unemployment is under 6%, but this fails to capture the true picture, because much of the economy is informal and underemployment remains high. Over the past few years, low growth and high inflation, led by a spurt in food prices, have increased the amount of poverty - the UN Human Development Report estimated poverty in 2011 at almost 50% of the population. Inflation has worsened the situation, climbing from 7.7% in 2007 to almost 12% for 2011, before declining to 10% in 2012. As a result of political and economic instability, the Pakistani rupee has depreciated more than 40% since 2007. The government agreed to an IMF Standby Arrangement in November 2008 in response to a balance of payments crisis. Although the

[97] Government sources and CIA Fact sheet (2013).

economy has stabilized since the crisis, it has failed to recover. Foreign investment has not returned, due to investor concerns related to governance, energy, security, and a slow-down in the global economy. Remittances from overseas workers, averaging about $1 billion a month since March 2011, remain a bright spot for Pakistan. However, after a small current account surplus in fiscal year 2011 (July 2010/June 2011), Pakistan's current account turned to deficit in fiscal year 2012, spurred by higher prices for imported oil and lower prices for exported cotton. Pakistan remains stuck in a low-income, low-growth trap, with growth averaging about 3% per year from 2008 to 2012. Pakistan must address long standing issues related to government revenues and energy production in order to spur the amount of economic growth that will be necessary to employ its growing population. Other long term challenges include expanding investment in education and healthcare, and reducing dependence on foreign donors.

Main features

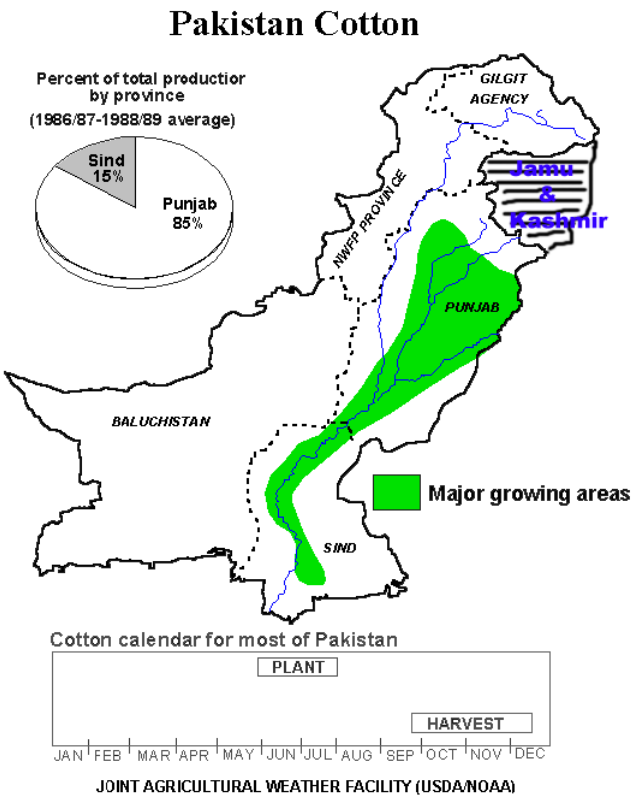
Pakistan is the 4th largest cotton producer and consumer (preceded by China (mainland), India and the USA). The cotton industry is an integral aspect of the economy. This is also true of the textile sector on which the economy is heavily dependent. As such cotton is a principal crop. Mill consumption of cotton has increased from 1.3 million tons in 1990/91 to 2.6 million tons in 2007/08.

Production in 2007/08 totalled approximately 1.9 million mts, with an average yield of 620 kilograms/ha. The cotton industry employs approximately 15 million people. Pakistan has been a net importer of cotton since the mid-1990s. This is due to expansion in domestic demand for cotton. Pakistan’s cotton exports have been below 65,000 tons for the past three seasons. The imports are significantly higher. Pakistan’s cotton imports have been increasing. Pakistan’s cotton imports have been increasing. Pakistan is currently the 2nd largest importer of cotton (behind China Mainland) with 880,000 tons in 2007/08. Pakistan imports a large amount of its cotton from the United States, specifically the Pima/Extra Long Staple cotton. In addition, in 2007/08, Pakistan imported significant quantities of short to medium staple cotton from India. Cotton imported from India is more cost effective since it’s cheaper to trade and transport over land than sea. Cotton trading is facilitated by the fact that the government has no quantitative restrictions or duties on imports and exports of cotton. The Pakistan economy is linked to the success of the cotton and textile sectors. They account for 8.2% of the value added in agriculture and 2% of GDP. Furthermore, the cotton and textile industries dominate exports, accounting for 55% of export value. The textile industry has been growing and is of considerable volume. Recent figures place the number of textile mills at 461. Although cotton is produced domestically, some textile mills are shifting their focus to higher quality cotton (such as the Extra Long Staple from the US); this is especially true for the export oriented textile market.

Production characteristics

The major cotton producing areas in Pakistan are Punjab and Sindh (see map below). Approximately 80% of cotton is produced in Punjab and the rest in Sindh. According to recent figures, there are approximately 1.3 million cotton farmers. 3 million hectares are currently allocated for cotton farming with an average farm size of 4 hectares. However, planting area and production strategy are influenced by a number of factors such as weather and government policy. As of 2005 there were approximately 1.5 million cotton farms. The planting season takes place from February to June and the harvest from August to December. Cotton yields have been increasing due to improved practices, greater experience with biotech varieties, and availability of higher quality inputs. Lack of irrigation is increasingly becoming a major cause for concern and noticeably affected 2007/08 cotton production. The main varieties planted in Pakistan are CIM 496 in Punjab and NIAB-78, and CRIS-134 in Sindh. The staple is short and medium (although it is mostly medium). A major impediment to the cotton production process in Pakistan is the prevalence of mealy bugs and more importantly, the cotton leaf curl virus (CLCV). Biotech has just been recently

introduced to Pakistan. According to recent reports the Pakistani government just approved field trials for biotech cotton and although it will not be commercially and officially approved for at least another season, it is expected to surpass 70% of the planted area in 2009/10.



Structure of the Pakistan cotton industry

In Pakistan, there are a number of government agencies and private initiatives that regulate and support the cotton sector. The Ministry of Food, Agriculture and Livestock, the agriculture departments in provinces where the cotton is grown and the Pakistan Cotton Central Committee are directly involved in the different aspects of the cotton production sector. Similarly, there are organizations and research institutes related to improving cotton production and quality such as the Central Cotton Research Institute and Centre of Excellence for Molecular Biology. Finally there are the institutions responsible for the oversight of the textile industry such as the Ministry of Textile and the Textile Commissioner's Office.

Current issues facing the Pakistan cotton industry

The cotton industry suffers from a variety of problems. Although Pakistan is the 4th largest producer of raw cotton it is still far behind in productivity per unit area when compared with the yields being realized in some other major cotton growing countries. Yields are not increasing due to absence of virus resistant varieties, emergence of new insect pests such as mealy bug and CLCV and the limited adoption of better scientific cultivation methods.

Annex 12 Sustainable Task Force and PPP Pilot Project ToRs

Sustainable agribusiness (coffee, tea and cotton) task forces (STFs)
It is recommended that STF TORs focus, as a prime responsibility, on initiatives at the Government policy level aimed at giving incentives to stakeholders in the sustainable coffee, tea and cotton sectors with an emphasis on achieving optimum sustainable production under a low carbon and green economy. In undertaking its mandate in this connection the STF should work in collaboration with other relevant public and private sector organisations.

(i) Identification and investigation of the feasibility of applying a broad range of macro-economic incentives, involving different ministries, of a broad range of green economy incentives to include (a) fiscal policy including VAT concessions, tax breaks for new sustainable investment, import and export duty rebates (b) export promotion zones (EPZs) (c) further processing and value addition (d) land registration policy with particular reference to smallholders (e) rural and trade credit policy (f) support to the promotion of sustainable environmental and climate change policies in agribusiness, including the reduction of GHG emissions, fostering fuel from waste projects (e.g. methane gas capture and power generation), sustainable land use and the conservation of forests.

(ii) The implementation of sustainable coffee, tea and cotton, promotion through (a) the institution of an awareness campaign through engagement with the public in the countries concerned (b) with the technical and financial support of international buyers, the implementation of an international campaign targeted at consumers of coffee, tea and cotton.

(iii) The identification of donor and private sector funding to enable the commissioning of research and feasibility studies on coffee, tea and cotton sustainability issues, e.g. review and assess current practice and initiatives in conserving biodiversity, reducing GHGs, and ensuring sustainable coffee, tea and cotton development.

The Pilot Project Concept
Recommendations for designing future climate change adaptation projects in agriculture:

- Designing adaptation strategies should be scaled up to a more long-term and strategic level, considering the implications for the mainstream sector, the future marketing potential and the value chain as a whole. The existing scientific climate maps, predicting future suitability of current production areas, should be designed as more in-depth studies, keeping in mind a more complex entity of influencing factors and potential impacts on quantity, quality and markets, but also new opportunities resulting from changing climate conditions like more appropriate crop varieties or more suitable alternative products.
- Knowledge on more resistant crop varieties based on the existing agro-biodiversity should be generated as public knowledge. With support of public, scientific and private institutions farmers should be enabled to benefit from crops adapted to climate change and get access to planting material and knowledge.
- The generation of carbon credits, climate friendly certification systems or other systems of payments for environmental services could be opportunities to sustainably finance adaptation in agriculture productions systems. Furthermore, those measures are not only generating additional income but also have positive impacts on the enhanced resilience of an agro-ecosystem as they often contribute to the conservation of biodiversity and natural resources, improve the water storage capacity of soils and enhance agriculture productivity. Hence, more profound technical and practical knowledge on how to integrate those opportunities into adaptation strategies need to be generated and spread in the agriculture sector.
- Build long-term partnerships between private and public actors and design development cooperation projects to strengthen the capacities of public institutions to

support adaptation to climate change in agriculture in the long run. Scientific work should form the basis for political decision-making, future climate change impacts on economies should be analysed and the costs and benefits of adaptation need to be considered.

- Besides technical adaptation knowledge the availability of financing and insurance mechanisms will always be the second most important success factor. Thus, financing options should be made available at public and private level.

The concept proposed entails the incorporation of a holistic approach to sustainable commodity development pilot projects using the following themes:

(i) The enhancement of the role of smallholders in the achievement of optimum sustainability through (i) fostering the establishment of smallholder marketing groups, based on common interest and community joint aspirations (ii) analysis of the fairness of prices paid to smallholders paid by processors/mills (coffee mills/tea factories/cotton ginneries) (iii) improvement of public and private sector extension services to coffee cherry/tea green leaf/cotton seed smallholders (iv) the establishment of meaningful capacity building incentives to smallholders to undertake the activities required to achieve sustainability and build smallholder capacity to achieve certification criteria, where available;

(ii) The promotion of GHG reduction techniques;

(iii) The promotion of fiscal and other incentives for the achievement of low carbon and green economy agribusiness at multi stakeholder levels from crop production, through processing, storage, transport and marketing methodologies;

(iv) The inclusion of PPP models, where appropriate, and the implementation of models, possibly in (i) research and development (ii) operational management of plantations (iii) capacity building of stakeholders (iv) new plantation development.

Feasibility Study – Outline TOR for Pilot Projects

Should the pilot project concept as defined by the report be of interest to value chain stakeholders in the coffee, tea and cotton sectors, the following TOR is suggested for a feasibility study on PPP pilot projects in Ethiopia, Rwanda, Kenya, Bangladesh, Tanzania and Pakistan:

1. Suitability of project locations in terms of sustainability; identify and assess proposed project areas particularly with regard to:

   (i) Degradation of land under coffee/tea and cotton production: new plantings can have a negative impact on the environment through, (a) deforestation through the destruction of primary and secondary rain forest, (b) the erosion of soils, (c) the reduced quality of ground and surface water, (d) reduced conservation of biodiversity through the destruction of habitats of endangered flora and fauna;

   (ii) Contribution to the negative impact of climate change: it is acknowledged by the industry that coffee/tea/cotton production can have a negative impact on climate change through, (a) the production, consumption, and emission, in the establishment of plantations and the process of production, of the three main GHGs, viz, carbon dioxide, nitrous oxide, and methane. Furthermore, increased GHG emissions are a consequence from changes in carbon stocks during the development of plantations from forests, including changes particularly in above ground and underground biomass and organic matter including peat, (b) mill by-products and residues, released during the production process, such as water, effluent and waste result in GHG emissions, particularly methane, (c) carbon sequestration in biomass during the crop cycle is returned to the atmosphere when trees are felled, (d) crops

grown in peat soils which release large amounts of GHG emissions due to the common practice of use of diesel by plantations for internal transport and the running of machinery;

(iii) Negative impact on livelihoods of poor and indigenous forest dwellers: if large tracts of primary forest land have been cleared, this can affect the traditional way of life and livelihoods of indigenous peoples, resulting in greater incidences of poverty amongst forest dwellers;

(iv) Social conflicts: conflict over the appropriate use of land, resources, rights and the culture of indigenous communities, conflicts between local communities and the companies and central and regional government institutions involved in developing the palm oil industry. The conflicts that arise between communities and within them are among the important and potentially damaging social issues that currently feature prominently in the development of the palm oil industry.

2. Suitability of locations in terms of practicality: in order to succeed pilot projects should be located in areas that meet minimum criteria in terms of basic facilities. The following should be assessed:

(i) Accessibility: roads - actual and planned/communications/connectivity between beneficiaries and processing facilities/markets/proximity of proposed project implementation units;
(ii) Rural infrastructure status (e.g. power and water supplies);
(iii) Crop production potential: current coffee/tea and cotton production and suitability of soil/climate/terrain for development;
(iv) Agricultural institutions: status of development of farmer groups, agricultural cooperatives, rural financial institutions, government agencies;
(v) Agricultural extension: presence of local service providers (NGOs etc);
(vi) Linkages: potential for effective linkages with other complementary projects and agribusiness sustainability initiatives;
(vi) Private sector development: extent of private sector agribusiness development in the area.

3. Project outputs: the pilot projects' outputs should be identified and summarised in the form of a design and monitoring framework (DMF) detailing:

(i) Design summary – impact, outcome and outputs;
(ii) Performance targets and indicators with baselines;
(iii) Data sources and reporting mechanisms;
(iv) Assumptions and risks.

4. Project Safeguards: the feasibility study should assess and suggest approaches to the following issues for inclusion in an eventual detailed project preparation and design:

(i) Poverty reduction and social development: how the project supports the growth of the agribusiness sector, fosters regional sustainable low carbon economic growth, and links to raising the incomes and improving the livelihoods of smallholder farmers and reduction of social inequalities;
(ii) Gender issues;
(iii) Indigenous/excluded peoples assessment and measures;
(iv) Involuntary resettlement assessment and measures;
(v) Environmental assessment and measures: the following damage mitigation measures should be assessed: (a) environmental screening and categorization, (b) environment assessment and review procedure, (c) climate

change measures, (d) general mitigation measures, (e) environmental awareness and capacity building, (f) environmental monitoring;

(vi) Project exit strategy/sustainability without external assistance.

5. Project content and components: as the pilot project concept is feasibility it should assess the suitability of a project comprised of a number of distinct components. The following are suggested as possible main components for inclusion in the project design:

1) Enhancing smallholder production of tree crops;
2) Strengthening smallholder participation in the tree crop value chain;
3) Support to small scale production area infrastructure;
4) Project management support.

Component 1 - Enhancing smallholder production of sustainable coffee/tea/cotton:

Under this component the feasibility study should assess the following possible sub components:

(i) Farmer group development: it is acknowledged that individual independent smallholders, operating on say 2/3 ha, have little economic power or negotiating strength, and in the tree crop sub sector are “price takers” often exploited by middle men. Therefore, the formation of groups, preferably village and community based, would be encouraged and assisted by the project. It should be noted that the cooperative movement is well developed in some commodity sectors;

(ii) Improvement of farmer awareness, knowledge and skills in crop production: possible methodologies could include (a) farmer training and farm demonstration plots, farmer field days and farmer study tours;

(iii) Improvement and enhancement of agricultural service delivery: this could include the promotion of farmer group/cooperative nurseries and demand driven research;

(iv) Increased technology access for project area farmers:

(v) Certification: training on compliance with, and certification.

Component 2 - Strengthening farmer participation in the commodity value chain.
Under this component the feasibility study should assess the following possible sub components:

(i) Awareness-raising in post-harvest and value chain issues: awareness raising for farmer groups and cooperatives in value addition options could be supported by the project through field based training and awareness programmes;

(ii) Post-harvest handling technology: training on the following (a) the importance of quality in the price determination (b) pre and post-harvest quality maintenance, and (c) best practice in harvesting and post-harvesting techniques including, harvesting equipment, the organization of the harvest and transportation to collection points;

(iii) Group/cooperative management and administration and marketing: training and support in the following, (i) group self-analysis to assess group strengths and comparative advantages over other producers and traders (ii) group organization and capacity building including management, administration, bookkeeping, accounts, report writing, to enable transparency within the group (iii) understanding the importance of agricultural marketing information and where to find it (iv) understanding the agricultural value chain and supply chain to demonstrate that different markets have different prices and calculate arbitrage opportunities; (v) understanding the cost of production and transaction costs and their implication for profit margins and the establishment of price bargaining opportunities (vi) the importance of networking, bargaining and negotiation skills in accessing optimum

markets (vii) understanding the rights, duties and responsibilities of the respective parties involved in contract farming arrangements, and (viii) the importance of establishing a seasonal agriculture plan to establish the best marketing strategies to pursue;

(iv) Improvement of marketing efficiency: under this sub-component the project should aim to build on the certification training on compliance with (v) above. Particular emphasis should be placed on the need for fair, appropriate and transparent price formulae between producers and mill owners. The feasibility study should propose a formulae specific to the commodities and project areas proposed. It is also important, with reference to the DMF, that benchmarks are established to monitor improvements in project beneficiaries' marketing efficiency, e.g. in the percentage of the free on board (FOB) price received over the lifetime of the project. In this context it is essential to have reliable and appropriate formulae in place accepted by all stakeholders along the value chain.

Component 3 - Support to small scale production area infrastructure.

Under this component the feasibility study should propose detailed criteria for financial support to infrastructure investments, which should include the possibility of matching grants. The matching grant system has the advantage of proving the beneficiaries belief and commitment, by their contributing a percentage of capital costs either in cash or in kind.

Component 4 - Support to project management.

Project Funding: Investigate sources of joint project funding including those who have shown interest in the development of the sustainable coffee, tea and cotton under low carbon and green economy principles.