Measuring Sustainability in **Cotton Farming Systems**

Towards a Guidance Framework

Food and Agriculture Organization of the United Nations

ICAC
International Cotton Advisory Committee

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Report prepared by
the ICAC Expert Panel on Social, Environmental
and Economic Performance of Cotton Production
with the FAO Plant Production and Protection Division

Food and Agriculture Organization of the United Nations
International Cotton Advisory Committee
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Foreword by FAO

The global cotton industry includes more than 100 million farm families across 75 countries, and generates about USD 51.4 billion annually in raw product. For many of these farmers, however, cotton constitutes only one component of a more complex and integrated farming system.

This report presents the outcome of a study designed to *Measure Sustainability in Cotton Farming Systems*. It is the culmination of several years of collaborative effort in a robust and science-based assessment of a range of relevant conventions, standards and benchmarks. The broad and scientific nature of the consultative process that characterized this study has stimulated dialogue across sectors and national boundaries and helped to build consensus around critical sustainability issues and their metrics.

The diversity of farming systems in different geographic areas, the specificity of sustainability challenges and the synergistic relationship between the different components of sustainability preclude the development of a blueprint or one-size-fits-all approach.

This report provides stakeholders with the key elements for understanding the potential threats to the sustainability of their particular farming system and explains how to perform both measurement and benchmarking. It provides a framework and a common language for farming communities pursuing the dual objectives of sustainable production and livelihood improvement.

FAO's Strategic Framework, particularly its second strategic objective, aims at making agriculture, forestry and fisheries more productive and sustainable. At its core is a holistic approach to sustainability, working in a more cross-sectoral and interdisciplinary manner, across the *environmental, economic and social* aspects of sustainability. The development of more integrated policy and enhanced governance structures are a means for preserving and enhancing the quality of our natural resources without compromising the quantity and quality of our agricultural products.

Although the study focused on cotton, this report provides a number of indicators that can be considered for evaluating sustainability across a range of agricultural production systems. It provides a framework for the continuous improvement of the sustainability of agricultural production from practitioners to policy-makers.

As a result, I believe that it represents a significant contribution towards bridging the gap between the universal ambition for sustainability and the practical realities of farming systems.

Clayton Campanhola
Director
FAO Plant Production and Protection Division

Foreword by ICAC

The compilation of appropriate sustainability metrics for the world cotton sector is the objective of this report prepared by the ICAC Expert Panel on Social, Environmental and Economic Performance of Cotton Production (SEEP). This document, which is the product of three years of hard work and selfless dedication on the part of some of the world's leading experts on cotton, is a giant step forward in our understanding of the myriad components that form part of the elusive concept of sustainability when applied to the world of cotton.

Above all, the study is important because accurate metrics are fundamental tools for evaluating the costs of achieving sustainability, which are not negligible. One of the great contradictions we face in our efforts to make our world a better place in which to live is that the widespread demand for sustainable products is not matched by the willingness of consumers to compensate, by means of higher prices, the considerable efforts required of producers. This report provides objective indicators for measuring sustainability; it helps us to evaluate our progress and, in the ultimate analysis, to assess the viability of such efforts.

The quality of the report's technical recommendations is a tribute not only to the high calibre of the members of SEEP but also to the democratic and inclusive procedures they adopted. The work of the group was enriched by interaction with representatives of the public and private sectors, academics and other stakeholders, culminating in a lively discussion involving more than one hundred participants during the ICAC Plenary Meeting in 2013.

By its very nature, sustainability is a moving target and is difficult, if not impossible, to define conclusively. Nonetheless, this report presents the state of the art today on measuring sustainability of cotton, which we hope will help improve the lives of around 250 million people worldwide involved in the production of this valuable crop.

José Sette
Executive Director
International Cotton Advisory Committee

Preface

“Sustainability” has become a conundrum for primary commodity industries: something everyone aspires to and demands but something that is difficult to define in practical terms.

This report by the ICAC Expert Panel on Social, Environmental and Economic Performance of Cotton Production (SEEP) will contribute to an understanding of how “sustainability” is defined and measured for cotton production around the world.

The indicators of sustainability, and the measures by which an industry is assessed, must have common definitions in order to provide a basis for evaluation and to establish benchmarks for measuring progress towards becoming more sustainable. Since the choice of indicators and the measures used for assessment will affect the structure, conduct and performance of the cotton industry in the decades to come, producers and all stakeholders in the cotton value chain have a vital interest in ensuring that “sustainable” cotton production is defined both ambitiously and pragmatically based on an inclusive process of consultation and extensive dialogue.

This report is technically focused and includes an empirically driven set of recommendations for a core set of indicators defining a minimum standard for sustainable cotton production. The premise of this report is that an industry-wide effort to measure sustainability of cotton farming will require a consensus regarding the identification of the key issues to be addressed, the best measures for assessing progress and the stakeholders responsible. The indicators detailed in this report will provide a basis for discussion as to the relevance, feasibility and usefulness of the indicators of sustainability in cotton production.

This report has been nearly three years in the making, with extensive research, consultation and writing by the members of SEEP. Nevertheless, it represents a mere starting point on the journey towards the definition and measurement of sustainability of cotton growing and the industry’s commitment to continuous improvement.

Terry Townsend

Former Executive Director (1999–2013)

International Cotton Advisory Committee

Acknowledgements

This report was prepared by the ICAC Expert Panel on the Social Environmental and Economic Performance of Cotton Production (SEEP). Allan Williams (SEEP Chair, CRDC) and Francesca Mancini (SEEP Vice-Chair, and FAO) served as lead authors and overall coordinators of the report. SEEP members, Michel Fok Ah Chuen (CIRAD), Denilson Galbero Guedes (ABRAPA), Kater Hake (Cotton Incorporated), Bill Norman (NCC), Patricia O'Leary (ex-SEEP member), Jens Soth (Helvetas) and Alejandro Plastina (ICAC), provided important individual contributions, numerous reviews of the report and engaged in cross-sector consultations.

SEEP is grateful for the significant support that Terry Townsend, former ICAC Director, extended for the realization of this report.

Significant contributions to the research and writing process have been made by Matthew Lynch (IISD) and Jason Potts (IISD), who developed the initial draft of the report and indicator set, as well as Uwe Grewer (FAO), who finalized the indicator review and contributed to various parts of the report, and Harry van der Wulp (FAO), who provided guidance throughout the development process. Important individual contributions were provided by Jacqueline Demeranville (FAO), Marie Mahieu (FAO) and Anne-Sophie Poisot (FAO).

The report benefited from extensive review and comments from Jesús Barreiro-Hurlé (FAO), Martial Bernoux (IRD), Louis Bockel (FAO), Richard Haire (CRDC), Barbara Herren (FAO), Grandelis Ileana (FAO), William Murray (FAO), Shengli Niu (ILO), Rebecca Pandolph (ICAC), Suzanne Phillips (FAO), Cristina Rapone (FAO), Nancy Shellhorn (CSIRO), Ilaria Sisto (FAO), and Robina Wahaj (FAO) and Guy Roth.

Representatives of the various voluntary sustainability initiatives (VSIs) provided significant contributions, most notably Angela Bradburn (Cotton Australia), Christina Bredehorst (Aid by Trade Foundation), Hana Denes, La Rhea Pepper and Liesl Truscott (Textile Exchange), Daniele Giovannucci (COSA), Jan Grenz (RISE), Joelle Kato-Andrigetto (IFOAM), Bill Norman (for Field To Market), Nicolas Petit (BCI), Damien Sanfilippo (Fairtrade International) and Nadia Scialabba (FAO, for SAFA).

The report also strongly benefited from the detailed and constructive review of delegates and observers at the 72nd ICAC Plenary Meeting in Colombia. Financial support for this study has been provided by the German Agency for International Cooperation (GIZ) on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). Thanks are expressed to Wolfgang Bertenbreiter and Sarah Götz for believing in this consultative process.

Acronyms and Abbreviations

ABRAPA	Brazilian Cotton Growers Association
AbTF	Aid by Trade Foundation
BCI	Better Cotton Initiative
CBD	Convention on Biological Diversity
CIRAD	International Cooperation Centre of Agricultural Research for Development
CmiA	Cotton made in Africa
CNCRC	China National Cotton Reserves Corporation
CNPB	Conseil National du Patronat Burkinabe (National Employers Council of Burkina Faso)
CO_2e	Equivalent carbon dioxide
COMPACI	Competitive African Cotton Initiative
COSA	Committee on Sustainability Assessment
CRC	The United Nations Convention on the Rights of the Child
CRDC	Cotton Research and Development Corporation
CSIRO	Commonwealth Scientific and Industrial Research Organization
EC	Electrical conductivity
EM	Electromagnetic mapping
ET	Evapotranspiration
ETa	Actual evapotranspiration (or water use)
FAO	Food and Agriculture Organization of the United Nations
FT	Fairtrade
FTM	Field To Market
GHG	Greenhouse gas
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GIZ	German Agency for International Cooperation
GPS	Global Positioning System
GPWUI	Gross production water use index
HAFL	School of Agricultural, Forest and Food Sciences, Bern University of Applied Sciences
HHP	Highly hazardous pesticide
ICAC	International Cotton Advisory Committee
ICCO	Interchurch Cooperative for Development Cooperation (Netherlands)
IDH	Sustainable Trade Initiative (Netherlands)
IFOAM	International Federation of Organic Agriculture Movements
IISD	International Institute for Sustainable Development
ILO	International Labour Organization
IPM	Integrated pest management

IPCC	Intergovernmental Panel on Climate Change
IRD	Institut de recherche pour le développement (Institute of research for development)
ISEAL	International Social and Environmental Accreditation and Labelling Alliance
ITC	International Trade Centre
IWUI	Irrigation water use index
LCA	Life Cycle Assessment
LEPA	Low Energy Precision Application
MEA	Multilateral Environment Agreement
MISTRA	Swedish Foundation for Strategic Environmental Research
myBMP	Australian Best Management Practices programme
NCC	National Cotton Council of America
NORAD	Norwegian Agency for Development Cooperation
OECD	Organisation for Economic Co-operation and Development
OHS	Occupational health and safety
RISE	Response-Inducing Sustainability Evaluation
SAFA	Sustainability Assessment of Food and Agriculture systems
SECO	State Secretariat for Economic Affairs (Switzerland)
SEEP	Social Environmental and Economic Performance
SIDA	Swedish International Development Cooperation
TE	Textile exchange
TOCMC	Texas Organic Cotton Marketing Cooperative
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VSI	Voluntary sustainability initiative
WCED	World Commission on Environment and Development
WCP	Water crop productivity
WHO	World Health Organization
WUE	Water use efficiency
WWF	World Wild Fund for Nature

About SEEP and this Report

The Expert Panel on the Social Environmental and Economic Performance of Cotton Production (SEEP) is an advisory body of the International Cotton Advisory Committee (ICAC) and was established during ICAC's 65th Plenary Meeting, held in Goiânia, Brazil in September 2006. However, the seeds for the panel were sown over a number of years as the cotton industry became increasingly focused on its broad sustainability obligations. Heightened global attention on the industry's supply chain provided the impetus for the ICAC not only to gain a greater appreciation of the industry's sustainability performance, but also to seek out appropriate responses to problematic activities. The SEEP Panel currently has fifteen members and reflects a broad cross-section of nationalities, expertise and experience. The members of SEEP serve without compensation. Members belong to research or development organizations, national cotton organizations or private sector associations. In having access to the specific skill sets of the individual representatives, and to the resources of their respective organizations, SEEP has powerful collaborative capacity and substantially broadens ICAC's resource base. The primary objective of the Panel is to collect and review independent, science-based information on the negative and positive social, environmental and economic aspects of global cotton production. Over the years, SEEP has not only reviewed existing information – making use of its internal expertise – but has also commissioned and supervised scientific studies. Based on the available information, SEEP formulates recommendations for further action as and when appropriate to improve the overall sustainability of cotton production.

At its inception meeting in 2007, SEEP reflected on the complexity and *quantum* of issues impacting the sustainability of cotton production. Specifically, as a result of pesticide use data of the industry that emerged during the 1990s, the Panel prioritized obtaining a greater understanding of plant protection practices and trends in chemical use. Water use and management, soil management, production efficiency and energy usage, greenhouse gas emissions and biodiversity were quickly added to the list of important environmental issues. Labour costs and workplace conditions became high priority topics from the social impact perspective. SEEP began working on this report in 2012 in close collaboration with the Plant Production and Protection Division of FAO. SEEP members, assisted by two international consultants from IISD, prepared the first draft which was then extensively reviewed and integrated with new contributions by sector specialists. In April 2013, a two-day technical workshop was held at FAO headquarters, Rome with the objective of reaching a consensus on the ranking of the indicators. At the 72nd ICAC Plenary Meeting in Cartagena, Colombia, delegates discussed the sustainability framework approach and its implementation. SEEP integrated the feedback from the Plenary Meeting into this final version of the report.

Executive Summary

Measuring Sustainability in Cotton Farming Systems – Towards a Guidance Framework ("Cotton Report") provides an overview of sustainability issues and recommends a set of indicators to assess and measure progress in addressing the critical sustainability issues for cotton farming. The list of recommended indicators was developed through a process that involved the following steps:

1. reviewing a range of programmes for their indicators and consulting sector specialists to create an inventory of potential indicators;
2. refining of the inventory through an objective rating system based on the considerations of relevance, feasibility and usefulness; and
3. expert review of the selected indicators.

Standardization of the indicators by which the performance of the global cotton industry is measured will improve the ability of the cotton industry, as a global entity, to understand, report on and improve its social, environmental and economic performance.

An internationally agreed list of sustainability indicators can provide a reference to benchmark the current (national) cotton industry "performance", and track ongoing improvements. The list of recommended indicators, however, is not intended as an absolute global list that every cotton-growing country should use to measure its performance. Nevertheless, where countries share common issues, agreement on the appropriate indicators will allow for the global cotton industry to better report on how the issue is being addressed internationally. It is also important to note that the list is not intended to establish a set of "pass/fail" levels, nor does the report intend to rate the merits of each sustainability framework or initiative reviewed. The focus should be on tracking continuous improvement using agreed measures for which this report provides a framework.

Sustainability Issues

Following the Brundtland Report definition: *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs,* the key issues for the cotton industry were organized into the three pillars of sustainability – environmental, economic and social – each comprising a number of themes. The environmental pillar comprises five themes: Pest and Pesticide Management, Water Management, Soil Management, Biodiversity and Land Use, and Climate Change. The economic pillar comprises two major themes: Economic Viability, Poverty Reduction and Food

Security, and Economic Risk Management. Finally, the social pillar comprises four themes: Labour Rights and Standards, Worker Health and Safety, Equity and Gender, and Farmer Organization.

An inventory of indicators was drawn from the monitoring and evaluation systems of five cotton-specific programmes, namely Better Cotton Initiative, Cotton made in Africa, Fairtrade cotton, Organic cotton and myBMP (Australian Best Management Practices programme), and four broader programmes on sustainable agriculture, namely the Committee on Sustainability Assessment Initiative, Field To Market (The Alliance for Sustainable Agriculture), the Response-Inducing Sustainability Evaluation (RISE) and the FAO Sustainability Assessment of Food and Agriculture Systems (SAFA) guidelines. Sector specialists reviewed, complemented and rated the inventory list to prioritize a set of 68 core indicators across the key sustainability themes.

This framework of indicators was presented to participants at the 72nd ICAC Plenary Meeting, held in Cartagena, Colombia in October 2013. Following workshop discussions, it was **agreed 1) that the recommended indicators be considered at a national level and that committees should be formed in each country to create the initial framework of indicators and to ensure that the framework is updated as production practices evolve.** National discussions will inform more effective linkage of sustainability indicators to activities and interventions that directly enhance the sustainability of local cotton production systems (for example, through policy decisions by government bodies, optimization of production practices by farmers or changes in support services by extension services). Such a focus at a national level is consistent with and enhances one of the key objectives of the Cotton Report – to provide a forum for the cotton industry to discuss, debate and reach agreement on what the priorities are for measuring the sustainability performance of the cotton industry.

Discussions among delegates also highlighted that a pilot testing of the framework would be beneficial. It is therefore **recommended 2) that appropriate national organizations consider pilot testing the framework.**

Ideally, pilot testing of the framework would be undertaken in a range of different farming systems and contexts (e.g. highly mechanized and labour-intensive; rainfed and irrigated). As such, SEEP hopes the framework will enhance and focus in-depth discussions on indicators and provide a springboard for their use and application within and across the cotton sector.

1

Introduction

As a global industry, the conditions under which cotton is grown and the issues associated with its cultivation vary enormously due to differing environmental, agro-ecological, climatic, socio-economic and political conditions. These varying conditions mean that the cultivation of the same crop may result in significantly different practices and impacts, and that there are significantly different options and capabilities available to address these impacts. An assessment of the impacts of cotton growing, and development of the best options for managing impacts, should therefore always be done with reference to the specific context. However, despite these highly variable conditions, and the site-specific nature of appropriate responses, the impacts of cotton growing are often considered globally. Both the cotton industry and cotton as a raw material are assessed either generically, or on the basis of the averaging of information from different countries without reference to the specific production locations. Access to comprehensive, site-specific, robust and uniform data is necessary to ensure that this "globalization" of the impacts of cotton farming portrays the actual impacts as accurately as possible.

One of the responses to the impacts of cotton production has been the establishment of programmes or initiatives working with farmers to improve the sustainability of growing cotton. Development programmes promoting sustainable intensification of agriculture to jointly protect and enhance the livelihoods of producers and the environment have long been working in cotton. There has also been an increasing regulatory interest in resource management by agricultural producers, leading to the implementation of production risk management systems focused on responsible natural resource stewardship. In recent years, there has been an emergence of initiatives aimed at promoting sustainability in cotton production that involve the downstream supply chain for cotton. This is evident with large retailers who have a growing interest in improving their own overall footprint and who seek to provide customers with greater confidence in the integrity of their products. As a result, there are an increasing number of production standards and systems that claim to promote the objectives of sustainable farming.

While these developments are positive, there is a need to understand their relevance to the cotton industry as a whole, including cotton farmers. A consequence of the increase in market-based initiatives to address the impacts of cotton growing is that a wider range of perspectives are influencing the development of these sustainability initiatives, including the approaches to information needs, collection and reporting. It is essential that the interests of all the participants in the cotton supply chain are considered. The specific information requirements of the different participants in the cotton industry will vary depending on how the information is used, and on the value of the information that is collected. This is especially so when it comes to the question of "how the sustainability of cotton farming is assessed". Among other things, collecting and reporting data requires a clear purpose, as well as clear links between the costs involved in collecting the data and the benefits of doing so.

Measuring Sustainability in Cotton Farming Systems – Towards a Guidance Framework ("Cotton Report") was conceived as a means to bring together the work of programmes and initiatives seeking to reduce the possible negative impacts of cultivating cotton.

The objective of the Cotton Report is to recommend a set of indicators to evaluate and track the performance of cotton production across a comprehensive range of sustainability issues. It is addressed to anybody working with cotton farmers – governments, industry organizations, development agencies, ginners, marketers, farmers' associations, funders and voluntary standards initiatives.

The list of recommended indicators was drawn from a range of sustainability programmes with relevance to cotton, an extensive literature review and thematic expert consultation. The indicator list has been developed on the understanding that any coordinated, industry-wide effort on measuring the sustainability of cotton farming will start with a discussion involving all stakeholders to agree on what are the key issues that need to be addressed, what are the best indicators to assess progress towards becoming more sustainable, and who are the appropriate stakeholders to undertake the responsibility for doing so.

Discussing and agreeing on what indicators or measures should be used to assess at a global level the sustainability of cotton farming will give rise to a range of potential benefits for the cotton industry, including:

- provision of a forum for the global cotton industry to discuss, debate and reach agreement on the priorities for measuring the sustainability performance of the cotton industry;
- better understanding of current levels of "performance" – environmental, economic and social – essential in order to improve performance, as actions can target the most critical areas requiring improvement;
- increased global relevance, comprehension and efficiency of data collection and reporting;
- improved capacity to satisfy market demand: the expectations of retailers and consumers are changing and they have increasingly high expectations both about how products are produced with respect to their environmental and social impact, and – importantly – about access to that information;
- access by the cotton industry to data used by the downstream supply chain to "assess" performance and, therefore, the possibility to check that the data are accurate and representative of cotton performance globally.

The list of recommended indicators is a starting point for discussion among cotton sector stakeholders, so that areas of agreement on these key issues can be found. It needs to be stressed that while there are sustainability issues with a recognized global relevance for which uniform indicators can be used (for instance no child labour involvement), there are also several other sustainability issues which, due to the diversity and variability in cotton production across regions, are very localized.

This report concentrates on the farm and farmer level. Issues relating to downstream activities may arise, but are not covered in any detail. It should also be noted that many of the issues highlighted are relevant to agricultural production in general, not just cotton.

Finally, the list is not intended to establish a set of "pass/fail" levels; the focus is on tracking continuous improvement, using agreed measures. Likewise, the rating is designed neither to judge the merits of each sustainability framework or initiative reviewed, nor to identify a preferred system. While an element of commonality around how different programmes and initiatives report on their outcomes is considered desirable, it is recognized that they are working in different countries on a range of issues.

Structure and Focus of the Cotton Report

The Cotton Report provides a brief overview of cotton production and trade **(Chapter 2)**. It then proceeds with an overview of the current status of knowledge on environmental, economic and social impacts associated with cotton production drawn from an extensive bibliography review **(Chapter 3)**. A methodological framework to prioritize sustainability areas and indicators according to their relevance, usefulness and feasibility to a specific country and/or regional context is then described and applied. This includes: a) an inventory, review and analysis of the indicators used for measuring sustainability performance across a range of different cotton-specific sustainability programmes and initiatives, as well as more generic initiatives aimed at assessing sustainability in agriculture; b) a methodology to rate these indicators; and c) identification of a set of recommended indicators to measure sustainability in cotton production based on this rating **(Chapter 4)**. Detailed background information on the various ongoing sustainability initiatives is included in the appendixes. The Cotton Report concludes with a discussion on the importance of complementing the recommended indicators with country and stakeholder perspectives in order to select the most relevant indicators for the circumstances in the country concerned and to enable steps towards implementation and engagement of private sector stakeholders **(Chapter 5)**.

2

Cotton Production and Trade

2.1 Cotton Production

The cotton plant includes 40 species in the genus *Gossypium* (family Malvaceae). Species of cotton grown for commercial purposes are *G. hirsutum* ("Upland cotton", native to Central America, the Caribbean and South Florida), *G. barbadense* ("Creole cotton" or "Sea island cotton", South America) known as New World species, *G. arboreum* ("Tree cotton", South Asia), and *G. herbaceum* ("Levant cotton", South Africa), called Old World or Asiatic cottons (UNCTAD, 2005). Cotton is grown around the world from the tropics to latitudes greater than 40° (Uzbekistan and Xinjiang Province in China) **(Figure 1)**. The basic conditions required for the successful production of cotton include a long frost-free period, a temperature range of 18–32° C and 600–1200 mm of water over the growing cycle which typically lasts 125–175 days (FAO, 2012). Cotton exhibits a certain degree of tolerance to salt and drought and it is therefore grown in arid and semi-arid regions. However, higher and consistent yield and fibre quality levels are generally obtained with irrigation or sufficient rainfall.

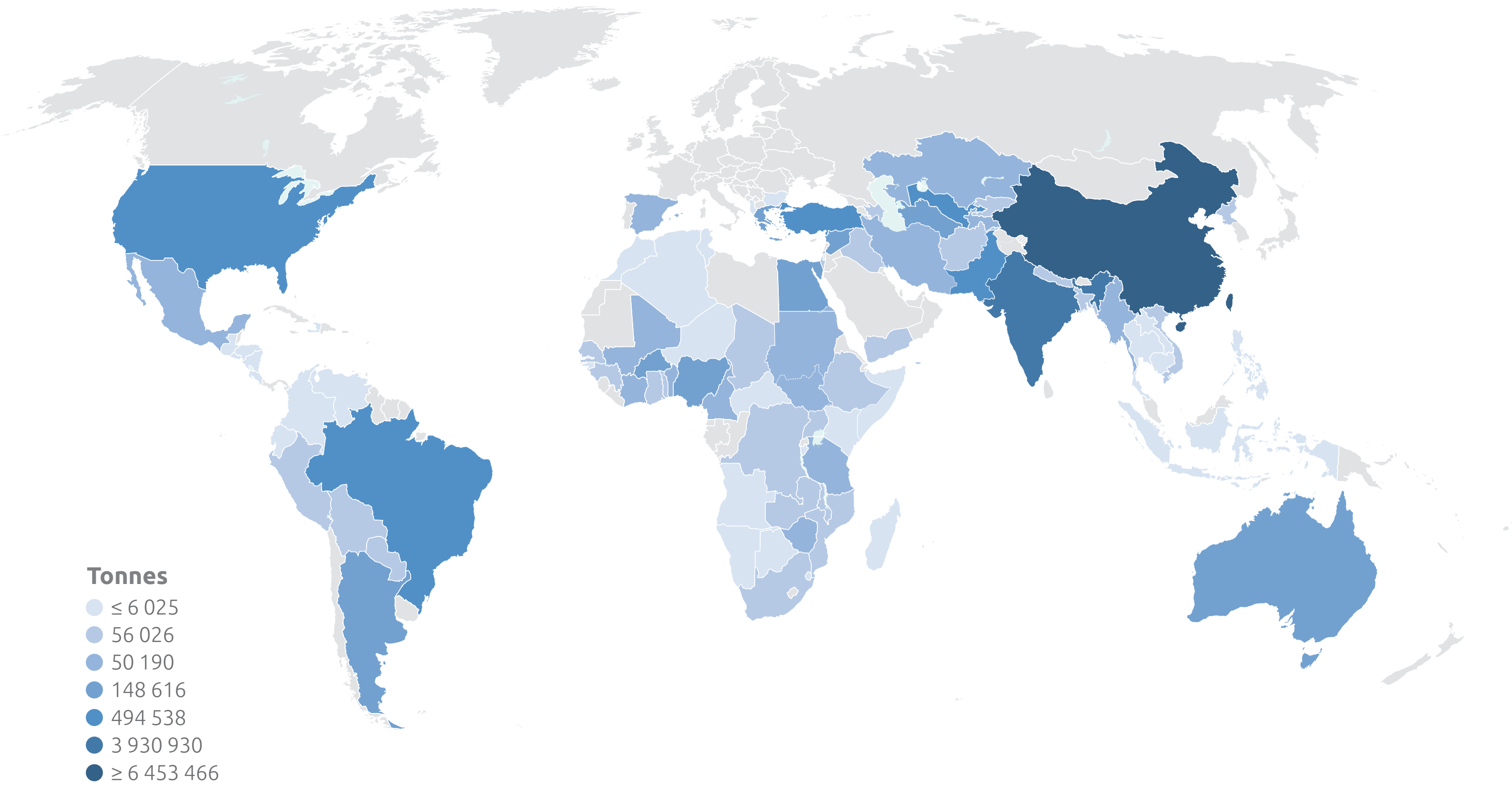
With a total production of 25 624 000 tonnes of lint during 2013/14 in more than 75 countries, the social and economic importance of cotton on a global scale is self-evident (ICAC, 2014). Cotton is primarily produced for its fibre, which is used as a textile raw material. In 2013/14, cotton was harvested on approximately 32 429 000 ha (ICAC, 2014), equivalent to about 2.3% of the world's arable land (almost 1.4 billion ha, average 1992–2009, FAOSTAT). About 80% of all cotton is produced in six countries. China is the world's leading producer with 6 700 000 tonnes, followed by India (6 371 000 tonnes), the United States (2 811 000 tonnes), Pakistan (2 076 000 tonnes), Brazil (1 644 000 tonnes) and Uzbekistan (920 000 tonnes) (ICAC, 2014). In 2013/14, China and India accounted for slightly more than half of world cotton production, while the United States, Pakistan, Brazil and Uzbekistan accounted for an additional 29%.

While the global area devoted to cotton production has remained relatively stable over the past three decades, regional changes have occurred. Australia, China, francophone Africa and South Asia have experienced a significant increase in the area under cotton cultivation, whereas cultivated area has shrunk by 40–50% in Brazil and the United States. The advent of new production technologies and better management practices has given rise to an almost 100% increase in average global yields over 30 years, up from 411 kg/ha in 1980/81 to 790 kg/ha of cotton lint in 2013/14 (ICAC, 2014).

While stable global land use and increasing yields in the major cotton-producing regions, with the exception of West and South African countries, suggest increased efficiency across the sector, cotton production remains an intensive agricultural commodity in terms of production inputs, e.g. energy, water, fertilizers and pesticides. New production practices and technologies offer real opportunities for improving the environmental and social impacts of global cotton production. Managing the adoption of such innovations for optimal outcomes will requires continued investment in research and farmer education.

Figure 1

Cotton-producing countries (lint, 2003–2013 average)



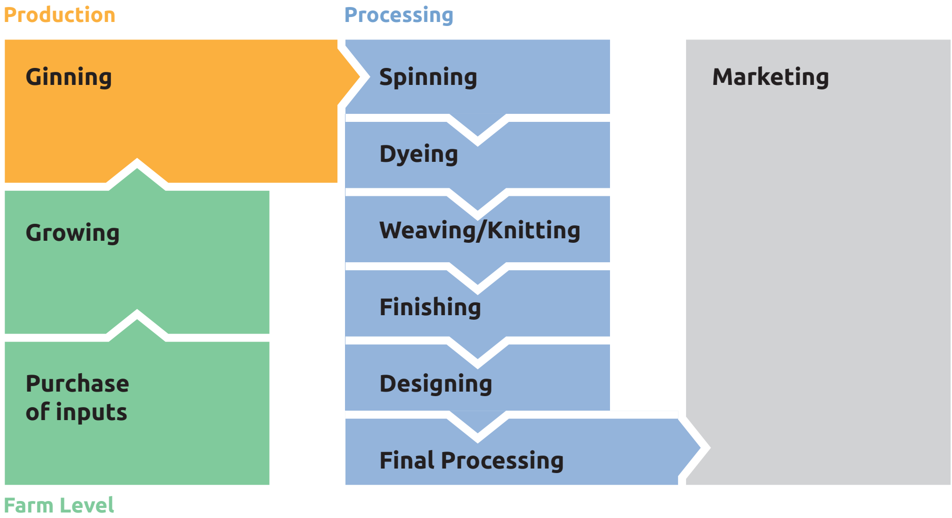
Source: FAOSTAT, 2014.

2.2 Global Cotton Market and Trends

The cotton value chain begins with the farmer, who grows cotton and harvests "seed cotton" from the bolls of the cotton plant. Cotton production systems vary globally, ranging from labour-intensive systems in Africa and Asia to highly mechanized systems in Australia, Brazil and the United States. By weight, seed cotton is composed of roughly one-third cotton lint and two-thirds cottonseed. The cotton lint is separated from the cottonseed ("ginning") using a cotton gin. Cotton lint is then sold to spinners who produce yarn. Textile manufacturers transform yarns into fabric by knitting or weaving the yarns and applying dyes and finishes. In the final stage, end products (garments, home textiles etc.) are made from fabrics **(Figure 2)**.

Cotton and cotton textile industries are central to the economic growth of both developed and developing countries. The large area under cotton cultivation makes it one of the most significant crops in terms of land use after food grains and soybeans. More than 100 million family units are directly engaged in cotton production (Fortucci, 2002). When family labour, hired on-farm labour and workers in ancillary services such as transportation, ginning, baling and storage are considered, over 250 million people are involved in the cotton sector (ICAC, 2009). Cotton also provides additional employment to several million people in related industries such as agricultural inputs, machinery and equipment production, cottonseed crushing and textile manufacturing. Cotton has played an important role in industrial development since the eighteenth century and continues to play a central role today in the developing world as a major source of revenue. The value of the 25.6 million tonnes of cotton production in 2013/14 **(Figure 3)** sold at an average price of about USD 0.91 per pound of lint (USD 2.01/kg), amounts to about USD 51.4 billion.

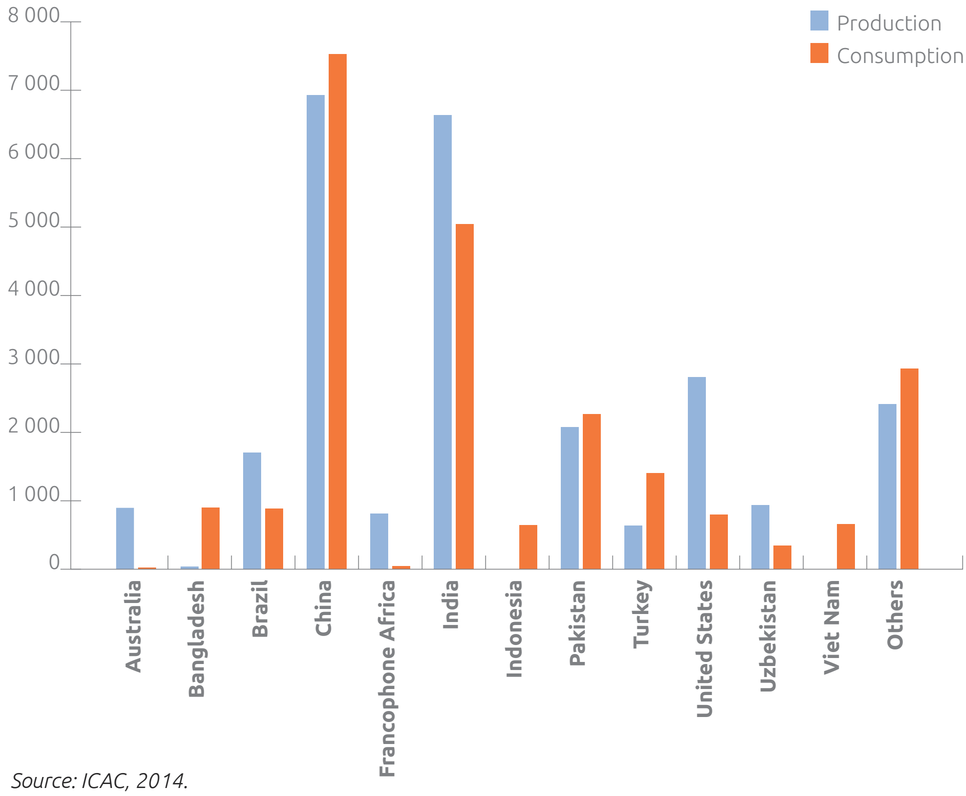
Figure 2
Schematic representation of the cotton textiles value chain



The length of the value chain and the manufacturing costs at the industrial stage result in the total value added throughout the cotton chain (from farm to retail) being several times the value of cotton at the production stage. On average, the retail price of a pair of jeans during the fourth quarter of 2010 in the United States was 12 times the value of the cotton lint used in its production; the corresponding ratios for t-shirts, polo shirts and woven shirts exceeded 27 (Devine and Plastina, 2011).

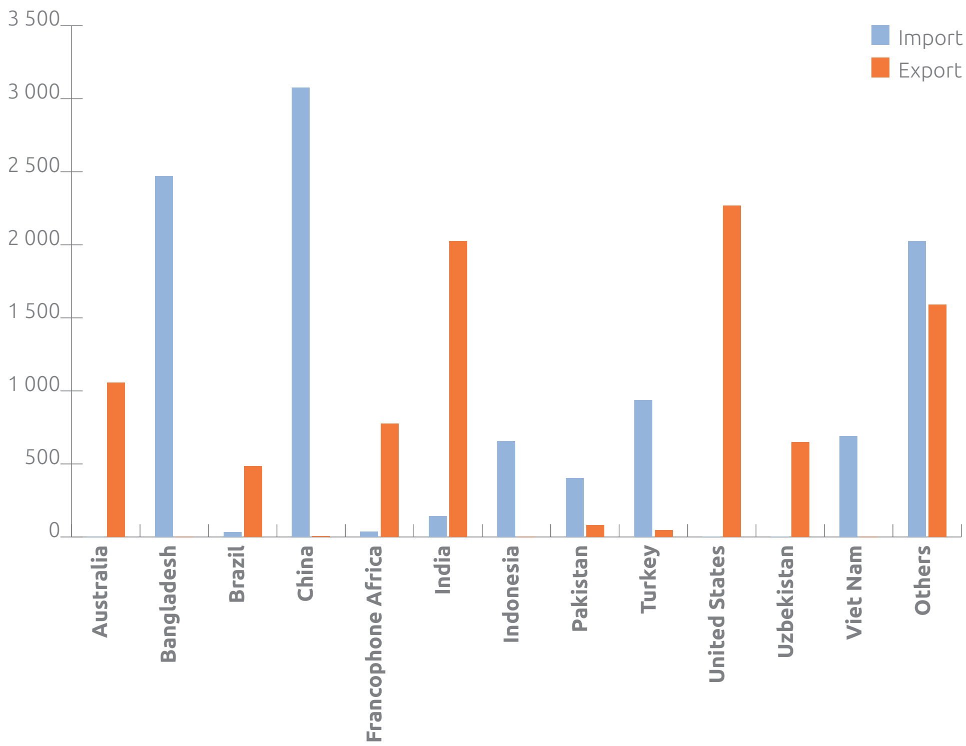
Increases in cotton yields, the phasing out of textile quotas under the Multifibre Arrangement, and sustained world economic growth fuelled a period of rapid growth for the world cotton market between 2000 and 2005. In the second half of the decade, stagnant cotton yields and the Great Recession resulted in a reduction of the world cotton market. However, substantial distortions caused by government support programmes to cotton farmers and the loss of price competitiveness in the face of competing textile fibres (mainly polyester) in the 2010s created a wedge between increasing cotton production and declining

Figure 3
Cotton lint production and consumption (thousand tonnes) by country (2013/2014)



Source: ICAC, 2014.

Figure 4
Cotton lint import and export (thousand tonnes) by country (2013/14)



Source: ICAC, 2014.

demand for cotton. The accumulated gap between world cotton production and world cotton consumption between 2010/11 and 2013/14 amounted to 11.6 million tonnes. Most of the additional carrying stocks were absorbed by the China National Cotton Reserves Corporation (CNCRC) as part of its efforts to maintain domestic farm prices.

In 2013/14, China and India accounted for 51% of world cotton mill use **(Figure 3)**. Pakistan, Turkey, Brazil, Bangladesh and the United States accounted for an additional 25%. While cotton is mostly processed in developing countries, per capita consumption of cotton at retail level is highest in developed countries.

About one-third of world cotton production is traded internationally. In terms of export value, cotton is one of the world's most important agricultural commodities with a market size of USD 17.4 billion in 2013/14, with the United States and India accounting for half of world cotton exports, and Australia, Brazil, Francophone Africa and Uzbekistan accounting for an additional 32% **(Figure 4)**.

In a year characterized by strong government interventions through the CNCRC, China accounted for 55% of world cotton imports in 2011/12. In 2013/14, Chinese imports accounted for 35% of world trade, while Bangladesh, Viet Nam, Indonesia Turkey and Pakistan jointly accounted for an additional 37%. Between 2003/04 and 2010/11, China's share of world cotton imports averaged 29% **(Figure 4)**.

Trade is expected to continue growing over the next few decades (as in the past six decades) with its share of world cotton production and mill use remaining around one-third. However, the origin and destination of cotton trade will likely experience variations over time, as cotton mill use continues to migrate to regions with the lowest costs of yarn production.

3

Sustainability Issues in the Cotton Sector

3

3.1 **Global Issues in Sustainable Development**

The report "Our Common Future" of the UN World Commission on Environment and Development (WCED) published in 1987, commonly known as the Brundtland Report, has provided the most widely accepted and enduring definition of sustainability at international level. According to the Brundtland Report:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

The report underlines in more detail two concepts: *needs*, in particular the essential need of the world's poor, to which overriding priority should be given; and *limitations,* imposed by the state of technology and social organization on the environment's ability to meet present and future needs (WCED, 1987).

The Brundtland Report treats the social, economic and environmental pillars of sustainability in an integrated and coherent manner. It also emphasizes that although goals of economic and social development will vary, it is essential to embark on a development pathway that can be maintained in the long term. Ecological resilience, remnant ecological diversity and productivity, respect for nature, universal human rights and a culture of peace, as well as economic prosperity, political justice and cultural vibrancy, are all part of the complex concept of sustainability (Earth Charter Commission, 2000; Magee *et al.*, 2013). The Brundlandt Report was followed by Agenda 21, a strategic implementation document addressing global sustainability goals. It was adopted by the Plenary of the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, on 14 June 1992 at the first Earth Summit. Agenda 21 identifies the relevant programme areas and relative basis for action, objectives, activities and means of implementation for achieving sustainable development. Programme areas for the agricultural sector are listed in Section 14 of Agenda 21 **(Table 1)**.

Agenda 21 is complemented by a wide range of international conferences, treaties and protocols concerning specific sustainability issues with varying degrees of relevance to the agriculture sector. While full consideration of such treaties is well beyond the scope of the Cotton Report, **Table 2** lists international agreements representing a series of "universally accepted" norms, prerequisites and priorities for sustainable rural development.

Table 1
Agenda 21 Section 14: Promoting Sustainable Agriculture and Rural Development Priorities for Sustainable Agriculture

Programme Areas
Agricultural policy review, planning and integrated programming in light of the multifunctional aspect of agriculture, particularly with regard to food security and sustainable development
Ensuring people's participation and promoting human resource development for sustainable agriculture
Improving farm production and farming systems through diversification of farm and non-farm employment and infrastructure development
Land-resource planning information and education for agriculture
Land conservation and rehabilitation
Water for sustainable food production and sustainable rural development
Conservation and sustainable utilization of plant genetic resources for food and sustainable agriculture
Conservation and sustainable utilization of animal genetic resources for sustainable agriculture
Integrated pest management (IPM) and control in agriculture
Sustainable plant nutrition to increase food production
Rural energy transition to enhance productivity
Evaluation of the effects of ultraviolet radiation on plants and animals caused by the depletion of the stratospheric ozone layer

Table 2
Major international instruments for sustainable development

International Instruments	Year
Universal Declaration of Human Rights	1948
Social Security (Minimum Standards) Convention	1952
International Covenant on Economic, Social and Cultural Rights	1966
Convention on Biological Diversity (CBD)	1993
UN Framework Convention on Climate Change (UNFCCC)	1994
United Nations Convention to Combat Desertification	1994
International Labour Organization (ILO) Declaration on Fundamental Principles and Rights at Work (Core 8)	1998
Millennium Development Goals	2000
Multilateral Environment Agreements (MEAs) (e.g. Chemicals MEAs: Basel, Rotterdam and Stockholm Conventions)	Multiple
The International Code of Conduct on the Management of Pesticides – 1985, revised in 2002 and in 2013	2013

Each of these international instruments establishes a normative framework for protecting globally recognized public goods and human rights that, although not specific to agriculture, are deeply entwined with agricultural production around the world.

3.2 Sustainability Themes

From the high level list of sustainability priorities derived from Agenda 21 **(Table 1)**, eleven areas or themes emerged from a review of "sustainability" literature relevant to cotton farming at a global level undertaken for the Cotton Report. Differences between the geopolitical context, production systems, climatic conditions and basic needs across countries and agricultural systems will determine their relative importance at a local level.

The themes are distributed across the three sustainability dimensions (economic, environmental and social) and include pest and pesticide management, water management, soil management, biodiversity and land use, climate change, economic viability, poverty reduction and food security, economic risk management, labour rights and standards, occupational health and safety (OHS), equity and gender, and farmer organization **(Figure 5)**.

Given the focus of the Cotton Report on farm-level impacts, broader and/or structural issues (for example, questions of sustainable market organization, the design of cotton-relevant agricultural policy) are not included in this report.

Figure 5

Priority sustainability themes for cotton farming systems

Environmental

Pest and Pesticide Management
- Environmental contamination by pesticides
- Pest management and crop production
- Human exposure to pesticides

Water Management
- Water depletion
- Crop water management
- Soil salinization
- Water quality

Soil Management
- Soil fertility
- Soil erosion

Biodiversity and Land Use
- Land conservation
- Land productivity

Climate Change
- Greenhouse gas (GHG) emissions
- Decomposition and mineralization
- Energy use
- Carbon stock changes

Economic

Economic Viability, Poverty Reduction and Food Security

Economic Risk Management

Social

Labour Rights and Standards
- Child labour
- Employment conditions
- Freedom of association
- Social protection

Worker Health and Safety

Equity and Gender

Farmer Organization

3.3 Pest and Pesticide Management

Pest management is a challenge and represents a cost to cotton production. Watkins (1981) estimated that insect damage was responsible for 15% of global cotton yield loss, with large variations between locations. For instance, insect pest losses for the United States in 2011 were estimated at 3.0% of the cotton crop (Williams, 2012). The extent of cotton yield loss from insect damage depends on the efficiency of available pest management strategies, as well as exogenous factors such as temperature variations and extreme weather events. Fungal, viral and bacterial plant pathogens tend to have less impact than insects, and although their incidence varies across regions and years, they also require adequate management. Good weed management is also critical to maintain productivity.

Since the 1950s, the most common method for preventing pest damage has been the application of pesticides. However, the introduction of integrated pest management (IPM)[1] and GM (genetically modified) cotton represent important and increasingly widespread elements of a broader pest management programme. Pesticides are used in cotton as seed treatments (insecticides and fungicides), as soil treatments (herbicides, nematicides and fungicides) and as foliar applications to the cotton crop (insecticides, herbicides and fungicides). The majority of commercial cottonseeds are treated with insecticides before they are planted. The three methods for applying pesticides in the field are aerial spraying (13% of total), field spraying by hand (52%) and tractor spraying (35%) (ICAC, 2005).

In 1999, cotton production was estimated to account for 11% of global pesticide use, 25% of global insecticide use and 50% of insecticide use across the developing world (Woodburn, 1995). By 2009, Cropnosis (cited in SEEP, 2012), the proportion of global pesticide sales for cotton was 6.2%, compared to 29.7% for fruits and vegetables, 17% for cereals, 9.6% for soybean and 9.3% for maize. The proportion of global insecticide sales for cotton, compared to sales for all crops, declined from 18.4% in 2003 to 14.1% in 2009 (SEEP, 2012). Nevertheless, significant disparities in pesticide use exist across countries **(Table 3)**.

The application of pesticides in cotton production can have negative impacts on human health and the environment as well as on crop productivity. Factors that might determine these effects include the following:

1 **Quantities used:** overuse of pesticides is common in many places and leads to unnecessary environmental and human exposure. Preventive pesticide applications not based on an agro-ecosystem analysis are the main factor leading to overuse. The choice of application technique can also be an important factor, as some techniques are more accurate than others. Application during suitable weather conditions and avoidance of pesticide drift is important.

2 **Type and behaviour of pesticides used:** pesticides are classified according to their hazard, from highly hazardous to unlikely to cause any harm. The two schemes most commonly used to classify pesticides by hazard level are: the World Health Organization (WHO) Recommended Classification of Pesticides by Hazard, which classifies pesticides by acute human toxicity, and the more recently introduced Globally Harmonized System of Classification and Labelling of Chemicals (GHS), which considers both acute and chronic human toxicity and en-

[1] FAO definition of integrated pest management (IPM): IPM means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

Table 3
Average pesticide use on cotton

Country	Year	kg a.i./ha
Australia	2007	1.0
Brazil	2006	4.9
India	2006	0.9
Togo	2010	1.1
Turkey	2006	0.6
United States	2006	1.2

Source: SEEP, 2010.

vironmental toxicity. In addition, FAO has introduced broader criteria for highly hazardous pesticides (HHPs), which not only consider chemical properties, but also the circumstances of use. The use of persistent, highly hazardous or non-selective products (i.e. those whose mode of action works across a wide range of organisms) tends to increase the environmental and human health risks.

3 **Handling and use:** pesticides should be used in accordance with label instructions and with the prescribed personal protective equipment. It is important that the selected pesticides are registered for use on cotton in the country concerned. Other relevant aspects include: storage of pesticides; selection, maintenance and cleaning of application equipment; disposal of leftover product, contaminated materials and empty containers; application procedures and mixing of different products.

Environmental impacts associated with the improper use of pesticides

- Contamination of drinking water, river systems, groundwater and aquifers
- Poisoning of fish and other aquatic organisms and biodiversity loss
- Long-term persistence in soils impacting rotational crops and beneficial soil organisms and loss of ecosystem services
- Poisoning of wildlife (including birds and bees) and biodiversity loss
- Poisoning or contamination of livestock
- Reducing populations of pollinating insects important for crop yield
- Air pollution

Impacts on pest management and crop production

Improper use of pesticides, including over-application, wrong application timing and use of non-selective insecticides, has resulted in pest species resistance to the pesticides designed to control them. Pest species develop pesticide resistance via natural selection caused by the most resistant organisms surviving treatments and passing on their genetic traits to their offspring. High treatment frequency and low killing efficiency of pesticides increase the likelihood that insects will develop resistance. In cases where the pest organism has developed resistance to the pesticides used, pest resurgence events can become especially destructive (Reissig and Heinrichs, 1982; Naranjo and Ellsworth, 2009).

Genetically Modified (GM) Cotton

Genetically modified (GM) traits for cotton specifically target yield reductions caused by weeds and/or fruit-feeding pests of the *Lepidoptrian* species (e.g. bollworm). The sustainability outcomes of GM cotton cultivation have been widely discussed, and empirical evidence exists that either supports or challenges GM cotton as a sustainable practice. Beyond the scale of limited contexts or very specific sustainability aspects, only limited data are available for a comprehensive review of the sustainability impact of GM cotton under various conditions. Thus, an evaluation of the cultivation of GM cotton has not been undertaken for the Cotton Report

In cotton fields under an intense chemical management regime, natural pest control mechanisms are often suppressed and natural enemies and other beneficial organisms, such as the soil fauna important for ensuring soil health, are impacted. As a result, secondary pest outbreaks occur which also then require further management intervention.

Human exposure to pesticides

People can be exposed to pesticides directly through oral, dermal and nasal routes while applying pesticides or through re-entry of treated fields, or indirectly through pesticide residues in air, food and water.

Exposure to pesticides can result in the following:

- **Acute poisoning:** the central and peripheral nervous systems can be affected by exposure to pesticides. The severity depends on the type of product/the hazard level of the product, the quantity exposed to/extent of exposure and other factors. Severe poisoning can cause convulsions, loss of consciousness, cardiac arrest and death.

- **Chronic illness:** some pesticides have known or suspected carcinogenic, genotoxic, reproductive or endocrine disruptive properties. Long-term exposure to small dosages of such products can cause major health problems such as cancers, birth defects or impaired development in children.

In 2010, a SEEP study found that a relatively high proportion of pesticides used in cotton are highly hazardous pesticides (HHPs), which, according to FAO criteria, should be considered for phasing out. They included: aldicarb, chlorpyrifos, endosulphan, methamidofos, methomyl, monocrotofos, parathion-methyl, profenofos and zeta cypermethrin (SEEP, 2010). Most of the above-mentioned pesticides are no longer permitted in countries with advanced regulatory systems, and are increasingly being phased out by developing countries. Pesticide poisoning can occur as a result of intentional ingestion or occupational exposure. Cotton farmers in the developing world commonly apply pesticides with back-pack sprayers or using other rudimentary tools, often without adequate personal protective equipment. Occupational poisoning of various degrees is common in these countries and has been documented in many studies (Wesseling *et al.*, 1993; Murphy *et al.*, 1999; Tovignan *et al.*, 2001; Eddleston *et al.*, 2002; Mancini *et al.*, 2005). FAO considers HHPs unsuitable for use in developing countries where adequate risk management measures cannot be guaranteed. However, some of these older and highly hazardous products continue to be used because they are less expensive and readily available.

International regulatory framework for the use of pesticides

In recognition of the widespread issues related to pesticide use in agriculture, an international regulatory framework has been developed to reduce the negative impacts of pesticide use:

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- The **Stockholm Convention** on Persistent Organic Pollutants lists chemicals, including pesticides, that should be phased out and prohibited.

- The **Rotterdam Convention** on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade lists chemicals, including pesticides, for which its Parties have agreed to adhere to a notification scheme prior to export. The export and import of cotton pesticides listed under the Convention should adhere to these notification requirements.

- The **International Code of Conduct on Pesticide Management** (the "Code") is a voluntary instrument but constitutes one of the most important reference frameworks for appropriate use of pesticides. The Code was developed by FAO and the WHO in close consultation with United Nations Environment Programme (UNEP), the pesticide industry and civil society organizations. It has been adopted by FAO member countries and leading associations in the pesticide industry. The Code provides guidance on the use of pesticides throughout their life cycle and promotes integrated pest management practices. As such, it serves as a key reference for any initiative aimed at pesticide risk reduction. The Code is available at: http://www.fao.org/agriculture/crops/thematic-sitemap/theme/pests/code/en/).

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Pest and Pesticide Management

Pest management and pesticide use is an area in which an extensive set of sustainability indicators have already been developed, due to their clear environmental, economic and social impacts. Indicators mostly address quantity and type of pesticides used (indicators 1.1 to 1.3), measures taken to reduce pesticide use (indicators 1.4 to 1.6), conditions of use and compliance with recommended practices in the use and handling of pesticides (indicators 1.7 to 1.11) and risk reduction measures to minimize exposure to pesticides (indicators 1.12 to 1.14). Of these indicators, the average kg/ha of active ingredients of total pesticides and HHPs used in production are perhaps the most significant metric. Indicators addressing the issue of risks associated with pesticide exposure of applicators and their families are very relevant, in particular to cotton-producing countries that do not yet have a full capacity to enforce legislation and regulations on work safety matters.

From the point of view of agronomic sustainability, for example, agro-ecosystem stability and yield levels, the existence and implementation of an IPM plan is critical. IPM based on an ecosystem approach increases the resilience of farming systems to pest attacks and sustains production. Chronic illness due to pesticide exposure is an important issue and cohort studies in key areas have been carried out to establish cause–effect attribution. However, at farm level, this could be a difficult aspect to monitor. The presence of storage facilities and protective equipment, in addition to an IPM plan in place, are useful potential indicators of care taken in the use and application of pesticides. Nevertheless, they do not, by themselves, automatically translate into improved worker health and safety (if, for example, protective equipment is present but not used). Training, while a prerequisite to the sound application of chemicals, suffers from variability in training quality and its application in the field.

Environmental

Pest and Pesticide Management

- Environmental contamination by pesticides
- Pest management and crop production
- Human exposure to pesticides

These indicators have been selected as a result of a scoring procedure described in Chapter 4.

1 Pest and Pesticide Management

1.1 Quantity of active ingredients of pesticides used (kg/ha)
1.2 Quantity of active ingredients of highly hazardous pesticides used (kg/ha)
1.3 Number of pesticide applications per season
1.4 % of treatments that involve specific measures to minimize non-target application and damage
1.5 Existence of a time-bound IPM plan
1.6 % of cotton area under IPM
1.7 % of farmers that use only pesticides that are nationally registered for use on cotton
1.8 % of farmers that use pesticides labelled according to national standards, in at least one national language
1.9 % of farmers that use proper disposal methods for pesticide containers and contaminated materials including discarded pesticide application equipment
1.10 % of farmers following recommended practices for pesticide mixing, application and cleaning of application equipment
1.11 % of farmers with dedicated storage facilities that keep pesticides safely and out of the reach of children
1.12 Total number and % of cotton area involving vulnerable persons applying pesticides
1.13 % of workers applying pesticides that have received training in handling and use
1.14 % of farmers having access to and using adequate protective equipment (by type)

3.4 Water Management

Water is important to increase crop yields and for aspects of cotton quality such as fibre length. In most countries, whether crops are irrigated or rainfed, cotton production is limited by water supply. Cotton can grow with minimal amounts of water, or if water is available it can utilize significant amounts at certain times during its production cycle. Requirements vary widely depending on region, length of growing season, climate, cultivar, irrigation method and production goal, and range from 600 to 1200 mm (FAO, 2012). The relationship between yield and water use for cotton is reportedly linear (Kanber *et al.*, 1996; Anac *et al.*, 1999; Irmak *et al.*, 2000; Istanbulluoglu *et al.*, 2002; Oktem *et al.*, 2003; Yazar *et al.*, 2002a) as well as curvilinear (Cetin and Bilgel, 2002 and Yazar *et al.*, 2002b).

It has been estimated that 3 000 to 7 000 litres of water are needed to produce 1 kg of cotton lint plus 1.4 kg of cottonseed. This means that 0.14–0.33 kg of cotton lint and 0.41–0.95 kg of cottonseed can be produced per m^3 of water with a mean value of 0.23 kg of lint (Zwart and Bastiaanssen, 2004). Cotton is a drought- and heat-tolerant crop, and thus generally well suited to climates with low rainfall, and it is grown in many regions where the natural precipitation is low. Irrigation is typically applied in these areas to ensure crop maturity and to stabilize and maximize productivity. Irrigated cotton accounts for half of all the land devoted to cotton production and is responsible for 73% of global production. **Table 4** lists key cotton-producing countries and their level of irrigated production. Cotton grown in African countries is mainly rainfed.

3

Table 4

Dependence on irrigation and area under irrigation of selected cotton-producing countries

Country	Region	Rainfall during growing season	% of cotton area irrigated
Australia (1)			74
Brazil (1)			< 1
China (2)	NW-Xinijang	0–200	100
	N-Yellow River	700–1 000	75–95
	S-Yangtse River	700–1 000	75–95
Egypt (2)	North	< 20	100
	Central	< 10	100
	South	0	100
India (2)	North	200–400	100
	Central	800–1 200	29–40
	South	400–1 000	29–40
Mexico (2)		25–2 000	84–95
Pakistan (2)		100–200	100
Turkey (1)			> 99
United States (1)		(86% of which is supplemental irrigation)	36
Uzbekistan (2)		30–70	100

(1) *ICAC, 2011.*

(2) *Koistra, 2005.*

Measures of water use

Water use can be measured and reported in a range of different ways, often referred to generically or interchangeably as a measure of "water use efficiency". The following paragraphs seek to provide a short explanation of the more common measures. These fall into three categories: direct measures of water use (e.g. evapotranspiration); water use indexes, which are ratios linked to water use (e.g. bales of cotton produced per m^3 of water supplied); and measures of efficiency, which relate water output to water input (e.g. the amount of water used by the crop by evapotranspiration as a percentage of total water supplied to the crop).

Water use (ETa) as defined in FAO (2012) is the actual evapotranspiration (ET) of water from the field. Evapotranspiration is a combination of two separate processes whereby water is lost from the soil surface through evaporation and used by the crop through transpiration. It provides a measure of the total amount of water used to grow the crop in field, but does not take into account the efficiency: either in terms of the actual production of lint and cottonseed associated with that water use, or in terms of water loss between the point of extraction and delivery to the crop. ETa varies from 410 to 780 mm per season, depending on the irrigation method and on how much deficit irrigation is applied. Even though ETa also depends on environmental factors, e.g. soil characteristics and climate, similar ranges have been reported for several climates: 390–780 mm on the southern High Plains of Texas (Howell *et al.,* 2004), 590–780 mm in the Central Valley of California (Grismer, 2002), and 430–740 mm in Uzbekistan (Ibragimov *at al.*, 2007). In Australia, the average for the period between 1988 and 2011 was 729 mm (Roth *et al.*, 2013).

Water crop productivity (WCP) on the other hand is an index that provides a measure of the production associated with the water use. In the Cotton Report the definition of WCP is as given in FAO (2008): the quantity (mass, calories) or value of output (including services) in relation to the volume of water used to produce this output (i.e. volume of water evapotranspired), i.e. WCP = kg/m^3ET. WCP is a measure of the plant's economic production, rather than vegetative growth, for the given water use. It is influenced by a range of factors including plant variety, nutrition, pest pressure, disease and climate, as well as management practices that affect the amount of energy used by the plant to produce cotton. Examples include timing of irrigation and prevention of waterlogging. Given this wide range of influences, this index provides a broad measure of crop performance rather than a specific measure of irrigation performance (CRDC, 2012). Again, this calculation does not take into account any losses of water between the point of extraction and delivery to the crop.

The irrigation water use index (IWUI) is similar, but is defined as the quantity of output per volume of water applied through irrigation, i.e. IWUI = kg/m^3 irrigation (or for example, bales per megalitre of irrigation water). All other components of the production system being equivalent, IWUI can provide a measure of productivity for a particular irrigation method. For this measure, it is important to state the scale at which the irrigation water being supplied is measured (e.g. field or farm). The gross production water use index (GPWUI) is similar to the IWUI, but includes seasonal rainfall and stored soil moisture at the start of the season.

Water use efficiency (WUE) (%) is the ratio between the amount of water actually used (ET) and the amount of water withdrawn or diverted from its source (river, lake etc). It is sometimes also referred to as "water supply efficiency" or "irrigation efficiency" (FAO, 2008).

Other measures of water use efficiency include:

- **application efficiency**: the ratio of the irrigation water directly available to the crop and the amount of water supplied to the crop;

- **farm efficiency**: the ratio of the irrigation water directly available to the crop and the amount of water supplied to the farm.

Table 5 provides an overview of the WCP and IWUI values of cotton in different countries in the world.

Cotton production gives rise to three significant sustainability issues associated with water management: water depletion (irrigated cotton only), soil salinization (generally associated with irrigated cotton) and water pollution, including eutrophication (relevant to both irrigated and rainfed cotton production).

3

Table 5

Values of water crop productivity (WCP) and irrigation water use index (IWUI) of irrigation methods in cotton production in selected countries

References	Regions	Irrigation methods	**WCP** (kg/m^3_{ET})	**IWUI** (kg/m^3_{irrig})
Colaizzi *et al.* (2005a and b)	USA (TX)	drip and/or LEPA*	0.152–0.194 lint	
Howell *et al.* (2004)	USA (TX)	sprinkler	0.144–0.219 lint	
Grismer (2002)	USA (CA)	not spec.	0.19–0.21 lint	
Ibragimov *et al.* (2007)	Uzbekistan	drip	0.63–0.88 seed	0.82–1.12 lint
			or 0.22–0.31 lint	
		furrow	0.46–0.50 seed	0.55–0.62 lint
			or 0.16–0.18 lint	
Cetin and Bilgel (2002)	Turkey	drip		0.24 seed
		furrow		0.39 seed
		sprinkler		0.49 seed
Dağdelen *et al.* (2009)	Turkey	drip	0.77–0.96 seed	0.82–1.44 seed
Dağdelen *et al.* (2006)	Turkey	furrow	0.61–0.72 seed	0.77–1.40 seed
Yazar *et al.* (2002b)	Turkey	drip	0.50–0.74 seed	0.60–0.81 seed
Oweis *et al.* (2011)	Syria	drip	0.32–0.39 seed	
Singh *et al.* (2010)	India	drip	0.394–0.418 seed	0.540–0.649 seed
Aujla *et al.* (2005)	India	drip	0.221 seed	
		check-basin	0.176 seed	
Karam *et al.* (2006)	Lebanon	drip	0.80–1.30 lint	
Zwart and Bastiaanssen (2004)	World	-	0.14–0.33 lint	
			0.41–0.95 seed	

**Low Energy Precision Application (LEPA).*

Water depletion

It has been estimated that cotton cultivation accounts for 3% of the world's irrigation water (Hoekstra and Chapagain, 2007), which is proportional to the 2.2% of global arable land planted to cotton. While water withdrawal for irrigation can be sustainable if the amount of water withdrawn is replenished by equal amounts in a timely manner, over-withdrawal can occur when removal for irrigation water exceeds replenishment over a number of years. The impact of irrigation water extraction on river flows, wetlands and aquatic biodiversity is an important consideration for sustainable communities.

The vast majority of irrigated cotton (approximately 85–95%) both on large and small farms is grown using surface irrigation methods – "flood or furrow" (ICAC, 2011). Surface irrigation can be associated with high water losses due to evapotranspiration, deep percolation (infiltration exceeding the irrigation requirement that goes past the root zone) and runoff from the field (Goldharner *et al.*, 1987). Excessive deep percolation results in plant nutrients and other chemicals infiltrating below the root zone. Deep percolation increases the risk of shallow water table development, water logging (Willis *et al.*, 1997) and salinity (Silburn *et al.*, 2013), but can also be a source of recharge for groundwater aquifers (Silburn *et al.*, 2013).

Improved design of irrigation methods (Clemmens and Molden, 2007) and the use of more efficient (but more energy intensive) irrigation systems, such as mobile irrigation and/or drip irrigation, offer important opportunities for reduced water depletion. Several studies on cotton have shown that drip irrigation increases lint yields and WCP compared with sprinkler or surface irrigation (Smith *et al.*, 1991; Bordovsky, 2001; Janat and Somi, 2002; Kamilov *et al.*, 2003), with furrow irrigation in Central Valley, California (Ayars *et al.*, 1999), Turkey (Cetin and Bilgel, 2002; Singh *et al.*, 2010), India (Rajak *et al.*, 2006) and Uzbekistan

(Ibragimov *et al.*, 2007), and with spray or Low Energy Precision Application (LEPA) in Arizona (Colaizzi *et al.*, 2005a and b). In Australia, farmers who used subsurface drip irrigation or centre pivots and lateral move irrigation systems reported a significant decrease in water use compared with surface irrigation. However, yield increases and decreases have both been reported (Roth *et al.*, 2013). It is important to note that the most significant improvement with drip irrigation was achieved on lighter textured soils, whereas much of the irrigated cotton crop in Australia is grown on heavy (clay) textured soils.

The use of drip irrigation can however lead to localized salinity/sodicity issues due to the reduced leaching associated with drip irrigation, and data recently presented at the Beltwide Conference show similar efficiencies for drip, sprinkler and surface irrigation for the High Plains in Texas (Weinheimer and Johnson, 2010). A key efficiency limitation in surface irrigation derives from the use of the soil surface to transport irrigation water across the field, while the other irrigation methods (sprinkler, drip) use impervious pipes or tubing. In both flood and furrow surface irrigation, the water is applied to the highest elevation end of the field and flows downhill as it infiltrates into the soil. Thus, to achieve high efficiency with surface irrigation, care is required with regards to: water flow rate (on and off the field); soil surface elevation gradient and infiltration rate level and uniformity; and field layout of irrigation run lengths and tail water return systems. When these conditions are optimized, as is frequently the case in Australia and the San Joaquin Valley, surface irrigation can be nearly as uniform as well-managed mobile and drip irrigation systems.

WCP is affected by many factors. Irrigation methods and scheduling, fertilizer management, planting practices, mulching, tillage conditions and plant genetic improvement can all be improved though research and farmer education. Tillage practices can improve soil moisture storage conditions, which vary depending on the location and period. For instance, no-till in Texas improved water storage and dryland cotton yield (Baumhardt *et al.*, 1993), but more recent studies

showed no improvement in WCP using conservation tillage in dryland cotton in Texas (Baumhardt and Lascano, 1999) and in irrigated cotton in Australia (Hulme *et al.*, 1996). Current research in Australia indicates that minimum tillage associated with crop rotation is improving WCP through higher water-holding capacity in the soil. Mulching, also with furrow irrigation, can lead to significant water savings of up to 0.5 m^3 for each kg of cotton produced (Qadir *et al.*, 2009; Bezborodov *et al.*, 2010).

Water pollution

Agricultural pollutants (pesticides, fertilizers and their metabolites) can affect freshwater quality (rivers, lakes, wetlands and aquifers) depending on their toxicity and ability to bio-accumulate. For pesticides, the main pathways into rivers and waterbodies are spray drift during application and water/sediment runoff from cotton fields. The likelihood of spray drift occurring and reaching water is influenced by weather conditions at the time of application, the method of application, crop stage and the distance between the crop and the water body.

Pesticides can be transported when dissolved in the water or attached to the soil particles carried by the runoff water. Minimizing runoff and erosion will therefore reduce the risk of pesticides contaminating water bodies. Crop nutrients and soil sediments are other potential sources of water pollution that can arise from cotton farming, and whose off-site impact will also be minimized through good management of water runoff and erosion. SEEP's report (2010) highlights the hazard to fish and aquatic species of some pesticides used on cotton.

Water eutrophication

Eutrophication of water supplies occurs when soil nutrients such as nitrogen and phosphorus move from the field and reach waterways. These nutrients typically promote excessive growth of primary production, for example, algae. As the increased biomass decomposes, high levels of organic matter and decomposing organisms deplete the water of available oxygen (hypoxia or anoxia), causing the death of other organisms, such as fish. Higher water turbidity also means light availability can become too low to sustain macroalgae and/or submerged plants. The application of synthetic and organic fertilizers to the soil surface, particularly in combination with significant application of water, can lead to a more concentrated and damaging form of eutrophication. Eutrophication typically results in algae blooms that reduce the ability of other life forms to subsist/survive, thereby threatening biodiversity. More generally, an increase in nutrients (both nitrogen and phosphorus) has the potential to threaten ecosystem stability, as well as both animal and human health.

Soil salinization

Salinization of soil results from the evaporation of water from the soil surface and leads to higher concentrations of mineral deposits in the root zone. In irri-

gated cotton, soil salinization occurs as a consequence of limited drainage combined with the application of saline or sodic water. Salinization is an acute problem in semi-arid areas. Irrigation often exacerbates the effects of salinization, especially surface irrigation (flood or furrow). Surface irrigation can be associated with higher rates of soil surface evaporation and thus accumulation of salt minerals in the soil surface (Sharma and Minhas, 2005; Qadir *et al.*, 2009). One estimate indicates that in six leading cotton-producing countries, 12–36% of the irrigated area was damaged through salinization (Dinar, 1998).

The volume of irrigation water is also a key factor in controlling salt accumulation: while excess irrigation water can lead to deep percolation and reduced water use efficiency, insufficient irrigation water does not provide for enough leaching of salts out of the root zone (Silburn *et al.*, 2013). Drip irrigation can also lead to salt accumulation (Liu *et al.*, 2012). The factors that can aggravate salinity problems associated with irrigation include: poor on-farm water use efficiency; poor construction, operation and maintenance of irrigation canals causing excessive seepage losses; and inadequate or lack of drainage infrastructure or, if drainage facilities are present, their poor quality of construction, operation and maintenance.

In certain contexts, a shallow groundwater table exacerbates salinization: when the groundwater is within 3 m of the surface (depending on the soil type), if ET demand is high, the groundwater rises to the surface by capillary action (rather than percolating down through the entire soil profile) and then evaporates from the soil surface. High rates of deep percolation can result in shallow water tables and increase salinization problems. As studied by Willis *et al.* (1997) in Australia, shallow water tables developed with high rates of deep percolation in cotton production under furrow irrigation. Surface irrigation can lead to shallow water tables and soil salinization especially in poorly drained soil, causing problems in extensive areas such as in the Aral Sea Basin (Qadir *et al.*, 2009).

Water Management

Water management indicators to assess and monitor impact fall into three broad categories: the quantity of water extracted for irrigation (and its relationship with the available resource) (indicator 2.1); the efficiency with which the extracted water is used in growing cotton (indicators 2.2 to 2.4); and the quality of the water – both as it goes onto the crop and as it (potentially) leaves the farm, either as surface runoff or deep drainage (percolation) (indicators 2.6 and 2.7). Aspects to consider when determining the quantity of water extracted include: the point at which the volume is measured; the reliability of the method used to measure the volume of water flowing past the measurement point; and compliance with regulations governing water extraction.

Measuring water use efficiency presents a number of challenges due to the range of definitions and potentially different ways that water management can be assessed, and the difficulties associated with obtaining accurate data on a large scale (e.g. ETa, water use at field level). As well as the difficulties associated with calculating some of the figures required (e.g. crop evapotranspiration), assessment can include or exclude rainfall or focus on the efficiency of the irrigation system itself (i.e. how much of the water extracted was delivered to the crop) as well as the crop's use efficiency. Indices (e.g. water use per unit production) and % efficiency measures (e.g. of water consumed by crop / water provided to the crop) are the two main approaches available.

Soil salinization indicators are likely to only be relevant to production systems that are heavily dependent on irrigation. The most direct indicator identified for measuring soil salinization is a straight electrical conductivity (EC) test. This indicator has the specific virtue of being discrete, highly quantifiable and comparable, but also presents the challenge of requiring special equipment and/or lab tests. It also runs the risk of attributing locally occurring EC characteristics to cotton production. Indicators on water use/application are a better proxy for measuring soil salinization impacts if the direct contribution of cotton production to soil salinization is to be captured. The general indicator of "number of hectares under irrigation" is promising due to the potential to use non-field sources to collect data.

Testing of water quality as it both enters the farm and leaves the farm requires good logistical support and solid sampling protocols. Given the influence of the entire catchment (watershed) on water quality, any sampling regime (e.g. location of sampling points) needs to take into account the range of influences and their location within the catchment. While some sampling can be conducted at farm level (e.g. testing of underground water quality), the catchment-wide nature of other water quality issues (especially discharge) means that some aspects of water quality may best be conducted at regional level.

While the testing of water quality is relatively straightforward, collection of the water samples may present logistical challenges, especially in the case of discharged water: significant water contamination is often associated with large storm events, during which sampling may be difficult. Lastly, cotton farms represent just one potential source of contamination and it may be difficult to discern the contribution of cotton farms (if any) to the overall level of contamination.

Environmental

Water Management

- Water depletion
- Crop water management
- Soil salinization
- Water quality

These indicators have been selected as a result of a scoring procedure described in Chapter 4.

2 Water Management

2.1 Quantity of water used for irrigation (m^3/ha)
2.2 Irrigation use efficiency (%)
2.3 Water Crop Productivity (m^3 of water per tonne of cotton lint)
2.4 % of area under water conservation practices
2.5 Groundwater table level (m from the surface)
2.6 Salinity of soil and irrigation water (deciSiemens [dS] per metre, EC)
2.7 Quality of discharge water (various)

3.5 **Soil Management**

Water, mineral nutrients and oxygen are provided to crops from the soil media. In most cotton-growing regions this essential life-supporting zone is no more than one metre thick. Protection of this global resource is an absolute priority in terms of the sustainability of agriculture as the impacts of climate change unfold with increasing rainfall intensity, mounting drought severity and oxidation of soil organic matter.

Extensive monoculture production of cotton increases soil vulnerability to erosion, soil structure decline, soil fertility loss and to a build-up of soil-borne pathogens and nematodes. Soil fertility is often supported by adopting crop rotation and using chemical fertilizer and organic fertilizer to rebuild soil structure. Cotton is grown as a monoculture in rotation with other crops, as well as in various intercropping combinations. In poorer regions, such as Africa, crop rotation and organic fertilizer are the predominant sources for maintaining soil fertility. In more prosperous regions, the use of chemical and organic fertilizers as well as crop rotation can enable more continual cotton production. The use of precision-farming techniques (where soil fertility levels are monitored directly) can also play an important role in more developed countries. The main issues related to soil management and sustainability in the cotton sector are: soil fertility depletion, soil contamination and soil erosion.

Soil fertility depletion

Although soil health is often seen as a means to an end (e.g. greater productivity), it is also an end in itself in the sense that soils represent critical elements of the broader ecosystem and biodiversity. Continuous input of chemicals into the soil ecosystem may affect soil micro-organisms and their activity. This can lead to stimulation, decrease or modification of soil biological processes that are essential for soil fertility and crop productivity (Zhang *et al.*, 2007; Vitousek *et al.*, 1997; Altieri, 1994; Edwards, 1989). In some of the top cotton-producing countries, cotton is grown in very large holdings with intensive use of inorganic agricultural inputs. These farming system practices might lead to the depletion of soil nutrients and deterioration of soil structure if proactive measures for rebuilding soil health are not implemented. Systematic nutrient exportation without adequate nutrient input, burning of crop residues and decreases in fallow periods have led to the depletion of soil organic matter and degradation of soil fertility in some countries (Brévault *et al.*, 2007, citing Boli *et al.*, 1991). Recognizing this, many cotton farmers use conservation tillage and crop rotation to ensure longer-term soil health.

Fertilizers, both synthetic and natural, remain an important input for maintaining yield levels in cotton **(Table 6)**, but they sometimes have their own specific ecosystem impacts such as water eutrophication. The management of soil fertility through the application of fertilizers and tilling practices can also have important implications for greenhouse gas (GHG) emissions at farm level. Nitrous oxide emissions are exacerbated by excessive N fertilizer use. Loss of 50–100 kg N/ha can occur during the growth of a cotton crop through denitrification and leaching (Rochester, 2012, citing Rochester, 2003), leading to inefficient use of N fertilizers.

Table 6
Average fertilizer use and application area on cotton by country

Country	Dose (kg/ha)			Application (% Area)				
	N	P	K	No Fert.	Organic	Gen	Ind	Fol
AUSTRALIA								
National	200	4	5		1		100	20
BENIN								
National	50		150			75	25	
BRAZIL								
Brazilian Savannahs	180	120	220				100	70
Northeast	30	60	40	80	5	5	10	
BURKINA FASO								
Sofitex	42–45	45–54	45–54		20	100		
CAMEROON								
National	46	14	24	1	3	96		
CHAD								
National	19	12	19	42	2	56		
CHINA (MAINLAND)								
Yellow River Region	225–300	50–150	100		90	50	50	5
COLOMBIA								
Coast	100–120	40–50	60–80			100		90
Interior	110	30	90		20	75	5	100
EGYPT								
National	140–150	350	120		1–2	90	10	10
KAZAKHSTAN								
National	120	80		3	12		85	
KYRGYZSTAN								
National	250	150	100		50	100		100
MALI								
National	44	33	18		50	100		
PAKISTAN								
Punjab	150	50	50	2	1–2	30	20	10
Sindh	150	50	50		5	73	20	2
TURKEY								
Aegean	12–150	70–80			10	5	5	80
Mediterranean	250	120	80			100		50
Southeast Anatolia	160	80			1	99		
UNITED STATES								
Farwest	167	22	22				100	
Midsouth	115	22	22				100	
Southeast	92	22	22				100	
Southwest	68	22	22	10			90	
ZAMBIA								
Region	40	16	25	91	< 1	4	< 1	4
ZIMBABWE								
National	50	30	20	1	1	98	1	

Legend

N, P, K = *Nitrogen, Phosphorous, Potassium* **Gen** = *General recommendations* **Ind** = *According to individual needs* **Fol** = *Foliar application of fertilizers*

Soil contamination

Many studies have reported residual concentrations of pesticides, and in particular endosulphan in cotton soils (Savadogo *et al.*, 2006; Tapsoba and Bonzi-Coulibaly, 2006). Pesticides can impact soil biotic and abiotic properties as well as change soil–microbe–plant dynamics with potential impacts on the soil and related crop health.

Soil erosion

Both rainfed and irrigated lands are susceptible to erosion. Both water and wind erosion can be severe if the land is conventionally tilled or the soil surface not protected by organic material. However, the total amount of cotton production vulnerable to erosion, as well as global estimates of the extent of land degradation and abandonment that has resulted historically from cotton production, are unknown.

Soil salinity

The risk related to soil salinity from cotton production was discussed in Section 3.4.

Soil conservation practices

A viable method to address soil productivity is conservation tillage (locally referred to as zero tillage, no till, reduced tillage, minimum tillage, strip tillage etc.). This set of practices leaves most of the soil surface undisturbed and protected with a layer of organic material. Benefits from these practices include: higher infiltration rates, greater water-holding capacity, better soil aeration, reduced runoff, improved rooting, less evaporative loss, carbon sequestration, and more stable long-term yields. For instance, a study by Feng *et al.* (2003) of soil microbial communities under conventional-till and no-till continuous cotton systems showed that no-till treatment increased soil organic carbon and total nitrogen content in the soil surface layer by 13% and 70%, respectively. The positive impact on soil health of other conservation practices, such as cultivation of nitrogen-fixing plants in polycultures, increasing permanent soil cover, green manure and diversified crop rotations, remains under-researched. However, many practices have been developed in the context of organic cotton cultivation.

Odion *et al.* (2013), a case study of organic cotton in Nigeria, suggests that the clipping management of legume green manure crops should be exploited by low-technology farmers as a strategy for improving soil fertility, while providing high protein animal fodder. The practice, if adopted, would not be affected by global economic downturns, as it would allow farmers to be self-sufficient or rely very little on external inputs. Finally, the results of Lee and Jose's study (2003) on soil respiration and microbial biomass in a pecan–cotton alley cropping system in the southern United States suggest that in the medium and long term, trees in agroforestry systems have the potential to enhance soil fertility and sustainability of farmlands by improving soil microbial activity and accreting residual soil carbon.

Soil Management

The most significant impact areas on soil health are salinization, fertility and erosion.

Soil fertility can be measured through soil testing of key nutrients (indicators 3.1 and 3.2). The key challenge with regard to the implementation of this indicator is its relatively high cost as it requires field visits and laboratory testing. New technologies are, however, being developed that could allow soil sampling on site at a low cost, and this may significantly improve the feasibility of this indicator in the future. An accounting of fertilizer types and quantities represents a proxy for understanding soil management practices and quality, but suffers from not being able to capture the actual efficiency of the application (indicator 3.3). Although arguably somewhat less accurate as a measure of specific outcomes, the tracking of specific soil conservation practices presents another promising way of measuring soil fertility rates at a relatively low cost.

Soil erosion is a widely recognized sustainability challenge in agriculture generally. Although cotton production can be susceptible to erosion, actual susceptibility is highly site-specific depending on a combination of factors: soil type, slope, and water application/rainfall intensity and duration. Indicators for measuring soil erosion are generally challenged by the specificity of the conditions that give rise to soil erosion and the corresponding difficulty in actually measuring successful erosion control.

The percentage of areas affected by erosion, if available would allow for tracking change over time (indicator 3.4). Soil salinity can be mapped on a large scale through the use of portable electromagnetic mapping (EM) instruments and four-electrode soil conductivity sensors (FAO, 1999).

Environmental

Soil Management
- Soil fertility
- Soil erosion

These indicators have been selected as a result of a scoring procedure described in Chapter 4.

3 Soil Management

3.1 Soil characteristics: organic matter content, pH, N, P, K

3.2 Use of soil sampling for N, P, K (% of farmers)

3.3 Fertilizer used by type (kg/ha)

3.4 % of area under soil erosion control and minimum/conservation tillage practices

3.6 **Biodiversity and Land Use**

Certain cotton production systems are simplified landscapes characterized by low habitat biodiversity. The Convention on Biological Diversity (UN, 1992, Article 2) defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Following this definition, biodiversity is often evaluated at three levels: genetic diversity, species diversity and ecosystem diversity. The concept of diversity includes not only the frequency in numbers but also the variety in components, structure and functions of all three entities, as well as the interaction between elements.

Biodiversity in and around cultivated fields is responsible for the creation of benefits by contributing directly to the productivity of agricultural production systems through the provision of a range of ecosystem services, in particular natural biological control, soil fertility and pollination. High soil fauna biodiversity is positively linked with soil fertility. The diversity of insects (and other pollinators such as birds and bats) affects pollination levels. Microbial and insect diversity are also necessary for effective pest and disease regulation. Biodiversity contributes to natural pest control and IPM, in terms not only of the number of species but of the functional diversity of soil and insect populations. Biodiversity also appears to enhance the resilience of systems, as required to secure the production of those essential ecosystem services (Elmqvist *et al.*, 2003). Both the diversity of responses to environmental change among species contributing to the same ecosystem function (response diversity) and the functional diversity of whole groups of species and trophic levels increase the capacity of agro-ecological systems to absorb changes, thus increasing their resilience (Folke *et al.*, 2004).

The main concerns with cotton production and biodiversity are centred on the loss, degradation or fragmentation of ecosystems as a result of the establishment of large monocultures and the suppression of ecosystem services caused by the excessive use of broad spectrum pesticides.

Land conversion, loss of biodiversity and field landscaping

Maintaining biodiversity in cotton fields and on the boundaries of farms requires an integrated and differentiated approach to farm management and is associated with numerous benefits for productivity and resilience. This led the Australian Cotton Catchment Communities Cooperative Research Centre to publish a information sheet dedicated to this issue.

In the context of Australia, Williams *et al.* (2011) lists 27 beneficial insects which act as a natural pest control system for a healthy cotton plant. High biodiversity can be fostered by conserving native vegetation in buffer zones and in proximity to the farm, and by connecting remnant vegetation to provide natural corridors for animals and insects. Buffer zones and natural vegetation allow beneficial insects to persist during stress periods, crop fallow or drought. High diversity of vegetation in those zones also provides an adequate habitat for a greater variety

Biodiversity and Land Use

The most promising indicator available for land conversion is the proxy of production efficiency per hectare, with greater productive efficiency placing reduced pressure on land conversion (indicator 4.1). Global Positioning System (GPS) mapping may provide a useful approach to low cost measurement of land conversion trends (indicator 4.2). Efficiency of inputs (water, fertilizers and pesticides) can be used as proxies for biodiversity impacts resulting from water depletion, eutrophication and pesticides, respectively.

Direct measures of actual biodiversity offer the most direct way of monitoring the desired outcome, but suffer from the fact that biodiversity is largely determined by landscape rather than on-farm activities alone. This suggests that farm-level biodiversity impacts are more accurately measured by tracking specific farm practices. In addition to tracking input use efficiency, tracking of the use of land set aside for conservation can provide an indication of trends towards biodiversity conservation in the sector (indicator 4.3).

Environmental

Biodiversity and Land Use
- Land conservation
- Land productivity

These indicators have been selected as a result of a scoring procedure described in Chapter 4.

4 Biodiversity and Land Use

4.1 Average yield (tonnnes of cotton lint/ha)
4.2 Total area (ha) and % of natural vegetation converted for cotton production (ha)
4.3 % of total farm area that is non-cropped
4.4 Average number of cotton and other crops per 5-year period

of beneficial organisms, especially if containing at the same time trees, shrubs, grasses and smaller herbs. Native riparian vegetation along rivers, creeks and water storages are of special value due to the especially high numbers of beneficial organisms they host. Thus farmers should try to include such zones as an active element in farm management planning, for instance by restoring patches of native vegetation and degraded land.

Effects of agrochemicals on ecosystem services

Ecosystem functions are governed by predators, parasites and pollinators. The widespread use of broad spectrum pesticides is particularly deleterious to non-target species. The ecosystem service of natural pest control, which is highly dependent on biodiversity, is thus negatively impacted by non-targeted frequent application of high doses of wide spectrum pesticides. A well-documented IPM case study is described by Naranjo and Ellsworth (2009). It is a long-term follow-up of IPM practices in the Arizona cotton system. The study shows that ensuring the survival of a rich fauna of beneficial arthropods gives a resilient food web with three to five insect predator species controlling the cotton pest whitefly (*Bemisia tabaci*). The authors also report on experiments where the natural enemies have been selectively reduced in the field, resulting in substantially lower cotton yields.

In the long term, cotton production systems are also dependent on existing cultivar intraspecies diversity for ongoing and future breeding efforts. The maintenance of gene banks and breeding programmes is essential for the enduring availability of high-yielding and resistant cultivars and can be identified as a global public good. To this end actions to protect cotton's wild relatives also need to be intensified.

3.7 **Climate Change**

Climate change will have both positive and negative effects on cotton. Higher levels of CO_2 may increase yield in well-watered crops, and rising temperatures will extend the length of growing season (especially in current short season areas). However, higher temperatures may result in significant fruit loss, lower yields and increased water requirements (Bange *et al.*, 2009). Any declining availability of water resources as a result of climate change will increase competition for these resources between irrigated cotton production, other crops and environmental uses. Region-specific effects will need to be assessed thoroughly, especially those related to rainfall.

Adaptation – coping with climate change

Forecasting climate change and its impacts, and thus the adaptation needs of farmers, is site-specific and associated with high levels of uncertainty. The limited studies available on climate change adaptation for cotton production systems indicate that in comparatively cooler cotton-growing areas, an increase in average daily temperatures will enhance crop growth (node development, rate of fruit production, photosynthesis and respiration), while the rising number of warm days per growing season will decrease crop losses due to frosts and also improve crop maturity. In warmer agro-ecological conditions – for example, as found in African production systems – temperature increase is not expected to have positive impacts on yield. Elevated atmospheric CO_2 concentration, on the other hand, is likely to be appreciated by cotton as a C3 plant through increased photosynthesis and water use efficiency, provided there is sufficient availability of other crop needs (Oosterhuis, 2013; Reddy *et al.*, 2007).

The main negative effects forecast are: increased frequency of severe high temperatures, changes in the amount and pattern of precipitation, frequency of droughts and floods, and changed conditions for pests. Increased heat stress causes reduced photosynthesis (Bibi *et al.*, 2008), smaller boll size and slower maturation (Reddy *et al.*, 1997), increased shedding of flower buds and reduced boll retention. Shifting and erratic rainfall patterns increase the risk of low germination rates and associated crop failure in rainfed cotton production systems, and reduce the reliability of water in-flows to irrigation water storages. Reduced total precipitation diminishes yields, especially when below 700 mm of annual precipitation or a total of 105 days of sufficient soil moisture in tropical conditions (Ton, 2012). Gwimbi and Mundoga (2010) and Hulme (1996) argue that water needs will further increase to compensate for the loss of soil moisture from elevated evaporation rates. Higher temperatures may extend the favourable range for pests and increase their population growth rates (ITC, 2011).

Mitigation – reducing GHG emissions

The main sources of GHG emissions and carbon sequestration offsets relevant to cotton production at farm level are:

- direct emissions of N_2O from soils due to denitrification of N-fertilizer and organic nitrogen sources;
- direct emissions of CO_2 from the combustion of fossil fuels for agricultural machinery (including irrigation facilities);
- indirect emissions of CO_2 created by production, packaging, storage and transport of fertilizers, herbicides, fossil fuels and other inputs;
- direct emissions from residue burning; and
- sequestration and preservation of carbon in soil through the incorporation of organic manure, compost and crop residues and the application of beneficial soil management practices (reduced tillage, crop rotation etc.).

GHG emissions per unit of cotton lint vary greatly with both location (e.g. climate, rainfall patterns, soil type) and production system (e.g. level of mechanization, use of irrigation water, fertilizer choice and management) (IPCC, 2007; Grace *et al.*, 2010). The approach used to estimate the "climate change impact" of a commodity – i.e. the emission of GHG associated with its production – is the Life Cycle Assessment (LCA). LCA is increasingly used to assess the impacts of agricultural systems on energy use, GHG emissions, water use, water consumption, water quality and air quality. Cotton LCAs have been conducted for various countries and production systems (Cotton Incorporated, 2012; Nill and Wick, 2013). Rigorous standards and methods for LCA development exist (ISO, 2010) and allow for product comparisons. To ensure that results from different LCA studies can be compared, it is critical that the data and detailed methodology underpinning the LCA calculations be included in the study report.

Climate Change

Direct measurement of GHG emissions would be the most relevant measure for this specific sustainability theme (indicator 5.1). While field measurements are too costly and difficult to apply, the total amount of GHG emissions and carbon sequestration can be estimated by biogeochemical process models as well as simplified and comprehensive GHG accounting tools.[2]

Nitrogenous fertilizer use (indicator 3.3) and energy use (indicator 5.2) are considered good proxies for GHG emissions.

[2] Examples for biogeochemical process models are Daycent/Century (www.nrel.colostate.edu/projects/daycent) and RothC (www.rothamsted.ac.uk/ssgs/RothC/RothC.html), while two comprehensive GHG accounting tools are the Cool Farm Tool (www.coolfarmtool.org.) and the Ex-Ante Carbon Balance Tool (www.fao.org/tc/exact). An example of a simplified and easy-to-use accounting tool is the ISR Cotton Greenhouse Gas Calculator (www.isr.qut.edu.au/tools/).

Environmental

Climate Change

- Greenhouse gas (GHG) emissions
- Decomposition and mineralization
- Energy use
- Carbon stock changes

These indicators have been selected as a result of a scoring procedure described in Chapter 4.

5 Climate Change

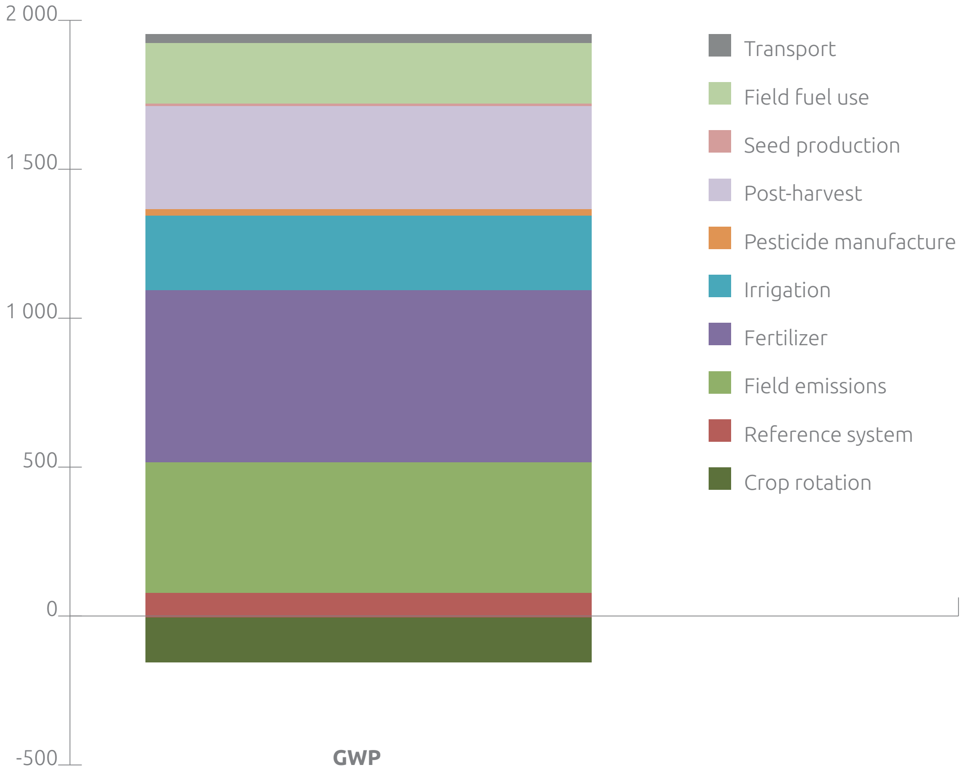
5.1 GHG emissions and carbon sequestration per tonne of cotton lint and/or ha (in CO_2-e)

5.2 On-farm energy use per tonne of cotton lint and/or ha (GJ)

Carbon Trust (2011) estimated that global cotton production up to ginning generates global emissions of 220 Mt CO_2e, accounting for 3.6–4.3% of GHG emissions from agriculture or 0.4% of overall global emissions.[3] Comparing various regions, Carbon Trust (2011) stated that between 4 and 12 tonnes of CO_2e were emitted per tonne of cotton lint. Cotton Incorporated (2012) indicated that aggregated cotton production in the United States, China and India averaged emissions of 1.8 tonnes CO_2e per tonne of cotton lint, while WWF (2013) reported that a project intervention in India had emission levels of 1.5 tonnes CO_2e (conventional production) and 0.43 tonnes CO_2e (improved management) per tonne of seed cotton (approximately 4.5 and 1.3 tonnes CO_2e, respectively, per tonne of lint).

Generally, such emission estimations take into account the direct and indirect emissions associated with agricultural production practices, as well as any soil carbon sequestration; on the other hand, the quantity of carbon fixed in cotton fibre is not regarded as withdrawn long term from the atmosphere, i.e. it is not "deducted" from the total emissions. Another source of GHG emissions is change in land use, especially if it involves deforestation or drainage of peat lands. While these elements are the primary causes of GHG emissions from cotton production systems, many contributing factors exist. **Figure 6** gives an indicative distribution of the different elements using the study on cotton cultivation in the United States, India and China by Cotton Incorporated (2012, p. 61).

Figure 6
Relative contributions to the global warming potential of 1 tonne of cotton fibre



[3] Using the estimates of 49.0 $GtCO_2e$ for 2004 concerning global GHG emissions (IPCC, 2007, p. 27) and 5.1–6.1 $GtCO_2e$ for 2005 concerning emissions for the agricultural sector (IPCC, 2007, p. 63).

It is important to note that the relative proportion of these elements can vary greatly depending on the location or management practice. The subsection on soil management gives a rough overview of the different uses of fertilizer in cotton production systems and how they affect GHG emissions.

3.8 Economic Viability, Poverty Reduction and Food Security

The economic sustainability of cotton production systems is a central concern of this analysis, as it determines the living standards of cotton farmers, regardless of the type of farming system and whether or not it is in a developing or industrialized country. While the importance of economic sustainability is a given in both contexts, the key variables that most adequately indicate economic sustainability vary depending on the production contexts. This section focuses on the more specific issues of poverty and food security for cotton-producing households. The special focus on poverty and food security is motivated by their central role in the sustainability of households' livelihoods.

The driving economic factor determining trends in cotton area and production is the price of competing crops. Since 1990/91, cotton prices have fallen relative to the prices of grains and oilseeds. Ratios of the price of cotton divided by prices of wheat, maize and soybean, indexed to January 1990 equals 100, indicate that cotton prices in 2013 are only one-half to one-third of their level relative to competing crops when compared with 1990. For cotton farmers in industrialized countries, early adoption of technologies, good cost control through progressive management, extensive use of hedging tools in marketing lint and seed, an emphasis on quality, equipment maintenance, and attention to water use efficiency, can help maintain the competitiveness of cotton. For farmers in both industrialized and developing countries, increases in average yields linked to improved varieties play a critical role in maintaining the terms of trade for cotton relative to competing crops. However, during the period 2007–2012, the average costs per hectare increased more than the rise in yields, resulting in an overall decline in the terms of trade of cotton.

Poverty reduction

It has been argued that, because cotton is essentially a smallholder crop in Africa, increased production will have a significant impact on poverty. West African governments also suggest that cotton production is really the only strategy they have for moving up the economic ladder. Minot and Daniels (2005), on the other hand, demonstrate that whether cotton alleviates poverty is highly dependent on world prices. When world cotton prices declined by 40% during 2001/02, rural poverty in cotton-growing regions of Benin increased by 8%. This illustrates how issues of poverty and cotton in Africa are linked to international pricing policies. However, Siaens and Wodon (2008) contend that farmers were buffered from world price decreases because of currency devaluation, cotton reforms that resulted in higher farm prices, and overall production increases. Moreover, many farmers only receive a part of their income from cotton production,[4] typically deriving only half their total income from cotton. This explains why changes in farm prices often have a lower than expected impact on cotton farmer poverty

[4] The question of whether cotton production provides a decent remuneration for the extent of labour and other production factors invested, and how this can be measured by an indicator, is part of the debate on decent rural employment in the section on labour rights and standards.

(Tsimpo *et al.*, 2007). Others have documented an increasing debt problem for many smallholder cotton farmers. Gray (2008) discusses how over 50% of farmers in her sample were indebted. Lacy (2008) notes that there is an increasing divide in many villages in southern Mali between poor indebted farmers and wealthier farmers. This has led to the break-up of village-level cooperative structures in many instances. Given normal rainfall variation in most cotton-growing areas, and the relatively high levels of inputs (and associated credit) required to grow cotton, it may be that cotton generates wealth only for those able to operate on a certain scale (Moseley and Gray, 2008; Tsimpo *et al.*, 2007).

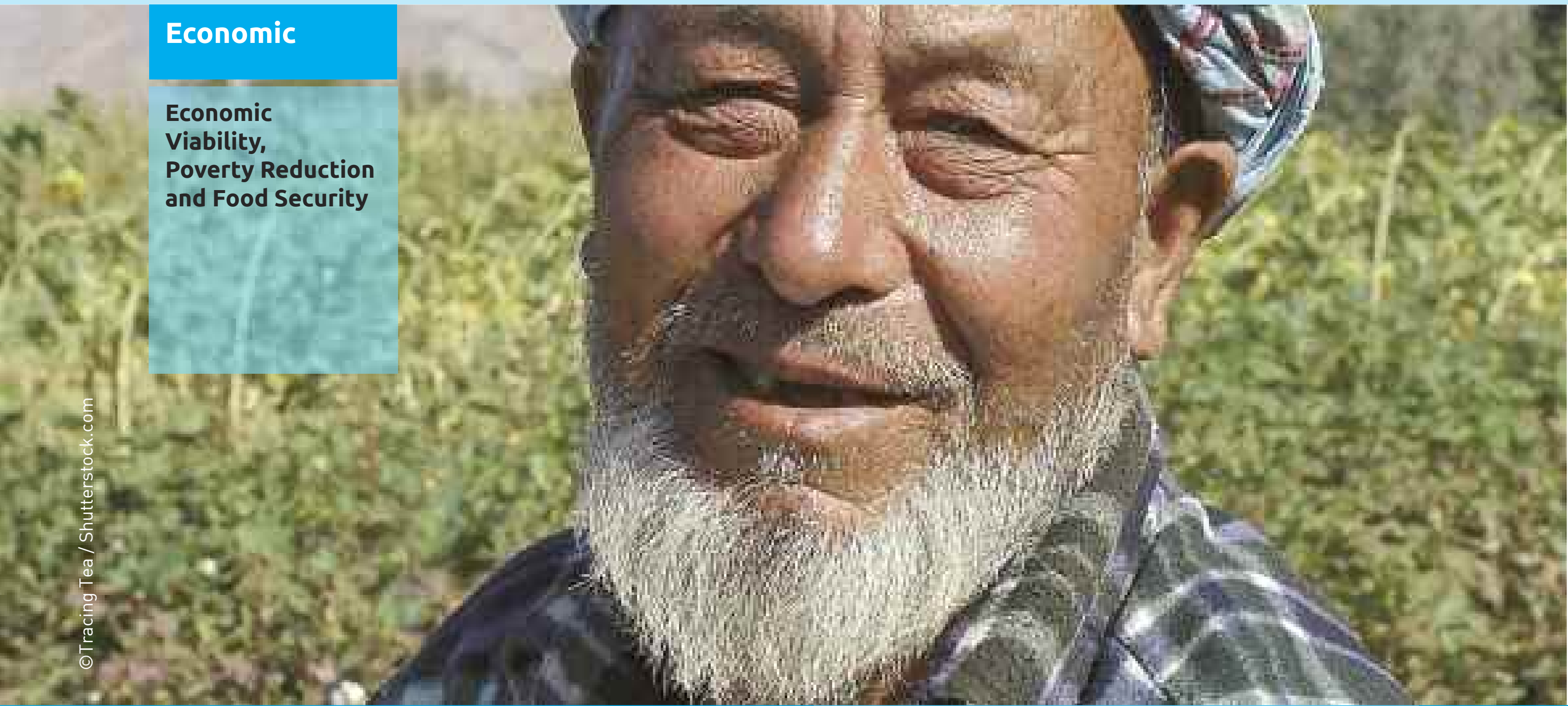
The complexity of poverty dynamics, transitory poverty and poverty traps requires further data and empiric analysis to reveal adequately the impact of producing cotton on poverty levels for smallholder farmers in developing countries. For instance, a key question is: Why, if farmers have such difficulty with cotton production, do they continue to grow it? Koenig (2008) describes how cotton systems provide a whole set of infrastructures that complement farmers' other activities. Through cotton, farmers have gained access to agricultural credit, equipment and fertilizer, as well as broader infrastructural improvements such as roads, telephones, schools and health centres. Similarly, Tsimpo and Wodon (2007) suggest that monetary income, access to credit and inputs, as well as training and education, may explain continued cotton cultivation by smallholders despite falling prices.

Critical factors to increase the contribution of cotton towards poverty reduction include fair prices, mechanisms for benefit-sharing along the value chain, and effective support services and marketing systems (Kaminski *et al.*, 2011). As with other cash crops, the full dependency on cotton for cash revenue inevitably leaves the livelihoods of poorer cotton farmers vulnerable to climatic, market and supply chain conditions. Although it may be difficult for farmers to influence

Economic Viability, Poverty Reduction and Food Security

Net income is often used as the primary indicator of impact on poverty (indicator 6.1). Although this is arguably the most accurate indicator for tracking impacts on poverty, the cost of collecting accurate, reliable data might be rather high. Proxy indicators may be more feasible, for example: price paid per kg of cotton (indicator 6.2), yield per ha (indicator), measurement of one or more fixed assets (indicators 6.8 and 6.9). Qualitative indicators, such as "perception of change in economic condition", can also provide a useful indicator of how farmers are feeling without needing significant data collection and calculation (indicator 6.10). Several generic indicator initiatives contain a variety of other poverty-related indicators, such as "access to health care" or "access to potable water", but given the importance of external factors, such as local government investment, they are unlikely to be the most direct indicator of cotton production's contribution to poverty reduction.

Food security indicators are aimed at quantifying consumption of food, rather than availability of or access to food crops (indicators 6.11 and 6.12).



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These indicators have been selected as a result of a scoring procedure described in Chapter 4.

6 Economic Viability, Poverty Reduction and Food Security

- **6.1** Average annual net income from cotton production
- **6.2** Price received per tonne of cotton lint at farmgate
- **6.3** Returns above variable costs per hectare and tonne of cotton lint
- **6.4** Return on investment
- **6.5** Debt to asset ratio
- **6.6** Number and % of household members living below the national poverty line
- **6.7** % of farmers/workers with access to productive resources
- **6.8** Average value of assets per producer household
- **6.9** % of producing households with a specific asset
- **6.10** Perception of change in economic situation over the last five years (% of farmers)
- **6.11** Total number and % of cotton farming household members with calorie intake below the international norm
- **6.12** Number of days per year with food deficiency in cotton-producing households

these conditions, overall capacity for the adoption of sound production and management practices can enable farmers to reduce the level of risk they face under such situations. For instance, in order to reduce dependency on cotton and negative impacts of commodity price fluctuations on cotton farmers, several researchers (Hussein, 2008; Tsimpo and Wodon, 2007) underline the critical role of livelihood and crop diversification among cotton farmers. The positive impact of adoption of farmer field school-based IPM cotton farming practices on rural poverty in Pakistan (Khan and Ahmad, 2005) suggests that cotton cultivation may or may not lead to poverty reduction depending on farming practices adopted and other conditions.

Food security

Food security is of particular relevance in countries with widespread subsistence farming. The colonial background of cotton production in some countries in Africa and South America has led cotton cropping to often be perceived as competing with food cropping at the expense of food security. Few published works exist to clarify the relationship between cotton cropping and food security following the independence of these countries. However, these claims are consistent with a set of analyses of food security projects conducted by Michigan State University in several African countries (e.g. Mali, Zambia, Mozambique – Kelly *et al.*, 2011; Moseley and Gray, 2008; Kabwe and Tschirley, 2007).[5]

Studies have pointed out the importance of the “food security first” issue encountered by subsistence farmers when adopting new (cash) crops. This concept is used to explain farmers' resistance to growing cotton in the absence of the social innovations necessary to face labour constraints in growing both for food and for cash. Raymond and Fok (1994) argue that mixed cotton and food cropping in African countries can be achieved by improving cotton productivity while preventing over-selling of cereals to meet necessary monetary needs. Techniques like mechanical sowing or fertilizing, initially introduced for cotton, have been adopted by farmers in food production, contributing to an increase in the farmers’ food crop acreage and increased food productivity. Such techniques allow cotton farm holdings to achieve levels of food production comparable to holdings producing exclusively food crops. Meanwhile, non-cotton farm holdings usually sell their food crops to meet their monetary needs. Often selling at harvest time – i.e. when prices are lower – they may be forced to sell too large a proportion of produce for them to remain self-sufficient. This endangers farmers’ food security and economic situation, as they are obliged to buy the products back later in the year at a much higher price.

Growing both food and cash crops can thus lead to a virtuous cycle of enhanced food security. There is strong evidence that when the cotton sector is thriving, it does indeed generate wealth and food for those able to participate in cotton farming. However, when the payment of marketed cotton is delayed or cotton production becomes less profitable, this economic mechanism is less virtuous. This is also the case when monetary needs increase, either because of inflation or due to reduced access to free public services in the context of economic liberalization. In these conditions, growing more cotton to meet increasing monetary needs can impact negatively on food production. As a consequence, the

[5] For a complete overview of the research of Michigan State University on cotton and food security, please refer to http://fsg.afre.msu.edu/cotton/index.htm.

relationship between cotton production and food security in countries widely practising subsistence agriculture is mainly linked to the economic viability of cotton production, the level of crop and livelihood diversification, and national policies for access to basic services such as health and education.

3.9 Economic Risk Management

For the purpose of the Cotton Report, risk is defined as the exposure to potential damage that may arise as a consequence of a present process or a future event. The cotton sector, like many other agricultural industries, faces a spectrum of risks whose importance varies widely from country to country, depending on both the natural (e.g. climate) and organizational (e.g. structure of the cotton trade) characteristics of the country in question. The key risks present in the cotton industry include the following (World Bank, 2010):

- **Climate risk:** the risk that cotton production and/or quality will be adversely affected by climatic events, for example a late start to the rainy season reducing yields, lack of rainfall at important times of the season affecting yield and/or quality, or excess rainfall that could damage or destroy crops. In the absence of irrigation, farmers can manage climatic risks by reducing input levels and/or by delaying the application of inputs (notably fertilizers). Such risk-averse behaviour however implies accepting lower expected yields, which in turn may reduce profitability.

- **Phytosanitary risk:** the risk that cotton production volume and/or quality will be affected by pests or diseases. In some developing countries, poor provision of production inputs at high cost and of uncertain quality, and poor farmer knowledge about IPM and alternatives to synthetic pesticides, enhance phytosanitary and quality risks.

- **Quality risk:** the risk that the quality of the cotton produced during a season may be lower than usual, resulting in difficulties when selling the cotton or meeting contractual obligations, or resulting in lower prices for the cotton.

- **Counterparty risk:** the risk that a key counterparty will fail to honour a contract. For example, a farmer might have a contract with a ginner to deliver cotton at a specified point in the future. The farmer faces the risk that the buyer will fail to honour that contract. Conversely, the ginner faces the risk that the farmer will fail to deliver the cotton.

- **Foreign exchange rate risk:** the risk that the local currency will move sharply against the US Dollar, the currency in which cotton contracts are predominantly priced. Depending on the mechanism of transmission of prices between traders and farmers, a sharp change in the local exchange rate can have a significant impact on the price received by farmers.

- **Physical risk:** the risk that the cotton product may be damaged or stolen at any stage of the delivery, resulting in a reduction in value.

- **Regulatory risk:** the risk of a change in the rules and regulations of a country's cotton sector that raises costs or otherwise damages operations, incentives or profitability.

- **Price risk:** the risk that earnings from cotton production or other cotton-related activity decline as a result of a change in the price of cotton, or as a result of volatility in the cotton market price. Price risk is caused by market volatility, and cotton farmers are more concerned with price risk when cotton prices fall than when cotton prices rise.

Economic risk is directly associated with price risk, but all other risks add to the overall uncertainty about the economic viability of cotton production. Risk management is the process where a farmer (or a sector as a whole) understands and proactively manages risks before future events occur, i.e. before the event that creates the risk occurs (World Bank, 2010).

A common risk-management technique used by farmers – mostly in developed countries – is hedging, i.e. using cotton futures and options to offset a position held in the cash market to minimize the risk of financial loss from an adverse price change (Chaudhry and Guitchounts, 2003). However, financial requirements to operate with futures and options make these instruments unsuitable for small and medium farmers. Measures to reduce the economic risk by compensating the collapse of income due to unfavorable cropping conditions are much less frequently in place in developing countries. Cotton crop insurance is one such measure, but it is still exclusively applied in developed countries. In some countries, such as the United States, governments promote the adoption of crop insurance by supporting farmers in paying part of the insurance premium. The application of weather index crop insurance is under consideration in some African countries, notably through the assistance of multilateral funding organizations. Access to timely, relevant and accurate statistics on cotton supply and demand, particularly data on physical stocks, is critical to managing economic risks. Transparent and well-publicized government policies facilitate

Economic Risk Management

Though economic risk management is an important sustainability issue for all agricultural farmers, irrespective of their production context, their context strongly influences the availability and efficiency of measures to manage price and production risks. Type and effectiveness of risk management strategies are therefore difficult to capture in purely quantitative indicators.

The core indicator set proposed consists of information on yield volatility (indicators 7.1 and 7.2), the percentage of farmers with measures in place to manage price risks by type (indicator 7.3) and the income percentage coming from the biggest income source (indicator 7.4). One of the more persistent challenges in monitoring the relationship between risk exposure in cotton production and effective risk management is the situation that risk management functions (e.g. future contracts, price guarantees or forms of crop insurance) are mostly constituted by non-farm actors. Their effectiveness depends on a set of variables that is not observable on-farm, including the cross-cutting issues of value chain governance. Due to this characteristic, this farm-level report is not able to fully consider all relevant aspects of risk management institutions. A practical example from the VSIs reviewed is the provision of credit (indicator 7.6), as well as a minimum price according to the Fairtrade standard. Farmers' market education and access to price information (indicator 7.7) can contribute to economic empowerment.

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These indicators have been selected as a result of a scoring procedure described in Chapter 4.

7 Economic Risk Management

7.1 Cotton yield volatility
7.2 Farmgate cotton price volatility
7.3 % of farmers with measures in place to manage price risks by type
7.4 % of total household income that the largest income source represents
7.5 Average number of days after sale that farmers receive payment
7.6 % of farmers with access to equitable credit
7.7 % of farmers showing understanding of the factors involved in price formation or who have daily access to international and domestic prices

better private sector planning. On the other hand, frequent changes in domestic and trade policies force market adjustments that result in added price volatility.[6]

Another common risk-management technique in developed and developing countries is the use of a target price, an indicative price, a minimum price or a guaranteed price, more or less connected to the level of the world price and stable throughout the whole marketing season. Together with mechanisms to help control interannual and intra-annual price volatility – as has been the case in many Francophone African countries – the modalities of input provision on a credit basis, at pre-agreed prices and with repayment at marketing, contribute to alleviating the economic risk for resource-poor farmers.

The organization of the cotton sector varies from country to country and even takes different forms within countries. It directly influences levels of risk and risk management. The World Bank (2009) provides a comprehensive typology of cotton sectors in sub-Saharan Africa, based on the structure of the market for the purchase of seed cotton and on the regulatory framework in which farms and firms operate. The report also analyses the links between sector structure and performance, summarized as follows:

- Competitive, market-based systems deliver relatively high prices to farmers, but are weak on input credit provision, extension and seed quality, because of the high risks for ginners of credit default. As a result they tend to generate low yields with poor lint quality (limiting the price advantage that can be passed to farmers).

- Concentrated and monopoly (national or local) sectors can perform well on prices paid to farmers, but such performance depends on the strategic priorities of dominant companies (which can change over time), on the existence of political interference, and on the voice of cotton farmers in price negotiations.

- Concentrated sectors do well on seed quality management and, to a certain extent, delivery of input credit and extension advice to farmers (although coverage is smaller than with national and local monopolies). However, concentrated sectors may pass little if any of the quality premium on to farmers, and they have a tendency to charge higher than market rates for the inputs they provide.

- National and local monopolies in West and Central Africa have been able to provide input credit and extension to a large number of farmers and achieve a relatively high (but declining) yield as well as high and fairly stable credit repayment rates.

Sectors performing best on returns to farmers are those that have benefited from many years of sustained investment in research and extension, and therefore have been able to raise the productivity of large numbers of farmers. However, research efficacy is not clearly linked to sector type.

[6] Conclusions from a seminar on cotton price volatility jointly organized by the ICAC and the World Bank in 2001, http://www.icac.org/mtgs/Seminar/Cotton-Price-Volatility.

3.10 **Labour Rights and Standards**

This section on labour rights and standards looks at the issues of employment and working conditions, freedom of association, social protection and child labour in cotton production systems.

One of the challenges in this area generally is the lack of cotton-specific data (Ergon, 2008). Nevertheless, there is clear evidence of the need to target labour rights and standards directly as a critical component for achieving inclusive and sustainable development (FAO, WFP, IFAD, 2012; FAO, 2013a). This understanding of the importance of labour rights and standards as a key element of sustainable development is further underlined by the ILO's decent work agenda (ILO, 2011).

Employment and working conditions

The elements of employment and working conditions are: the absence of forced and bonded labour; non-exploitative work, adequate remuneration, the respect of decent hours of work, the possibility for social dialogue between employer and employee, and access to dispute settlement in an independent court with enforcement power. The issue of safe work is covered by the separate subsection on occupational health and safety. A critical distinction is made between wage-employed workers, and self-employed and family workers; the latter often face structurally different challenges concerning their working conditions. Focusing on wage-employed workers first, Ergon (2008) argues that in cotton production systems, employment relations of a longer duration and of a more formal character generally respect more labour rights, such as health care or paid sick leave. In contrast, and often characterized by an absence of central employment and working conditions, are cotton cultivation labour activities that are traditionally remunerated on a per piece basis (e.g. hand-harvesting), involve little supervision (e.g. land clearing) or that are labour-intensive while being part of low productive systems. Measures that increase the vocational qualification levels of rural workers have the potential to tackle the root causes of labour rights deficiencies and, most directly, non-adequate remuneration.

Bonded and forced labour – i.e. especially severe violations of labour rights – is often characterized and driven by: the practice of intermediaries offering to provide contacts to employers in exchange for service fees; strong institutions of social exclusion, for example, on the basis of caste or tribe; asymmetries of information, as in the case of illiteracy and geographical remoteness; (informal) labour migration; strong financial and labour monopolies; and state-organized coercion (Ergon, 2008). Ergon (2008) also points out that credit is one of the most stabilizing factors for bonded employment conditions in cotton, which sometimes extends practices of bonded labour from the worker to his entire family. Where labour relations do not include bondage, but are on a seasonal, casual or per day basis, they include strong income vulnerability, which – while lower – is also a major problem faced by self-employed cotton farmers. Conditions for causal wage labourers are especially unfavorable where labour is abundant, control over land concentrated and other labour opportunities largely absent.

Self-employed and contributing family workers in cotton production systems face structural incentives to overwork. In many cultures, this includes (especially for women) the need to repartition agricultural and domestic work that does not result in a structural overburden. While data on net farm incomes are often only sparsely available in developing countries, it is widely assumed that self-employed cotton farmers in non-industrialized production systems do not always achieve decent levels of remuneration from their farming activity. This is largely due to risks stemming from yield variability and the volatility of farmgate prices, while the impact of the often monopsonistic market position of cotton ginneries is still controversially debated.

Freedom of association

Freedom of association and the right to collective bargaining are two essential rights of both workers and self-employed farmers, since they enable them to play an active role in the process of determining central rules of the production process, such as working conditions, wages and further claims. It involves the right of workers as well as employers to "draw up their constitutions and rules, to elect their representatives in full freedom, to organize their administration and activities and to formulate their programmes" (ILO, 2003). Such association may in effect then be used for the purpose of collective bargaining. The degree of organization of cotton farmers and cotton workers is significantly different between industrialized countries and developing countries. While the former are characterized by a considerable number of unions and high degrees of organization among farmers, most developing countries are at the other extreme. The poor level of organization in developing countries is largely due to the low revenues of cotton farmers and agricultural workers which are insufficient to finance the work of agricultural unions. Another important determinant is dispersion over large areas that adds, in the face of missing transport infrastructure, the constraint of high transaction costs for organization. A third aspect of farm workers' organization is the high frequency of short-term and non-regularized forms of employment that are not easily represented by labour unions.

Social protection

The ILO's Social Security (Minimum Standards) Convention, 1952 (No. 102) covers: medical care; income security in the cases of sickness, unemployment, old age, employment injury, family needs, maternity and invalidity; and survivors' benefits. While the Convention clearly defines universal coverage as the objective for all countries, it allows for flexibility in defining when such targets may be reached. As with union representation of workers, coverage by social protection is often universally assured in industrialized countries, while in many cotton production systems in developing countries none of the above-listed services are linked to labour activities. Limited forms of social protection are often provided under government schemes that address the entire population, but require additional payments. Differences in the level of provision of social protection are strongly linked to differences in per capita income levels. Institutions of social protection are essential to provide safety nets in crisis and shock situations, enhance productivity, maintain a stable workforce and contribute to social cohesion as well as each individual's potential of full personal realization and dignity. For contexts where such social protection is not provided, either as part of employment relations, or by the state, often traditional institutions perform selected functions of social protection. Whether such traditional and local social safety nets are as effective and efficient as formalized forms of social protection and how they can be strengthened is highly context-specific and part of an ongoing debate.

Child labour

Child labour is defined in three main international Conventions:

- United Nations Convention on the Rights of the Child (CRC) (ratified by all but two countries);
- ILO Minimum Age Convention, 1973 (No. 138) (ratified by 165 countries); and
- ILO Worst Forms of Child Labour Convention, 1999 (No. 182) (ratified by 177 countries).

The more general definition of child labour is provided by the CRC: "a child performing any work that is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral or social development" (Article 32). The CRC has no limits on whether the child is formally employed or not or is working as unpaid family labour.

Under the ILO Minimum Age Convention, State Parties must specify a minimum age for admission to employment below which no child may be employed. This age should not be lower than the age of completing compulsory schooling and not less than 15 years (or 14 years initially for a developing country that requested this exception at the time of ratification). Convention No. 138 also allows the exceptional permission of light work from 13 years (or 12, where the general minimum age is 14), as long as the work does not interfere with the child's schooling and is not physically, mentally or socially damaging. Light work can only be applied if national legislation specifies the activities and conditions that can be considered light work. An example would be a specific country allowing two hours of work per day, in a certain time window (not at night) under non-hazardous conditions. The minimum age for hazardous work is 18.

The ILO Worst Forms of Child Labour Convention addresses issues such as debt bondage, forced labour, trafficking and what is commonly referred to as "hazardous child labour", which refers to Article 3(d) and is defined as: "work which, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety or morals of children". Hazardous child labour is particularly relevant in the agricultural context, as agriculture is one of the most hazardous occupations in terms of work-related injury, illness and death. Under this Convention, countries define for themselves what activities, tasks and conditions are considered hazardous and are prohibited for children under 18. These may in fact make specific references to crops or be more general, such as handling or applying agrochemicals or handling plants or soil for a certain period after their application, using dangerous tools, working at night, working for more than a certain number of hours per week, or carrying or lifting loads over certain limits established for age ranges and gender. At the national level, State Parties to the ILO Conventions are bound

to bring their legislation into line with the Conventions and further define what is acceptable or not. According to the international Conventions, child labour in the family context may be acceptable children's work, child labour or a worst form of child labour. It is not the family aspect that defines the work, but rather the age, hours, tasks and conditions. However, some government policy documents explicitly mention that national labour legislation does not apply or does not fully apply to family farming. In countries that have ratified the two ILO Child Labour Conventions, this discrepancy still poses enforcement challenges. In these situations, children may be legally protected under specific child protection legislation.

The issue of child labour in cotton differs depending on the socio-economic context. In countries where cotton is grown in smallholdings, children commonly help with agricultural tasks. This practice can have positive implications for the household economy and for the child's development, provided children are not exposed to unacceptable risks and the work does not jeopardize their schooling. Examples of field practices that would indicate instances of child labour, rather than acceptable children's work or household chores, are: direct or indirect exposure to chemicals, use of dangerous tools, working at night, working for more than a certain number of hours per week, and carrying or lifting loads over certain limits.

Some national legislation specifically refers to the prohibition of hazardous children's work in cotton fields, such as the ministerial order in Zambia that further stipulates that the prohibition extends to undertakings in which only members of the family are employed, i.e. family labour. In India, children are employed in the production of cotton hybrid seeds, especially in Gujarat and Andhra Pradesh. The issue is well described in the study carried out by Venkatswarlu (2010). In Egypt, child labour in cotton is reported, although it is in decline with the mechanization of agriculture (Levy, 1985).

Child labour in cotton production has been reported/documented in: Argentina, Azerbaijan, Benin, Brazil, Burkina Faso, China, Egypt, India (hybrid cottonseed production), Kazakhstan, Kyrgyzstan, Mali, Paskistan, Paraguay, Tajikistan, Turkey, Turkmenistan, Uzbekistan and Zambia. More information on Azerbaijan and Tajikistan can be found in http://www.dol.gov/ilab/reports/pdf/2012TVPRA.pdf. Mention of forced labour in cotton can be found in the same report and in the Trafficking in Persons Report 2012 (http://www.state.gov/j/tip/rls/tiprpt/2012/index.htm) for Benin, Burkina Faso, China, Guinea, Mali, India (hybrid cottonseed production), Kazakhstan, Senegal, Togo, Tajikistan, Turkmenistan and Uzbekistan.

Labour Rights and Standards

Although all core ILO Labour Standard issues are potentially important sustainability issues for the cotton sector, the issue highlighted in the literature and initiatives is child labour (indicators 8.1 and 8.5). The issue of child labour is closely associated with poverty and therefore generally relevant to developing country production. One of the inherent challenges in measuring the enforcement of labour standards is the difficulty associated with obtaining accurate data, since many respondents are inclined to answer in a manner that reflects positively on their operations or work situation. As such, the implicit indicator of child labour, in the form of tracking school attendance and completion levels by certain age groups, represents one of the more promising avenues for tracking the relationship between cotton production and child labour. Aspects of working conditions are well captured by indicators tracking access to basic services and goods (indicators 8.2 to 8.4). The remaining indicators focus on aspects of employment and social protection (indicators 8.6 to 8.11).

Social

Labour Rights and Standards
- Child labour
- Employment conditions
- Freedom of association
- Social protection

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These indicators have been selected as a result of a scoring procedure described in Chapter 4.

8 Labour Rights and Standards

8.1 % of children attending and completing appropriate level of school (by gender)
8.2 % of farmers/workers with effective access to health care facilities
8.3 % of farmers/workers with access to potable water
8.4 % of farmers/workers with access to sanitation facilities
8.5 Number of child labourers (by age and gender)
8.6 % of workers with an enforceable employment contract (by age and gender)
8.7 % of workers who are paid a minimum or living wage and who always receive their full wage in time (by age and gender)
8.8 Total number and % of workers subordinated by forced labour
8.9 % of active cotton farmers and workers contributing to a pension scheme and/or eligible to receive a pension
8.10 % of cotton farming households benefiting from income support in case of officially recognized extreme income shocks
8.11 % of employed women that have the right to maternity leave and payments

3.11 **Worker Health and Safety**

Agriculture is the third most hazardous occupational sector (ILO, FAO, IUF, 2007) containing various risks for injuries, work-related diseases and fatalities. With an estimated global annual number of fatalities of 170 000 (ILO, 2010), farmers and workers in agriculture face twice the risk of work-related fatalities compared with the combined average of all other sectors. In contrast to other issues covered in the Cotton Report, a high incidence of injuries, work-related diseases and fatalities can be found in both industrialized and developing countries. However, workers in developing countries do not have the same access to social security safety nets in the case of injury, and the strong dependency on their own labour force as a source of income and factor of production creates a strong link between worker health and safety (WHS) incidences and food security (Olowogbon, 2011).

ILO (2010) states that the rate of injury and fatality incidence in agriculture has not decreased to the same extent as in other sectors during the last decade. This is attributed to the physically demanding nature of the work, the structural exposure to dangerous machinery and substances, as well as the prevalence of "fatigue, poorly designed tools, difficult terrain, exposure to extreme weather conditions, and poor general health, associated with working and living in remote and rural communities" (ILO, 2008). While cotton production systems share these occupational health and safety characteristics with the rest of the agricultural sector, there follows an overview of the main cotton-specific risks, an introduction to the different hazards in mechanized and smallholder farming systems and a discussion on the need for key measures to address deficiencies and ensure health and safety.

Intensively mechanized farming systems with larger farm sizes, as opposed to manual smallholder farms, provide the main global differentiation in terms of typical risks from machinery-related injury and pesticide poisoning.

In an analysis of company data from Australia, Franklin *et al.* (2001) come to the conclusion that accidents occur most frequently during machinery and equipment operation and maintenance (28.4%), ginning (25%),[7] the plant growth period and during picking and carting (ibid., p. 9). The main agents are mobile plant (mainly utility vehicles), fixed plant (mainly ginning machinery), workshop equipment and hand tools. Data from the Queensland Workers' Compensation Scheme (1992–99; ibid., p. 13f) reveal in addition that important injuries are sprains and strains of joints and adjacent muscles (32.8%), fractures (22.1%) and open wounds (14.5%), while only one farmer (0.8%) contacted the scheme due to the toxic effects of substances.

Smallholder cotton farmers are more likely to experience high frequency of injuries from hand farm tools (such as cutlasses), muscular injuries and fractures from carrying and handling of heavy loads, chronic defective postures and back injuries preventing further full work participation, and repetitious and continuous exposure to high temperatures (CNPB & ILO, 2006). As well as these risks of direct physical damage, cotton farmers in developing countries face severe acute and chronic health risks from direct exposure to pesticides. In contrast to developed countries, a lack of sophisticated storage and han-

[7] The reference to ginning has been maintained to provide some context; while ginning and downstream sectors of the cotton supply chain are associated with a wide range of specific health and safety issues, they are outside the scope of the Cotton Report, which focuses on the on-farm stage.

Worker Health and Safety

Agricultural work is associated with considerable risks and requires appropriate preventive measures that promote a safe working environment. Training of workers, establishment of safe working protocols and the annual number of work-related incidences by type and gravity (indicators 9.1 and 9.2) as well as the percentage of farmers having access to and using adequate protective equipment are all important indicators for worker health and safety in cotton production systems. The exposure to hazardous pesticides, another central issue, is covered under the section on pest and pesticide management (indicators 1.13 and 1.14).

Social

Worker Health and Safety

These indicators have been selected as a result of a scoring procedure described in Chapter 4.

9 Worker Health and Safety

9.1 Annual non-fatal incidences on cotton farms (total, % of workforce by age, gender)

9.2 Total number of fatalities on cotton farms per year


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dling systems, greater use of manual application methods, unavailability or underutilization of protective equipment and use of toxic pesticides makes incidences of pesticide poisoning structurally more common and more severe in developing countries.[8]

Key elements for ensuring adequate safety and health standards

While the diversity in cotton production makes it difficult to give a comprehensive overview of measures for improvement, selected key issues include: implementation of hazardous pesticide mixing, application, storage and disposal practices; use of appropriate protective equipment; substitution with other transport methods of repeated carrying of heavy loads resulting in lasting damage; introduction of improved hand tools with reduced associated hazards; and sufficient protection from exposure to zoonoses and other infectious and parasitic diseases.

Other important elements are farmers' knowledge of the safest behaviour and working practices, clear communication of hazards and threats, inclusion of adequate protective structures in all kinds of agricultural machinery (e.g. roll-overs), respect of adequate wheel spacing for tractors, guarding of agricultural equipment, availability of adequate field sanitation, timely access to medical care and provision of regular medical examinations.

The ILO Safety and Health in Agriculture Convention 2001 (No. 184), its accompanying Recommendation No. 192 and the Code of Practice on Safety and Health in Agriculture provide a framework for the development of national policies that aim at preventing accidents and injury to health by eliminating, minimizing or controlling hazards in the agricultural working environment. They also include mechanisms that promote the participation of workers' and employers' organizations during such legislative processes.

[8] For a comprehensive discussion of the issue of occupational risks and hazards due to the use of pesticides, please refer to the section on pest and pesticide management.

3.12 **Equity and Gender**

Women in cotton production

In small-scale farming, women provide a large part of the labour for cotton production from planting to harvesting. According to the International Center for Research on Women (2010), this is the case in Benin, Burkina Faso, Côte d'Ivoire, Malawi, Uganda and Zambia. Gender studies leading to the same conclusions have also been carried out in India and Pakistan. However, women are under-represented in decision-making positions (farmers' associations, cooperatives etc.), and, compared with men, have fewer contracts with cotton companies, lower attendance at trainings, and less access to inputs and to returns from cotton production. This gender gap exists for many assets, inputs and services – land, livestock, labour, education, extension and financial services, and technology – and it imposes costs on the agriculture sector, the broader economy and society as well as on women themselves. If women were provided with the same access to productive resources as men, they would increase yields on their farms by to 20–30%, with a significant reduction in the number of hungry people in the world (FAO, 2011).

From a global but non-representative[9] survey in Africa, Asia and Latin America, Knappe (2011) found that women tend to work in the same cotton-related activities across regions (picking, catering, planting and field management), and they are paid less than men (around 90% of the average male salary), although there are significant disparities across countries. In small-scale family agriculture, since women are mainly involved in cotton production together with their husbands, their work often goes unrecognized. In particular, Bassett (1991) observed that in Côte d'Ivoire, the more cotton was grown, the more women were pushed to work in cotton plots, sometimes at the expense of their own plots cultivated with secondary species necessary for obtaining cash. This imbalance might nevertheless be evolving together with changes in the social structure of farming. As traditional large patriarchal holdings – characterized by patriarchs reigning over families of sons – are increasingly replaced by nuclear families, where women are less numerous, and individual women may achieve greater bargaining power in farming-related decision-making in the household and contribute to cotton production on more equitable terms.


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[9] No survey sampling design was followed, and responses were equally weighted across organizations with different numbers of members.

The feminization process of agriculture, triggered by the increased involvement of men in off-farm activities, is also leading to greater involvement of women as farm managers in cotton production. The ICAC survey on Cotton Production Practices included for the first time in 2011 a question about the percentage of female farmers **(Table 7)**. "Farmer" is defined as the head of a household that grows cotton and is neither hired nor family labour. Female cotton farmers account for 17% of all cotton farmers among respondents. That average hides strong differences across countries and regions for reasons not yet clarified. Kyrgyzstan and Kazakhstan top the list of countries with a high percentage of female farmers, with more than 70% each. Zimbabwe, Kenya, Uganda, Sudan, Zambia and Australia follow with more than 25% of female farmers (but no more than 60%). However, in terms of numbers of female farmers, Zimbabwe and Kazakhstan together account for about half of all female farmers on the list. Zambia, Uganda and Kyrgyzstan together account for about an additional 30% of the female farmers on the list.

Table 7

Total and female cotton farmers, for selected countries and regions

Country (Region)	Total number of cotton farmers	Female farmers as % of total cotton farmers
Argentina (Santiago del Estero)	4 600	2%
Australia (National)	1 350	40%
Brazil (Savannahs)	384	5%
Brazil (Northeast)	9 750	< 1%
Burkina Faso (Sofitex)	220 000	< 1%
Cameroon (National)	206 000	6%
Chad (National)	350 000	10%
Colombia (National)	6 700	5%
Egypt (National)	100 000	5%
Israel (National)	100 (farms)	40%
Kazakhstan (National)	250 000	70%
Kenya (East)	39 000	50%
Kenya (West and Nyanza)	58 045	40%
Kyrgyzstan (National)	70 000	71%
Mozambique (National)	170 061	11%
Pakistan (Punjab)	1 300 000	< 1%
Pakistan (Sindh)	237 000	< 1%
Sudan (Gezira Scheme)	15 000	30%
Turkey (Aegean Region)	12 645	20%
Uganda (National)	150 000	40%
United States (Far West)	1 156	3%
United States (Mid South)	3 830	3%
United States (Southeast)	2 500	2%
United States (Southwest)	5 000	3%
Zambia (National)	250 000	25%
Zimbabwe (National)	250 000	55%
Total (except Israel)	3 713 000	17%

Source: ICAC, 2011.

Equity and Gender

Equity and gender indicators are usually concerned with equal access and/or participation of vulnerable groups as well as minorities in farmers' organizations, leadership roles (indicator 10.1), productive activities (indicators 10.2 and 10.3) and productive resources such as credit. The indicators also specify age and gender differences in self-employed and employed income levels.

Governance is not explicitly recognized as a major sustainability issue in the cotton literature, but it is recognized in Agenda 21 as a priority. As with risk management, most governance issues will be dependent on issues and practices that extend well beyond the actual unit of cotton production. Among the indicators collected, female management at the household level is one of the few indicators directly related to "on-farm governance". With this indicator it may be difficult to obtain accurate information and it may also be subject to cultural distortions. Some of the more generic and applicable indicators on access to governance are: i) farmer participation in a democratic organization; and ii) farmers' right to establish organizations representing their interests.

These indicators have been selected as a result of a scoring procedure described in Chapter 4.

10 Equity and Gender

10.1 % of leadership roles held by women in a producers' or workers' group

10.2 Gender and age wage differentials for the same quantity of produce or same type of work

10.3 % of women whose income from independent sources has increased/decreased

3.13 **Farmer Organizations**

While farmer organization[10] is important for farmers from both developed and developing countries, the rationale for being organized is quite distinct. For farmers from developed countries, farmer organization is generally focused on advocacy and promoting the interests of farmers. In developing countries, organizing farmers is generally considered a key tactic in addressing the structural challenges typically faced by small-scale farmers, for example (Penrose-Buckley, 2007):

- lack of capital and assets, and access to information and training;
- inefficiency of scale (high transaction costs in relation to the size of production)
- poor bargaining position (e.g. due to small production volume and/or lack of market information) and
- limited ability to influence policy and markets.

In other words, small-scale farmers are at a disadvantage in the market place because of their size and lack of resources. As many of these challenges are direct consequences of the small-scale nature of the farms, combining resources and production through collective action – e.g. through forming farmer organizations or associations – is one of the few options available for overcoming these structural limitations.

In light of the economic nature of the challenges, farmer organizations for small-scale farmers in developing countries generally have a business focus, cf. the policy and advocacy focus of such organizations in developed countries. Penrose-Buckley (2007) in *Producer organizations: A guide to developing collective rural enterprises* defines “farmer organizations” for the purpose of the guide as being:

- a rural business;
- a farmer-owned and controlled organization; and
- engaged in collective marketing activities.

Improved market access is therefore the key objective in organizing farmers under this definition, on the basis that it will help farmers become more self-reliant and obtain better prices for their production, resulting in increased income and reduced poverty. As noted in the Cotton Report, there has been a rise in the number of VSIs. These standards require that farmers are trained in the requirements of the standard, and that certain information about the farmers’ production system is reported upon. Given the large numbers of small-scale farmers in developing countries, grouping of farmers is common practice so that these standards work with farmers. As well as improving efficiency when implementing the standard, participation in farmer organizations helps ensure that farmers receive the necessary support when they must meet management and technical requirements to comply with a standard.

[10] Farmer organization is defined broadly in the Cotton Report to include formally incorporated farmer associations, cooperatives and informal groups of farmers.

Farmer Organizations

Two basic indicators are proposed to measure the participation of farmers in organizations (indicator 11.2) and their access to capacity-building activities such as training (indicator 11.1).

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These indicators have been selected as a result of a scoring procedure described in Chapter 4.

11 Farmer Organizations

11.1 Numbers of farmers and workers who have attended training (by training type, age and gender)

11.2 Number of farmers and workers participating in democratic organizations (by age and gender)

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A number of potential benefits[11] can arise from organizing farmers in developing countries, providing a useful means for measuring the impact of farmer organization, beyond simple participation:

- **Increased profitability.** Economy of scale can drive both lower costs and higher prices: lower costs through collective bargaining for aggregated inputs, and higher prices through reducing transaction costs for purchasers. Participation in farmer organizations may also facilitate access to market information, helping farmers achieve a better price, and/or meeting market requirements.

- **Improved market reach.** As noted by Penrose-Buckley (2007),"[m]any small-scale farmers are unable to get a good price for their produce because they are unable to access other markets, further along the market or value chain, where prices are higher. Because they have no choice, small-scale farmers have to accept the price that traders offer them locally. In such cases, collective action can enable small-scale farmers to access other markets by combining their produce to reach the scale necessary to deal with buyers in other markets, or by processing their produce to access higher value markets at a later stage in the chain".

- **Increased support.** A focus for the more efficient provision of support and investment to small-scale farmers.

- **Improved quality.** Participation in a farmer organization can help drive quality assurance, for example through supporting "clean cotton" campaigns.

[11] It is important to note that 1) farmer organizations are not a universal solution to the challenges faced by small-scale farmers, which may include systemic market access or political problems and socio-economic barriers and 2) there are a number of aspects associated with organising farmers that need to be ensured for an organization to be effective: strong governance structures; minimising internal transaction costs; avoiding free-riders (Penrose-Buckley, 2007).

4

Identifying Indicators for Measuring Sustainability in Cotton Farming Systems

As a result of the analysis of global sustainability themes and their contextualization to the cotton sector, eleven sustainability areas with primary relevance to cotton farming were identified **(Figure 5)**.

For each of these areas, farm-level indicators were derived from existing sustainability standards and initiatives to monitor progress and impact. As a result, an inventory of 189 indicators with relevance to cotton was generated **(Appendix 1)**. Subsequently, this list of indicators was analysed for application to the cotton sector using three main criteria: relevance, usefulness and feasibility. The application of these criteria is described in detail, below. As a result, a core set of 68 indicators to track cotton performance was identified **(Table 8)**.

4.1 Voluntary Sustainability Standards Relevant to the Cotton Sector

Over the past decade there has been a significant growth in the number and uptake of international voluntary sustainability initiatives (VSIs). VSIs are initiatives, standards or methodologies that aim to enhance and measure the sustainability outcomes of agricultural production systems. VSIs often involve other stages of the value chain, for example: consumers through the use of labels; the processing and retailing industry through vertical integration; and the public sector through extension or central marketing programmes. By 2000, there were more than 30 ecolabelling initiatives around the world, concentrated in retail markets in developed countries. Although some of these initiatives were endorsed by governments for their formation and implementation, they were typically designed to be voluntary instruments to facilitate consumer identification of "environmentally preferable" products.

While a considerable number of these initiatives can be identified as constituting "niche" markets that serve particular consumer preferences only, or that are associated with luxury items, the past few years have seen the entry of VSIs into mainstream channels. The stakeholders and dynamics behind these initiatives vary. Large retailers have a growing interest in improving their own overall environmental footprint and in providing customers with greater confidence in the social and environmental integrity of their products, while public sector development programmes promote a sustainable intensification of agriculture to protect the livelihood of farmers and the environment. In some developed countries, an increasing regulatory interest in resource management by agricultural farmers has inspired the implementation of production risk management systems focused on responsible natural resource stewardship.

VSIs in the cotton sector came into existence later than similar initiatives for the coffee and cocoa sectors, but have increased in number and market share over the last decade (ICAC, 2010). The current VSIs with dedicated application to the cotton sector and reviewed for the Cotton Report are:

- Better Cotton Initiative (BCI)
- Cotton made in Africa (CmiA)
- Fairtrade Cotton
- Organic Cotton
- myBMP (Australian Best Management Practices programme)

A number of initiatives generic to agriculture, but with potential relevance to cotton production were also reviewed:

- Committee on Sustainability Assessment (COSA)
- Field To Market (The Alliance for Sustainable Agriculture)
- Response-Inducing Sustainability Evaluation (RISE)
- FAO Sustainability Assessment of Food and Agriculture (SAFA) systems guidelines

These cotton-specific VSIs, as well as the more generic agricultural impact assessment initiatives, provided an important foundation for understanding how to assess sustainability at the global level. The indicators used by these initiatives are the result of discussions and negotiations among stakeholders with different perspectives, and provided an important first filter as to the most critical sustainability issues for cotton production.

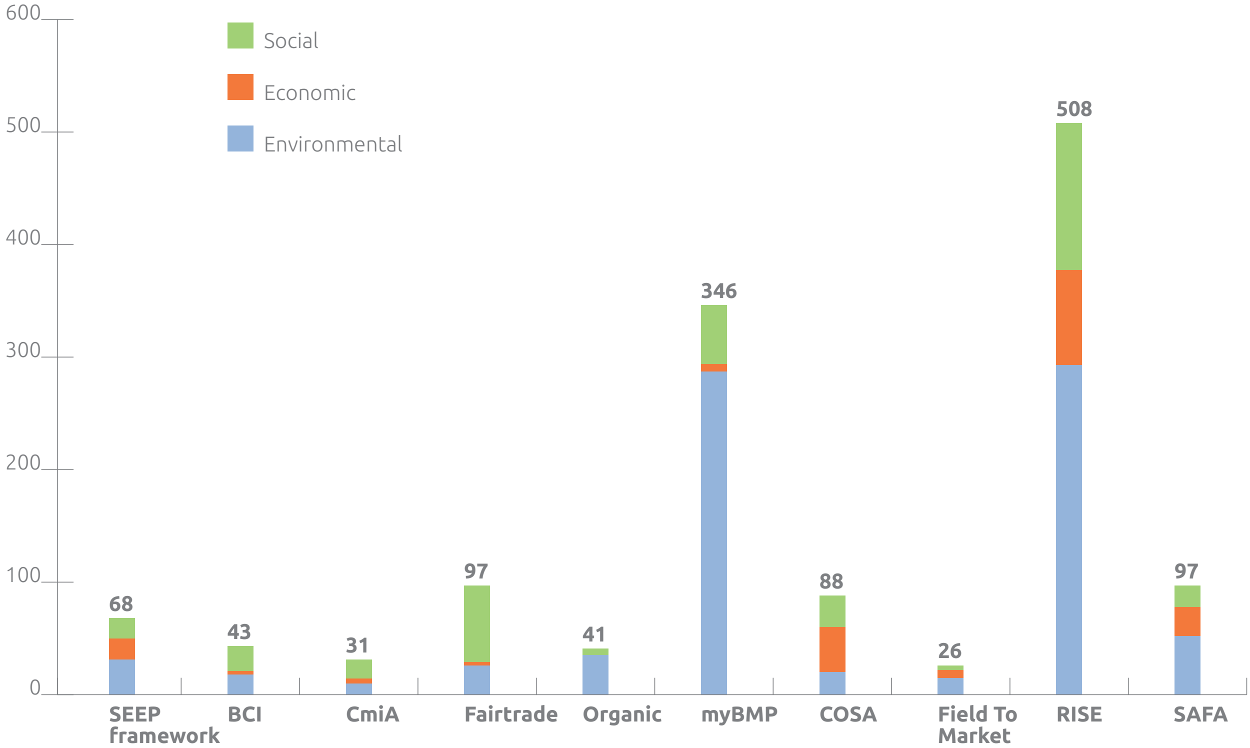
A summary of the main features of each programme, including a brief overview, scope and main objective, geographical coverage, scale, production, stakeholder involvement, financing model, major donors, total funding, verification process and technical assistance provided to farmers, can be found in **Appendix 2**.[12] These descriptions are not intended to be an assessment of the effectiveness and impact of the initiatives as such assessment was beyond the scope of this report.

The farm-level indicators used by these initiatives were inventoried and classified according to the eleven sustainability areas relevant to the cotton sector. **Figure 7** presents the total number of sustainability indicators that were considered for the scope of the Cotton Report. Indicators that were either beyond the farm level (focused on aspects of value chain arrangements and governance issues) or purely oriented towards administrative procedures of certification and management were not considered in this review. As a result, the complete set of indicators of Cotton made in Africa, Organic Cotton, Fairtrade Cotton and SAFA is significantly larger than the subset analysed in the Cotton Report. Further, indicators that were substantially similar were generally not double counted if present in more than 1 of the 11 sustainability areas.

[12] The information in the fact sheets was provided by the respective organizations.

Figure 7

Number of indicators by certification/verification body, 2007–2012



4.2 Methodology for Rating Sustainability Indicators

Indicators might be designed to serve the purpose of monitoring or impact assessment. Where indicators are designed for monitoring, the priority for indicator development will be feasibility concerns (cost, accessibility and accuracy). Where indicators are primarily for impact assessment, the indicator development process will emphasize the relevance of the indicators to the broader (sustainability) outcomes sought by key stakeholders in the process and their usefulness (comparability, significance and conceptual logic) as tools for detecting a causal relationship between a series of interventions and the desired outcomes. While monitoring indicators are usually more assessable and the data collection less expensive, it is impact indicators that provide evidence that sustainability goals have been achieved. A comprehensive and feasible sustainability assessment framework will include a mix of monitoring and impact indicators.

Monitoring: a process that measures the immediate outputs (e.g. training workshop delivered, fertilizer applied) related to a specific set of activities or intervention (cotton production).

Impact assessment: a process that measures the long-term outcomes (e.g. poverty reduction, access to medical facilities) associated with an activity or intervention (OECD, 2002). In assessing the impact, demonstrating a causal link between outcome observations and the activity/intervention of concern is a priority.

Criteria and variables used to score indicators

Three criteria, relevance, feasibility and usefulness, were used to score and rank indicators in the Cotton Report. The criteria were primarily drawn from key references in the area of impact assessment methodology, namely:

- Assessing the Impacts of Social and Environmental Standards Systems v1.0 ISEAL Code of Good Practice, available at: www.isealalliance.org/sites/default/files/P041_ISEAL_Impacts_Codev1.0.pdf

- IISD General Indicator Selection Criteria, available at: www.iisd.org/casl/CASLGuide/Criteria.htm

- Second Meeting of the Expert Group on the Revision of the Framework for the Development of Environment Statistics, available at: http://unstats.un.org/unsd/environment/fdes/EGM2/EGM-FDES.2.3%20-%20FinalReport.pdf

While not an exhaustive list of the many considerations that might influence the selection of a set of sustainability indicators, these criteria provide a basic rubric for understanding and preselecting indicators for application at the global level.

Relevance
Relevance refers to the meaningfulness of the indicator to the broader community of stakeholders. It is a measure of the directness of the conceptual relationship between the indicator and the longer-term objectives being sought. Given the focus on cotton production, relevance to cotton was used to score the indicators, specifically:

1 **Cotton relevance:** alignment with sustainable development priorities for the cotton sector.

Usefulness
Usefulness refers to the ability to causally link a specific set of activities to the outcomes sought. Three variables can be used to assess the usefulness of indicators:

1 **Comparability:** applicability across different regions and production systems; ability to provide comparable results that will allow the interpretation of a causal relationship.
2 **Significance:** capacity to generate statistically significant data. Statistical significance refers to the probability that a given observation can be causally attributed to a given activity rather than being considered a mere product of chance.
3 **Conceptual logic:** existence of an adequate logical chain/theory of change to attribute causality between the activity and the outcome being measured.

Feasibility
Feasibility refers to the practicality of collecting data to apply the indicator. If information on a particular indicator cannot be gathered reliably, then the in-

dicator will not serve its purpose. In such cases, proxy indicators that point towards the desired outcome but do not require direct measurement may be the preferred approach. Three variables can be used to assess the feasibility of indicators:

1 **Cost:** cost of collecting the data. Ultimately, the actual decision on indicator selection will likely entail a balance between cost and relevance/usefulness (more relevant/useful indicators will often also be more costly).
2 **Accessibility:** availability of data and at which level (community, province, state, nation). Even when cost is not a limiting factor, some indicators might require the collection of data that are not accessible.
3 **Accuracy:** precision, consistency and targeted. For example, an indicator of "adoption of good management practices" in the absence of detailed descriptions of what such practices are would be difficult to apply with consistency at the global level and thus be prone to results that are not particularly accurate.

Scoring and ranking procedure

Indicators were scored across the seven variables – cotton relevance, comparability, significance, conceptual logic, cost, accessibility and accuracy – using a scale of 3–1, with 1 the lowest value in the scale (i.e. a score of 1 for relevance to cotton would indicate low relevance and a score of 1 for cost would indicate high cost).

In addition, each indicator was assessed for its balance across the three criteria – relevance, usefulness and feasibility. Indicators with a high absolute score, but which scored well in only one or two of the criteria, were assessed as less balanced and therefore of lower priority than indicators that scored well across all three criteria. The standard deviation was used as a measure of balance.

The list of 189 indicators is presented in **Appendix 1**. Whether or not to include an indicator in the core set of recommended sustainability indicators **(Table 8)**, depended on:

1 **total score:** the sum of the seven scores had to be ≥ 14;
2 **balance:** the standard deviation between the average scores of the three scoring dimensions (relevance, usefulness and feasibility) had to be < 0.59; and
3 **expert judgment** of sector specialists (in a few selected cases, SEEP overrode the first two criteria and in-/excluded indicators based upon the judgment of sector specialists).

Figure 8 provides a snapshot of the scoring for one of the indicators.

It is, however, critical to note that the analytic framework and the way it is applied could and even should be modified, depending on the priorities of the specific group seeking to identify indicators relevant to them. This is because the scoring of criteria will necessarily depend on specific conditions (e.g. a country, a farming system, an agro-ecological zone).

Figure 8
Example of scoring matrix of indicators

Sustainability indicator	Rationale	VSIs[1]	Indicator score – Relevance	Usefulness			Feasibility			Selection criteria[2]			Indicator selected?
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	
1 **Quantity of active ingredients of pesticides used** (kg/ha)	Quantity of pesticides applied can provide an indication of the use of appropriate pest management practices (e.g. when compared with country-specific benchmarks) and negative environmental impact	myBMP, BCI, RISE	2	2	3	3	2	2	2	16	0.38		✓

4.3 Core Set of Indicators

The Cotton Report analysed a wide-ranging list of sustainability indicators for cotton production systems based on the literature review of existing sustainability frameworks and a complementary review of the main sustainability issues associated with cotton production at the farm level.

As a result of this analysis, a core set of 68 indicators has been identified as a recommended set to choose from when assessing the sustainability of cotton production. With the interest of identifying a globally applicable set of indicators, the selection consists of those indicators scoring highest across the main criteria of relevance, usefulness and feasibility.

The indicators proposed under a sustainability theme should be considered as a set, rather than individually to address sustainability in the given category. For instance, kg/ha of fertilizer by type used *per se* does not provide any meaningful indication that the soil is being managed sustainably.

It is worth noting that specific indicators can interact with, or be relevant to particular sustainability outcomes in different ways, depending on the context and nature of the indicator. One the one hand, any given indicator has the potential to be relevant to more than one theme and the themes to which a given indicator is applicable may vary from country to country. The ranking process tried to select indicators that could or would be important to several producing countries without necessarily suggesting that such indicators would be important to all cotton-producing countries.

Finally, some indicators, such as the monitoring of water quality, do not detail the specific parameters to be assessed. Instead the specific water quality variables to be measured in laboratory tests will have to be specified based on the local environmental and production context.

Table 8

Core set of indicators to meausure sustainability in cotton farming systems

Environmental

Pest and Pesticide Management

No.	Indicator
1	**Pest and Pesticide Management**
1.1	Quantity of active ingredients of pesticides used (kg/ha)
1.2	Quantity of active ingredients of highly hazardous pesticides used (kg/ha)
1.3	Number of pesticide applications per season
1.4	% of treatments that involve specific measures to minimize non target application and damage
1.5	Existence of a time-bound IPM plan
1.6	% of cotton area under IPM
1.7	% of farmers that use only pesticides that are nationally registered for use on cotton
1.8	% of farmers that use pesticides labelled according to national standards, in at least one national language
1.9	% of farmers that use proper disposal methods for pesticide containers and contaminated materials including discarded pesticide application equipment
1.10	% of farmers following recommended practices for pesticide mixing and application and cleaning of application equipment
1.11	% of farmers with dedicated storage facilities that keep pesticides safely and out of reach of children
1.12	Total number and % of cotton area involving vulnerable persons applying pesticides
1.13	% of workers applying pesticides that have received training in handling and use
1.14	% of farmers having access to and using adequate protective equipment (by type)

Environmental

Water Management

No.	Indicator
2	**Water Management**
2.1	Quantity of water used for irrigation (m^3/ha)
2.2	Irrigation use efficiency (%)
2.3	Water crop productivity (m^3 of water per tonne of cotton lint)
2.4	% of area under water conservation practices
2.5	Groundwater table level (m from surface)
2.6	Salinity of soil and irrigation water (deciSiemens [dS] per metre, EC)
2.7	Quality of discharge water (various)

Table 8 (cont'd)

Core set of indicators to meausure sustainability in cotton farming systems

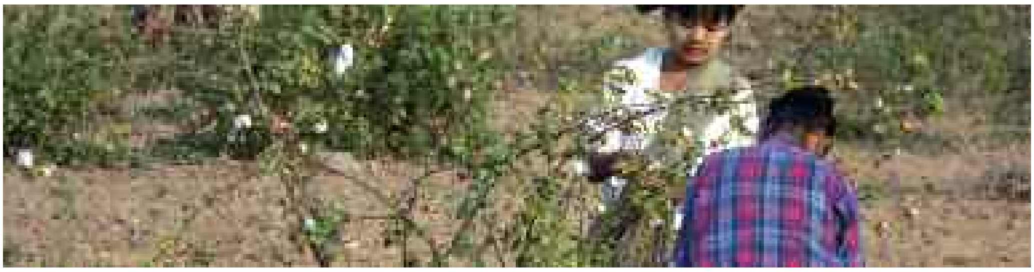
Environmental

Soil Management

No.	Indicator
3	**Soil Management**
3.1	Soil characteristics: organic matter content, pH, N, P, K
3.2	Use of soil sampling for N, P, K (% of farmers)
3.3	Fertilizer used by type (kg/ha)
3.4	% of area under soil erosion control and minimum/conservation tillage practices

Environmental

Biodiversity and Land Use



No.	Indicator
4	**Biodiversity and Land Use**
4.1	Average yield (tonne of cotton lint/ha)
4.2	Total area (ha) and % of natural vegetation converted for cotton production (ha)
4.3	% of total farm area that is non-cropped
4.4	Average number of cotton and other crops per 5-year period

Environmental

Climate Change

No.	Indicator
5	**Climate Change**
5.1	GHG emissions and carbon sequestration per tonne of cotton lint and/or ha (CO_2-e)
5.2	On-farm energy use per tonne of cotton lint and/or ha (GJ)

Table 8 (cont'd)

Core set of indicators to meausure sustainability in cotton farming systems

Economic

Economic Viability, Poverty Reduction and Food Security

No.	Indicator
6	**Economic Viability, Poverty Reduction and Food Security**
6.1	Average annual net income from cotton production
6.2	Price received per tonne of cotton lint at farmgate
6.3	Returns above variable costs per ha and tonne of cotton lint
6.4	Return on investment
6.5	Debt to asset ratio
6.6	Number and % of household members living below the national poverty line
6.7	% of farmers/workers with access to productive resources
6.8	Average value of assets per producer household
6.9	% of producing households with a specific asset
6.10	Perception of change in economic situation over last five years (% of farmers)
6.11	Total number and % of cotton farming household members with calorie intake below the international norm
6.12	Number of days with food deficiency per annum in cotton-producing households

Economic

Economic Risk Management

No.	Indicator
7	**Economic Risk Management**
7.1	Cotton yield volatility
7.2	Farmgate cotton price volatility
7.3	% of farmers with measures in place to manage price risks by type
7.4	% of total household income that the largest income source represents
7.5	Average number of days after sale that farmers receive payment
7.6	% of farmers with access to equitable credit
7.7	% of farmers showing understanding of the factors involved in price formation or with daily access to international and domestic prices

Table 8 (cont'd)
Core set of indicators to meausure sustainability in cotton farming systems

Social

Labour Rights and Standards

No.	Indicator
8	**Labour Rights and Standards**
8.1	% of children attending and completing appropriate level of school (by gender)
8.2	% of farmers/workers with effective access to health care facilities
8.3	% of farmers/workers with access to potable water
8.4	% of farmers/workers with access to sanitation facilities
8.5	Number of child labourers (by age and gender)
8.6	% of workers with an enforceable employment contract (by age and gender)
8.7	% of workers who are paid a minimum or living wage and who always receive their full wage in time (by age and gender)
8.8	Total number and % of workers subordinated by forced labour
8.9	% of active cotton farmers and workers contributing to a pension scheme and/or eligible to receive a pension
8.10	% of cotton farming households benefiting from income support in the case of officially recognized extreme income shocks
8.11	% of employed women that have the right to maternity leave and payments

Social

Worker Health and Safety

No.	Indicator
9	**Worker Health and Safety**
9.1	Annual non-fatal incidences on cotton farms (total, % of workforce by age, gender)
9.2	Total number of fatalities on cotton farms per year

Table 8 (cont'd)

Core set of indicators to meausure sustainability in cotton farming systems

Social

Equity and Gender

No.	Indicator
10	**Equity and Gender**
10.1	% of leadership roles held by women in a producers' or workers' group
10.2	Gender and age wage differentials for the same quantity of produce or same type of work
10.3	% of women whose income from independent sources has increased/decreased

Social

Farmer Organizations

No.	Indicator
11	**Farmer Organizations**
11.1	Numbers of farmers and workers who have attended training (by training type, age and gender)
11.2	Number of farmers and workers participating in democratic organizations (by age and gender)

5

Conclusions and Way Forward

Over the past decade, significant advances have been made in implementing sustainable development across the cotton sector. Technological advances and the ongoing promotion of good management practices, together with increasing pressure from the market, continue to underpin a focus on "sustainable production". But as new methods and initiatives are applied, there are growing questions as to what the overall outcomes of these efforts are: are some efforts more effective in specific regions or applied within specific production systems? How is the sustainability of the global cotton sector performing over time? What are adequate benchmarks for sector sustainability and how will these be measured? A first step in the broader process of impact monitoring and evaluation revolves around the identification of what should be measured. While the ultimate determination of globally appropriate indicators for monitoring and impact assessment must be made through the appropriate political processes, the Cotton Report seeks to outline some of the major considerations to help inform these discussions.

The overview of current indicators being applied across existing cotton voluntary sustainability initiatives (VSIs) provides a bird's eye view of "current practice" within the sector, which is an indication of current priorities and also, of possible gaps in existing systems. Regardless, these initiatives, combined with other generic impact indicator initiatives from the agriculture sector, provide a rich indicator base to draw from for possible application within the cotton sector.

Global guidance. The list of recommended indicators

While the Cotton Report seeks to develop a global set of indicators, it also recognizes that the conditions under which cotton is grown and the issues associated with its cultivation vary enormously due to differing environmental, agro-ecological, climatic, socio-economic and political conditions. For example, a country that generally relies on irrigation will be more interested in including indicators on water usage compared with a country reliant on rainfed production. Similarly, the feasibility of gathering specific indicators (cost, accessibility, accuracy) is likely to vary from country to country, as well as the options and capabilities for performance improvements.

The recommended set of indicators gave priority to indicators with importance in several production contexts, without necessarily suggesting that such indicators are important in all cotton-producing countries. An agreed set of indicators is considered a worthwhile objective, since standardizing the indicators by which

the performance of the global cotton industry is measured will allow for more focused data collection. While the diversity and variability in cotton production and context conditions across regions does not allow for a globally uniform, fixed standing set of indicators that would sufficiently and adequately address sustainability in all producing countries, the recommended indicators represent an important starting point for the national level and provide essential guidance while allowing at the same time for variation.
The potential benefits of collecting and reporting against a set of key sustainability indicators include the following:

- All sector stakeholders are provided in a participatory way with the possibility to discuss, debate and reach agreement on the priority indicators to measure sustainability of the cotton sector.

- Current sustainability performance levels may be clearly identified and reported on, there is guidance for policy interventions to reach continuous improvement and a good standard is provided to evaluate the effectiveness of sector support policies over time.

- Agreement at the global level and associated technical guidance material facilitate the more feasible and less cost-intensive development of sustainability assessments at the various national levels.

- Collected data can be used to report along the value chain, thus meeting the increasing market requirements of retailers and consumers with regard to environmental and social impacts.

Each of these benefits can be or is best realized at the national level. Discussions on this scale will be better able to link the usage of sustainability indicators to activities and interventions that directly enhance the sustainability of local cotton production systems, for example through policy decisions by government bodies, optimization of production practices by farmers or changes in support services by extension services, cotton ginning, cotton trading companies etc. Local participants are better placed to take advantage of one of the anticipated outcomes from collecting sustainability indicators, i.e. better understanding of current levels of “performance” – environmental, economic and social – allowing for actions to be targeted at the most critical areas requiring improvement.

Furthermore, assessment at a local or national level will help to check and validate the selection process used for determining the list of recommended indicators, and ensure that local considerations are fully brought to bear on the selection process – i.e. something beyond the scope of the Cotton Report, which was undertaken with a focus on the global level.

An initial Executive Summary of the Cotton Report was provided to participants in the 72nd ICAC Plenary Meeting, held in Cartagena, Colombia in October 2013. Following workshop discussions on the Executive Summary, there was consensus among ICAC delegates that any framework for measuring sustainability needs to be implemented on a country-by-country basis, and that committees should be formed in each country to create an initial framework of metrics and to ensure that the framework is updated as production practices evolve.

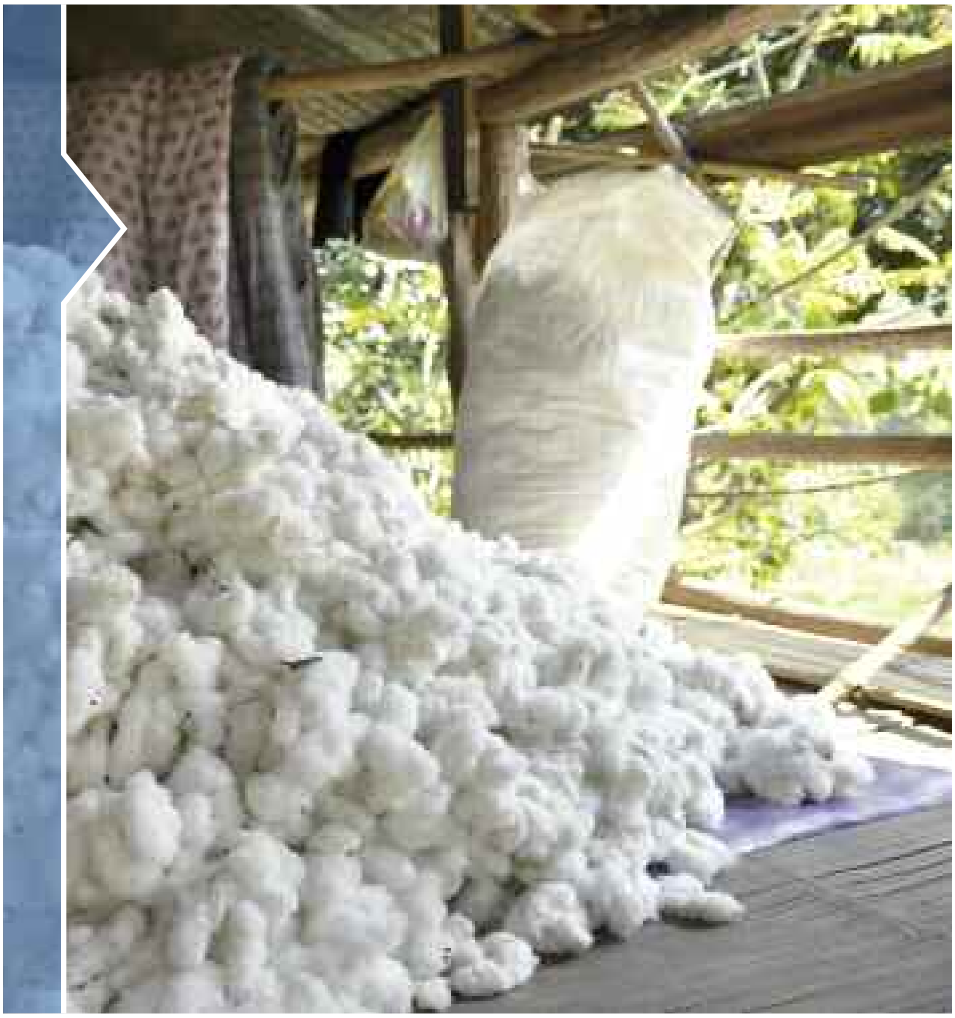
5

It is therefore recommended that consideration of the set of recommended indicators and further selection take place at a national level.

Such a focus at a national level is consistent with and enhances one of the key objectives of the Cotton Report – to provide a forum for the global cotton industry to discuss, debate and reach agreement on the priorities for measuring the sustainability performance of the cotton industry – by facilitating the equivalent discussion on a national and perhaps even regional scale.

Testing the framework

As noted above, there was consensus among the delegates at the 72nd ICAC Plenary Meeting that any framework for measuring sustainability needs to be implemented on a country-by-country basis, and that committees should be formed in each country to create their initial framework of metrics and to ensure that the framework is updated as production practices evolve. Discussions among delegates during the workshop focused on the Executive Summary provided and highlighted that a pilot testing of the framework – to demonstrate how it might be implemented – would be beneficial.



A pilot testing of the framework would help address the following issues:

- How can a national multistakeholder consultation board or committee best be established, which organizations should be represented, what are its precise roles and responsibilities?
- How can the initial list of 68 recommended indicators detailed in the Cotton Report be refined to a smaller core set of indicators, and how consistent might this core set be across different contexts?
- What is the optimal number of global indicators, given the diversity of farming systems and contexts within which cotton farming takes place?
- How practical are indicators in terms of availability of data to measure sustainability, and which indicators would require dedicated effort for their collection (cf. rely on existing data collection processes). Is there any consistency between countries as to what data are currently available?

Given the global focus of the set of recommended indicators and the diversity of conditions under which they therefore need to apply, it would be important that any pilot testing of the framework be undertaken in a range of different farming systems and contexts (e.g. highly mechanized and labour-intensive; rain-fed and irrigated).

The analytic framework described in the Cotton Report provides an objective process for assessing the relevance, feasibility and usefulness of indicators. Given the wide range of conditions and contexts in which cotton is grown, analysis of the potential sustainability indicators was only undertaken at the global level, and this global assessment framework is really the starting point in the prioritization process for the selection of indicators. The analysis was by no means exhaustive, particularly with regard to the influence of specific local conditions, and the ultimate appropriateness of any given indicator will depend on the development context and production systems present in any given case. A national pilot testing of the framework could also address the following challenges:

- being sensitive to local context, while maintaining global comparability;
- maintaining accuracy, while keeping the cost of gathering data reasonable; and
- allowing for causal attribution, while remaining attentive to external causal factors.

The Cotton Report provides sufficient detail about how the scoring process was undertaken, and interested parties can therefore undertake their own scoring of the indicators assessed by the Cotton Report (the full indicator list is in **Appendix 2**), taking into account local circumstances and assessing other indicators not considered in the Cotton Report, but potentially relevant in the local context. In such a way, the priority areas of a given country can be adequately captured and the cotton sustainability assessment can claim to be sufficiently context-specific.

6

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Measuring Sustainability in **Cotton Farming Systems**

Towards a Guidance Framework

Appendix 01

Comprehensive List of Indicators for Measuring Sustainability in Cotton Farming Systems

A) Environmental Sustainability

1) Pest and Pesticide Management

Environmental contamination and integrated pest management

	Sustainability indicator	Rationale	VSIs[1]	Indicator score							Selection criteria[2]			Indicator selected?
				Relevance	Usefulness			Feasibility						
				Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	
1	**Quantity of active ingredients in pesticides used** (kg/ha)	Quantity of pesticides applied can provide an indication of the use of appropriate pest management practices (e.g. when compared with country-specific benchmarks) and negative environmental impact	myBMP, BCI, RISE	2	2	3	3	2	2	2	16	0.38		✓
2	**Quantity of active ingredients in highly hazardous pesticides used** (kg/ha)	Quantity of highly hazardous pesticides applied can provide an indication of the use of appropriate pest management practices (e.g. when compared with country-specific benchmarks) and negative environmental impact	BCI, myBMP, RISE	3	3	3	3	2	2	3	19	0.38		✓
3	**Number of pesticide applications per season**	High annual application frequencies/regularity of application may prevent the regeneration of non-target plants and organisms and may intensify the environmental impact of pesticides	myBMP	2	2	2	3	3	2	2	16	0.19		✓
4	**Percentage of treatments that involve specific measures to minimize non-target application and damage**	Appropriate pesticide application techniques and timing can strongly decrease total volumes of pesticides applied, e.g. by reducing losses from application on non-targeted vegetation as well as leaching and runoff (edge of field, bottom of root zone)	myBMP	2	2	3	3	2	2	3	17	0.33		✓
5	**Existence of a time-bound IPM plan** (IPM plans should reference systematic scouting, pest control decisions that are based on thresholds for pest infestation, and agro-ecological management practices that prevent the development, spread and persistence of pest populations)	The presence of an IPM plan provides an indication of the use of good pest management practices	FT, CmiA, BCI	3	1	3	3	2	3	1	16	0.51		✓
6	**Percentage of cotton area under IPM**	The actual implementation of an IPM programme provides an indication of the use of good pest management practices		3	2	3	3	3	1	2	17	0.51		✓
7	**Implementation of the International Code of Conduct and the three international conventions on the use and distribution of pesticides**	The enforcement of international standards for the management of pesticides provides a good indicator for the existence of risk reduction measures in the country	CmiA, BCI	3	3	3	3	2	1	3	18	0.58	✗	✗
8	**Herbicide-resistant cotton: A management plan is set up to control weed escapes and cotton volunteers**	Non-managed escapes promote the emergence of resistant weeds	myBMP	3	2	2	2	1	2	2	14	0.69		✗
9	**Extent of compliance with regulations for buffer zones and no-spray zones**	Non-compliance with regulations on buffer zones may lead to negative environmental impacts	myBMP	2	2	2	2	2	2	2	14	0.00	✗	✗

No.	Sustainability indicator	Rationale	VSIs[1]	Indicator score							Selection criteria[2]			Indicator selected?
				Relevance	Usefulness			Feasibility						
				Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	

A) Environmental Sustainability

1) Pest and Pesticide Management

Environmental contamination and integrated pest management

No.	Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
10	**Extent of implementation of good farm hygiene practices to minimize the movement of pests and pathogens onto and off the farm**	Good farm hygiene practices reduce the likelihood of pest and pathogen infestation and spread (e.g. of nematodes and fungi), which can reduce the need for pesticides	myBMP	2	1	2	2	2	2	1	12	0.19		✗
11	**Percentage of farmers that use only pesticides that are nationally registered for use on cotton**	Pesticides that are registered have been formally assessed, and the requirements for their proper use determined	myBMP, CmiA, BCI	2	2	2	3	2	3	3	17	0.33		✓
12	**Percentage of farmers that use pesticides labelled according to national standards, in at least one national language**	Proper pesticide labelling enhances the capacity of farmers to apply them efficiently and avoid negative environmental impacts	myBMP, BCI, CmiA, FT	2	2	2	3	2	3	3	17	0.33		✓
13	**Percentage of farmers that use proper disposal methods for empty pesticide containers and contaminated materials including discarded pesticide application equipment**	Inadequate waste disposal is correlated to leakage of pesticides and hazardous chemicals into the environment; proper disposal of pesticide containers and application equipment minimizes the risk of environmental contamination	RISE, myBMP, CmiA, BCI, FT	2	3	2	3	1	2	3	16	0.38		✓

Human exposure

No.	Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
14	**Percentage of farmers following recommended practices for pesticide mixing and application, and for cleaning of application equipment**	Use of recommended techniques of pesticide handling, mixing and application reduces the risk of exposure	RISE, myBMP, CmiA, FT, BCI	3	2	3	3	2	1	2	16	0.69	✓	✓
15	**Quantity of active ingredients in pesticides used** (kg/ha)	The amount of pesticides used may provide an indication of workers' total exposure to hazardous material, which may affect their health	myBMP, BCI, RISE	3	3	3	3	2	2	3	19	0.38		✓
16	**Quantity of active ingredients in highly hazardous pesticides used** (kg/ha)	The amount of pesticides used may provide an indication of workers' total exposure to hazardous material, which may affect their health	BCI, myBMP, RISE	3	3	3	3	2	2	3	19	0.38		✓
17	**Implementation of the International Code of Conduct and the three international conventions on the use and distribution of pesticides**	The implementation of international tools for the management of pesticides provides a good indicator for the existence of risk reduction measures	CmiA, BCI	3	3	3	3	2	1	3	18	0.58	✗	✗
18	**Percentage of farmers that use proper disposal methods for empty pesticide containers and contaminated materials including discarded pesticide application equipment**	Inadequate waste disposal is correlated to leakage of pesticides and hazardous chemicals into the environment; proper disposal of pesticide containers and application equipment minimizes the risk of environmental contamination	RISE, myBMP, CmiA, BCI, FT	3	2	3	3	1	1	3	16	0.69	✓	✓

	Sustainability indicator	Rationale	VSIs[1]	Indicator score							Selection criteria[2]			Indicator selected?
				Relevance	Usefulness			Feasibility						
				Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	

A) Environmental Sustainability

1) Pest and Pesticide Management

Human exposure

No.	Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
19	**Percentage of farmers with dedicated storage facilities that keep pesticides safely and out of reach of children**	Appropriate pesticide storage reduces the risk of contact with hazardous pesticides	myBMP, CmiA, BCI, FT	3	2	3	3	1	2	3	17	0.51		✓
20	**Percentage of farmers that use pesticides labelled according to national standards, in at least one national language**	Use of properly labelled pesticides provides an indication of appropriate pesticide use and management	myBMP, BCI, CmiA, FT	2	2	2	3	2	3	3	17	0.33		✓
21	**Percentage of farmers that use only pesticides that are nationally registered for use on cotton**	Pesticides that are registered have been formally assessed, and the requirements for their proper use determined	myBMP, CmiA, BCI	2	2	2	3	2	3	3	17	0.33		✓
22	**Existence of a time-bound IPM plan** (IPM plans should reference systematic scouting, pest control decisions that are based on thresholds for pest infestation and agro-ecological management practices that prevent the development, spread and persistence of pest populations)	The presence of an IPM programme provides an indication of the use of good pest management practices	FT, CmiA, BCI	2	1	3	3	2	3	1	15	0.19		✓
23	**Total area and percentage of cotton area involving vulnerable persons applying pesticides** (e.g. persons below the age of 18, pregnant and breastfeeding women; disaggregated by age and gender)	Vulnerable groups are especially at risk of severe consequences from pesticide exposure	COSA, myBMP, FT, CmiA, BCI	3	2	2	3	2	1	2	15	0.67	✓	✓
24	**Percentage of workers applying pesticides who have received training in handling and use**	The qualification level of workers applying pesticides reduces the risks associated with pesticide application	myBMP, FT, BCI, CmiA	3	3	2	2	2	2	2	16	0.51		✓
25	**Percentage of farmers having access to and using adequate protective equipment** (by type)	The use of adequate protective gear reduces the risks associated with pesticide application	SAFA, RISE, COSA, myBMP, FT, BCI	2	2	2	3	2	3	2	16	0.19		✓
26	**Frequency of pesticide applications within 10 m of ongoing human activity** (housing, canteens, offices, warehouses or similar)	Pesticide application in proximity to human activity exposes non-protected individuals with pesticides and hazardous chemicals	FT	3	3	3	3	1	1	2	16	0.96		✗
27	**Extent of aerial spraying carried out above or around human activities or open water sources**	Aerial spraying that exposes humans and water bodies to pesticides may have impacts on human health and the environment	FT	1	2	3	3	2	1	1	13	0.88		✗
28	**Percentage of pesticide applications in locally suitable meteorological conditions**	Pesticide application in unsuitable meteorological conditions may increase the amount of off-site pesticide movement	myBMP, BCI	3	3	3	3	2	1	2	17	0.77		✗

A) Environmental Sustainability

1) Pest and Pesticide Management

Human exposure

No.	Sustainability indicator	Rationale	VSIs[1]	Relevance: Cotton	Usefulness: Comparability	Usefulness: Significance	Usefulness: Logic	Feasibility: Cost	Feasibility: Accessibility	Feasibility: Accuracy	Selection criteria[2]: Total score	Selection criteria[2]: Balance	Selection criteria[2]: Expert ex-/Inclusion	Indicator selected?
29	**Number of pesticide applications per season**	Provides an indication of worker total potential exposure to pesticides	myBMP	1	3	3	3	2	2	2	16	1.00		✗
30	**Are protective gear, application and mixing equipment decontaminated in an adequate way and at a suitable frequency as recommended**	Contaminated protective gear, mixing and application equipment can be a source of human pesticide exposure	myBMP	3	2	3	3	2	3	2	18	0.33	✗	✗
31	**Percentage of farmers that possess adequate emergency equipment to provide first aid** (e.g. treating wounds or pesticide spills/exposure)	Emergency equipment may greatly reduce the severity and health consequences of accidents at work	FT, myBMP, BCI	2	1	2	2	2	2	2	13	0.19		✗

2) Water Management

Water depletion

No.	Sustainability indicator	Rationale	VSIs[1]	Relevance: Cotton	Usefulness: Comparability	Usefulness: Significance	Usefulness: Logic	Feasibility: Cost	Feasibility: Accessibility	Feasibility: Accuracy	Selection criteria[2]: Total score	Selection criteria[2]: Balance	Selection criteria[2]: Expert ex-/Inclusion	Indicator selected?
32	**Quantity of water used for irrigation** (m^3/ha)	Provides a measure of the amount of water used per ha, which can give an indication of productivity and water depletion	SAFA, RISE, FTM, myBMP, BCI	3	3	2	3	2	1	3	17	0.51		✓
33	**Irrigation use efficiency** (%)	When used with country-specific benchmarks, irrigation use efficiency may provide an indication of the relative performance	myBMP, RISE	3	3	2	3	1	1	3	16	0.69	✓	✓
34	**Groundwater table level** (m from the surface)	Provides an indication of the state of groundwater resources and water depletion (monitoring over time is needed)	RISE, myBMP	2	3	2	2	2	3	2	16	0.19		✓
35	**Total volume and percentage of surface water used for irrigation**	Provides an indication of the relative use by cotton production of irrigation water	RISE	3	2	2	2	1	1	2	13	0.84		✗
36	**Total area and percentage of cotton production area under irrigation by type of irrigation**	Provides an indication of the adoption of different types of irrigation	myBMP	2	3	2	3	3	3	3	19	0.51	✗	✗
37	**Ratio of the recharge rate of groundwater aquifer (m^3/year) to the groundwater extraction per year** (m^3/year)	Measures the impact of water withdrawal on groundwater tables, taking into account the degree of groundwater recharge		3	3	2	3	1	1	2	15	0.88		✗

Crop water management

No.	Sustainability indicator	Rationale	VSIs[1]	Relevance: Cotton	Usefulness: Comparability	Usefulness: Significance	Usefulness: Logic	Feasibility: Cost	Feasibility: Accessibility	Feasibility: Accuracy	Selection criteria[2]: Total score	Selection criteria[2]: Balance	Selection criteria[2]: Expert ex-/Inclusion	Indicator selected?
38	**Percentage of area under water conservation practices** (based on the context, e.g. conservation tillage, mulching, enhanced irrigation scheduling and uniformity, contour bunds and terracing, inclusion of less water-demanding crops/varieties in rotations, compost application etc.)	The presence of water conservation practices provides an indication of the use of appropriate water management practices	COSA, myBMP, BCI	2	2	1	2	2	3	2	14	0.33		✓

Sustainability indicator	Rationale	VSIs[1]	Indicator score							Selection criteria[2]			Indicator selected?
			Relevance	Usefulness			Feasibility						
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	

A) Environmental Sustainability

2) Water Management

Crop water management

No.	Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
39	**Crop water use productivity** (m^3 of water per tonne of cotton lint)	When used with country-specific benchmarks, crop water productivity may provide an indication of the relative performance	FTM, myBMP	3	3	2	3	1	1	3	16	0.69	✓	✓
40	**Marginal crop water productivity** (m^3 of water per tonne of cotton lint)	The growth in cotton production quantities due to the last applied m^3 of water indicates whether a marginal reduction in water consumption would be associated with strong production disadvantages	FTM	3	3	2	2	1	1	3	15	0.67		✗
41	**Salinity of soil and irrigation water** (measured by the electrical conductivity [EC] in deciSiemens [dS] per metre)	High levels of irrigation water salinity decrease crop yields, while very low concentrations reduce water infiltration which indirectly affects the crop	RISE, myBMP	2	3	1	2	2	3	3	16	0.38		✓
42	**Percentage and total cotton production area managed under a water management plan** (specifying amount and timing of irrigation, estimation of Plant Available Water Content [PAWC] and Readily Available Water [RAW])	Provides an indication of the implementation of appropriate water management	myBMP, BCI, RISE	2	1	2	3	2	2	1	13	0.19		✗
43	**Percentage of farmers trained in measures of water management**	The existence of training on water management provides an indication of the use of appropriate water management practices	FT	1	1	1	1	2	2	1	9	0.38		✗

Soil salinization

No.	Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
44	**Salinity of soil and irrigation water** (measured by the electrical conductivity [EC] in deciSiemens [dS] per metre)	High levels of irrigation water salinity decrease crop yields, while very low concentrations reduce water infiltration which indirectly affects the crop	RISE, myBMP	2	3	2	3	2	3	3	18	0.38		✓
45	**Quantity of water used for irrigation** (m^3/ha)	Volume of water used per hectare together with levels of salinity of irrigation water provide an indication of risk of soil salinity	SAFA, RISE, FTM, myBMP, BCI	3	3	2	3	1	1	3	16	0.69		✗
46	**Total area and percentage of cotton production area under irrigation by type of irrigation**	The type of irrigation applied can affect the distribution and amount of salts deposited	myBMP	2	3	2	3	3	3	3	19	0.51	✗	✗
47	**Percentage and total cotton production area managed under a water management plan** (specifying amount and timing of irrigation, estimation of Plant Available Water Content [PAWC] and Readily Available Water [RAW])	The presence of a water management plan may indicate reduced exposure to salinization	myBMP, BCI, RISE	1	1	3	3	1	3	1	13	0.67		✗
48	**Irrigation use efficiency** (%)	When used with region-specific benchmarks, irrigation use efficiency may provide an indication of the amount of salts delivered to the soil	myBMP, RISE	3	3	2	3	1	1	3	16	0.69		✗

Sustainability indicator	Rationale	VSIs[1]	Indicator score							Selection criteria[2]			Indicator selected?
			Relevance	Usefulness			Feasibility						
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	

A) Environmental Sustainability

2) Water Management

Water quality

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
49 **Quality of discharge water** (based on context conditions this can include acidity, pH, Chemical Oxygen Demand [COD], Total Organic Carbon [TOC], Biochemical Oxygen Demand [BOD], faecal coliforms, salinity, nitrates, metals, phosphorus, total solids, temperature, turbidity)	The monitoring of water quality parameters offers a direct evaluation of water quality	SAFA, RISE, COSA	2	2	2	2	2	3	2	15	0.19		✓
50 **Extent that riparian vegetation is retained and protected**	Riparian vegetation contributes to the functioning of the overall ecosystem, including water quality	myBMP, RISE	2	1	2	2	2	2	2	13	0.19		✗
51 **Existence of waste water discharge control practices**	The presence of waste water discharge control practices may provide an indication of the use of appropriate waste water management practices, and reduced risk of water eutrophication and pollution	RISE	1	2	1	2	2	3	2	13	0.67		✗
52 **Percentage of pesticide applications in locally suitable meteorological conditions**	Pesticide application in unsuitable meteorological conditions may increase the amount of off-site pesticide movement	myBMP BCI	2	2	2	2	2	3	2	15	0.19	✗	✗
53 **Percentage of water bodies separated from cotton fields by buffer stripes**	Buffer stripes may diminish the amount of sediment, nutrients and contaminants that end up in surface waters	RISE, FT	2	2	2	2	1	2	2	13	0.19		✗

3) Soil Management

Soil fertility

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
54 **Soil organic matter content**	A measure of soil health	RISE, Organic myBMP COSA	2	3	3	3	2	3	3	19	0.51		✓
55 **Soil sampling of N, P, K concentration**	Soil samples, when compared with region-specific benchmarks, provide an indication of soil fertility	RISE, myBMP	3	3	3	3	1	2	3	18	0.58		✓
56 **Use of soil sampling for N, P, K** (% of farmers)	Soil sampling by farmers supports targeted fertilization rates and helps minimize overfertilization		3	2	3	3	1	2	3	17	0.51		✓
57 **Soil pH**	Soil pH can provide an indication of the presence of microfauna within the soil	RISE	3	3	3	2	1	1	3	16	0.69	✓	✓
58 **Average yield** (tonnes of cotton lint/ha)	Average yield trends can provide a proxy for soil fertility	RISE, FTM, COSA, BCI	2	3	2	3	1	2	3	16	0.38	✗	✗
59 **Fertilizer used by type** (kg/ha)	Quantity and type of fertilizer applied can provide an indication of integrated soil fertility (especially if compared to country-specific benchmarks)	RISE, BCI, myBMP COSA	2	3	3	3	2	3	2	18	0.51		✓

#	Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance	Usefulness			Feasibility			Selection criteria[2]			Indicator selected?
				Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	

A) Environmental Sustainability

3) Soil Management

Soil fertility

#	Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
60	**Quality of discharge water** (based on context conditions this can include acidity, pH, Chemical Oxygen Demand [COD], Total Organic Carbon [TOC], Biochemical Oxygen Demand [BOD], faecal coliforms, salinity, nitrates, metals, phosphorus, total solids, temperature, turbidity)	Elevated concentrations of nutrients and organic matter in discharge water from cotton production areas may indicate inefficient and environmental harmful methods of soil management; in aquatic ecosystems this may cause algal blooms/red tides, fish kills and reduce the microbiological quality and biodiversity	SAFA, RISE, COSA	2	2	2	2	2	3	2	15	0.19	✗	✗
61	**Ratio of nutrient supply and demand at farm or field level** (especially for nitrogen and phosphorus)	Nutrient supply and demand (and its corresponding ratio) provide a measure of soil health	SAFA, RISE, COSA	3	3	2	3	1	1	3	16	0.69		✗
62	**Percentage of on-farm N and P self-sufficiency**	Nutrient self-sufficiency at farm level is one element of an integrated farming system	RISE, COSA	2	2	2	2	1	1	2	12	0.38		✗
63	**Total and percentage of cotton area benefiting from manuring** (recycling of local nutrients)	The use of compost provides an indication of the presence of management practices that promote soil fertility	RISE, Organic, myBMP, COSA	2	1	1	1	2	2	1	10	0.51		✗
64	**Soil physical structure: share of the utilized land characterized by good conditions of soil physical structure in consideration of the local climate and bedrock**	Soil physical structure is an important determinant of permeability and water-holding capacity of soils, which in turn influences fertility	SAFA, myBMP, BCI	2	1	3	3	3	2	1	15	0.19	✗	✗
65	**Soil biological quality: share of the utilized land characterized by high biological soil quality in consideration of the local climate and bedrock**	The presence of diverse soil organisms ensures a working soil food web contributing to nutrient cycling and soil fertility	SAFA, Organic	2	1	3	3	3	2	1	15	0.19	✗	✗
66	**Share of cultivated cotton area for which a fertilizer budget is prepared to optimize nutrient inputs, taking account of nutrient availability and removal from crops**	Specifically targeted fertilization rates guarantee adequate nutrient availability and minimize overfertilization	myBMP, BCI, COSA, RICE	2	1	3	3	2	2	2	15	0.19	✗	✗
67	**Percentage of farmers trained in fertilizer use**	The presence of training on fertilizer use may provide an indication of the use of appropriate fertilizer management practices	FT	1	1	1	1	2	2	1	9	0.38		✗

Soil erosion

#	Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
68	**Percentage of area under soil erosion control and minimum/conservation tillage practices** (including various forms of soil conservation, crop residue management, conservation agriculture, agroforestry, ridges, contour bunds, use of terraces and ditches)	Soil erosion and prevailing tillage practices are strong determinants of soil organic matter and soil fertility	SAFA, COSA, Organic, myBMP, CmiA, BCI	2	1	3	3	2	3	1	15	0.19		✓

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance – Cotton	Usefulness – Comparability	Usefulness – Significance	Usefulness – Logic	Feasibility – Cost	Feasibility – Accessibility	Feasibility – Accuracy	Selection criteria[2]: Total score	Balance	Expert ex-/Inclusion	Indicator selected?
A) Environmental Sustainability													
3) Soil Management													
Soil erosion													
69 **Total amount of soil lost annually through erosion** (kg/ha) **and share of land subject to erosion**	Provides a direct measure of soil erosion	SAFA, RISE, FTM, COSA	3	3	1	3	1	1	2	14	0.84		✗
70 **Percentage of farmers trained to manage soil erosion**	Provides an indication of the capacity to manage soil erosion	FT	1	1	2	1	2	2	1	10	0.33		✗
71 **Ratio of net loss to net gain of productive land: What is the ratio between rehabilitated land and degraded land in your operations?**	Provides a direct measure of the net change in productive land	SAFA	2	1	2	2	1	2	1	11	0.33		✗
4) Land Use and Biodiversity													
Land conservation													
72 **Total area and percentage of natural vegetation converted for cotton production** (ha)	Direct measure of land conversion	SAFA, RISE, COSA, Organic, myBMP, CmiA, BCI	1	3	1	1	3	2	3	14	0.84	✓	✓
73 **Percentage of total farm area that is non-cropped** (buffer zones, set aside areas etc)	Non-cropped farm areas may indicate low pressure for converting land	RISE, COSA	1	1	2	2	2	2	2	12	0.51	✓	✓
Land productivity													
74 **Average yield** (tonnes of cotton lint/ha)	Average yield is a direct measure of land productivity, indicates the degree of land use efficiency and land productivity	RISE, FTM, COSA, BCI	2	3	2	3	1	2	3	16	0.38		✓
75 **Average number of cotton and other crops per 5-year period** (including cotton itself and intercropping)	Crop rotation can provide an indication of soil health and corresponding pressure for land conversion	RISE, Organic, CmiA	2	3	2	3	2	2	3	17	0.33		✓
76 **Soil sampling of N, P, K concentration**	Soil sampling (especially over time) provides an indication of changes in soil health and productivity	RISE, myBMP	3	3	3	3	1	2	3	18	0.58	✗	✗
77 **Soil organic matter content**	Percentage of organic matter provides an indication of soil health and land productivity and may be an indicator of marginal farming land	RISE, Organic, myBMP, COSA	2	3	3	3	1	3	3	18	0.51	✗	✗
78 **Share of planted area not harvested and share of harvested quantity lost as waste in farm operations**	High levels of crop loss contribute to low land productivity	SAFA, myBMP, BCI	1	2	2	2	2	2	2	13	0.58		✗

A) Environmental Sustainability

4) Land Use and Biodiversity

Biodiversity

	Sustainability indicator	Rationale	VSIs[1]	Relevance: Cotton	Usefulness: Comparability	Usefulness: Significance	Usefulness: Logic	Feasibility: Cost	Feasibility: Accessibility	Feasibility: Accuracy	Selection criteria[2]: Total score	Selection criteria[2]: Balance	Selection criteria[2]: Expert ex-/Inclusion	Indicator selected?
79	**Total area and percentage of natural vegetation converted for cotton production** (ha)	The conversion of natural and near natural ecosystems may be associated with decreases in biodiversity	SAFA, RISE, COSA, Organic, myBMP, CmiA, BCI	2	3	1	1	3	2	3	15	0.51		✓
80	**Percentage of total farm area that is non-cropped** (buffer zones, set aside areas etc)	The conversion of natural and near natural ecosystems may be associated with decreases in biodiversity	RISE, COSA	1	2	3	3	2	2	1	14	0.84	✓	✓
81	**Quantity of active ingredients in pesticides used** (kg/ha)	The use of pesticides may decrease biodiversity	myBMP BCI, RISE	2	2	3	3	2	2	2	16	0.38	✗	✗
82	**Quantity of active ingredients in highly hazardous pesticides used** (kg/ha)	The use of highly hazardous pesticides may decrease biodiversity	BCI, myBMP, RISE	3	3	3	3	2	2	3	19	0.38	✗	✗
83	**Number of pesticide applications per season**	High annual application frequencies/regularity of application may prevent the regeneration of non-target plants and organisms and reduce biodiversity	myBMP	2	2	2	3	2	2	2	15	0.19	✗	✗
84	**Percentage of cotton area under IPM**	The presence of an IPM programme provides an indicator of the use of good pest management practices, which may have positive effects on biodiversity		3	1	3	3	2	3	1	16	0.51	✗	✗
85	**Percentage of area covered by border trees and overstory on farm**	The percentage and degree of overstory on farm may provide an indicator of the conservation of natural habitats, which may have positive effects on biodiversity	COSA	3	2	1	2	2	3	2	15	0.67		✗
86	**Soil organic matter content**	The presence of organic matter can affect the presence of micro-organisms within soil, which may positively contribute to biodiversity	RISE, Organic, myBMP, COSA	2	3	3	3	1	3	3	18	0.51	✗	✗
87	**Percentage of farmers receiving training on biodiversity protection**	The presence of training on biodiversity protection may provide an indicator of the capacity to implement conservation practices	FT	1	1	1	1	2	2	1	9	0.38		✗
88	**Average number of species found in habitats within sphere of influence**	Provides a measure of species diversity which constitutes an element of biodiversity	SAFA	3	1	2	1	1	3	3	14	0.84		✗
89	**Fish kills attributed to cotton pesticides or % of fish mortality linked to cotton pesticides**	Fish kills may indicate poor application management practices and environmental contamination by pesticides	myBMP	3	3	1	3	1	1	2	14	0.84		✗

Sustainability indicator	Rationale	VSIs[1]	Indicator score							Selection criteria[2]			Indicator selected?
			Relevance	Usefulness			Feasibility			Total score	Balance	Expert ex-/Inclusion	
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy				

A) Environmental Sustainability

4) Land Use and Biodiversity

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
90 **Average number of cotton and other crops per 5-year period** (including cotton itself & intercropping)	A higher number of different crops identifies a diversified agricultural landscape	RISE, Organic, CmiA	2	3	3	2	2	1	2	15	0.51		✓
91 **Number of hectares and percentage of total area cultivated as GMO crop**	Provides an indication of the adoption of biotechnology	Organic, FT, CmiA	1	3	2	2	1	2	3	14	0.69		✗
92 **Share of cotton production from others than the most common genetic lineage/breed**	A higher number of different varieties might indicate higher intra-varietal genetic variability (agro-biodiversity)	SAFA	2	3	3	2	2	1	2	15	0.51	✗	✗
93 **Locally adapted and traditional varieties and breeds: What is the share of production accounted for by locally adapted varieties/breeds and by rare and traditional (heirloom) varieties and breeds**	The cultivation of local and traditional varieties prevents their extinction and promotes additional environmental services as compared to pure conservation in genebanks	SAFA	2	2	1	2	2	2	2	13	0.19		✗
94 **Ecosystem connectivity: What share of the natural and semi-natural ecosystems in your operation are connected with similar ecosystems (within and adjacent to your operation's borders) in a way that allows an exchange between populations of key species**	The presence and conservation of natural corridors contributes to habitat conservation for species	SAFA, RISE	2	1	2	2	2	2	1	12	0.19		✗
95 **Riparian vegetation is retained and protected**	Riparian vegetation contributes to the functioning of the overall ecosystem, including water quality	myBMP	2	1	2	2	2	2	2	13	0.19		✗

5) Climate Change

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
96 **GHG emission and carbon sequestration per cotton lint and/or ha** (CO_2-e)	Provides a per unit measure of the balance of GHG emissions and carbon sequestration	SAFA, RISE, FTM	1	3	2	3	1	1	2	13	0.88	✓	✓
97 **Total emission reduction by and efficacy rating of GHG mitigation measures, including carbon sequestration by soils and vegetation, and carbon offset schemes**	Provides a measure of net emission reductions	SAFA, FT	3	2	1	3	1	2	2	14	0.69		✗

A) Environmental Sustainability

5) Climate Change

Decomposition and mineralization

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance – Cotton	Usefulness – Comparability	Usefulness – Significance	Usefulness – Logic	Feasibility – Cost	Feasibility – Accessibility	Feasibility – Accuracy	Selection criteria[2]: Total score	Balance	Expert ex-/Inclusion	Indicator selected?
98 **Fertilizer used by type** (kg/ha)	Volume of fertilizers used is directly linked to emissions of N_2O and CO_2 through application and production (specifications in tonnes of N, Urea, P_2O_5 and $CaCO_3$ per ha needed)	RISE, BCI, myBMP, COSA	2	3	3	3	2	3	2	18	0.51	✗	✗
99 **Percentage of area affected by waterlogging longer than 20 days** (usually n.a. in cotton)	Waterlogged soil may result in methane emissions	RISE	1	3	2	2	2	1	3	14	0.69		✗

Carbon stock changes

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance – Cotton	Usefulness – Comparability	Usefulness – Significance	Usefulness – Logic	Feasibility – Cost	Feasibility – Accessibility	Feasibility – Accuracy	Selection criteria[2]: Total score	Balance	Expert ex-/Inclusion	Indicator selected?
100 **Total area and percentage of natural vegetation converted for cotton production** (ha)	Deforested area reduces carbon stocks through soil carbon losses and losses in biomass, while the conversion of other types of vegetation may have similar impacts	SAFA, RISE, COSA, Organic, myBMP, CmiA, BCI	1	3	2	3	2	2	3	16	0.88		✗
101 **Percentage of total farm area that is non-cropped** (buffer zones, set aside areas etc)	Non-cropped farm areas may be correlated to natural areas with higher levels of biomass	RISE, COSA	1	1	1	1	1	2	1	8	0.19		✗
102 **Percentage of area covered by border trees and overstory on farm**	Trees at the margin and within the farm plot (e.g. shear nut trees) store additional carbon in their biomass	COSA	1	2	2	1	2	3	2	13	0.67		✗
103 **Percentage of area affected by residue burning**	Burning of crop residues reduces soil carbon levels and causes the release of CO_2 from biomass		1	3	2	3	2	1	3	15	0.84		✗
104 **Percentage of area managed under advanced management practices** (precision agriculture, improved nutrient management, improved crop rotation, reduced tillage, residue mulching, cover crops, IPM, investment in energy-efficient machinery)	Improved management practices can reduce GHG emissions	Organic, FT	2	1	1	2	2	2	1	11	0.33		✗

Energy use

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance – Cotton	Usefulness – Comparability	Usefulness – Significance	Usefulness – Logic	Feasibility – Cost	Feasibility – Accessibility	Feasibility – Accuracy	Selection criteria[2]: Total score	Balance	Expert ex-/Inclusion	Indicator selected?
105 **Amount of other artificial inputs** (tonnes/ha) (pesticides, herbicides, fungicides etc.)	Volumes of artificial inputs applied translate into indirect CO_2 emissions from production, storage and transport		3	3	2	2	2	2	3	17	0.38	✗	✗
106 **On-farm energy use per tonne of cotton lint and/or ha** (GJ)	Fossil fuel and energy used per area or quantity produced provides a measure of energy intensity of production and production efficiency	SAFA, RISE, FTM, myBMP, FT, COSA	2	3	2	3	1	1	2	14	0.67	✓	✓

A) Environmental Sustainability

5) Climate Change

Energy use

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance	Indicator score: Usefulness			Indicator score: Feasibility			Selection criteria[2]			Indicator selected?
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	
107 **Existence of recycling**	The existence of recycling may provide an indication of advanced waste management and waste reuse that decreases resource use intensity and thus contributes to avoiding GHG emissions	SAFA, COSA, FT	1	3	1	2	2	2	2	13	0.58		✗
108 **Percentage of recycling of total material inputs**	The existence of recycling may provide an indication of advanced waste management and waste reuse that decreases resource use intensity and thus contributes to avoiding GHG emissions	SAFA	1	3	2	2	1	1	3	13	0.67		✗

B) Economic Sustainability

6) Economic Viability, Poverty Reduction and Food Security

Economic viability

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance	Indicator score: Usefulness			Indicator score: Feasibility			Selection criteria[2]			Indicator selected?
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	
109 **Average annual net income from cotton production** (per ha and per farmer, or per person-day)	Average annual incomes per unit provide an indication of poverty when compared with average national incomes	SAFA, RISE, COSA, BCI	3	3	2	3	1	2	3	17	0.51		✓
110 **Average yield** (tonnes/ha of cotton lint)	Average yields are one determinant of production efficiency and the economic viability of cotton production systems	RISE, FTM, COSA, BCI	2	3	2	3	1	2	3	16	0.38	✗	✗
111 **Price received per tonne of cotton lint at farmgate**	Product prices are one determinant of economic viability of cotton production systems	COSA	2	3	2	2	1	2	3	15	0.19		✓
112 **Returns above variable costs per hectare and tonne of cotton lint**	Returns above variable costs are an important indicator of the profitability and economic viability of cotton production systems	FTM	3	2	3	3	2	2	2	17	0.51		✓
113 **Returns on investment**	The return on investments provides a measure of the economic viability of cotton production systems	RISE	2	3	2	3	1	1	3	15	0.51		✓
114 **Debt to asset ratio**	The debt to asset ratio may indicate the long-term economic viability of cotton production systems	RISE, FTM	2	3	3	3	2	1	2	16	0.69	✓	✓
115 **Total value and share of cotton production in regional and national agricultural GDP**	The share of cotton production systems in agricultural GDP provides an indication of the economic importance for a territory and may complement questions of economic viability	FTM	2	2	1	2	1	1	1	10	0.51		✗

B) Economic Sustainability

6) Economic Viability, Poverty Reduction and Food Security

Poverty reduction

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance	Usefulness			Feasibility			Selection criteria[2]			Indicator selected?
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	
116 **Number and percentage of household members living below the national poverty line**	The headcount ratio is a direct measure of the extent of poverty	RISE, COSA	2	2	3	3	1	1	3	15	0.51		✓
117 **Number and percentage of household members with a daily income of < USD 1.25 and < USD 2** (PPP)	The headcount ratio is a direct measure of the extent of poverty		2	2	3	3	1	1	3	15	0.51	✗	✗
118 **Poverty gap of members from cotton-producing households at national poverty line**	The poverty gap is a measure for the intensity of poverty	RISE	2	2	2	2	1	1	2	12	0.38		✗
119 **Poverty gap at USD 1.25 and USD 2 a day** (PPP) **of members from cotton-producing households**	The poverty gap is a measure for the intensity of poverty		2	2	2	2	1	1	2	12	0.38		✗
120 **Percentage of farmers/workers with access to productive resources** (subdifferentiated by land, water, inputs etc.)	Access to productive resources determines whether the economically most viable production methods are available to the household and indicates poverty	SAFA	3	1	3	3	1	1	1	13	1.02	✓	✓
121 **Average value of assets per producer household** (sum of land, real estate, machinery, livestock etc.)	Asset values per household may provide an indication of poverty when compared with regional norms	COSA	3	2	2	2	2	3	3	17	0.51		✓
122 **Percentage of producer households with a specific asset** (bicycle, mobile phone etc.)	The presence of specific assets may provide an indication of buying power		2	2	2	2	2	3	3	16	0.38		✓
123 **Financial amounts invested by farmers, producer groups, partners in community and social development, organizational and capacity-building, infrastructure development etc.**	Investment in social development provides an indication of capital flows to farmers, which may reduce poverty	SAFA, COSA, FT	2	1	1	2	2	2	2	12	0.38		✗
124 **Perception of change in economic situation over last 5 years** (% of farmers)	Provides an indication of perceived change in wealth and/or well-being	COSA	2	2	3	3	2	2	2	16	0.38		✓

Food security

Sustainability indicator	Rationale	VSIs[1]	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
125 **Total number and percentage of cotton-farming household members with calorie intake below the international norm**	Proportion of the population estimated to be at risk of caloric inadequacy	RISE, COSA	2	2	2	3	2	1	2	14	0.33		✓

Sustainability indicator	Rationale	Indicator score								Selection criteria[2]			Indicator selected?
		VSIs[1]	Relevance	Usefulness			Feasibility						
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	
B) Economic Sustainability													
6) Economic Viability, Poverty Reduction and Food Security													
Food security													
126 **Average Dietary Supply Adequacy of cotton-farming household members**	The indicator expresses the Dietary Energy Supply (DES) as a percentage of the Average Dietary Energy Requirement (ADER)		2	2	3	3	1	1	2	14	0.67		✕
127 **Depth of the Food Deficit** (concerning food-deficient cotton-farming household members)	The depth of the food deficit indicates how many calories would be needed to lift an individual out of food deficiency		2	2	3	3	1	1	2	14	0.67		✕
128 **Per capita food supply variability of members from cotton-producing households** (standard deviation of the average food supply)	Variable food supply may indicate periods of food insecurity or the extent of the risk of food insecurity		2	1	2	2	1	1	2	11	0.33		✕
129 **Share of food expenditure in producers' total household expenditure**	The share of expenditure for food gives in low-income countries an indication of the living standard as well as the vulnerability to food price increases and variability		2	2	1	1	1	2	2	11	0.33		✕
130 **Percentage of children in cotton-producing households under 5 years of age who are stunted**	Stunting describes the condition that a child's height-for-age is lower than 2 standard deviations of the WHO Child Growth Standards median; under most conditions it is caused by food insecurity		2	2	2	2	1	1	2	12	0.38		✕
131 **Percentage of children in cotton-producing households that are under 5 years of age affected by wasting**	Wasting describes the condition that a child's weight-for-height is lower than 2 standard deviations of the WHO Child Growth Standards median; under most conditions it is caused by food insecurity		2	2	2	2	1	1	2	12	0.38		✕
132 **Percentage of children in cotton-producing households under 5 years of age who are underweight**	Underweight describes the condition that a child's weight-for-age is lower than 2 standard deviations of the WHO Child Growth Standards median; under most conditions it is caused by food insecurity		2	2	3	3	1	2	2	15	0.51	✕	✕
133 **Percentage of adults in cotton-producing households who are underweight**	Adults underweight is defined by a Body Mass Index (weight/squared height) below the international reference standard of 18.5; it may indicate situations of food insecurity		2	2	2	2	1	2	3	14	0.00	✕	✕
134 **Share and market value of food produced by the household per household member**	The average food production per household indicates whether a bigger share of the household's food requirements can be covered by its own sources; in the case of absence of other cash revenue it can provide an important indicator for vulnerability to food insecurity		2	2	2	2	1	1	2	12	0.38		✕
135 **Share of dietary energy supply of producer households derived from cereals, roots and tubers**	Healthy diets are characterized by variability in composition; diets with a strong tendency to comprise exclusively cereals, roots and tubers are very likely caused by food insecurity		2	2	2	2	1	1	2	12	0.38		✕

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance – Cotton	Usefulness – Comparability	Usefulness – Significance	Usefulness – Logic	Feasibility – Cost	Feasibility – Accessibility	Feasibility – Accuracy	Selection criteria[2]: Total score	Balance	Expert ex-/Inclusion	Indicator selected?

B) Economic Sustainability

6) Economic Viability, Poverty Reduction and Food Security

Food security

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
136 Average protein supply of producer households per day and per household member	Protein-insufficient diets are very likely caused by food insecurity and indicate poor nutritional status of a household		2	2	2	2	1	1	2	12	0.38		✗
137 Domestic Food Price Level Index	The Domestic Food Price Level Index is calculated by dividing the Food Purchasing Power Parity (FPPP) by the General PPP, thus providing an index of the price of food in the country relative to the price of the generic consumption basket		2	2	1	1	3	3	2	14	0.67		✗
138 Number of days with food deficiency per annum in cotton-producing households	Provides a measure of food security	COSA	3	2	2	2	2	2	2	15	0.58		✓

7) Economic Risk Management

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
139 Cotton yield volatility	Yield volatility provides an indication of potential cash shortfalls, which can increase liquidity risk	COSA	2	2	2	3	1	2	3	15	0.19		✓
140 Farmgate cotton price volatility	High volatility in prices is a major cause of economic risk for producers	COSA	2	3	2	1	2	2	3	15	0.19		✓
141 Percentage of farmers with measures in place to manage price risks by type	Missing risk management strategies for price volatility increase the negative impacts of fluctuating prices	SAFA	2	2	3	2	2	1	2	14	0.33		✓
142 Percentage of total household income that the largest income source represents	Provides an indicator for economic vulnerability in the case of shocks to the main income source	RISE, COSA	3	2	3	3	2	1	2	16	0.69	✓	✓
143 Average number of days after sale that farmers receive payment	Timely payment reduces the risk of farmers engaging in non-beneficial coping strategies when facing cash constraints		2	3	2	3	2	2	3	17	0.33		✓
144 Percentage of farmers with access to equitable credit	Access to credit provides an indication of a farmer's ability to invest in their farm and withstand a liquidity crisis	COSA, FT	2	3	3	3	2	2	3	18	0.51		✓
145 Percentage of farmers showing understanding of the factors involved in price formation or with daily access to international and domestic prices	Access to market information provides an indication of a farmer's ability to analyse and adapt to changing market conditions, which can affect risk management	COSA, CmiA, FT	2	1	2	2	2	1	1	11	0.33	✓	✓
146 Frequency of liquidity crisis	Provides a proxy for a farmer's ability to manage risk	SAFA	3	2	1	3	1	1	2	13	0.84		✗
147 Number of actual and alternative buyers	Provides a proxy for the risk of marketing and income problems in the case of loss of selected buyers	SAFA	3	3	3	3	2	1	2	17	0.77		✗

Sustainability indicator	Rationale	VSIs[1]	Indicator score							Selection criteria[2]			Indicator selected?
			Relevance	Usefulness			Feasibility						
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	

C) Social Sustainability

8) Labour Rights and Standards

Employment conditions

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
148 **Share of inputs coming from biggest supplier**	Provides a proxy of the stability of supply	SAFA	2	2	2	2	1	2	2	13	0.19		✗
149 **Total annual production costs for cotton per hectare**	High production costs may contribute to economic risk	COSA, SAFA, RISE	2	1	2	2	2	2	2	13	0.19		✗

Child labour

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
150 **Percentage of children attending and completing appropriate level of school** (disaggregated by gender; age 5–12 attending school; age 12–15 completed primary)	Provides a measure of the proportion of children attending school	COSA	3	3	2	2	2	2	3	17	0.38		✓
151 **Access to primary education for all children**	Provides an indication of the amount of children attending school	RISE	2	2	1	1	2	1	1	10	0.38		✗
152 **Number of child labourers** (disaggregated by age and gender)	Direct indicator of child labour	SAFA, RISE, COSA, Organic, FT, CmiA, BCI	3	3	2	3	2	1	1	15	0.88	✓	✓

Employment conditions

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
153 **Share of workers with enforceable employment contract** (disaggregated by age and gender)	Provides an indicator of the extent of protection of workers afforded by labour laws and norms	SAFA, RISE, FT, CmiA, BCI	2	3	2	3	2	2	3	17	0.33		✓
154 **Percentage of farm workers who are paid a minimum or living wage and who always receive their full wage in time** (disaggregated by age and gender)	The share of workers benefiting from a living wage indicates one aspect of decent employment	SAFA, COSA, FT, CmiA, BCI	1	2	3	3	2	2	3	16	0.88	✓	✓
155 **Number of human rights abuses**	Direct indicator of human rights violation	Organic	1	2	3	3	1	1	2	13	0.88		✗
156 **Number of incidents of corporal punishment, mental or physical coercion or verbal abuse**	Direct indicator of human rights violation	FT, BCI	2	1	2	3	1	1	2	12	0.38		✗
157 **Total number and percentage of workers being subordinated by forced labour**	Direct indicator of forced labour	SAFA, RISE, Organic, FT, CmiA, BCI	2	2	3	3	2	1	2	15	0,51		✓

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance	Usefulness			Feasibility			Selection criteria[2]			Indicator selected?
			Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	

C) Social Sustainability

8) Labour Rights and Standards

Employment conditions

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
158 **Percentage of workers and farmers with access for dispute settlement to an independent court with enforcement power**	The access to a forum for dispute settlement is a precondition for fair dispute settlement and the possibility to enforce contracts	SAFA	2	2	2	2	2	2	2	14	0.00	✗	✗
159 **Can the enterprise show evidence of a prompt and responsible response to legal, regulatory, international human rights and voluntary code breaches, including detailed response on how the breach was remedied, how the effects of the breach will be restored or compensated and the policies and processes instituted to prevent further breaches**	Direct indicator of the presence of institutions that discourage, prevent and sanction the violation of basic rights and enforce their adherence	SAFA	2	1	3	3	1	1	1	12	0.69		✗
160 **Average working time per week (in hours) and total working days per year**	Indicator of working conditions	RISE, CmiA, BCI	2	2	3	3	2	2	1	15	0.51	✗	✗
161 **Average labour productivity of cotton farmers and cotton workers**	Labour productivity may be related to remuneration levels and thus contribute to decent employment	COSA	2	2	2	2	2	1	2	13	0.19		✗
162 **Existence of practices that make employment or housing conditional on the simultaneous employment of spouses or children**	Conditional contracts including other family members limits their personal freedom and bargaining position	FT, CmiA	2	1	2	2	2	1	1	11	0.33		✗
163 **Percentage of farmers/workers with effective access to health care facilities**	Access to health care facilities is a major determinant of living standards and well-being	COSA, CmiA, BCI	2	2	3	3	3	3	2	18	0.38		✓
164 **Percentage of farmers/workers with access to potable water**	Access to potable water is an important dimension of living standards and poverty	COSA, FT, BCI	2	2	2	2	2	3	3	16	0.38		✓
165 **Percentage of farmers/workers with access to sanitation facilities**	Existence and usage of proper maintained sanitation facilities reduces the transmission of diseases as well as pollution of water and other resources, which contributes to overall health and well-being	FT, BCI	2	2	2	2	2	3	1	14	0.00		✓

Freedom of association

Sustainability indicator	Rationale	VSIs	Cotton	Comparability	Significance	Logic	Cost	Accessibility	Accuracy	Total score	Balance	Expert ex-/Inclusion	Indicator selected?
166 **Share of farm workers that are free to form workers' organizations and participate in group negotiations of contracts**	Provides an indication of the ability of workers to exercise their labour rights	SAFA, RISE, Organic, FT, CmiA, BCI	1	1	2	2	2	1	2	11	0.38		✗

C) Social Sustainability

8) Labour Rights and Standards

Social protection

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance – Cotton	Usefulness – Comparability	Usefulness – Significance	Usefulness – Logic	Feasibility – Cost	Feasibility – Accessibility	Feasibility – Accuracy	Selection criteria[2]: Total score	Balance	Expert ex-/Inclusion	Indicator selected?
167 **Percentage of active cotton farmers and workers contributing to a pension scheme and/or eligible to receive a pension**	Direct indicator of social security coverage	SAFA, RISE	2	1	3	3	2	3	2	16	0.19		✓
168 **Percentage of cotton-farming households being covered by a health care insurance**	Direct indicator of social security coverage	BCI, SAFA, RISE, CmiA, COSA	2	2	3	3	2	2	2	16	0.38	✗	✗
169 **Percentage of cotton-farming households benefiting from income support in case of officially recognized extreme income shocks**	Direct indicator of social security coverage	RISE, SAFA	2	1	3	3	2	2	1	14	0.33		✓
170 **Percentage of employed women that have the right to maternity leave and to receive payments**	Direct indicator of social security coverage	FT, SAFA	2	1	3	3	2	2	1	14	0.33		✓

9) Occupational Health and Safety

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance – Cotton	Usefulness – Comparability	Usefulness – Significance	Usefulness – Logic	Feasibility – Cost	Feasibility – Accessibility	Feasibility – Accuracy	Selection criteria[2]: Total score	Balance	Expert ex-/Inclusion	Indicator selected?
171 **Percentage of farmers having access to and using adequate protective equipment (by type)**	The use of adequate protective gear reduces the risks associated with pesticide application	SAFA, RISE, COSA, myBMP, FT, BCI	2	2	2	3	2	3	2	16	0.19	✗	✗
172 **Annual non-fatal incidences on cotton farms** (total and percentage of workforce by age and gender)	Provides a measure of workers' health and safety	RISE, FTM, COSA	2	3	2	3	2	1	2	15	0.51		✓
173 **Number of total workdays lost due to non-fatal injuries**	Provides an approximate measure of the severity of non-fatal injuries as well as the associated economic consequences	FTM	2	2	2	1	2	1	2	12	0.19		✗
174 **Total number of fatalities on cotton farms per year**	Provides a measure of workers' health and safety	RISE, FTM, COSA	2	3	2	3	2	1	2	15	0.51		✓
175 **Number of working days in which workers are exposed to dangerous processes, machinery and equipment**	Provides a measure of workers' exposure to risks of injury	FT	1	1	2	3	2	2	3	14	0.69		✗
176 **Percentage of farm personnel, consultants, contractors and relevant visitors that are briefed on the farm's hygiene and biosecurity practices and requirements**	Provides a measure of awareness of adequate safety behaviour and reduced risk of injury from hazards	SAFA, RISE, myBMP	2	1	2	2	1	1	2	11	0.33		✗

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance – Cotton	Usefulness – Comparability	Usefulness – Significance	Usefulness – Logic	Feasibility – Cost	Feasibility – Accessibility	Feasibility – Accuracy	Selection criteria[2]: Total score	Balance	Expert ex-/Inclusion	Indicator selected?
C) Social Sustainability													
9) Occupational Health and Safety													
177 **Percentage of farmers that systematically assess and register safety risks**	Risk screening and communication reduces the risk of work hazards	RISE, myBMP, FT, BCI	1	1	2	2	2	2	2	12	0.51		✗
178 **Percentage of farmers that possesses adequate emergency equipment to provide first aid** (e.g. treating wounds or pesticide spills/exposure)	Emergency equipment may greatly reduce the severity and health consequences of accidents at work	FT, myBMP, BCI	2	1	2	2	2	2	2	13	0.19		✗
10) Equity and Gender													
179 **Percentage of leadership roles held by women in a producers' or workers' group**	Provides a measure of gender equity	COSA, CmiA	2	3	2	1	2	3	3	16	0.38		✓
180 **Gender and age wage differentials for the same quantity of produce or the same type of work**	Provides a measure of gender equity	SAFA, RISE, COSA, Organic, FT, BCI	2	3	3	2	3	2	2	17	0.33		✓
181 **Equal participation of different producers (gender, ethnicity, social class) in training or skills development activities (participation rates as compared to share in population)**	Equal participation in central activities of individuals from various backgrounds signifies higher levels of social equity	SAFA, RISE, COSA, FT, CmiA, BCI	2	1	2	3	1	1	1	11	0.58		✗
182 **Percentage of women whose income from independent sources has increased/decreased**	Own control of an income source is a central determinant of equal economic and social opportunities and contributes to empowerment of women as a vulnerable group	CmiA	2	2	2	2	2	2	2	14	0.00		✓
183 **Percentage of women-headed households**	-	COSA, CmiA	3	2	2	1	2	1	3	14	0.69		✗
184 **Percentage of youth of cotton-producing households (15–24) in neither education nor employment**	Provides an indication of the state of youth inclusiveness and promotion		2	2	3	3	2	2	2	16	0.38	✗	✗
185 **Can actors involved in cotton production identify potential conflicts of interest with and among various stakeholder groups, and provide examples of resolution through collaborative dialogue, based on respect, mutual understanding and equal power**	The active participation of all stakeholders influenced by cotton production systems facilitates the active distribution of decision power	SAFA	1	1	2	2	1	1	1	9	0.38		✗

Sustainability indicator	Rationale	VSIs[1]	Indicator score: Relevance – Cotton	Usefulness – Comparability	Usefulness – Significance	Usefulness – Logic	Feasibility – Cost	Feasibility – Accessibility	Feasibility – Accuracy	Selection criteria[2]: Total score	Selection criteria[2]: Balance	Selection criteria[2]: Expert ex-/Inclusion	Indicator selected?
C) Social Sustainability													
10) Equity and Gender													
186 **Free, prior and informed consent: Is the enterprise aware of stakeholders' pre-existing access to land, water and resources, has it mapped this to the satisfaction of all affected stakeholders and agreed to take no action to reduce this access until it has fully informed stakeholders, negotiated on equal terms and provided for mutually agreeable compensation, sufficient to allow sustainable livelihoods?**	Non-formalized ownership and use rights of natural resources by indigenous communities, smallholder farmers or other actors that use formal land registers only to a limited extend can be easily not respected by more formal acting, profit-oriented entities	SAFA	1	1	2	2	1	2	1	10	0.33		✗
11) Farmer Organization													
187 **Number of farmers/workers who have attended training** (disaggregated by training type, age and gender)	Provides an indication of programmes in place to promote worker equity	SAFA, COSA, CmiA	2	3	3	2	2	2	2	16	0.38		✓
188 **Number of farmers/workers participating in democratic organizations** (disaggregated by age and gender)	The degree of organization of farmers may indicate to what extent farmers are organized and benefit from collective action and lower transaction costs	COSA, FT	3	3	2	2	3	3	3	19	0.38		✓
189 **Existence of on-farm and off-farm management procedures and instruments (e.g. risk management, environmental impact assessment) to identify and address sustainability challenges**	Organizational capacity and institutionalized management structures devoted to sustainability management are prerequisites for long-term improved sustainability outcomes	SAFA	3	1	1	2	2	2	1	12	0.88		✗

[1] **VSIs (Voluntary Sustainability Initiatives)**
Voluntary Sustainability Initiatives (VSIs):
Better Cotton Initiative (BCI), Cotton made in Africa (CmiA), Faritrade (FT), my Best Management Practices (myBMP), Organic Cotton (Organic), Committee on Sustainability Assessment (COSA), Field To Market (FTM), Response-Inducing Sustainability Evaluation (RISE), Sustainability Assessment of Food and Agriculture systems (SAFA).

[2] **Indicator Scoring**
Indicator Scoring: The decision of whether an indicator presented in this list was included in the more concise core set of sustainability indicators, depended firstly on its total score, secondly on whether the indicator scored invariably high across all three scoring dimensions (relevance, usefulness and feasibility) and thirdly on the expert judgment of SEEP. Indicators have been scored from 1 to 3 on seven criteria covering the three scoring dimensions: relevance, usefulness and feasibility. The sum of the seven scores had to reach at least 14 in order to qualify for inclusion in the proposed core sustainability indicator set. Furthermore, the standard deviation between the average scores of the three scoring dimensions (relevance, usefulness, feasibility) had to be lower than 0.59 in order for an indicator to qualify as balanced. SEEP reserved the right to outvote these criteria in few selected cases and in-/exclude selected indicators upon their expert judgment.

Measuring Sustainability in **Cotton Farming Systems**

Towards a Guidance Framework

Appendix 02

Fact Sheet of Sustainability Initiatives in the Cotton Sector


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Better Cotton Initiative (BCI)

Fact Sheet

Date established
2005

Geographic scope
Currently operating in Brazil, India, Mali, Pakistan, China, Turkey and Mozambique. Global scope intended.

Area covered
755 000 ha (2012/13)

Farmers participating
300 000 participating farmers (excluding equivalent standard CmiA farmers)

Total production
750 000 tonnes of lint (2012/13) (excluding CmiA)

Average yield
1 tonne/ha of lint

Initiative overview

The Better Cotton Initiative (BCI) is a multistakeholder initiative comprising retailers and brands, suppliers and manufacturers, as well as donor, civil society and producer organizations.[1] It was founded in 2005 intending global scope and currently operates in eight countries (excluding those in Africa covered by its recognized equivalent standard CmiA).

In 2013, 755 000 ha were cultivated by 300 000 participating farmers under BCI. Targets for 2015 are 1 million Better Cotton farmers and 2 million ha under Better Cotton cultivation.

The initiative requires participating cotton growers to adopt and adhere to specific production and management practices – farmers have to comply with the initiative's minimum production and management criteria and achieve continuing progress on the wider sustainability indicators (BCI, 2009). Compliance is verified by annual self-assessments that farmers need to report. Self-assessment is then complemented by second party credibility checks (carried out by BCI or partners) and independent third party verification on a sample of farms. Ginners are obliged to track (physically segregate) "Better Cotton" and produce bales of lint using only Better Cotton

[1] As of June 2014, the BCI has 350 members.

Global market share
2.8% of global production (2012/13)

Main objective
To promote environmentally friendly cotton production systems as well as decent working conditions and realize their financial profitability as a contribution to an overall vibrant cotton sector.

Implementing or coordinating organization
Better Cotton Initiative (BCI)

Stakeholder involvement
Multistakeholder initiative comprising retailers and brands, suppliers and manufacturers, civil society, producer organizations and associate members.

Financing model
Combination of membership fees (currently at about 30%), donations and grants, training fees and a currently foreseen volume-based fee on Better Cotton use from retailers and brands.

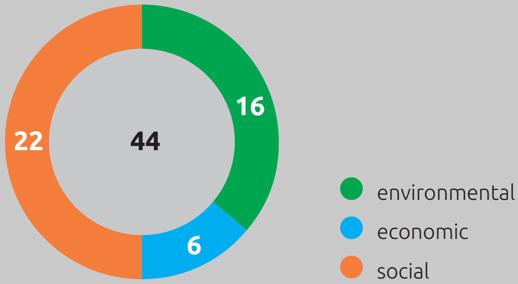
Major donors
IDH, ICCO, SECO, SIDA, Swedish Postcode Lottery, Rabobank, WWF

Total funding
Annual funding EUR 3.8 million (2013) to cover the Secretariat, plus approximately EUR 8 million from brands and retailers, and donors to cover farmer training programmes.

Verification process
Guided self-assessment by farmers on an annual basis, second party credibility checks (by BCI or partners) and independent third party verification on a sampling basis.

Technical assistance to farmers
Selected farmer trainings on agricultural practices, knowledge-sharing, skill development, organizational capacity and financial services through implementing partners.

Number of farm-level intervention criteria by sustainability dimension



(instead of a product mix). No physical segregation is required after the ginner. In such a way, BCI's overall objective is to transition mainstream cotton production towards production systems of enhanced environmental sustainability that respect and promote decent working conditions and realize financial profitability.

BCI does not set or encourage a premium price for producers. The objective is that the producers earn more money through enhanced yields and lower input costs. The avoidance of any larger price differential provides the basis for absorbing a very high share of the global cotton sector into BCI. BCI furthermore does not carry a consumer facing label and is entirely conceived as a business-to-business standard.

BCI aims to transform cotton production worldwide by developing Better Cotton as a sustainable mainstream commodity. BCI's specific aims are to:

- reduce the environmental impact of cotton production;
- improve livelihoods and economic development in cotton-producing areas;
- improve commitment and flow of Better Cotton throughout the supply chain; and
- ensure the credibility and sustainability of the Better Cotton Initiative.

BCI is a membership association,[2] composed of a secretariat, advisory committee, council and general assembly. All members can attend the General Assembly, which elects the BCI Council and decides on any proposed changes to the BCI statutes. The Council (equally represented by each full membership category) makes decisions for the organization, and is supported in this task by an Advisory Committee and the BCI Secretariat. The Council is currently composed of the following organizations: WWF, Solidaridad and PAN UK for civil society; IKEA, H&M and Nike for retailers and brands; OLAM International Ltd, Spectrum International and Orta for suppliers and manufacturers; and Guoxin Rural Technology Service Association, Cotton Australia and Farmers Associate of Pakistan for producer organizations. BCI is currently 30% financed by membership fees, with the aim to reach the target of 75% earned income as a percentage of global costs by 2015. Current donors include IDH, ICCO, SECO, SIDA, Swedish Postcode Lottery, Rabobank and WWF.

[2] Full members are categorized into one of the following categories: producer organizations, civil society, brands and retailers, and suppliers and manufacturers; organizations that do not fall into one of these categories but wish to collaborate with BCI are eligible to join as associate members.

Indicator framework

In order to qualify as producing Better Cotton, BCI farmers have to comply with the initiative's minimum criteria as well as achieving continuing progress on a suite of wider sustainability indicators until full adherence with them is reached. These indicators are presented in the table on p. 113–14.

For aspects that are not measurable on the activity level and for evaluating the broader achievements of the initiative, BCI uses instead a selected number of results indicators. They are listed in the table on p. 115.

BCI minimum requirements and long-term production criteria (BCI, 2009a)

Classification in the VSI	Key performance indicator	Classification under the SEEP framework
Crop protection (minimum criteria)	An integrated pest management programme is adopted that includes the following elements: (i) cultivation of a healthy crop, (ii) prevention of build-up of pest populations, (iii) preservation and enhancement of populations of beneficial insects, (iv) regular field observations of the crop's health and key pest and beneficial insects, and (v) management of resistance.	Pest and pesticide management
Crop protection (minimum criteria)	Only pesticides that: (i) are registered nationally for the crop being treated, and (ii) are correctly labelled in the national language are used.	Pest and pesticide management
Crop protection (minimum criteria)	Pesticides listed in the Stockholm Convention are not used.	Pest and pesticide management
Crop protection (minimum criteria)	Pesticides are prepared and applied by persons who are: (i) healthy, (ii) skilled and trained in the application of pesticides, (iii) 18 or older, and (iv) not pregnant or nursing.	Pest and pesticide management
Crop protection	Use of pesticides in any of the following categories: (i) WHO Class I, (ii) those listed by the Rotterdam Convention, (iii) endosulphan, is phased out, with the timeline based on the availability of better alternatives and ability for the risk to be properly managed.	Pest and pesticide management
Crop protection	Pesticides are always prepared and applied by persons who correctly use appropriate protective and safety equipment.	Pest and pesticide management
Crop protection	Pesticide application equipment and containers are stored, handled and cleaned so as to avoid environmental harm and human exposure.	Pest and pesticide management
Crop protection	Pesticides are applied in appropriate weather conditions, according to label directions, and or manufacturers' directions, with appropriate and well-maintained equipment.	Pest and pesticide management
Crop protection	Used pesticide containers are collected by a recycling programme, or disposed of safely.	Pest and pesticide management
Water use efficiency (minimum criteria)	Water management practices are adopted that optimize water use.	Water depletion
Water use efficiency	Management practices are adopted to ensure that water extraction does not cause adverse effects on groundwater or water bodies.	Water depletion
Soil fertility	Soil management practices are adopted that maintain and enhance the structure and fertility of the soil.	Soil fertility; land erosion
Soil fertility	Nutrients are applied on the basis of crop and soil needs. Timing, placement and quantity applied are all optimized.	Soil fertility
Soil fertility	Management practices are adopted that minimize erosion, so that soil movement is minimized and water courses, drinking water sources and other bodies of water are protected from farm runoff.	Land erosion; water eutrophication

Classification in the VSI	Key performance indicator	Classification under the SEEP framework
National habitat conservation	Practices are adopted that enhance biodiversity on and surrounding the farm.	Biodiversity
National habitat conservation (minimum criteria)	The use and conversion of land to grow cotton conforms with national legislation related to agricultural land use.	Land conversion; climate change
Fibre quality	Management practices are adopted that maximize fibre quality.	-
Fibre quality (minimum criteria)	Seed cotton is harvested, managed and stored to minimize waste contamination and damage.	-
Freedom of association (minimum criteria)	Smallholders (including tenants, sharecroppers and other categories) have the right, on a voluntary basis, to establish and develop organizations representing their interests.	Freedom of association
Health and safety	Access to potable and washing water is provided.	Occupational health and safety; poverty
Child labour (minimum criteria)	There is no child labour, in accordance with ILO Convention No. 138.	Child labour
Forced labour (minimum criteria)	For hazardous work, the minimum age is 18 years.	Child labour
Non-discrimination (minimum criteria)	There is no discrimination (distinction, exclusion or preference) practised that denies or impairs equality of opportunity, conditions or treatment based on individual characteristics and group membership or association.	Equity and gender

Additional criteria for employers

Classification in the VSI	Key performance indicator	Classification under the SEEP framework
Freedom of association (minimum criteria)	All workers and employers have the right to set up and join organizations of their own choosing and to draw up their constitutions and rules, to elect their representatives and to formulate their programmes.	Freedom of association
Freedom of association (minimum criteria)	Workers and employers have the right to bargain collectively (including no discrimination against trade unions and provision of reasonable facilities for workers' representatives).	Freedom of association
Health and safety	Workers receive regular health and safety training appropriate to the work that they perform.	Occupational health and safety
Employment conditions	Wages respecting national minimum wage; regularity of payments; equal pay for equal work principle; workers' consultation on working conditions; employment under legally binding contracts.	Employment conditions; equity and gender
Basic treatment and disciplinary practices (minimum criteria)	Employers do not engage in or tolerate the use of corporal punishment, mental or physical coercion, sexual or other harassment or physical or verbal abuse of any kind. A transparent and clear system of proportionate disciplinary measures is in place.	Employment conditions

BCI minimum requirements and long-term production criteria (BCI, 2009a)

Original classification in the VSI	Key performance indicator	Classification under the SEEP framework
Results indicator	Total area produced as Better Cotton (hectares harvested)	-
Results indicator	Number of farmers producing Better Cotton	-
Results indicator	Total volume of Better Cotton purchased by spinners	Pest and pesticide management
Results indicator	Pesticide use and type (kg/ha/season for each active ingredient)	Pest and pesticide management
Results indicator	Water use for irrigation (m^3/season/ha)	Water depletion
Results indicator	Fertilizer use and type (kg/ha/season)	Climate change
Results indicator	Profitability	Economic viability
Results indicator	Influence of women	Equity and gender
Results indicator	Elimination of child labour	Child labour
Results indicator	Yield	Land productivity; economic viability

Cotton made in Africa (CmiA)

Fact Sheet

Date established
2005

Geographic scope
Sub-Saharan Africa: Burkina Faso (SCS), Cameroon,[3] Côte d'Ivoire, Ethiopia,[3] Ghana, Malawi, Mozambique, United Republic of Tanzania (including CmiA-Organic),[3] Uganda,[3] Zambia, Zimbabwe

Area covered
585 748 ha (2012/13)
610 659 ha (2013/14, preliminary data)
plus 397 031 ha starting with harvest 2014/15 (preliminary data)

Farmers participating
438 605 (2012/13)
448 406 (2013/14, preliminary data)
plus 401 351 farmers starting with harvest 2014/15 (preliminary data)

Total production
144 909 tonnes lint (2012/13)
193 956 tonnes lint (2013/14, preliminary data)
plus 162 200 tonnes lint starting with harvest 2014/15 (estimate)

Average yield
0.25 tonnes/ha lint (2012/13),
0.32 tonnes/ha lint

Initiative overview

Cotton made in Africa (CmiA) works according to the principles of a social business. It was initiated in 2005 and is currently (2014) implemented by the non-profit Aid by Trade Foundation in 11 sub-Saharan African countries: Burkina Faso (SCS), Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Malawi, Mozambique, United Republic of Tanzania (ncluding CmiA-Organic), Uganda, Zambia and Zimbabwe.

CmiA aims at improving the livelihoods of sub-Saharan African smallholder cotton producers by enabling farmers to adopt good agricultural practices and by requiring production standards that are environmentally and socially sustainable, thereby contributing to protect the environment in cotton-producing countries and increasing the demand for African cotton on international retail markets. By linking participating farmers to the regular and growing demand of specific retail partners for sustainable cotton, CmiA activates market forces instead of aid.

[3] Verification during 2014, the 2014/15 harvest qualifies for CmiA-verified cotton sales.

Global market share
0.6% (2012/13)

Main objective
CmiA aims at improving the livelihoods of sub-Saharan African smallholder cotton producers by increasing the adoption of good agricultural practices, linking farmers to a secure and growing demand of retail partners for sustainable cotton and thus achieving environmental, social and economic sustainable production systems.

Implementing or coordinating organization
Aid by Trade Foundation (AbTF),
Competitive African Cotton Initiative (COMPACI)

Stakeholder involvement
Farmers, cotton companies, retailers and other supply chain actors

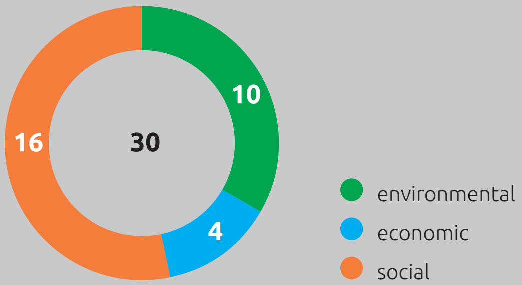
Financing model
Combination of licence fees by participating retailers and brands, cotton companies and donor contributions.

Major donors for COMPACI
Aid by Trade Foundation,
Bill & Melinda Gates Foundation (BMGF),
German Federal Ministry for Economic Cooperation and Development (BMZ),
Gatsby Foundation, Walmart.

Verification process
Annual self-assessment of participating cotton companies and biannual external verification of Managing Entities on field and gin level by independent verification companies (at present EcoCert and AfriCert) serves to verify the adherence to the specified production standards.
This is complemented by sample-based surveys and selected impact evaluation studies on the social, environmental and economic outcomes of CmiA activities.

Technical assistance to farmers
Farmer trainings on production practices, such as crop rotation, pesticide use, eradication of child labour and other related issues, are an important component of the initiative.

Number of farm-level indicators by sustainability dimension



International retail partners do not pay any premium prices for cotton verified as CmiA. Instead they pay a licence fee that is levied at the end of the textile value chain and which is at present approx. 0.025 – 0.10 EUR per piece of garment (depending on total transacted volumes). The CmiA logo can be used as an additional or ingredient brand on the product as well as at the corporate level. Depending on the chosen purchasing model – Mass Balance (MB) or Hard Identity Preserved (HIP) – retailers can indicate the use of CmiA verified cotton in specific products or their support of the initiative and its work. In the framework of the Competitive African Cotton Initiative (COMPACI), the work of Cotton made in Africa is indirectly also funded by the public sector, for example the German Ministry for Economic Cooperation and Development (BMZ).

Revenues paid to the Foundation are reinvested to benefit smallholder farmers in the project countries. Partly with additional capacity support under COMPACI, CmiA engages in agricultural as well as business training measures for farmers and capacity support to cotton companies, the provision of loans and inputs on credit and support to additional community projects under private–public partnership funding) – e.g. improving school infrastructure or promoting women's cooperatives in rural cotton-growing regions.

The verification of adherence to the initiative's standard criteria extends to smallholder outgrower farmers and ginnery workers. The verification lies to a significant extent in the responsibility of the actor identified as the so-called "managing entity", which is often the participating ginning or aggregator company. They provide annual self-assessments of practices and also have the responsibility to provide specified training and capacity support measures to farmers. These control processes are complemented by bi-annual independent verifications from external companies (at present EcoCert and AfriCert, c.f. Aid by Trade Foundation, 2013b) which serve to verify the adherence to the specified production standards. This is complemented by sample-based surveys and selected impact evaluation studies on the social, environmental and economic outcomes of CmiA activities.

The initiative's stronger use of sustainability criteria that actively demand service provision from intermediate or downstream value chain actors to farmers is thus, besides the direct provision of a market linkage, a further important differentiation to other initiatives.

Indicator framework

The CmiA sustainability indicators are subdivided into the categories' exclusion criteria and sustainability criteria at farm, ginnery and management level. Since the SEEP report focuses exclusively on the farm level, ginnery and management aspects are largely omitted below.

The criteria catalogue firstly sets out exclusion criteria to decide whether smallholder farmers and cotton companies are eligible to participation in the Cotton made in Africa initiative. These minimum requirements include, for example, bans on slavery, human trafficking, exploitative forms of child labour according to the ILO, as well as deforestation of primary forests. There is also a ban on the use of hazardous pesticides and of genetically modified seeds. The exclusion criteria presented below are motivated by a specific vision of environmental sustainability, basic social rights of the decent work agenda, and by major consumer preferences for sustainability.

The wider sustainability indicators (farm level criteria) rank CmiA participating farmers concerning their crop rotation practices, application of pest management, access to training on agricultural practices, and the minimization of pesticide use and hazards from their application, handling, storage and disposal. A second set of indicators specifies whether the cotton company/ginning enterprise engages in fair pricing methods for provided inputs, controls the quality of the produced cotton, pays farmers without major time delays and respects a broad range of minimum working conditions and rights. The performance of farmers and cotton companies is evaluated on a traffic light rating scale, to promote an orientation and mechanism for continued improvements. To support smallholder farmers and cotton companies in their efforts, CmiA conducts through partners technical trainings for smallholder farmers in efficient and environmentally sound farming methods for cotton.

BCI minimum requirements and long-term production criteria (BCI, 2009a)

Original classification in the VSI	key performance indicator	Classification under the study framework

CmiA exclusion criteria

Original classification in the VSI	key performance indicator	Classification under the study framework
Exclusion criteria	Management units with more than 10% of their total area and/or more than 5% of their farmers cultivating more than 20 ha of cotton	-
Exclusion criteria	Use of irrigation to grow crops	Water depletion
Exclusion criteria	Non-submission of input and production data in annual self-assessment as prescribed by AbTF	Soil management, climate change, land conversion
Exclusion criteria	Non-submission of a verifiable list of pesticides, the corresponding active ingredients utilized and volumes traded with farmer base during the most recent season in annual self-assessments	Pest and pesticide management
Exclusion criteria	Production of Biotech cotton	-
Exclusion criteria	Use of pesticides banned under the WHO list of highly hazardous and hazardous pesticides, the Stockholm Convention, listed in the Rotterdam Convention on Persistent Organic Pollutants (POPs) or pesticides with improper labelling	Pest and pesticide management
Exclusion criteria	Pesticides are not prepared and applied by persons who are a) not healthy, b) not skilled and trained in the application of pesticides, c) not 18 years or older, or d) pregnant or nursing	Pest and pesticide management
Exclusion criteria	Absence of a time-bound management plan for the implementation of integrated pest management	Pest and pesticide management
Exclusion criteria	Conduction of deforestation (cutting of primary forest or destruction of other forms of natural resources)	Land conversion; climate change
Exclusion criteria	Participation in activities contravening core ILO Conventions (bonded or forced labour, child labour, freedom of association, trafficking of persons etc.)	Labour rights and standards
Exclusion criteria	Immoral transactions in business relations defined by international covenants, national law and practices	Labour rights and standards

CmiA farm level criteria

Social welfare programme	Provision of social welfare services (e.g. education, health) to farmers by the managing entity.	Poverty; social protection
Freedom of bargaining and written contracts	The managing entity demonstrates that all farmers receive and can bargain their written input and output sales contracts and understand their implications.	Freedom of association
Equal rights regarding gender	The managing entity demonstrates to train women as trainers and lead farmers, encourages female producer groups, supports contract conclusion by women, increases women's access to inputs and training.	Equity and gender
Soil and water conservation	Training needs are systematically identified, farmers receive regular training and more than 50% apply methods of soil and water conservation.	Land erosion, water depletion
Crop rotation	Crop rotation with legumes is common practice.	Land erosion, soil fertility
Pesticide management	The managing entity demonstrates to regulate pesticide use under its premises in order to minimize negative outcomes on environment and health.	Pest and pesticide management
Storage and transportation of pesticides	The managing entity demonstrates that farmers and employees are aware of the risks associated with pesticide handling. More than 80% of farmers store chemicals correctly and prevent access by children.	Pest and pesticide management, occupational health and safety
Spraying of pesticides and health protection	The managing entity prevents runoff and leaching of chemicals into streams or groundwater by appropriate techniques and can prove their implementation for at least 66% of sampled farmers. In addition, it demonstrates that farmers were trained on appropriate spraying techniques, protective clothing and equipment and more than 80% of farmers fulfil minimum requirements of protective clothing.	Pest and pesticide management, occupational health and safety
Disposal of empty plant protection chemical containers	The managing entity demonstrates that farmers have been trained on adequate measures to dispose pesticide containers and generally apply them.	Pest and pesticide management
IPM/pest thresholds	The managing entity demonstrates that farmers have been trained in scouting and pest thresholds and more than 80% (as of 1 Januray 2015) of farmers apply it.	Pest and pesticide management
Skills training and capacities	The managing entity demonstrates that training needs on agronomic practices are systematically identified, farmers receive regular training and practice application rates are measured.	Soil management, water management
Input prices	The managing entity demonstrates that farmers are made aware of necessary input costs, makes price calculations accessible and transparent and guarantees fair pricing methods (without which it functions itself as input provider).	Employment conditions; economic risk management and organization
Quality assurance	The managing entity demonstrates that a transparent quality grading system for cotton seed and an arbitration system for farmers and buyers is in place.	Employment conditions
Quality assurance	The managing entity has procedures in place to improve lint quality and discourages use of polypropylene bags for harvesting.	-
Payment	Farmers receive payments no later than 30 days after delivery. Deductions for input are carried out transparently.	Employment conditions

Fairtrade Cotton

FAIRTRADE

Fact Sheet

Start of wider diffusion
2004

Geographic scope
Global (small-scale farming only)

Farmers participating
58 468 (2010/11)[4]

Total production
23 948 tonnes of lint (2011/12),
19 639 tonnes of lint (2010/11)[5]

Global market share
0.1%

Initiative overview

The Fairtrade standard defines a set of environmental, social and economic requirements in production, trade and transformation of agricultural commodities and their end products. Cotton was first listed as a Fairtrade certified product in 2004 (ICAC, 2010) in four West African countries linked to Max Havelaar France and subsequently in India linked to Max Havelaar Switzerland (NRI and IDS, 2011, p. 11). The Fairtrade standard originated from the natural growth of a series of independent national initiatives, while since 1994 the Fairtrade Labeling Organizations International (FLO), renamed Fairtrade International in 2012, has been the international standard setting umbrella organization.

This harmonized Fairtrade standard entails the provision of a set of social and work rights for producers, environmental production standards, and economic benefits for producers as well as their communities. Most notably the Fairtrade standard regulates the adherence to a comprehensive set of ILO conventions on rights at work (ICAC, 2010), offers producers an expectable minimum price for their goods that usually leads to sales above the market price, entails a Fairtrade Premium paid to producer organizations for health, education, social or business investment projects, and offers the possibility of upfront credit which may reach a maximum of 60% of the estimated pur-

[4] Textile Exchange (2012).

[5] ICAC (2013).

Main objective
Fairtrade is a strategy that aims at providing fair remuneration and further economic benefits to producers and their organizations, guaranteeing the respect of basic decent work standards and increasing the environmental sustainability of production systems.

Implementing or coordinating organization
Fairtrade International (FLO)

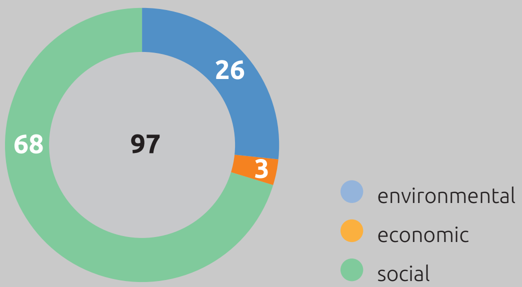
Stakeholder involvement
Fairtrade International, including its standards and the Fairtrade Mark (product labelling) is owned and governed 50% by Fairtrade farmers and 50% by 24 national Fairtrade organizations in main marketing countries bringing together NGOs, consumer associations, trade unions and other stakeholders.

Financing model
Fairtrade minimum price and Fairtrade Premium are paid to producers and their organizations. The Fairtrade system including producer support activities is financed by licensing fees. Certification is paid independently to the certification body by all certified operators.

Verification process
Third party certification and annually executed audits through on-site visits of participating farmers cooperatives and selected participating farmers.

Technical assistance to farmers
Fairtrade encourages farmers to establish their own environmental development plans to ensure that waste is managed correctly, materials are recycled, and steps are taken to avoid soil erosion and water pollution.

Number of farm-level indicators by sustainability dimension



chase price. The Fairtrade minimum price for cotton is set depending on the production region and updated at intervals. It intends to reflect and remunerate the costs of sustainable cotton production systems and is replaced by the market price, whenever it exceeds the minimum price level. Besides, the so-called Fairtrade Premium accounts for around 5 EUR per kg of seed cotton (ICAC, 2010) and is paid to the producer organizations. Fairtrade does not include any guaranteed market.[6]

The Fairtrade rationale is also based on the condition that cotton producers need to be dominantly small family farms and producers need to be organized in democratically structured and farmer-owned organizations and cooperatives. With regard to the latter, India and Pakistan are somewhat an exception, since in both country contexts a business model of individual acting cotton farmers selling to a promoting body is established, as a transitional phase towards building producer organizations (ICAC, 2010).

Besides the higher purchase price, financing for core operations is provided by licensing fees which are charged to all retail marketers of Fairtrade labelled products. Instead, producer organizations that want to become Fairtrade certified must meet the criteria for the general Standard for Small Producer Organiza-

[6] ICAC (2010) thereby reports that, e.g. in 2008/09, Fairtrade cotton farmers in West Africa indeed faced market problems and were not able to commercialize the desired quantities as Fairtrade.

tions (Fairtrade Internatioal, 2011a), as well as the specific fibre crop standard (Fairtrade International, 2011b).

The initial Fairtrade certification, as well as subsequent inspections and audits, are carried out by the separate company FLO-CERT, under ISO-65 accreditation, making use of local auditors who are annually trained. The initial audit covers a varying number of farmers as well as the cooperative or farmers' organization itself. Also subsequent annual inspections involve on-site visits, though organizations with high compliance levels over several years may be inspected as part of a three-year inspection cycle only (Fairtrade International, 2011e).

Contemporarily there are 33 Fairtrade cotton producer groups existing and Fairtrade cotton is mainly produced in India, Burkina Faso, Cameroon, Mali, Senegal, Brazil, Egypt, Peru and Kyrgyzstan, with West Africa and India the biggest producing regions (ICAC, 2010). By the end of 2008, over 27.6 million items made of Fairtrade certified cotton were sold, which almost doubled the sales of the previous year, while 2.3 million items were at the same time certified as organic (ibid.).

Indicator framework
Fairtrade sustainability standards are mainly defined in the Fairtrade Standard for Small Producer Organizations (Fairtrade Internatioal, 2011a), the Fairtrade Standard for Fibre Crops (Fairtrade International, 2011b) and the Fairtrade Standard for Contract Production (Fairtrade International, 2011d).

When considering only farm level and production linked indicators, and thus omitting many additional issues covered by the above-named standards, the relevant indicators account for more than 90 indicators that are often still divided into several subrequirements. The main sustainability issues covered are specified in the table on p. 125.

Main sustainability issues covered by the Fairtrade standard

General Requirements
Members are small producers

Production
Pest management
Soil and water
Waste
Genetically modified organisms (GMO)
Biodiversity
Energy and greenhouse gas (GHG) emissions

Labour Conditions
Freedom from discrimination
Freedom of labour
Child labour and child protection
Freedom of association and collective bargaining
Conditions of employment
Occupational health and safety

Business and Development
Development potential
Democracy, participation and transparency
Non-discrimination

Australian Best Management Practices (myBMP)

COTTON AUSTRALIA

Fact Sheet

Date established
1997 (then: BMP)

Geographic scope
Australia

Area covered
120 000 ha (2011/12)

Farmers participating
300 farmers currently actively using the programme (accounting for roughly 20% of Australian cotton farmers)

Total production
The number of certified bales exported (2012/13) has been reported as 13 000 (2 951 tonnes), however the total production of Australian cotton by farms participating in the BMP programme (but not certified) represents a significantly greater proportion.

Average yield
2 320 tonnes/ha (Australian average, 2012/13 season)

National market share
Above 20% of Australian farms and increasing (2013). Last season, 30% of the Australian bales exported were produced by BMP growers (almost all Australian product is exported). It is worth noting that almost all Australian gins and classers are myBMP certified.

Initiative overview

The "my Best Management Practices" (myBMP) programme is a voluntary farm management system that was launched in 1997 as an outcome of a joint government/industry research partnership. At that stage BMP was delivered to growers through the regional staff of Cotton Australia (the representative body of the Australian cotton industry), as well as extension staff and cotton consultants.

The BMP programme was initiated as a coordinated industry response to concerns about the off-farm movement of pesticides.[7] Over time, the scope of the BMP programme expanded to include a comprehensive suite of sustainability management issues. It has also undergone cycles of industry change, expansion and, finally, contraction as a result of a long-standing drought that significantly

[7] Minimizing the impact of pesticides on the riverine environment: key findings from research with the cotton industry – 1998 conference. LWRRDC Occasional Paper 23/98, Canberra, April 2009.

Main objective
myBMP is the Australian cotton industry's environmental management programme, and is a voluntary system for achieving best practice in the growing, ginning and classing of cotton. myBMP is web-based system that acts as a centralized location for best practice, tools, resources and scientific information.
It links supporting knowledge, data and resources to best practice principles and guidelines, allowing growers, ginners and classers immediate access to cutting edge research as well as support from industry and extension staff when there is an issue to solve or investigate.

Implementing or coordinating organization
Cotton Australia, Cotton Research and Development Corporation (CRDC) and Cotton Seed Distributors

Stakeholder involvement
An additional 15 Australian cotton agribusinesses, who are building BMP into their own businesses (advisors work with interested cotton clients at local level, helping them to effectively participate in the myBMP programme).

Financing model
Collaboratively funded between industry organizations, Cotton Australia (funded by voluntary levy payments from members), CRDC (statutory industry and government partnership [grower/government funded]).

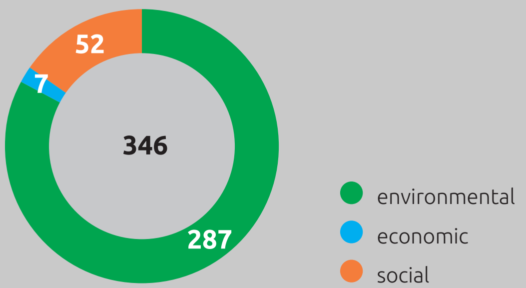
Financing organizations
Cotton Australia and Cotton Research and Development Corporation (CRDC)

Total funding
AUD 293 400
(2012/13, estimate)

Verification process
Farmers' Self-Assessment followed by independent control through a certified auditor.

Technical assistance to farmers
Identification of discrepancies of own farm performance as compared to the Australian best practice. Cotton Australia regional managers and the industry's development and delivery team provide some on-ground support (e.g. workshops) with small groups of growers, to introduce them to the myBMP system.

Number of farm-level indicators by sustainability dimension



reduced resources. During this time the BMP programme underwent a transformation into its current online format, myBMP, which was launched in 2010.

myBMP is funded by Cotton Australia, the Cotton Research and Development Corporation and Cotton Seed Distributors. Cotton Australia provides programme management, programme infrastructure development and service support.[8] CRDC contributes directly to content development and audit services. The extension component is provided by industry-supported personnel, and also driven through the industry's CottonInfo team which provides industry extension services via on-ground personnel. The CottonInfo programme is funded and managed via a joint venture between Cotton Australia, CRDC and Cotton Seed Distributors.

8 Cotton Australia http://cottonaustralia.com.au/cotton-library/publications/reports CRDC http://crdc.com.au/what-we-do/crdc-annual-reports/.

myBMP provides growers with access to the latest technical and research information, and provides tools for and details solutions to a range of farming and sustainability issues. The myBMP programme aims to provide an applied management tool that transfers research and development outputs into best management practices for farmers. It also aims to drive continuous improvement. myBMP consists of an online self-assessment tool for cotton growers encompassing 11 topic areas ("modules") to support effective, efficient and sustainable on-farm management.

After completion of their self-assessment, growers can choose to attain certification. For certification, growers have to comply with the Level 1 (legal standard) and Level 2 (industry standard) practice requirements outlined in the 11 modules, and pass an audit of their compliance with the five core modules of myBMP (Soil Health, Water Management, Pesticide Management, Natural Assets, and Petrochemical Storage and Handling), in addition to a randomly selected module. If a grower successfully passes the audit, they receive a myBMP certificate valid for 5 years.

myBMP also includes Level 3 or aspirational standards – items to consider in the future. While compliance with these aspirational standards is not compulsory, they represent aspirational industry goals for continual improvement, and myBMP provides a platform for promoting the types of practices being implemented by leading and innovative growers. Those growers who do achieve Level 3 standards receive commendation.

Designated industry experts coordinate an annual review of the myBMP module relevant to their expertise to ensure that the standards defined in myBMP continue to meet industry and legal requirements, and that the supporting tools, resources and information remain current and relevant.

The myBMP programme also extends to cover areas of the supply chain beyond the farmgate and into processing and warehousing. Cotton ginning and classing modules are available and currently almost all Australian gins and classers are myBMP certified.

The future focus for the myBMP programme will be around improvements and adaptations to the platform and the programme to deliver on-farm and industry outcomes by:

- continually modernizing the platform and updating practices and information to maximize value and ease of use;
- fostering robust grower participation;
- enhancing capability to enable better demonstration of on-farm performance and reporting though to stakeholders and markets (e.g. against established sustainability indicators); and
- using myBMP to best position Australian sustainable BMP cotton in the global marketplace.

Indicator framework

The myBMP standard consists of a comprehensive set of defined "practices" across 11 modules (or theme areas). These are broken down into 34 key areas, and 76 standards, with 599 "checklist" items detailing the specific practices across the three levels. Level 1 and 2 practices concerning legal requirements and current industry-determined best practice standards represent some 485 practices.

Sustainability themes and sub-issues covered by myBMP

Biosecurity	**Pesticide Management**
People	Farm maps
Signage	Workplace record-keeping
Crops	Pre-season communication
Facilities	In-season communication
Machinery and equipment	Product selection
Biotechnology	Transport, storage and handling
Pre-Season	In-season application
Bollgard II – in-season	In-season decontamination and disposal
Bollgard II – picking and post-picking	**Petrochemical Storage and Handling**
Roundup Ready / Roundup Ready Flex	Design and installation of tanks
LibertyLink	Bulk tank storage location
Energy and Input Use	Storage of lubricants
Whole farm energy	Spill containment
Energy measurement	Signage
Energy-saving practices	Emergency procedures
Nitrogen	**Workplace Safety**
Soil carbon	Safe storage and disposal of waste
Fibre Quality	Licensing or notification of dangerous goods
Crop management	**Soil Health**
Crop preparation	Soil structure
Delivering uncontaminated cotton	Soil nutrition
Human Resources	Salinity and sodicity
Recruitment and engagement	Erosion
Staff/family employment	**Water Management**
Contractor employment	Whole farm water records
Discipline and termination	Field water management and record-keeping
Integrated Pest Management	Crop and soil water status
Integrated disease management	Water storage and distribution management
Integrated Insect and mite management	Surface irrigation systems
Integrated weed management	Drip irrigation systems
Natural Assets	Central pivot or lateral movement
Catchment awareness	Irrigation systems plan
Farm maps – natural features	Irrigation bore construction
Farm maps – soils	Dryland water management
Farm maps – land use and Infrastructure	Tailwater and stormwater management
Farm maps – other information	Stormwater capture
Resource and property information	
Biodiversity	
River health	

Organic Cotton

TextileExchange
Creating Material Change

Fact Sheet

Start of wider diffusion
1990s

Geographic scope
20 countries, of which the five largest producing countries: India, Turkey, China, United Republic of Tanzania and the United States.

Area covered
316 907 ha (2011/12), 324 577 ha (2010/11), 460 973 ha (2009/10)

Farmers participating
214 905 (2011/12), 218 966 (2010/11)

Total production
138 813 tonnes lint (2011/12), 151 079 tonnes lint (2010/11)

Productivity (average annual yield and range)

- Africa[9] 0.274 (0.170–0.365) tonnes/ha
- China 2.097 (1.001–2.835) tonnes/ha
- India 0.407 (0.155–1.289) tonnes/ha
- Turkey 1.432 (1.415–1.600) tonnes/ha
- United States 0.6 tonnes/ha
- Latin America[10] 0.708 (0.272–0.991) tonnes/ha
- Egypt (biodynamic) 1.432 tonnes/ha
- Central Asia[11] 1.030 (0.9-1.16) tonnes/ha

Initiative overview

Organic cotton defines a holistic approach that addresses the entire production system. Organic production thereby entails to follow a specific vision of environmental sustainability, a set of social rights, and fair compensation/rewards for ecological "value added". It may in addition provide economic benefits through the associated consumer-facing label and product differentiation.

Certified organic cotton gained its first momentum in the 1990s. It refers to any type of production that is certified by an independent organic certification body that either follows its own defined standard or applies an established national or international standard (e.g. the EU regulations for organic farming or the USDA National Organic Program [for cotton production]). The Organic Content Standard (OCS) is a voluntary standard used to track and verify the organic fibre content in the finished product and the Global Organic Textile Standard (GOTS)

9 Africa includes Benin, Burkina Faso, Mali, Senegal, United Republic of Tanzania.

10 Latin America includes Brazil, Nicaragua, Paraguay, Peru.

11 Central Asia includes Kyrgyzstan and Tajikistan.

Global market share
0.6% of global production[12] (0.7% average over past 3 years)

Main objective
Organic Agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.

Implementing or coordinating organization
Decentralized implementation and coordination by autonomous organizations.

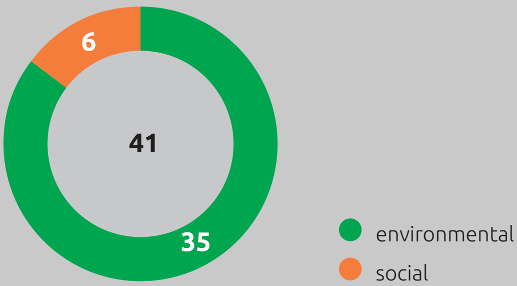
Stakeholder involvement
Farmers, producer associations, ginners, traders, NGOs, spinners/manufacturers, certifying agencies, textile brands and retailers, some with direct links to farmers.

Financing model
Farmers utilize existing financing systems and certification fees are usually covered by the farmers' group or a coordinating organization acting on behalf of the farmers.

Verification process
Organic production practices are verified by third party certifying agencies.

Technical assistance to farmers
Organic certified systems have no standard mechanism of technical assistance in place and largely depend on the existence of farmers' membership in producers' organizations, extension services through contractor or supply chain partner (e.g. ginner, spinner), funded programmes, or targeted state extension programmes.

Number of farm-level indicators by sustainability dimension[8]



builds textile processing criteria for the entire supply chain on the basis of farm-level requirements.

While considerable freedom exists for private certification bodies to define their specific standard independently, the International Federation of Organic Agriculture Movements (IFOAM) Organic Guarantee System serves to harmonize organic agricultural standards on a global scale as well as to make them more comparable. It is built around the IFOAM Norms that contain the Common Objectives and Requirements of Organic Standards (COROS) which were agreed upon by the IFOAM members and endorsed by FAO and UNCTAD.

Certified organic cotton farmers pay annual fees for certification to the respective certification agency and usually realize higher market prices than for conventional cotton (Note: For small-scale farmers this is often taken care of by the

[12] Calculated using organic production from Textile Exchange and world production from ICAC.

association administrative department or contracting partner.). While organic production is in general a stronger autonomous and decentralized activity, certified organic cotton producers often establish a link to ginning or spinning facilities that are equally certified for processing organic cotton.

Despite the above-outlined diversity of certification standards, the associated farming principles of organic cotton production are still comparably well defined and centered around the following:

- No application of any synthetic fertilizers such as NPK or urea and the importance of nutrient recycling as well as locally closed nutrient cycles.
- No application of toxic and persistent synthetic pesticides (including herbicides, insecticides, fungicides), growth promoters or defoliants to facilitate mechanized harvest.
- No use of genetically modified organisms (GMO) such as Bt-cotton varieties.
- Adoption of crop rotation (no cotton after cotton in the same field in two subsequent years) and of intercropping.
- Prevention of spray drift from neighbouring conventional fields, e.g. by growing border crops.
- Maintenance of records and documents for inspection and certification.

Indicator framework
The organic production standards promote a specific vision of sustainability. While having many indicators similar to those of the other voluntary initiatives presented, organic production also gives importance to aspects of integrated

farming systems that do not use synthetic fertilizers or pesticides and includes practices of crop rotation as well as on-farm crop diversity. Integration of livestock (food products, soil fertility, farm work) is also often part of the integrated organic production system. A product cannot be certified Organic if human rights or labour standards (ILO) have been breached. It is common for small-scale producers in developing countries to combine Fairtrade standards/certification with their organic criteria.

The following list displays the main sustainability issues that are covered by the above-identified Common Objectives and Requirements of Organic Standards, relevant to crop production.

Cotton relevant sustainability issues covered by the Common Objectives and Requirements of Organic Standards (COROS, 2011)

Organic Ecosystems

Ecosystem management, including water use efficiency (blue water) and avoidance of water pollution (grey water)

Resource management

Genetically Modified Organisms and Nanotechnology

General Requirements for Plant Production

Maintenance of organic management

Avoiding contamination

Crop Production

Seed, propagation material and seedlings

Soil conservation and crop rotation

Management of soil fertility

Pest, disease, weed and growth management

Processing and Handling

Ingredients and processing aids

Processing methods

Packaging and containers

Cleaning, disinfecting and sanitizing processing facilities

Pest and disease control

Social Justice

Labelling

Economic

Fair prices for organic (sometimes called value added premiums), as well as farmer-centric contractual terms and conditions (e.g. prefinancing and forward contracting) are sometimes part of the organic cotton business model. The potential for lower input costs and secondary incomes from rotation/intercrops in mature systems, can also result in higher and/or more reliable incomes for farmers.

Committee on Sustainability Assessment (COSA)

Committee On Sustainability Assessment

Fact Sheet

Date established
2005

Geographic scope
Developing countries globally (currently 16 countries)

Initiative overview

The Committee on Sustainability Assessment (COSA) is a non-profit global consortium of institutions that generates a new level of collective impact, balancing scientific methods with business-like pragmatism in the measurement of sustainability. It has developed and applied an increasingly popular measurement framework to analyse the distinct social, environmental and economic impacts of agricultural practices (SCI, 2013). It was jointly initiated by the International Institute for Sustainable Development (IISD) and the United Nations Conference on Trade and Development (UNCTAD), and is now a registered non-profit research consortium encompassing a wide range of more than 30 collaborating partner organizations (COSA, 2013a).

COSA was launched in 2005 in response to a need for better information on the impacts of operative sustainability initiatives, particularly in commodities such as the coffee sector where many of these (e.g. Fairtrade, Organic, Rainforest Alliance, UTZ Certified) had their origins. The coffee sector presented an acute challenge for policy-makers and supply chain decision-makers, with more than six global sustainability initiatives operating and only limited information on their actual sustainability at the field level. As a response, COSA convened hundreds of expert stakeholders into a participatory process and developed a rigorous approach of mixed methods built around baseline and control measurements with the objective of reliably understanding the short- and long-

Main objective
COSA's main objective is to establish common global indicators and measurement tools that help to understand and improve sustainability practices in agriculture.

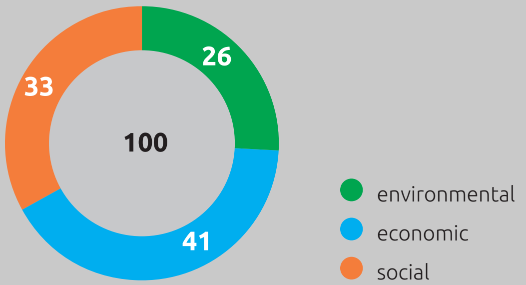
Coordinating organization
COSA is an independent non-profit institution coordinating an applied research consortium.

Stakeholder involvement
International development agencies, research institutions, private firms, financial organizations, NGOs and producer associations.

Financing model
Core funding from multiple public–private sources plus additional fees for service.

Major donors
Swiss Confederation (SECO),
Ford Foundation, InterAmerican Development Bank, IISD, UNCTAD, USAID,
Entwined Consortium – MISTRA, NORAD

Number of farm-level indicators by sustainability dimension



term impacts of any sustainability initiatives. Four key characteristics of the COSA system are:

- **Tools** – Indicators and the way to measure them are designed to be comparable across countries and sectors (one size fits most and is available for use as open source).
- **Validity** – Broad participatory stakeholder engagement develops and refines the indicators that are all subject to scientific verification as well as alignment with the international normative references embodied in many UN and multilateral agreements.
- **Balanced Perspectives** – COSA Indicators are SMART-designed and offer a balanced view of environmental, social and economic sustainability.
- **Locally Relevant** – COSA work is executed by leading institutions in each country to ensure contextual validity, low cost, and local ownership.

The COSA methodology was designed to be as generic as possible to allow adaptation for application to any intervention; it began by measuring the impacts of sustainability initiatives in the coffee sector and has since been adapted to cocoa and food crops. Although COSA does not currently have a cotton-specific set of indicators, about 90% are relevant for cotton and COSA expects to have cotton-specific metrics in the near future. As of 2014, COSA had collected more than 22 000 data sets on coffee and cocoa farms. COSA data are gathered by farm visits over multiple years.

The declared main objective is "to establish useful global indicators and measurement tools which farmers, policy-makers, and the industry can use to understand and improve their sustainability…" as noted in its initial application in the coffee sector (IISD, 2008). "COSA facilitates this by enabling them to accurately calculate the multifaceted costs and benefits of becoming involved in any sustainability initiative" (SCI, 2013). COSA works with more than 30 institutions globally including the other three major entities of the Sustainable Commodity Initiative: The Sustainable Commodity Assistance Network (SCAN), the Finance Alliance for Sustainable Trade (FAST), and the State of Sustainability Initiatives (SSI) (UNCTAD, IISD, undated).

Prior to its original application (IISD, 2008), COSA engaged in a high-level scientific review of various existing voluntary standards and private initiatives in order to come up with a comprehensive list of sustainability indicators. This was expanded with a multistakeholder consultation (hundreds of experts). In this sense, the methodology of COSA was similar to the process that guided the publication at hand and thus is a specifically interesting reference point. Validating this process, the International Coffee Organization passed an official resolution supporting COSA efforts and in recent years tens of other organizations now integrate COSA indicators and approaches in their assessments (IISD, 2008).

Indicator framework

As an initiative aiming at the measurement of sustainability outcomes, and going beyond self-reported data, the COSA indicators focus on two levels: highly credible Impact Assessment and low-cost Performance Monitoring that identifies impact pathways (COSA, 2013). COSA indicators capture specific characteristics of a farming system that are consistently measureable and provide important contextual information that can be expected to change measurably over time as the sustainability of a farming system alters. When appropriately paired with accompanying metrics (specifically how to measure) and sound methods for getting and analysing data, COSA indicators provide accurate insights and serve as vital components or proxies for sustainability. To avoid misleading results, indicators must be optimally balanced to provide a multidimensional perspective that encompasses social, economic and environmental facets.

In addition to the instruments that fulfil the task of completing indicators (metrology, survey questions and data-gathering technology), COSA partners typically apply mixed methods that blend quantitative and qualitative approaches and rely on constantly updated statistical and econometric techniques to ensure optimal and scientifically-grounded analyses.

In addition to the local adaptation and context analysis that COSA conducts, most COSA indicators are designed to be fully answerable through surveys conducted at the farm or cooperative level. It gathers some indicators into larger indices that give an overall understanding of the key factors in a sector. This is the case, for example, for the indicator net income, which constitutes one of the most central indicators in COSA. For several of the social and environmental impacts, COSA uses evidence of specific management techniques or other indirect or proxy indicators (e.g. level of educational participation and absence of dangerous practices to understand child labour). COSA also includes a number of qualitative perception questions along each of the social, economic and environmental categories. The table below specifies the main sustainability topics covered by the indicator set.

Sustainability topics covered by the Committee on Sustainability Assessment (COSA)

Environmental	Social	Economic
1. Resource Management	**1. Living and Working Conditions**	**1. Producer Livelihood**
Waste management	Health and safety	Revenue
Input management	Living conditions	Costs
		Income
2. Water	**2. Basic Human Rights and Equity**	
Water quality	Labour rights	**2. Risk**
Water quantity	Education	Diversification
	Food security	Information
3. Soil	Gender	Credit
Conservation		Volatility
Soil health	**3. Community**	Vulnerability
	Participation	
4. Biodiversity		**3. Competitiveness**
Plant diversity	**4. Trading Relationships**	Business development
Genetic diversity	Transparency	Differentiation
Tree density	Capacity and finance	Efficiency
5. Climate Change	**5. Perception**	**4. Producer Organization**
Sequestration and mitigation	Social situation	Governance
		Services
6. Perception		
Environmental situation		**5. Perception**
		Economic situation

Field To Market: The Alliance for Sustainable Agriculture

Field to Market
The Keystone Alliance for Sustainable Agriculture

Fact Sheet

Date established
2007

Geographic scope
United States

Initiative overview

Field To Market, The Alliance for Sustainable Agriculture (FTM), is a collaborative stakeholder group of producer organizations, agribusinesses, food and retail companies, conservation and non-profit organizations, universities, and agency partners that are working together to define, measure and develop a supply-chain system for agricultural sustainability. Founded in 2007, facilitated by the NGO, "The Keystone Center", FTM is headquartered in Washingtom DC and is funded by dues from its member organizations.

Nearly all estimates of future demand for agricultural goods suggest a need to double agricultural production by 2050, if not before, in order to maintain adequate supplies for a growing world population that will use its expanding income to purchase fibre and fuel products and to diversify diets with more meat, dairy, fruits and vegetables. FTM believes this increased production must be accomplished in a manner that does not negatively impact – and actually improves – overall environmental and societal outcomes.

Area covered
3 047 000 ha (total cultivated area United States 2009/10)

Farmers participating
Approximately 12 000 United States cotton growers (2009/10)

Total production
2.654 million tonnes cotton lint (2009/10)

Average yield
0.871 tonnes/ha cotton lint (2009/10)

Global market share
11.9 % (2009/10)

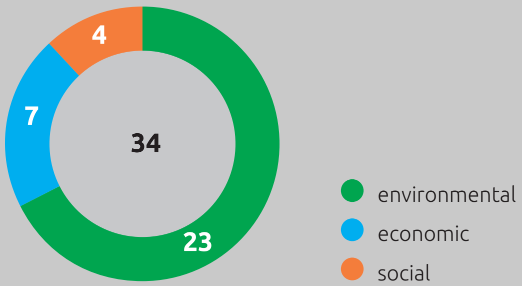
Main objective
Field To Market aims at facilitating the identification and quantification of key environmental a nd socio-economic sustainability outcomes, and fosters industry-wide dialogue on sustainability issues.

Implementing or coordinating organization
Established as a non-profit organization with headquarters in Washington DC and facilitated by The Keystone Center.

Stakeholder involvement
Producer organizations, agribusinesses, food companies, conservation organizations, research organizations, retailers and agency partners.

Financing model
Membership dues

Number of farm-level indicators by sustainability dimension



As an initial step, the group has defined sustainable agriculture as meeting the needs of the present while improving the ability of future generations to meet their own needs by focusing on the specific, critical outcomes:

- Increasing agricultural productivity to meet future nutritional needs
- Improving the environment, including water, soil and habitat
- Improving human health through access to safe, nutritious food
- Improving the social and economic well-being of agricultural communities

It is within this context that the group has developed and continues to develop metrics to measure the environmental, health and socio-economic outcomes of agriculture in the United States at the national, regional and field level. FTM has developed two significant tools – the Environmental and Socioeconomic Indicators Report and the Fieldprint Calculator – to further the discussion about agriculture and sustainability. FTM released an update to its National Indicators Report in 2012 and is currently working on updates to the Fieldprint Calculator for release in 2016. FTM has more than 20 active Fieldprint projects across the United States to evaluate the tools it has developed and help determine how they can help drive sustainable choices. In a broader perspective the initiatives goals are expressed as follows:

- **Advancement of continuous improvement and creation of shared value through strategic implementation of metrics and tools:** Foster shared commitments and programmes for continuous improvement across commodity agricultural supply chains in order to meet sustainability challenges and create shared value for Field To Market members and other efforts.

- **Metric and tool development:** Provide useful measurement tools and resources for growers and the supply chain to track and achieve continuous improvement against key outcomes.

- **Communication and outreach:** Engage in broad communication with external stakeholders and other sustainability efforts to convey the agricultural challenge of the twenty-first century and communicate Field To Market's strategies for addressing the challenge.

FTM Environmental and Socioeconomic Indicators Report

In 2012, FTM released the second version of its report entitled "Environmental and Socioeconomic Indicators for Measuring Outcomes of On-Farm Agricultural Production in the United States". As agreed and defined by the membership, the report indicators should: represent national scale trends over time, be based on transparent and credible, peer-reviewed science using publicly available data, be outcome-based rather than prescriptive, be practice/technology neutral and measure only on-farm production outcomes within a grower's control.

The initial crops of maize, cotton, soy and wheat were selected as they represent 73% of cropland acres in the United States and 58% of cash crop receipts. Since the initial report was released, potatoes and rice joined the alliance and are included in this most recent report.

Part I of the 2012 environmental and socio-economic indicators report analyses national-scale trends for the six above-mentioned focal crops concerning five environmental resource indicators (land use, soil erosion, irrigation water applied, energy use, and greenhouse gas emissions); data are analysed for the United States, 1980–2011.

Part II of the 2012 report analyses the socio-economic performance. In such a way trends over time are observed for six socio-economic indicators (debt/asset ratio, returns above variable costs, crop production contribution to national and state gross domestic product, non-fatality injury, fatality, and labour hours). In addition, the report also touches upon other potentially relevant socio-economic indicators for agricultural production that, although not fully meeting the Field To Market criteria described above, remain important elements for a broader evaluation.

Fieldprint Calculator

FTM has also developed the "Fieldprint Calculator", an online education and awareness tool which helps United States growers to evaluate their farming decisions in the areas of efficient land use, soil conservation, soil carbon, irrigation water use, water quality, energy use and greenhouse gas emissions.

First launched in 2009, the Fieldprint Calculator allows individual corn, wheat, soybean, cotton, potato and rice growers to explore relationships between management practices and outcomes, and allows farmers to compare their own Fieldprint results against national, state and local averages. Farmers can also save their information and compare the environmental impact of different management decisions or scenarios on their operation.

Indicator framework

Sustainability indicators considered by the Field To Market Environmental and Socioeconomic Indicators Report (Field To Market, 2012)

Environmental Indicators

Land Use
- Total ha planted to cotton
- Yield
- Planted area per tonne of cotton

Soil Erosion
- Total soil erosion
- Soil erosion per ha
- Soil erosion per tonne of cotton

Irrigation Water Applied
- Total irrigation water applied
- Irrigation water applied per ha
- Irrigation volume per incremental tonne of cotton (Marginal technical coefficient)

Energy Use
- Total amount of energy consumed
- Consumed energy per ha
- Consumed energy per tonne of cotton

GHG Emissions (CO_2 Equivalents)
- Total amount of GHG emitted
- GHG emissions per ha
- GHG emissions per tonne of cotton

Socioeconomic indicators

National Debt to Asset Ratio

Returns Above Variable Costs

Contribution to National and State GDP
(total and percentage)

Non-fatal Injury
(total and percentage of agricultural workforce)

Fatalities

Labour Hours
(per ha, per tonne of cotton)

Response-Inducing Sustainability Evaluation (RISE)

Fact Sheet

Date established
2000

Geographic scope
The RISE methodology is globally applicable and has been implemented to date in more than 220 farms in 47 different country contexts.

Initiative overview
Response-Inducing Sustainability Evaluation (RISE) is an interview-based and software-supported methodology to evaluate the sustainability of farm operations across the economic, social and environmental dimension. It has been developed since 2000 by the School of Agricultural, Forest and Food Sciences (HAFL) of Bern University of Applied Sciences and is a globally applicable assessment methodology that is confined neither to a specific commodity nor to a sector of production. RISE focuses explicitly on the farm as a unit of analysis and follows the main objective to provide a holistic, improvement-oriented and communicable sustainability assessment.

The implementation of the methodology is carried out by on-farm face-to-face interviews with farmers through qualified RISE consultants, also drawing upon farm documentation and records where available as well as regional and national data from public sources. The time requirement of the contact phase ranges between 3 and 4 hours, while no on-farm measurements are needed. With the help of a software that can be used online and offline, the collected 508 survey questions, organized under 50 issue areas, are combined into ten indices and visualized in the form of a sustainability radar chart. The subsequent face-to-face feedback consultation then serves as the main intervening mechanism aimed at inducing changes in farm management, where necessary.

Main objective

RISE's main objective is to provide a holistic, improvement-oriented and communicable sustainability assessment that allows farmers to improve the sustainability performance of their farm.

Implementing or coordinating organization

School of Agricultural, Forest and Food Sciences (HAFL) of Bern University of Applied Sciences.

Stakeholder involvement

Farmers, researchers, development project interventions.

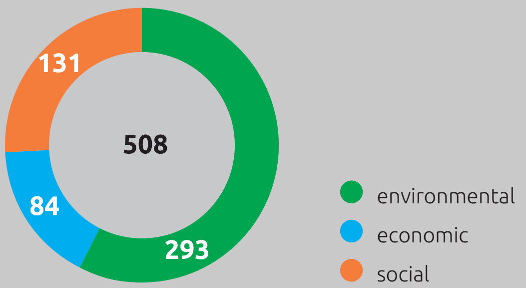
Financing model

Development and improvement of the method have been financed by funds of HAFL (public funding) and the Gebert Rüf Foundation. RISE studies, training courses and usage by licensed experts are paid for either by the clients (e.g. industry, development agency, extension service) or from public project funding.

Technical assistance to farmers

Farmers are provided with an in-depth analysis of the production system and specific advice to increase sustainability with often strong co-benefits for overall farm efficiency and resilience.

Number of farm-level indicators by sustainability dimension



RISE does not involve any financial incentives, nor does it lead to certification or product differentiation, but instead targets enhancements of on-farm sustainability that are self-supporting and are not discouraged by, for example, a worse financial performance. It serves as a decision making tool for farmers at the operational and strategic level, may lead to specific propositions for optimization but does not regularly involve any follow-up or later verification by external actors.

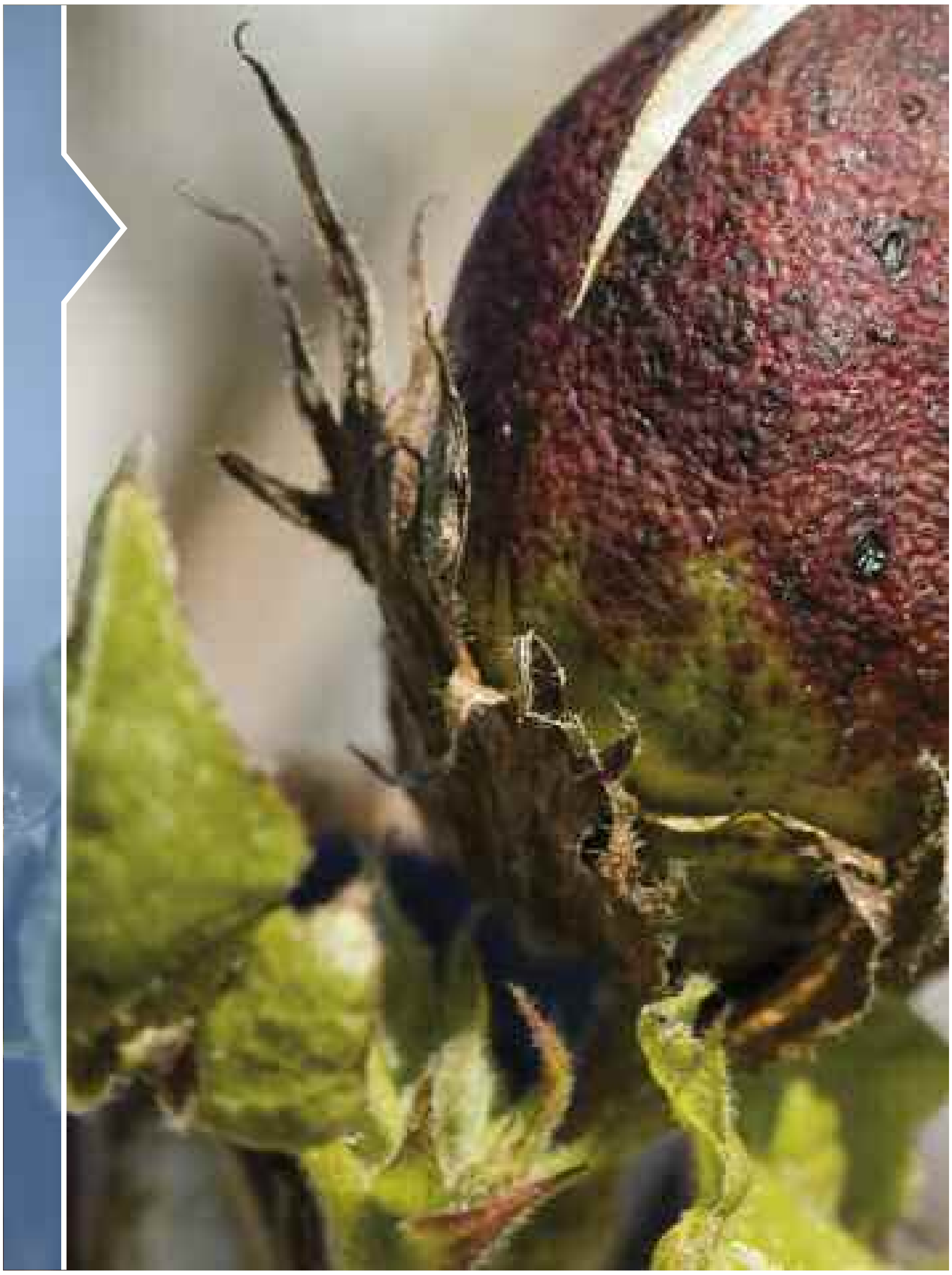
Between 2000 and 2013, more than 1 400 farms in 40 countries were analysed in such a way, including dairy, vegetable, arable and mixed farms, coffee, cocoa and tea plantations, as well as smallholder farms and nomadic herders. RISE can be used by other actors on a cost basis and is regulated within a licence agreement.

Indicator framework

RISE collects 508 survey questions grouped into 50 issue areas that then form the basis of the 10 sustainability indices. Issue areas and sustainability indices are displayed in the table at the end of this section.

The specific farm survey questions are a mixture of qualitative and quantitative indicators which are either assessed in natural units (e.g. pH level of top soil, number of large animal units [LAU]) or on dedicatedly developed point scales. These point scales are based on the specification of three benchmarks, identifying central thresholds for the sustainability performance that are grouped in the three categories: problematic (0–33 points), critical (34–66 points) and positive (67–100 points). RISE includes guidance on how to derive region-specific benchmarks.

The comparison of the aggregated farm performance with the benchmarking scale leads to the evaluation of the farm. The RISE analysis is not a "pass or fail" analysis, as no threshold is defined that separates "sustainable" from "non-sustainable". Instead, the assessment serves to position a farm's sustainability performance with regards to each parameter on a continuum from very poor (0 points) to very good (100 points).



Issue areas and sustainability indices of RISE

Energy and Climate	Animal Welfare
Energy management	Livestock management
Energy intensity	Livestock productivity
Share of sustainable energy carriers	Species-appropriate housing
Greenhouse gas balance	Quality of the physical environment
	Livestock health

Energy and Climate
- Energy management
- Energy intensity
- Share of sustainable energy carriers
- Greenhouse gas balance

Water Use
- Water management
- Water supply
- Water use intensity
- Risks to water quality

Soil Use
- Soil management
- Crop productivity
- Soil organic matter balance
- Soil reaction
- Soil pollution
- Soil erosion
- Soil compaction

Biodiversity and Plant Protection
- Crop protection and biodiversity management
- Ecological priority areas
- Intensity of production
- Landscape quality
- Diversity of production

Nutrient Flows
- Nitrogen balance
- Phosphorus balance
- Tightness of N and P cycles
- Ammonia emissions
- Waste management

Animal Welfare
- Livestock management
- Livestock productivity
- Species-appropriate housing
- Quality of the physical environment
- Livestock health

Economic Viability
- Liquidity reserve
- Indebtedness
- Economic vulnerability
- Livelihood ensurance
- Financial scope

Farm Management
- Farm strategy and planning
- Supply and yield stability
- Planning instruments and documentation
- Quality management
- Cooperation

Quality of Life
- Work and education
- Financial situation
- Social relations
- Personal freedom and values
- Health
- Further aspects of life

Working Conditions
- Personnel management
- Working times
- Work safety
- Wage and income level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Sustainability Assessment of Food and Agriculture Systems (SAFA)

SAFA

Fact Sheet

Date established
2009

Geographic scope
The SAFA approach is globally applicable. The SAFA guidelines were pilot-tested in 23 different settings across 19 countries and the SAFA Tool software has been beta-tested in seven countries.

Initiative overview
The Sustainability Assessment of Food and Agriculture systems (SAFA) guidelines have been developed since 2009 by FAO in cooperation with a wide range of stakeholders. The finalized, tested and peer-reviewed SAFA guidelines were presented to FAO member countries in October 2013. The SAFA guidelines are accompanied by the SAFA Tool (free open-access software for Windows and Mac for conducting SAFA impact assessments) and the SAFA Indicators (a detailed reference guide to the SAFA default indicators). The SAFA Small App is the latest SAFA product, specifically designed to focus on the sustainability indicators that are most relevant to smallholders, while supporting capacity-building and practical solutions to improve sustainability performance.
SAFA provides an international reference point by describing the essential elements of sustainable food and agriculture systems. Rather than competing with other standards, SAFA builds on existing initiatives to provide a holistic definition of sustainability in food and agriculture systems. The SAFA framework defines common sustainability themes and subthemes that apply to all food and agriculture systems and suggests default indicators to measure sustainability performance in these areas. Yet SAFA is also a flexible, multipurpose tool that can be adapted by customizing the indicators to reflect local conditions.
One of the major strengths of SAFA is its flexibility. The definition of common sustainability themes ensures equivalency among different enterprises, while

Main objective
SAFA provides a holistic framework that identifies the major sustainability themes for food and agriculture systems. The methodology can be customized, in order to rate the sustainability performance of a farm, production site, company or value chain. SAFA supports capacity-building and continuous improvement in each of the dimensions of sustainability – environmental integrity, economic resilience, social well-being and good governance.

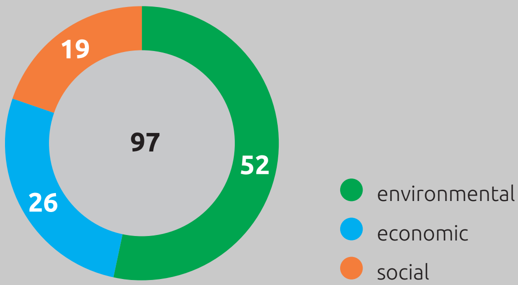
Implementing or coordinating organization
SAFA can be implemented as a self-assessment, or with the assistance of an agricultural extension agent, or as an external audit by agricultural producers, processors, manufacturers and retailers.

Stakeholder involvement
SAFA has been developed by FAO through a five-year participatory process involving various research organizations, producer organizations, the private sector, and civil society organizations. The consultation process included targeted stakeholder interviews, expert meetings, electronic public consultations and a partners and practitioners workshop.

Financing model
The SAFA Tool and Small App are freely available open access softwares that stakeholders can use to conduct an impact assessment of their operations or for B-2-B communication. It is expected that stakeholders will finance the application of the SAFA guidelines by themselves.

Verification process
SAFA can be both implemented as a self-evaluation or by independent auditing entities acting on behalf of business, consumer or public interests.

Number of farm-level indicators by sustainability dimension



specific indicators can be customized to reflect local contexts and different scales of production in different subsectors (i.e. agriculture, livestock, forestry, fisheries and agrifood processing) operations. SAFA can be applied at all stages of the supply chain and it is possible to overlay and compare the performance of different entities, production years or phases of the supply chain. It should be emphasized that SAFA is not an index, standard or labelling tool; SAFA is an approach that can be tailored to suit different users' needs, promoting sustainability through a range of applications.

The overall objectives of the SAFA guidelines are to:

- Provide a common understanding of sustainability that can be applied by primary producers, manufacturers and retailers in the food and agriculture sector, including crops, livestock, forestry and fisheries production of food, fibre, energy and other biomass-related products.
- Provide a benchmark that defines the essential components of sustainable food and agriculture systems, including the environmental, social, economic and governance components.
- Provide a customizable template for agriculture and food sustainability assessment, for those who wish to substantiate sustainability claims.
- Raise awareness and build capacity among users to implement and monitor improvements in sustainability performance.

Rating and reporting sustainability performance

The SAFA guidelines identify four overarching sustainability dimensions: good governance, environmental integrity, economic resilience and social well-being. These sustainability dimensions are further differentiated into 21 themes, 58 subthemes and 116 default indicators. The SAFA guidelines can be implemented as part of a self-assessment process or by external auditing agencies. The guided process of implementing a SAFA assessment leads participating organizations through the steps of defining enterprise boundaries and contextualization, collecting data on core indicators, and reporting SAFA results. The SAFA guidelines identify default indicators of sustainability performance in each of the subthemes and suggest practical ways in which they can be measured. During the contextualization process, users are able to customize these indicators to reflect the specific local conditions in which they operate.

The SAFA guidelines provide instructions for users to translate original quantitative and qualitative measurements into a sustainability rating for each indicator. The rating is based on a 5-scale colour code that highlights the areas where sustainability performance is “best” (dark green), “good” (green), “moderate” (yellow), “limited” (orange) or “unacceptable” (red). This “traffic light” system is reported as a “sustainability polygon”. The polygon allows users to quickly and clearly identify sustainability hotspots, in order to target improvements in these areas. The polygon can reveal trade-offs and synergies among different sustainability themes, helping enterprises to improve their decision-making and sustainable management.

The SAFA Small App provides an example of how the SAFA guidelines can be adapted to meet the needs of different enterprises. The assessment involves an hour-long survey that examines up to 39 indicators, chosen to focus on the specific requirements of smallholder producers and processors. For example, smallholders may face constraints such as limited existing data, limited relevance of global indicators, and lack of time, resources or capacity to conduct testing or other expensive means of collecting primary data for certain performance indicators (e.g. GHG balance). The survey questions are designed to be brief and easily understandable, in order to raise awareness of sustainability issues, build capacity among smallholders and trigger a continuous process of sustainability improvements. The SAFA Small App has been field-tested in Colombia and Kenya, with the participation of over 400 farmers, including subsistence, semi-commercial and commercial producers.

Sustainability themes and subthemes covered by the SAFA guidelines

Dimension	Theme	Subtheme
Good Governance	Corporate Ethics	Mission statement
		Due diligence
	Accountability	Holistic audits
		Responsibility
		Transparency
	Participation	Stakeholder dialogue
		Grievance procedures
		Conflict resolution
	Rule of Law	Legitimacy
		Remedy, restoration and prevention
		Civic responsibility
		Resource appropriation

Sustainability themes and subthemes covered by the SAFA guidelines

Dimension	Theme	Subtheme
	Holistic Management	Sustainability management plan
		Full-cost accounting
Environmental Integrity	Atmosphere	Greenhouse gases
		Air quality
	Water	Water withdrawal
		Water quality
	Land	Soil quality
		Land degradation
	Biodiversity	Ecosystem diversity
		Species diversity
		Genetic diversity
	Materials and Energy	Material use
		Energy use
		Waste reduction and disposal
	Animal Welfare	Animal health
		Freedom from stress
Economic Resilience	Investment	Internal investment
		Community investment
		Long-ranging investment
		Profitability
	Vulnerability	Stability of production
		Stability of supply
		Stability of market
		Liquidity
		Risk management
	Product Quality and Information	Food safety
		Food quality
		Product information
	Local Economy	Value creation
		Local procurement
Social Well-being	Decent Livelihood	Quality of life
		Capacity development
		Fair access to means of production
	Fair Trading Practices	Responsible buyers
		Rights of suppliers
	Labour Rights	Employment relations
		Forced labour
		Child labour
		Freedom of association and right to bargaining
	Equity	Non-discrimination
		Gender equality
		Support to vulnerable people
	Human Health and Safety	Workplace health and safety provisions
		Public health
	Cultural Diversity	Indigenous knowledge
		Food sovereignty

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