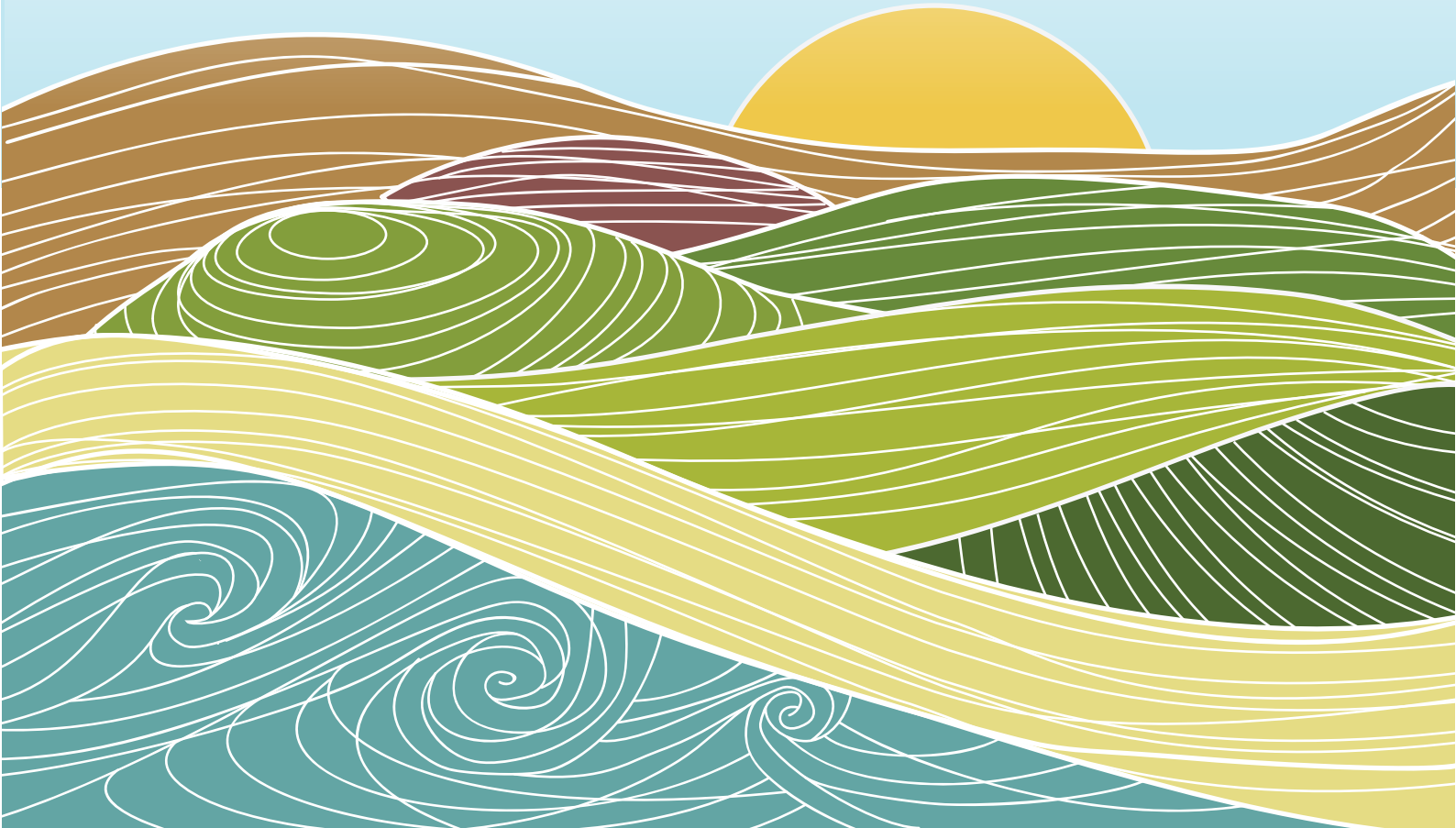
Food and Agriculture Organization of the United Nations

Dare to Understand and Measure (DaTUM)

A literature review of Monitoring and Evaluation (M&E) frameworks for Climate-Smart Agriculture



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A literature review of Monitoring and Evaluation (M&E) frameworks for Climate-Smart Agriculture

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Abbreviations and acronyms

ADAPT	adaptive, dynamic, active, participatory, thorough
AF	Adaptation Fund
AfDB	African Development Bank
AFOLU	agriculture, forestry and other land use
ALM	adaptation logic model
AMAT	Adaptation Monitoring and Assessment Tool
AMIA	Adaptation and Mitigation Initiative in Agriculture (Philippines)
APEC	Asia and Pacific Economic Cooperation
ASAP	Adaptation for Smallholder Agriculture Programme
ATI	Agricultural Transformation Index
BAU	business as usual
BRACED	Building Resilience and Adaptation to Climate Extremes and Disasters
BUR	biennial update report
CARE	Cooperative for Assistance and Relief Everywhere
CBA	community-based adaptation
CBD	Convention on Biological Diversity
CCA	climate change adaptation
CCAFS	Climate Change, Agriculture and Food Security programme
CCC	Climate Change Commission (Philippines)
CCVI	climate change vulnerability indices
CDM	clean development mechanism
CDP	Carbon Disclosure Project
CEOS	Committee on Earth Observations Satellites
CGIAR	Consultative Group on International Agricultural Research
CH4	methane
CIAT	Centro Internacional de AgriculturalTropical/International Center for TropicalAgriculture
CIDA	Canadian International Development Agency
CIF	Climate Investment Funds
COP	Conference of the Parties
CRA	climate-resilient agriculture
CRiSTAL	Community-based Risk Screening Tool – Adaptation and Livelihoods
CSA	Climate-Smart Agriculture
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSV	climate-smart village
CVCA	Climate Vulnerability and Capacity Analysis
DA	Department of Agriculture (Philippines)
DAS	German Strategy for Adaptation to Climate Change
DFID	Department for International Development (UK)
DPSIR	driving forces, pressure, state, impact, response
DRR	disaster risk reduction
DTU	Technical University of Denmark

EBRD	European Bank for Reconstruction and Development
EEA	European Environment Agency
ENRM	Environment and Natural Resource Management
EO	Earth Observation
EPIC	Economic and Policy Analysis of Climate Change
ESA	European Space Agency
Ex-ACT	Ex-Ante Carbon Balance Tool
FAIR	findability, accessibility, interoperability, reusability
FAO	Food and Agriculture Organization of the United Nations
FERDI	Fondation pour les études et recherches sur le développement international/Foundation for Studies and Research on International Development
FSB	Financial Stability Board
GACSA	Global Alliance for Climate-Smart Agriculture
GAP	good agricultural practices (certification)
GCCA	Global Climate Change Alliance
GCF	Green Climate Fund
GEF	Global Environment Facility
GEO	Group on Earth Observations
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit/German Corporation for International Cooperation
GLEAM	global livestock environmental assessment model
GRASP	global risk assessment on social practice
GRI	Global Reporting Initiative
GSARS	Global Strategy on Improving Agricultural and Rural Statistics
IADB	Inter-American Development Bank
IAEG	Inter-Agency and Expert Group (on SDGindicators)
ICAT	Initiative for Climate Action Transparency
ICRAF	World Agroforestry Centre
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IIED	International Institute for Environment and Development
IISD	International Institute for Sustainable Development
INDC	intended nationally determined contribution
INFORM	Index for Risk Management
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
JRC	Joint Research Centre (European Commission)
KJWA	Koronivia Joint Work on Agriculture
KPI	key performance indicator
LDC	least developed country
LDCF	Least Developed Countries Fund
LEG	UNFCCC LDC Expert Group
LGU	local government unit
MAAIF	Ministry of Agriculture Animal Industry and Fisheries (Uganda)
M&E	monitoring and evaluation

ME&L	monitoring, evaluation and learning
MDB	Multilateral Development Bank
MDB–IDFC	Multilateral Development Bank–International Development Finance Club
MOOC	massive open online course
MRV	monitoring, reporting and verification
MSCD	minimum set of core data
NAMA	nationally appropriate mitigation action
NAP	national adaptation plan
NAPA	national adaptation plan of action
NAP-Ag	national adaptation plan for agriculture
NAS	National Academy of Sciences (USA)
NC	national communication
NCCAP	National Climate Change Action Plan (Philippines)
NDC	nationally determined contribution
ND-GAIN	Notre Dame Global Adaptation Initiative
NORAD	Norwegian Agency for Development Cooperation
NVA	New Vision for Agriculture (WEF)
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development
OECD–DAC	Organisation for Economic Co-operation and Development–Development Assistance Committee
OREDD	Regional Observatory on Environment and Sustainable Development (Morocco)
PATPA	Partnership on Transparency in the Paris Agreement
PDO	project development objective
PEG	progress, effectiveness and gaps
PMERL	participatory monitoring, evaluation, reflection and learning
PMF	performance measurement framework
PPCR	Pilot Program for Climate Resilience
PRM	productivity, resilience, mitigation
PROSA	progress towards sustainable agriculture
PVCCI	Physical Vulnerability to Climate Change Index (FERDI)
RBM	results-based management
RBMES	Results-Based Monitoring and Evaluation System (Philippines)
REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RHoMIS	Rural Household Multi-Indicator Survey
RIMA	Resilience Index Measurement and Analysis
RIMS	Results and Impact Management System
RREIE	Regional Network of Exchanging Environmental Information (Morocco)
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCCF	Special Climate Change Fund
SDG	Sustainable Development Goal
SHARP	Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists
SIDA	Swedish International Development Agency
SIRE	Système d'information régional de l'environnement/regional environmental information system
SMART	specific, measurable, achievable, realistic, time-bound

SOM	soil organic matter
SWCCO	Systems-Wide Climate Change Office (Philippines)
TAMD	Tracking Adaptation and Measuring Development
TCFD	Task Force on Climate-related Financial Disclosures
TOC	theory of change
UDP	UNEP DTU Partnership
UKCIP	United Kingdom Climate Impacts Programme
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNGWG	United Nations Global Working Group
UNISDR	United Nations International Strategy for Disaster Reduction
UNITAR	United Nations Institute for Training and Research
USAID	United States Agency for International Development
VCS	Verified Carbon Standard (now Verra)
WBCSD	World Business Council for Sustainable Development
WEF	World Economic Forum
WRI	World Resources Institute

Chemical formulae

CO_2	carbon dioxide
CO_2eq	carbon dioxide equivalent
N_2O	nitrous oxide

Acknowledgements

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Executive summary

Objectives of the report

The main objective of this report is to review the monitoring and evaluation (M&E) frameworks, tools and guidance documents that are available for Climate-Smart Agriculture (CSA), and in particular for objective ("pillar") two on adaptation and resilience. The report is a literature review and does not propose a new methodology. It is not an exhaustive list, but summarises the main M&E frameworks. This report represents the first step towards the development of operational guidelines for the design and implementation of national M&E frameworks for CSA, to be developed during the first quarter of 2019. The envisioned operational guidelines will address the core constraints and needs of Member States on both the design and implementation of an M&E system that can simultaneously address CSA and sector reporting requirements for the 2030 Agenda climate instruments. These guidelines will address the principal need expressed by Member States that M&E systems and indicators should be simple and not onerous. The intended users are practitioners designing CSA projects at country level and policy-makers coordinating national-sector monitoring and reporting efforts on climate change under the following three global agreements: the United Nations 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction, and the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement of 2015.

Monitoring for Climate-Smart Agriculture

The CSA approach was developed to tackle three main objectives, or pillars: (1) sustainably increasing agricultural productivity and incomes; (2) building resilience and adaptation to the impacts of climate change; and (3) contributing to climate change mitigation, where possible.

Implementation of CSA requires a well-defined and effective approach to M&E and the development of indicators. However, the development of M&E concepts and systems for CSA has lagged behind the development of methods and approaches for implementation.

Indicators that can serve the purpose of monitoring for CSA Pillar 1 (production) are relatively straightforward. FAO is the custodian agency of 21 Sustainable Development Goal (SDG) indicators relating to agriculture, forestry and fisheries. Most relevant to Pillar 1 is Indicator 2.4.1, which is the *percentage of agricultural area under productive and sustainable agriculture*, and falls under SDG Target 2.4 (resilience, productivity, ecosystem maintenance, adaptation to climate change and extreme events, soils). The indicator reflects the multiple dimensions of sustainability and allows measurement of progress towards more productive and sustainable agriculture through monitoring at farm level (FAO PROSA, forthcoming).

For CSA Pillar 3 (mitigation), the CO_2 equivalent is the standard common metric to measure greenhouse gas (GHG) emissions reductions. For mitigation tracking, it is relatively easy to assess progress as GHG emissions reductions can be tracked in all sectors against this one standard metric. That said, there remain challenges to monitoring, as in all pillars, including data collection, reporting, access, sharing and availability, institutional challenges, and a lack of standardised methods for measurement of direct and indirect emissions and standardised methods at project level. For a brief overview of methodologies and tools for GHG emissions quantification and monitoring, reporting and verification (MRV) of mitigation, see Chapter 5.

In the absence of the standard CO_2 metric, CSA Pillar 2 (adaptation and resilience) exhibits the most critical need for consensus on the selection of indicators. It is indeed difficult to measure adaptation and resilience given the myriad challenges inherent to the context-specific nature of climate change adaptation, including differing timeframes, multidimensional aspects (social, economic, environmental, financial), difficulty in capturing both processes and outcomes through adaptation indicators, lack of capacity for monitoring over the longterm, and data constraints.

Why guidance is needed for monitoring Climate-Smart Agriculture

In 2015, a majority of countries committed to three global agreements: (1) the 2030 Agenda for Sustainable Development; (2) the Sendai Framework for Disaster Risk Reduction (2015–2030); and (3) the UNFCCC Paris Agreement. The 2030 Agenda for Sustainable Development contains 17 SDGs and 169 related targets that will be monitored using a set of 232 global indicators, which are part of a framework being developed by the Interagency and Expert Group on SDG indicators.

Additionally, M&E guidance is increasingly needed to track the influx of climate finance for adaptation in recent years. Donors require countries to meet certain conditions in order to obtain funding, and then to regularly report on the use of these funds. Climate finance mechanisms such as the UNFCCC Adaptation Fund, Global Environment Facility (GEF) and Green Climate Fund (GCF) have developed indicators to assess the contributions of projects to decreased vulnerability and increased resilience.

Currently about 40 countries have started to develop national adaptation M&E systems, but only a few of them are fully operational to date (Leiter, 2017b; GIZ, 2017a). Those that have completed the evaluation of their national adaptation plan or strategy include Finland (2013), France (2015), Germany (2015) and the United Kingdom (2015). Very few national systems have a method to aggregate information from subnational scales (Leiter, 2015), which will prove increasingly important especially considering the global stocktake under the 2015 Paris Agreement.

Structure of the report

Several international organisations, non-governmental organisations, research institutes and donor agencies have provided tools and guidance to governments, local communities, and project proponents on the development of M&E frameworks and indicators for climate change adaptation. The report summarises these frameworks in two broad categories: agriculture-specific and non-agriculture-specific frameworks. A brief summary of frameworks and tools for MRV of mitigation is included in Chapter 5. The report also summarises five climate change vulnerability indices, which may be of use in developing monitoring frameworks. In all, the frameworks encompass 745 indicators. Lastly, the report provides an overview of the main challenges to M&E.

Key strengths and limitations of agriculture-specific frameworks

The agriculture-specific frameworks focus mostly at national level; however, these frameworks can often be applied at other levels. For example, the FAO *Tracking adaptation in agricultural sectors* framework (FAO, 2017c) is intended for monitoring at national level, but may also be customized for application at local level depending on data availability. The framework presents a concrete methodology for monitoring adaptation processes and outcomes for three main dimensions of adaptation: (1) reducing vulnerability; (2) strengthening adaptive capacity; and (3) enhancing resilience. Indicators are

divided into four categories: (1) natural resources and ecosystems; (2) agricultural production systems; (3) socio-economics; and (4) institutions and policy. These categories are further divided into 16 indicator subcategories with 111 possible indicators. Several frameworks monitor co-benefits (beneficial side effects of a targeted policy), accounting for all three CSA pillars and for unintended outcomes in more than one pillar. The Consultative Group on International Agricultural Research (CGIAR) CCAFS (Climate Change, Agriculture and Food Security programme) Programming and Indicator Tool is interactive, providing concrete indicator recommendations as well as a graphical visualization to help users to interpret results. Having noted that there is a gap with regard to indicators on policy and legal frameworks to improve food security, availability and access, CGIAR–CCAFS has developed diverse sets of indicators for readiness, resilience and food security. The body of work developed by CGIAR–CCAFS accommodates the related concepts of adaptive capacity and resilience, and the context-specific factors that affect resilience.

A few frameworks attempt to link indicators to specific SDG targets or indicators, at least in theory. These are Syngenta's Good Growth Plan, the Global Climate Change Alliance Plus (GCCA+) Index, and the International Fund for Agricultural Development (IFAD) Adaptation for Smallholder Agriculture Programme (ASAP 1/2), which has started to conceptually link its ten generic indicators with SDGs.

The World Bank CSA Indicators serve as a robust tool to meet the needs of a variety of agriculture and rural development projects. The framework is able to accommodate new data and indicators while allowing consistent comparison and analysis. It can also be used during different phases of a project. One limitation of indices in general is that they provide a number as an output, which then must be translated into practical solutions on how to improve a project.

So far there are limited examples of the applications of frameworks or case studies. Importantly, as noted across all levels of applicability, the frameworks are often unable to function as stand-alone instruments; instead, they must be embedded within a generic M&E system and accompanied by the development of a theory of change/results framework.

Limitations of private-sector frameworks relate to the inherent challenges in reconciling metrics between CSA indicators based on global data (e.g. FAO, IFAD, World Bank) and those used in the private sector. Several member companies of the World Business Council for Sustainable Development (WBCSD) do not have quantitative targets for Pillar 2, nor do they have global data linking to resilience indicators. The private sector has been largely uninvolved in reporting on resilience indicators, nor has it explicitly tracked agro-ecology activities.

The community-level monitoring frameworks exhibit unique strengths in their function as internal M&E and learning tools, and in their emphasis on participatory processes designed to support vulnerable and marginalised populations. These more participatory frameworks empower groups typically excluded from the process of developing context-specific indicators relevant to their own priorities. Through this participatory method, communities gain a greater sense of ownership in the monitoring process and its outcomes.

The Cooperative for Assistance and Relief Everywhere (CARE) community-based adaptation (CBA) framework is comprehensive, providing a "menu", including milestones, indicators and indicator definitions for three different levels that reflect the enabling environment: household/individual, local government/community and national. However, as noted previously, even thorough and extensive frameworks such as this one sometimes do not provide explicit guidance on the actual selection of indicators based on objectives and priorities.

Limitations of community-level frameworks stem from the time and resources required of the many stakeholders and community members. These frameworks are mainly effective at supporting incremental changes in project design and management, not necessarily longer-term assessments. They are also limited in their ability to meet more stringent requirements of donors with different objectives and indicators. This type of framework is limited in its potential for scaling up or enabling comparison of communities.

At household level, the frameworks are relatively flexible and can be tailored to meet the needs of specific projects and communities. Several exhibit flexibility through their modular structure, which allows users to choose certain modules rather than requiring the use of all. This flexibility is further magnified by the common use of tablets, which facilitates the interview process and provides immediate results. Certain frameworks allow data to be disaggregated by gender and age

group. Similar to the strengths displayed in the community-level frameworks, these also take a participatory approach that empowers farmers and pastoralists.

There is a high level of technical complexity in certain household-level tools, such as FAO's Resilience Index Measurement and Analysis (RIMA I/II), which makes some of them less accessible to certain groups. Tools such as the Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists (SHARP) are not stand-alone tools and need to be integrated with M&E and information systems to take full advantage of the collected information. There are similar time and resource requirements for household-level frameworks as for the community-level frameworks. Enumerators need training to ensure the quality and validity of data, and coordinated planning is often necessary to enable participants to complete surveys.

Key strengths and limitations of non-agriculture-specific frameworks

The non-agriculture-specific frameworks have been developed by various donor agencies for financing mechanisms, and for adaptation planning. Also highlighted are three examples of M&E systems from national adaptation or national climate change plans (Germany, the Philippines and Morocco).

Donor-funded frameworks have similar strengths and limitations. The World Bank's Climate Investment Funds (CIF) Pilot Program for Climate Resilience (PPCR) Monitoring and Reporting Toolkit indicates the responsibilities of various actors in monitoring and reporting for each core indicator and provides useful scoring criteria. The World Bank's *Operational guidance for monitoring and evaluation (M&E) in climate and disaster resilience-building operations* (2013/2017) provides both "core" evaluation considerations and "resilience-specific considerations" for each step in the evaluation section. This framework does provide sample sector-specific indicators from existing operations, and lists good practices, excerpts from case studies and recommendations.

The GCF and GEF have both revised their M&E frameworks to be more consistent with the results frameworks of other funds, such as the Adaptation Fund, the World Bank's CIF PPCR, and each other. The GCF framework and the revised GEF tool include qualitative as well as quantitative scoring methodologies, and now incorporate gender indicators. Both GCF and GEF propose indicators that are broad and generic. It should be noted that the frameworks are not intended to replace more project-specific M&E frameworks, meaning that there may still be an additional reporting burden for countries. Several frameworks provide generic indicators while allowing and/or requiring additional, project-specific indicators. However, they tend to be limited in their guidance on selecting these project-specific indicators.

The UNFCCC Adaptation Fund includes a complete explanation and guidance addressing each indicator with supplementary information. It is one of the only frameworks with a generic discussion on developing baselines. There is, however, limited discussion of sector-specific data or data complications.

In general, the multilateral development banks are increasingly developing metrics to monitor and evaluate climate-resilient development pathways based on principles that are consistent with national adaptation plans (NAPs) and nationally determined contributions (NDCs). This shows that they are aware of the potential reporting burden and at least attempting to streamline monitoring and reporting initiatives. However, monitoring can be challenging when adaptation activities are part of a larger development project due to difficulty in defining project boundaries, and Chapter 6 addresses these challenges.

The adaptation planning frameworks have similar strengths and limitations. Several frameworks are applicable at different levels (e.g. the International Institute for Environment and Development's (IIED) Tracking Adaptation and Measuring Development (TAMD) tool) and can be used for both planning and evaluation (i.e. ex-ante and ex-post), adding to their

versatility. Generally, indicators are generic and broad enough to aggregate for an assessment of progress on adaptation. This also means that they may need to be translated into context-specific indicators.

The original UNFCCC Least Developed Countries Expert Group (LEG) technical guidelines for the national adaptation plan process (2012) were fairly generic. In 2015, the LEG and the Adaptation Committee collaborated with the German Corporation for International Cooperation (GIZ) and the International Institute for Sustainable Development (IISD) to develop more detailed guidance for the development of national adaptation M&E systems. The 2015 *M&E guidebook* (Price-Kelly *et al*., 2015) displays many strengths and advantages over the older version. It provides examples of national adaptation frameworks and resources for further reading, as well as a flowchart of responsibilities for each step in the NAP process. As might be expected, the guidance is not sector-specific.

GIZ has published myriad guidance documents and tools on adaptation M&E, including *The vulnerability sourcebook: concept and guidelines for standardised vulnerability and risk assessments* (Fritzsche *et al*., 2014/2017), the guidebook *Adaptation made to measure* (2013a), and *Repository of adaptation indicators* (Hammill *et al*., 2014/2017). The *vulnerability sourcebook* uses a standardised approach to vulnerability assessments covering a wide range of sectors, levels and timeframes. It also provides good coverage of indicator selection and since updating in 2017, it refers to the climate risk framework from the most recent Intergovernmental Panel on Climate Change (IPCC) report. The main strength of the GIZ repository is that it provides indicator lists by focus area and sector with clear definitions and detailed explanations of terms, and is a reliable reference for practitioners developing country-specific indicators. An associated Microsoft Excel spreadsheet helps users to organise indicators and serves as a "living document" for future updates.

For non-state actors and corporate disclosures, the Global Reporting Initiative (GRI) provides standards and the Carbon Disclosure Project (CDP) provides a global system for companies, cities, states and regions to measure, disclose, manage and share information on their environmental performance. CDP has the most comprehensive global collection of corporate environmental data, which can be used to track progress towards the 2015 Paris Agreement and the SDGs. CDP has integrated the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) (see Section 3.3.1) into its climate change questionnaires. The TCFD recommendations provide a framework for companies to develop more effective climate-related financial disclosures through their existing reporting processes. The GRI standards are compatible with a wide range of international frameworks and reporting for economic, environmental and social categories. GRI and CDP have worked together to ensure alignment in disclosures on climate change.

Challenges to monitoring and evaluation for Climate-Smart Agriculture

The following challenges are mostly relevant to the monitoring of Pillar 2 (adaptation and resilience). Although there is overlap between all three CSA pillars on several challenges relating to data constraints and institutional capacity, the challenges are formidable for Pillar 2.

- *Aggregation vs context-specific indicators/comparisons (no one standardised indicator or "one size fits all" framework)*: Indicators are highly variable and diverse, depending on the objectives of the assessment, the location, the project or action, stakeholder input, donor requirements and the larger goals of the project or programme. This makes the aggregation and comparison of results across different sectors, locations and time periods difficult.
- *Different objectives for M&E of adaptation*: Adaptation activities have been designed with different scopes and scales and with a wide range of objectives for M&E. These objectives can be incompatible when stakeholders have different requirements and time and/or resources for M&E are limited.
- *Choosing types of indicator (process and outcome indicators, in particular)*: It is a challenge to choose the appropriate types of indicator and find the correct balance in order to achieve the objectives of the assessment. The total

number of indicators should be chosen in light of the M&E objective and the resources needed to obtain data while also aiming to cover all dimensions relevant to adaptation.

- *Public vs private M&E frameworks*: Most frameworks have been developed by the public sector. There has indeed been recent progress on the development of frameworks by the private sector but more engagement is needed. Additionally, many private companies do not explicitly track activities essential to the monitoring of specific agricultural indicators standard to other frameworks, leading to complications in harmonization.
- *Attribution*: Assessing attribution is difficult, given that it is not often possible to establish a direct causal link and confirm that the outcome was successful due to the adaptation action and not to other external factors. The main tool used in attempting to determine attribution is the development of a sound theory of change, which then informs the entire M&E process.
- *Capacity/responsibility for maintaining M&E systems, ownership and an emphasis on learning*: The determination of who is responsible for updating data and the frequency of these updates is crucial to ensure the sustainability of the M&E system. Local communities will feel a greater sense of ownership if the framework produces results that are useful to them.
- *Tracking system-wide capacities across people, organisations, institutions and the enabling policy environment for country-driven climate action*: Enhancing adaptive capacity requires efforts to strengthen capacities through a system-wide approach across people, organisations, institutions and the enabling policy environment. It is a challenge to track and monitor system-wide changes in capacity.
- *Tracking co-benefits*: There is no commonly agreed standard indicator to account for co-benefits associated with adaptation activities, which tend to exhibit a wide range of social, economic or mitigation benefits, some measured quantitatively and some qualitatively. Frameworks designed with a specific goal of tracking co-benefits are better able to achieve this. Co-benefit indicators should be robust to ensure that projects are fairly considered when being evaluated for funding.
- *Baseline development*: Baselines are constantly changing over time due to the dynamic nature and uncertainty of climate change and climate impacts. Updating them continuously may be resource-intensive, as the data needed to construct baselines may be located in different agencies, ministries and institutions. There are also challenges in deciding on methods for constructing baselines for adaptation, and how to deal with uncertainties.
- *Data challenges*: There are myriad data challenges associated with M&E systems. These include high costs; data availability, access and ownership; institutional data management; multiple international reporting obligations; diversity of assessment timeframes; collection and dissemination of Earth Observation satellite data; and using big data.

1 Introduction

1.1 Background

Climate-Smart Agriculture (CSA) was developed as a framework to tackle three main objectives: (1) sustainably increasing agricultural productivity and incomes; (2) building resilience and adaptation to the impacts of climate change; and (3) contributing to climate change mitigation, where possible. This three-tiered approach promotes the adoption of climate-smart practices, supports existing production systems in adapting to the impacts of climate change, and fosters an enabling environment for conducive policies, institutions and finance. CSA can facilitate a transition to more productive and yet sustainable agriculture systems while helping stakeholders to identify agricultural strategies suited to their local conditions. These approaches also aim to address trade-offs between the three objectives, or pillars, of CSA.

Implementation of CSA requires a well-defined and effective approach to monitoring and evaluation (M&E) and the development of indicators. However, the development of M&E concepts and systems for CSA has lagged slightly behind the development of methods and approaches for implementation. It is difficult to measure adaptation, given the myriad challenges inherent to the context-specific nature of climate change adaptation including differing timeframes, multidimensional aspects (social, economic, environmental, financial), difficulty in capturing both processes and outcomes through adaptation indicators, lack of capacity for monitoring over the long term, and data constraints. Thus M&E systems for adaptation developed to date cover a wide range of purposes and objectives, target audiences, scales and levels (Leiter, 2017a; Bours, McGinn and Pringle, 2015).[2]

Sustainable Development Goal (SDG) Indicator 2.4.1, which is the *percentage of agricultural area under productive and sustainable agriculture*, falls under SDG Target 2.4: "By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality." Indicator 2.4.1 addresses the issues covered in Target 2.4: resilience, productivity, ecosystem maintenance, adaptation to climate change and extreme events, and soils. In November 2018, it was reclassified as Tier 2 from its original status as Tier 3.[3] The indicator reflects the multiple dimensions of sustainability and enables the measurement of progress towards more productive and sustainable agriculture through monitoring at farm level (FAO PROSA, forthcoming).

Indicators exist that can serve the purpose of monitoring for the CSA production pillar. In its forthcoming report on progress towards sustainable agriculture (PROSA), FAO aims to identify ways to measure sustainable agriculture with available data,

and to complement existing SDG monitoring systems by measuring and tracking progress towards sustainable agriculture as described in SDG Indicator 2.4.1. The PROSA report will also provide concise analyses of the observed trends in sustainable agriculture according to key indicators under FAO's mandate.

The eleven sub-indicators for 2.4.1 are listed in Table 1 by dimension and theme.

Table 1: SDG Indicator 2.4.1, sub-indicators by dimension and theme

	Theme	Sub-indicators
Economic	Land productivity	Farm output value per hectare
	Profitability	Net farm income
	Resilience	Risk-mitigation mechanisms
Environmental	Soil health	Prevalence of soil degradation
	Water use	Variation in water availability
	Fertilizer pollution risk	Management of fertilizers
	Pesticide risk	Management of pesticides
	Biodiversity	Use of biodiversity-supportive practices
Social	Decent employment	Wage rate in agriculture
	Food security	Food insecurity experience scale (FIES)
	Land tenure	Secure tenure rights to land

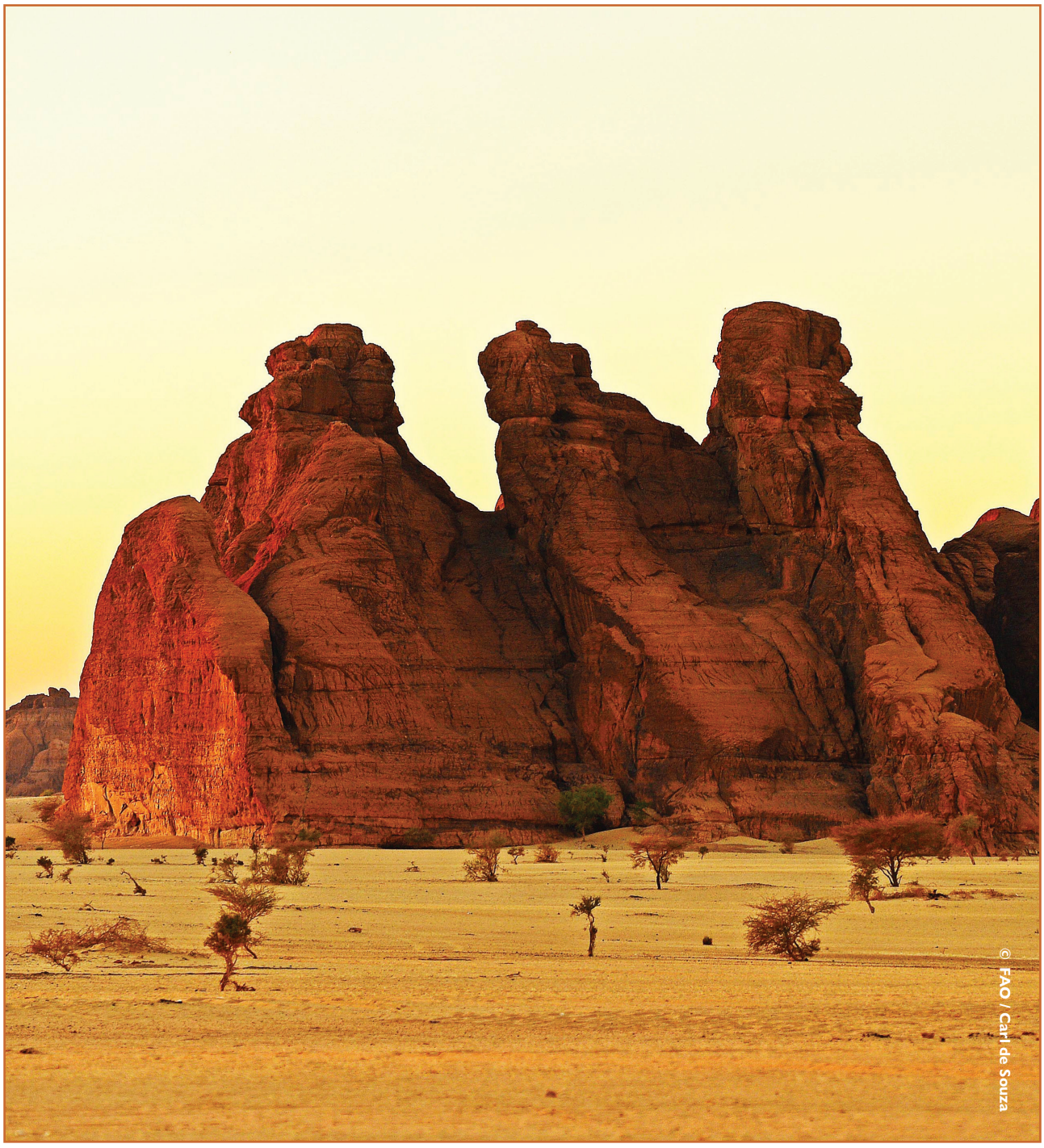
Source: FAO PROSA (forthcoming)

Each sub-indicator is derived by calculating the proportion of agricultural area by sustainability status (i.e. desirable, acceptable and unsustainable) in total agricultural area.[4]

FAO is the custodian agency of 21 SDG indicators relating to agriculture, forestry and fisheries. Generally, FAO monitors agricultural production at national level in FAOSTAT, the largest database relating to food and agriculture, where 633 primary and processed crop and livestock commodities are tracked, including aspects of productive activity such as area harvested, output and yields. For an easy-access quick reference, FAO also publishes an annual *World food and agriculture statistical pocketbook*[5] in which selected key indicators relating to agriculture and food security can be used to assess trends and inform policymaking. For global crop production, the analysis examines harvested area, returns per hectare (yields) and quantities. The pocketbook also provides country profiles that include production indices for 1995, 2005 and 2016 (the most updated year in the 2018 edition) for food, crops, cereals, vegetable oils, roots and tubers, fruit and vegetables, sugar, livestock, milk, meat and fish.

For CSA Pillar 3 (mitigation), the carbon dioxide equivalent (CO_2eq) is the standard common metric to measure greenhouse gas (GHG) emissions reductions. FAOSTAT tracks direct and indirect emissions (CO_2eq) at national level in all agriculture domains[6] and for methane (CH_4) and nitrous oxide (N_2O) emissions where applicable. For mitigation tracking, it is relatively easy to assess progress as GHG emissions reductions can be tracked in all sectors against this one standard metric.

In the absence of such a standard metric, the pillar with the most critical need for the development of indicators is Pillar 2 (adaptation and resilience). Contrary to M&E systems for adaptation, monitoring systems in the context of mitigation are referred to as monitoring, reporting and verification (MRV) systems. In general, verification by the international community is somewhat less important in the context of adaptation because the benefits are mainly local, as opposed to mitigation which addresses a problem that is more a tragedy of the commons.



Box 1 explains the difference between MRV systems for mitigation and M&E systems for adaptation.

BOX 1

Understanding transparency: backgrounds and key differences between MRV (for mitigation) and M&E (for adaptation) systems

Monitoring, reporting and verification (MRV) systems were first mentioned in the context of climate change mitigation in the 2007 Bali Action Plan, which introduced the principle of MRV for the purpose of enhancing action at international and national levels to mitigate climate change. This idea was further developed through a series of COP decisions. The impetus for the development of metrics for adaptation monitoring and evaluation M&E was the influx of climate funds aiming for accountability regarding the use of allocated resources (Christiansen, Martinez and Naswa, 2018). The development of M&E was bolstered by the 2010 Cancun Agreements, which required all Parties to report on activities undertaken in the delivery of support to ensure transparency, accountability and use of best practices (UNFCCC, 2011). Finally, there was an additional emphasis on the evaluation of adaptation actions in the lead up to the adoption of the 2015 Paris Agreement, which requires a review of adaptation effectiveness as part of the global stocktake of progress, as well as a review of progress towards achieving the global goal on adaptation: *Enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2 (Article 7.1).*

The main differences between the two types of system stem from the verification aspect. Verification of GHG emissions data in GHG inventories and emissions reductions resulting from mitigation actions is important for a number of reasons:

- The atmosphere is a global common good.
- Planned emissions reductions must be verified to ensure they have occurred and to maintain an accurate GHG inventory.
- Actions taken in one country affect others in terms of leakage and the global commons.
- In light of the Paris Agreement, verification is intended to contribute to increased transparency under the enhanced transparency framework, and aims to build trust among nations and increase ambition.

Verification of adaptation, on the other hand, presents greater challenges due to the lack of a standard common metric (Leiter & Pringle, 2018) similar to the CO_2eq used to measure mitigation. For mitigation, one tonne of avoided GHG emissions has the same global effect no matter where it was achieved. Additional challenges for adaptation verification include the context-specific nature of adaptation and the location-specific subjective definitions for terms such as resilience and vulnerability.

Thus verification in the international community is not viewed as equally critical for adaptation as for mitigation. The benefits of adaptation are largely experienced locally, whereas mitigation benefits are global. Exceptions are risk transfer (e.g. insurance), migration and human security and markets/global supply chains (GIZ, 2017b).

Figure 1 shows the intended reporting structure of the Enhanced Transparency Framework under development by the UNFCCC. As shown, there are three different aspects to measure under the framework: mitigation, adaptation and support.

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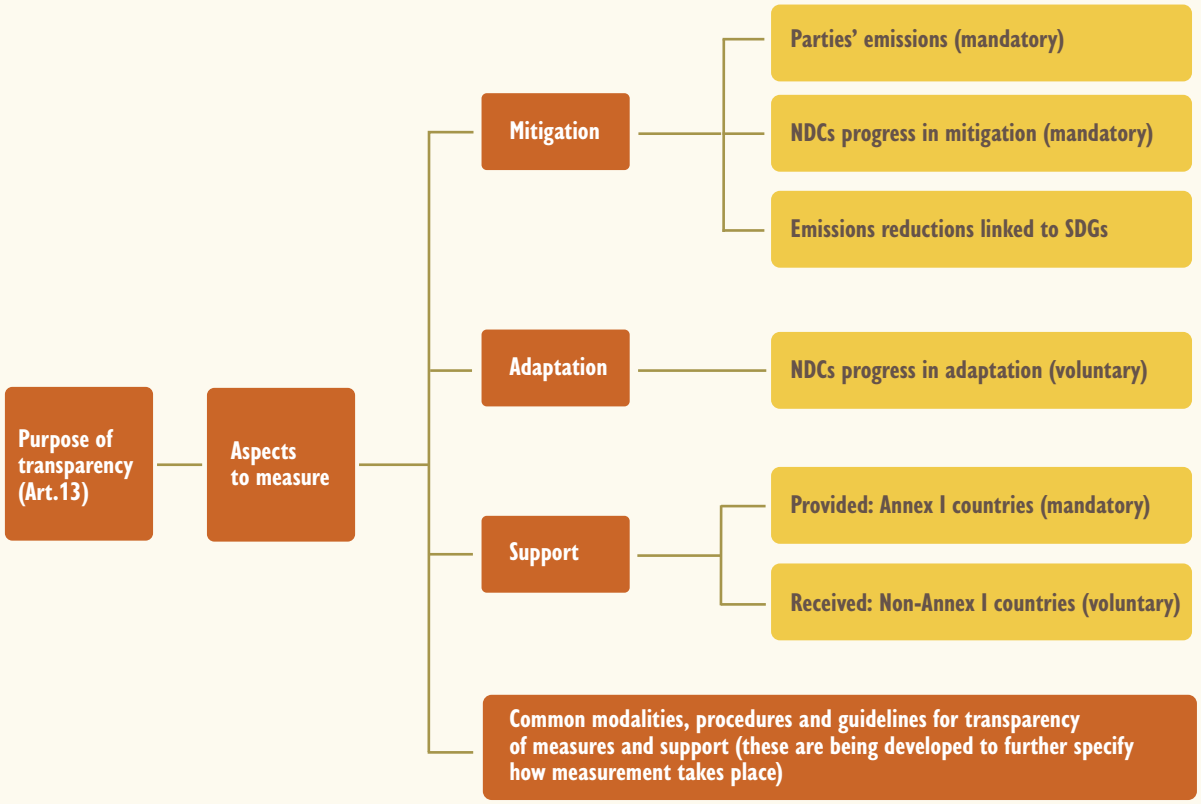
Figure 1: Reporting structure under the enhanced transparency framework of the 2015 Paris Agreement



Source: Adapted from Nairobi NDC Partnership workshop presentation (April 2018)

There has been an increase in requests from governments for guidance on M&E since the entry into force of the 2015 Paris Agreement under the UNFCCC, which defined a global goal on adaptation and requires all Parties, as appropriate, to engage in adaptation planning and implementation and to communicate their priorities, action plans and support needs through adaptation communications. The Agreement aims at improving transparency by establishing a new transparency framework under which Parties are expected to report on climate change impacts and adaptation. Thus countries need to be able to monitor and report on their adaptation interventions using appropriate indicators (Möhner, Leiter and Kato, 2017).

Additionally, M&E guidance is increasingly needed to track the influx of climate finance for adaptation in recent years. Donors require countries to meet certain conditions in order to obtain funding, and then to regularly report on the use of these funds. Climate finance mechanisms such as the UNFCCC Adaptation Fund (AF), Global Environment Facility (GEF) and Green Climate Fund (GCF), as well as bilateral and multilateral development finance institutions, are in the process of developing indicators to assess the contributions of projects to decreased vulnerability and increased resilience. It is very important for countries to understand how to communicate their objectives and plans for the implementation of adaptation actions in order to obtain this funding, as well as how to account for financial support once activities are underway.

1.2 Monitoring the three global agreements

In 2015, a majority of countries committed to three international agreements: (1) the 2030 Agenda for Sustainable Development, which has 17 Sustainable Development Goals (SDGs); (2) the Sendai Framework for Disaster Risk Reduction (2015–2030); and (3) the UNFCCC Paris Agreement. The 2030 Agenda for Sustainable Development was adopted in 2015. The 17 SDGs and 169 related targets are being monitored using a set of 232 global indicators, which are part of a framework being developed by the Interagency and Expert Group on SDG indicators, comprised of Member States and regional and international agencies as observers. It was agreed upon at the 48th session of the United Nations Statistical Commission and adopted by the General Assembly on 6 July 2017.

The Sendai Framework for Disaster Risk Reduction, adopted in 2015, is a voluntary, non-binding agreement which is the successor agreement to the *Hyogo Framework for Action (HFA) 2005–2015: Building the Resilience of Nations and Communities to Disasters*. The Sendai Framework aims for the following outcome: *the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of person, businesses, communities and countries*. It recognises that the state has the primary role to reduce disaster risk but that it should be a shared responsibility with local government, private-sector actors and other stakeholders. The framework has four priority areas for action: (1) Understanding disaster risk; (2) strengthening disaster risk governance to manage disaster risk; (3) investing in disaster risk reduction for resilience; and (4) enhancing disaster preparedness for effective response to "build back better" in recovery, rehabilitation and reconstruction. The UNISDR has been called upon to support the implementation, follow-up and review of the Sendai Framework.

Lastly, the Paris Agreement entered into force in 2016 after Parties to the UNFCCC reached an agreement to undertake ambitious efforts to combat climate change at the Conference of the Parties (COP) 21 in 2015. The Agreement's main goal is to strengthen the global response to climate change by keeping global temperature rise this century well below 2° C above pre-industrial levels. The Agreement also provides for an enhanced transparency framework for action and support. It requires all Parties to submit nationally determined contributions (NDCs) that outline and communicate their intended GHG emissions reductions and efforts towards mitigation and adaptation.

Currently about 40 countries have started developing national adaptation M&E systems, but only few of them are yet fully operational (Leiter, 2017b).[7] The Organization for Economic Cooperation and Development (OECD) recognises that many more have indicated in their NDCs that they are either developing one or they plan to do so (Vallejo, 2017). Of the 55 NDCs (39 intended nationally determined contributions (INDCs))[8] that mentioned a national adaptation plan (NAP) had started or was planned, 15 INDCs (9 NDCs) specifically mention monitoring and evaluation of adaptation.[9] OECD notes that the national approaches to M&E systems include a number of qualitative and quantitative indicators that ranges between three (Mexico) and over 100 (France, Germany, Kenya and the Philippines). These M&E systems rely on a combination of indicators that provide information on climate hazards, impacts, adaptive capacity, adaptation processes and outcomes. Adaptation processes are most commonly monitored, whereas adaptation outcome indicators are the most difficult to produce and evidently least used to date. Only a few countries have completed the evaluation of their national adaptation plan or strategy, including Finland (2013), France (2015), Germany (2015) and the United Kingdom (2015). Very few national systems have a method to aggregate information from sub national scales (Leiter, 2015), which will prove increasingly important especially considering the global stocktake under the 2015 Paris Agreement.

The OECD provides a list of SDG indicators that could be linked to the review of overall progress in achieving the global goal on adaptation under the UNFCCC, shown in Table 2.

Table 2: Examples of SDG indicators that could relate to climate change adaptation

Goal		Indicators
Climate action	13.1.1	Number of deaths, missing people, injured, relocated or evacuated due to disasters per 100 000 population
	13.2.1	Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other)
	13.3.1	Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula
Zero hunger	2.4.1	Proportion of agricultural area under productive and sustainable agriculture
Clean water and sanitation	6.4.1	Change in water-use-efficiency over time
	6.5.1	Degree of integrated water resources management implementation (1–100)
Sustainable cities and communities	11.b.1	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030
	11.b.2	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies
Life on land	15.2.1	Progress towards sustainable forest management

Sources: Adapted from Kato and Ellis (2016); United Nations Statistics Division (2018)

To support the assessment of global progress in achieving the outcome and goals of the Sendai Framework, seven global targets have been agreed:

- Substantially reduce global disaster mortality by 2030, aiming to lower average per 100 000 global mortality between 2020–2030 compared with 2005–2015.
- Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100 000 between 2020–2030 compared with 2005–2015.
- Reduce direct disaster economic loss in relation to global gross domestic product by 2030.
- Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and education facilities, including through developing their resilience by 2030.
- Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.
- Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the framework by 2030
- Substantially increase the availability of and access to multihazard early warning systems and disaster risk information and assessments to the people by 2030.

Table 3 provides examples of Sendai Framework compound indicators on disaster risk reduction that could relate to climate change adaptation. These are potentially useful to practitioners who wish to take disaster risk into account in the development of an M&E framework for adaptation and in the development of outcome indicators. Table 4 lists Sendai framework indicators that are specific to enabling environment for disaster risk reduction that could relate to climate change adaptation, which may be useful to practitioners in the development of process or outcome indicators or in developing indicators relating to institutional capacity.

Table 3: Examples of Sendai Framework compound indicators on disaster risk reduction outcomes that could relate to climate change adaptation

Global target		Indicators
Disaster mortality	A-1	Number of deaths and missing persons attributed to disasters, per 100 000 population
Affected people	B-1	Number of directly affected people attributed to disasters, per 100 000 population (including population injured or ill, whose dwelling is damaged or destroyed, and whose livelihood is disrupted or destroyed)
Economic loss	C-1	Direct economic loss attributed to disasters in relation to global gross domestic product (including losses from agriculture, housing sector, productive assets, critical infrastructure and cultural heritage damaged or destroyed)
Critical infrastructure and basic services	D-1	Damage to critical infrastructure attributed to disasters (including health and education facilities damaged or destroyed and critical infrastructure units and facilities)
	D-5	Number of disruptions to basic services attributed to disasters (including education, health and other basic services)

Source: United Nations Statistics Division (2018)

Table 4: Examples of Sendai Framework indicators on enabling environment for disaster risk reduction that could relate to climate change adaptation

Global target		Indicators
Risk reduction strategies	E-1	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030
Developing countries' support	F-1	Total official international support (official development assistance (ODA) plus other official flows), for national disaster risk reduction actions
Early warning systems	G-1	Number of countries that have multihazard early warning systems

Source: United Nations Statistics Division (2018)

The reporting that is required under these frameworks is onerous and there is a clear burden on countries. There has been a great deal of discussion about a possible streamlining of indicators and reporting in order to alleviate this burden (GIZ, 2017d), and the entry of the SDGs introduces an opportunity to achieve a more coherent reporting process.

1.3 Objectives

The objective of this report is to review the M&E frameworks, tools and guidance documents that are available for CSA, and for Pillar 2 in particular. The report is a literature review and does not propose a new methodology. It is not an exhaustive list, but summarises the main M&E frameworks. The report is the first step towards the development of a set of operational guidelines for the design and implementation of an M&E framework for CSA, which will be developed as a second step during the first quarter of 2019. The intended users are practitioners designing CSA projects at country level and policy-makers coordinating national-sector monitoring and reporting efforts on climate change under the three global agreements discussed in Section 1.2. The envisioned operational guidelines will address the core constraints and needs of Member States on both the design and implementation of M&E systems that can address sector reporting requirements for the 2030 Agenda climate instruments. These guidelines will address the principal need expressed by Member States that M&E systems and indicators should be simple and not onerous.

Lastly, this report aims at contributing to discussions on "Methods and approaches for assessing adaptation, adaptation co-benefits and resilience", which is one of the five thematic elements stated in the Koronivia Joint Work on Agriculture (KJWA). The KJWA has been under negotiation since 2011 and became the first substantive outcome and the first COP decision on agriculture at COP23 in 2017, when Parties reached a decision on the KJWA within the UNFCCC framework. The decision requests the Subsidiary Body for Implementation (SBI) and Subsidiary Body for Scientific and Technological Advice (SBSTA) to jointly address issues relating to agriculture. The SBSTA and the SBI initiated their joint consideration of the KJWA at SB48, and based on Parties' and observers' views, a road map to guide the KJWA was adopted. This road map provides for in-session workshops starting at SB49 in December 2018 and ending in 2020.

1.4 Organisation

This report is organised into six chapters. Following the introduction, Chapter 2 summarises the M&E frameworks that are available for adaptation in the agriculture sector. It is divided into subsections for the following different levels of applicability addressed by the agriculture-specific frameworks: national, programme/project, private sector, community, and household level. Chapter 3 summarises non-agriculture-specific M&E frameworks and is divided into four subsections: frameworks for financing mechanisms, frameworks for adaptation planning, frameworks for non-state actors and corporate disclosures, and country-level cases. The country-level cases demonstrate M&E systems in three countries that have included and reported on agriculture-sector indicators in their adaptation monitoring systems.

Several international organisations, non-governmental organisations, research institutes, and donor agencies have provided guidance to governments, local communities, and project proponents in the development of M&E frameworks and indicators for climate change adaptation. The development and selection of indicators depends on national, regional, local, or project/programme objectives and on the results framework, including its theory of change or logic model. As outlined by GIZ and FAO, the first step in developing an M&E system to track adaptation is contextualizing the adaptation action and identifying its dimensions and contributions, followed by the formulation of the results framework, and finally the definition of indicators for monitoring and the setting of a baseline against which to monitor and evaluate (GIZ, 2013a).

For the purposes of this summary, the frameworks, tools and guidance documents are divided into two broad categories: those that focus specifically on agriculture (Chapter 2) and those that are broader and not agriculture-specific (Chapter 3).

This summary covers a wide range of literature, from generic guidance on how to develop M&E systems for adaptation, to complex frameworks containing suites of indicators and indices tailored to Climate-Smart Agriculture. Chapter 4 presents five climate change vulnerability indices, which may be of use in the development of M&E frameworks, perhaps offering underlying data for indicators relating to resilience or vulnerability. Chapter 5 provides a brief summary of frameworks and tools for MRV of mitigation. Chapter 6 begins a discussion regarding the challenges of M&E for adaptation in general and specific to agriculture. It addresses issues of aggregation, attribution, selection and number of indicators, data challenges including high costs, and others. Annex I contains the glossary. Annex II is a selection of guidance documents that have contributed to the discussion on challenges in Chapter 6 and also serves as a reference for broad guidance addressing the development and implementation of M&E systems and indicators for adaptation in general. Annex III provides two comparative tables, one for the agriculture specific frameworks and one for non-agriculture-specific frameworks. These tables summarise the key attributes of the frameworks and can be used as a quick reference for practitioners.

2

2 Monitoring and Evaluation (M&E) guidance specific to the agriculture sector

This chapter presents M&E frameworks that are specific to the agriculture sector. These frameworks have been developed by different organisations mainly focused at national level (e.g. FAO, CGIAR–CCAFS, World Bank, WRI), at community level (e.g. CARE, IISD), at household level (RIMA, SHARP, RHoMIS), and the private sector (e.g. WEF, WBCSD and Syngenta). Where possible, the strengths and limitations of each framework have been highlighted following the description.

2.1 National level

2.1.1 FAO: Climate-Smart Agriculture Sourcebook (2013)

The *Climate-Smart Agriculture Sourcebook* (FAO, 2013)[10] was a collaborative effort involving several departments within FAO and a variety of partner organisations. CSA implementation, monitoring and evaluation continue to be challenging because climate-smart interventions are highly location-specific and knowledge-intensive. In a nutshell, the sourcebook aimed to further elaborate the concept of CSA, demonstrate its potential and limitations, as well as help decision-makers to understand the different options available to achieve a climate-smart approach to the agricultural sectors. It contains a chapter on M&E, as well as a table with examples of indicators of common outputs, outcomes and impacts in monitoring and evaluation for CSA programmes and projects, which are categorized by the following outputs, outcomes and impacts:

Poverty and household impacts (where possible this data should be disaggregated by gender or by male- and female-headed households)

- percentage of population that is food insecure;
- percentage of population below the poverty line;
- household income, income variability and diversification.

Outcomes in terms of CSA-related productive change

- agricultural productivity (e.g. tonnage of crop produced per hectare);
- changes in productive resilience to climate variability.

Outcomes in terms of adoption of CSA systems

- number of irrigation systems that raised drought prevention standards and area of farmland area covered;
- number of soil and water conservation works;
- area of farmland that adopted CSA technologies (e.g. reduced tillage, permanent crop cover, agroforestry).

Outputs and outcomes relating to capacity building and service-related intervention

- number of male- and female-headed households that have gained direct household benefits from more climate-resilient agriculture infrastructure;
- farmgate and market prices;
- women beneficiaries constitute half of participants in capacity-development activities.

Institutional outputs and outcomes

- strategy, policy and regulation formulated for CSA;
- inclusion of climate change in agricultural policy frameworks.

The challenges cited by the authors in the monitoring chapter that are unique to assessment, monitoring and evaluation for CSA include the following: the difficulty of setting the goals and an agreed definition of CSA; the multisectoral nature of CSA and the involvement of various stakeholders; the issues of scale, leakage, permanency, externality and ancillary impact; the difficulty of obtaining quality data and information; the uncertainties with data, information, and methods; difficulty of attribution; inadequate capacity and resources; and the practicality of methods and tools.

Strengths

- Although broad, the discussion on M&E is tailored to CSA.

Limitations

- The sourcebook is not a framework and does not focus on M&E specifically but on CSA in its entirety.

2.1.2 WRI: Indicators of sustainable agriculture: a scoping analysis (2014)

The World Resources Institute (WRI) conducted a scoping exercise to identify a preliminary list of quantifiable candidate indicators of the environmental sustainability of agriculture to assess progress towards a sustainable food and agriculture future. Their working paper describes the methods and results of this analysis (Reytar, Hanson and Henninger, 2014).[11]

This work was originally carried out in order to design an Agricultural Transformation Index (ATI) to guide public/private sector decision-making and to identify where policies were needed to promote sustainable growth in the agriculture sector.

WRI proposes that an environmental sustainability index reflect at least five thematic areas based on the most important and commonly assessed impacts:

- water;
- climate change;
- land conversion (terrestrial ecosystems);
- soil health;
- pollution (nutrients, pesticides).

Importantly, WRI points out that four out of five of these thematic areas align with international conventions. Climate change is covered in the UN Framework Convention on Climate Change (UNFCCC); land conversion has links to the UNFCCC and the Convention on Biological Diversity (CBD); soil health has links to the UN Convention to Combat Desertification (UNCCD); and pesticide pollution has links to the Stockholm Convention on Persistent Organic Pollutants and the Rotterdam Convention.

They developed a list of candidate indicators for three dimensions of the "causal chain" (policy, practice and performance). For the climate change thematic area, the candidate indicators are focused on the impact of agriculture on GHG emissions. Candidate indicators included those listed in Table 5 for the thematic areas of Agriculture and also for Soil Health, which could also inform the development of useful indicators for tracking Climate-Smart Agriculture and adaptation in agriculture.

Table 5: Candidate indicators for agriculture and soil health by policy, practice and performance dimensions

Agriculture		
Policy	**Practice**	**Performance**
· Existence of low-GHG agricultural development policies or emissions management incentives · Existence of policies or incentives that promote soil carbon sequestration · Participation in UNFCCC and other international treaties	· Share of farms with GHG emissions management practices in place	· Total GHG emissions from food production per tonne of food produced · Total GHG emissions from agriculture · Energy consumption
Soil health		
Policy	**Practice**	**Performance**
· Existence of policies that promote soil conservation practices	· Share of arable land under soil conservation practices · Share of cropland under conservation agriculture (e.g. organic soil cover greater than 30% measured immediately after planting) · Share of agricultural land under certified organic farm management	· Share of agricultural land affected by soil erosion · Percent change in net primary productivity (NPP) across agricultural land · Share of cropland under conservation agriculture (e.g. organic soil cover greater than 30% measured immediately after planting) · Organic carbon content in topsoil · Share of irrigated farmland affected by salinization · Extent and degree of soil degradation due to water erosion, wind erosion, chemical deterioration, or physical degradation

Source: Reytar, Hanson and Henninger (2014)

Strengths

- This scoping analysis provides a list of indicators that are relevant to M&E for adaptation in agriculture. It also elucidates areas of overlap between thematic areas and international conventions with reporting obligations for countries. This could be useful for future discussions on streamlining country reporting obligations, global aggregation and country comparison.

Limitations

- This is not a comprehensive framework for monitoring adaptation in agriculture, but rather the foundation for an environmental sustainability index to track sustainable agricultural practices. It would need to be used or embedded within a coherent and elaborated M&E framework.

2.1.3 FAO: Addressing agriculture, forestry and fisheries in national adaptation plans (*supplementary guidelines*) (2017)

The FAO supplementary guidelines on agriculture in NAPs (FAO, 2017a)[12] are intended to accompany the UNFCCC NAP technical guidelines prepared by the LEG of the UNFCCC by providing specific guidance for the agriculture sector. The LEG technical guidelines provide advice on establishing a national planning process, identifying and addressing capacity gaps, preparing NAPs, and establishing a monitoring and evaluation system; however because they are not sector-specific, the UNFCCC invited agencies and partners to submit sector-specific supplementary technical guidelines. FAO first responded to this invitation with its voluntary guidelines for the integration of genetic diversity in the NAP process and has subsequently published this guidance (FAO, 2015a).[13]

Four chapters of the supplementary guidelines cover NAP formulation, implementation and assessment. Chapter 4 includes step-by-step guidance for agriculture adaptation planning and implementation, as well as resources and examples to support monitoring and evaluation.

Annex 4 provides examples of indicators of common outputs, outcomes and impacts for adaptation programmes and projects adapted from the CSA sourcebook and including additional expert input. The outcome/impact areas with example indicators are indeed similar to those listed in the CSA sourcebook Section 2.1.1, but here the indicators have been further elaborated, as listed in Table 6.

Table 6: Common impacts and outcomes and associated indicators for adaptation programmes and projects

Impacts and outcomes	Indicators
Poverty and household impacts (where possible these data should be disaggregated by gender)	· Percentage of population that is food insecure · Percentage of population below the poverty line · Household income, income vulnerability and diversification · Proportion of food and income coming from climate-sensitive sources · Farmgate and market prices · Amount of time spent collecting firewood · Amount of time spent collecting water
Outcomes in terms of adaptation-related changes in production	· Agricultural productivity (e.g. yield and its stability) · Changes in land use (area) · Changes in soil biophysical characteristics (e.g. organic matter content) · Diversification of climate-sensitive income sources · Marketing chains that are adapted to changing conditions
Outcomes in terms of adoption of resilient systems	· Number and/or coverage of irrigation systems that improved farmers' resilience to drought · Number and coverage of climate change resilient crop varieties, livestock breeds, forest species and aquaculture strains · Number and/or coverage of soil and water conservation works · Area of farmland that adopted climate-resilient practices (e.g. conservation agriculture, legume intercropping, agroforestry) · Number and/or coverage of easily accessible national and transnational transhumance corridors for allowing livestock mobility
Outcomes relating to capacity development and services	· Number of men and women who are applying new knowledge gained from capacity development interventions · Number of male- and female-headed households that have gained direct benefits from more climate-resilient agricultural and fisheries infrastructure · Proportion of women beneficiaries participating in capacity development activities · Number of officials and/or extension workers trained in climate change adaptation issues
Outcomes in terms of vulnerability and risk assessment	· Magnitude of impacts · Timing of impacts · Persistence and reversibility of impacts · Likelihood (estimate of uncertainty) of impacts and vulnerabilities and confidence

Box 2 summarises the communications, monitoring and evaluation module in the massive open online course on National Adaptation Plans developed by the Integrating Agriculture in National Adaptation Plans (NAP-Ag) programme.

BOX 2

NAP-Ag massive open online course on National Adaptation Plans: Building Climate Resilience in Agriculture

Module 6: Communications, monitoring and evaluation (2017)

The NAP-Ag massive open online course (MOOC)[14] was a six-week course developed in 2017 as part of the Integrating Agriculture in National Adaptation Plans (NAP-Ag) programme jointly organised by FAO, the United Nations Development Programme (UNDP) and the United Nations Institute for Training and Research (UNITAR) to examine coordination and governance aspects of implementing adaptation actions in agriculture. Using interactive lessons, case studies and stories, the course aims to build capacity and explores the process for addressing the agriculture sectors in the development and implementation of NAPs. Module 6 addresses communications, monitoring and evaluation.

According to FAO and Module 6 of the course, national-level tracking of the overall progress of adaptation actions should start at the beginning of the adaptation planning process and requires continuous assessment. As adaptation is a local issue, adaptation programmes should include indicators that capture changes at local levels. When designing the M&E framework, it is important to understand what aspects of adaptation to measure (process, outcomes or impacts), who will make use of the M&E and how M&E results might be used and fed into decision-making.

According to FAO, the indicators should:

- be aligned with existing indicators and national targets, whether reporting to national goals or reporting to major international mechanisms (e.g. Paris Agreement, SDGs, Sendai Framework for Disaster Risk Reduction);
- consider data already available on climate trends, vulnerabilities, economic and social dimensions, status of natural resources and land use, from various sources to avoid unnecessary burden on data collection and reporting;
- be gender-disaggregated to capture gender perspectives;
- be agreed by all stakeholders engaged in the process;
- be both process- and outcome-based.

The indicators for climate change adaptation M&E processes and outcomes in the agricultural sectors can be categorized into these four key dimensions: natural resources, agricultural production, socio-economics, and institutions and policy:

- natural resource indicators: relationship between state of environment and agricultural sector activities;
- agricultural production: relationship between natural resources, agricultural production and climate change impacts;
- socio-economic indicators: relationship between adaptation and social economic development;
- institutions and policy: evaluate existence and effectiveness of institutions and policies.

BOX 3

Ugandan Ministry of Agriculture, Animal Industry and Fisheries Performance M&E Framework for National Adaptation Plan for Agriculture (NAP-Ag)

The Government of Uganda approved the National Climate Change Policy in April 2015. Its goal is "ensuring a harmonized and coordinated approach towards a climate-resilient and low-carbon development path for sustainable development in Uganda". Prior to this, in 2011, Parties to the UNFCCC adopted national adaptation plans of action (NAPAs) in Durban, South Africa. The Global Climate Change Alliance (GCCA) is working in partnership with UN-FAO and UNDP in Uganda to support the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) in the development of these plans. The MAAIF Climate Change Unit developed the national adaptation plan for the agriculture sector (NAP-Ag), whose vision is a "climate-resilient and sustainable agricultural sector contributing towards achievement of the Uganda Vision 2040".

It has the following overall objectives:

- Promote climate-resilient cropping systems and value chains.
- Promote climate-resilient livestock production systems and value chains.
- Promote climate-resilient fisheries and integrated fisheries resource management.
- Strengthen climate information, early warning and disaster preparedness mechanism for a better informed agricultural planning and decision-making.
- Promote sustainable natural resources management that enhances the resilience of agriculture and agrarian communities to a changing climate.
- Promote climate-smart agricultural research and innovations.
- Enhance knowledge of good practices and partnerships to reduce vulnerability of the agriculture sector to the impacts of climate change.
- Promote a gendered Climate-Smart Agriculture programme to reduce the vulnerability of women, youth and other groups.

In order to assess progress, the government implemented an M&E framework to support the assessment of NAPAs for agriculture (NAP-Ag) and to support the documentation of progress at national and subnational levels. It contains performance indicators at output and outcome levels, mechanisms to capture and manage data (with gender perspectives), and estimates the implementation costs. The M&E framework for the NAP-Ag will be embedded in the existing MAAIF M&E framework, and the data will respond to needs that have been expressed at district and national levels. Local government data will feed into the national MAAIF M&E system, and the Ministry of Agriculture will generate quarterly reports to support national reporting under the broader performance-based budgeting tool, which is submitted quarterly to the MAAIF. The system will host a main repository fed by data from other stakeholders, research institutions, districts and non-state actors.

The ministry has used a variety of tools to capture data on climate change adaptation, including CARE's Climate Vulnerability and Capacity Analysis (CVCA) and Community-Based Adaptation Framework and Project Toolkit (CARE, 2011), and the IISD's Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) (IISD, 2014). As CRiSTAL has already been used in 13 districts, it has been scaled up for broader use as a performance measurement framework (PMF) data management tool. The government will also develop training materials and tools for users such as sector- and district-level officials and community duty bearers.

continued overleaf

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The performance of the NAP-Ag interventions will be assessed against a set of indicators under each component (objective). The plan provides information for the indicators, including an explanation, source and frequency of data collection. In Annex III, and shown in Table 7, there is a concise indicator descriptor.

Table 7: Indicator descriptor (see also Annex III)

Components	Output	Output indicators	Outcome	Indicator definition
Crop production	High quality crop output produced	Number of farmers trained and equipped on improved farming methods	Increased crop yields	Opting for better farming techniques that are resilient to climate change
Livestock development	Improved indigenous livestock and poultry breeds and management practices that are climate resilient	Number of improved species variety produced	Increased growth rates of livestock population	Increase in livestock population can be achieved through an improved management system within the livestock value chain
Fisheries	Climate-resilient fishing practices adopted	Number of fish farmers that have adopted the fishing practices	Increase in fish stock	Capture fisheries or farmed fish increasing in volume and value due to adoption of climate-smart practices
Climate information, early warning and disaster preparedness system	Ability to mitigate, adapt and being resilient to climate change	Number of plans and frameworks integrating climate change issues into national plans and policies	Prior warning and dissemination of climate change information	Raising prior awareness and provision of scientifically proven information on potentiality of occurrence of adverse effects of climate change.
Forestry, land and natural resource management	Sustainable use of LULUCF (land use, land use change and forestry)	Number of LULUCF prioritized	Increase of LULUCF prioritized	Restoring the carbon stock in the ground as a measure to support forest, land and resources
Research on climate-resilient agricultural development	Established climate change patterns, vulnerability, adoptive capacities and agricultural technologies to minimise impacts and risks	Number of resilient agricultural technologies	A resilient agriculture sector	Climate-resilient agriculture development built on technologies and resilient capacities for sustainable agriculture
Knowledge management and partnerships for climate action	Efficient and systematic dissemination and communication of climate actions between all stakeholders	Number of dissemination and communication platforms	Acquisition of information and communication systems that will aid decision-making	Information and communication shared among stakeholders
Gendered approach to climate change adaptation	Climate change adaptation responsive to gender issues	Number of adaptation programmes integrating gender issues	Gender mainstreaming in CSA	Plans/programmes on gender issues in climate change adaptations

Strengths

- Addresses the importance of tracking progress in NAPs specific to agriculture and thus serves an important niche.
- Accounts for and stresses the importance of building gender-sensitive indicators into M&E frameworks, and emphasizes the need for gender-responsive and nutrition-sensitive analysis and solutions.
- In terms of guidance on adaptation planning in general, the NAP guidelines provide useful information on cross-cutting issues and approaches to consider in adaptation in the agriculture sectors, such as co-benefits and externalities, gender-responsive adaptation, indigenous peoples, social protection, disaster risk management and deduction, migration, tenure rights, food-energy nexus, water, biodiversity and genetic resources, landscape approach, ecosystem approach and value chain approach.
- Provides a good reference/starting point for thinking about outcome/impact areas and possible indicators.

Limitations

- Although the guidelines are specific to agriculture and useful for planning adaptation activities and initial assessments of potential impacts and outcomes, the guidance on M&E and indicators is not as thorough or detailed as is provided in the more recent publication Tracking adaptation in agricultural sectors (FAO, 2017c), which presents a fully-fledged M&E framework.
- There is no discussion of the difficulty in obtaining gender-disaggregated data.

2.1.4 FAO: Tracking adaptation in agricultural sectors (2017)

This FAO framework and methodology for tracking adaptation in agriculture is intended for monitoring at national level, but may also be customized for application at local level depending on data availability (FAO, 2017c).[15] Tracking here refers to "the monitoring of adaptation processes and outcomes along a continuum for three main dimensions of adaptation": (1) reducing vulnerability, (2) strengthening adaptive capacity and (3) enhancing resilience. The rationale for the development of this framework is the current lack of M&E frameworks that track both adaptation processes and outcomes, and which are specific to agriculture. There are several existing generic frameworks that are not agriculture-specific and therefore do not capture interlinkages between adaptation processes and outcomes and effects on food security and nutrition. The authors note the importance of capturing all five general elements of adaptation activities in these frameworks:

- observation of climatic and non-climatic variables;
- assessment of impacts, vulnerability and risks;
- adaptation planning and mainstreaming;
- implementation of adaptation measures;
- monitoring and evaluation.

This framework is guided by the following four categories of agricultural adaptation indicators:

1. Natural resources and ecosystems
2. Agricultural production systems
3. Socio-economics
4. Institutions and policy

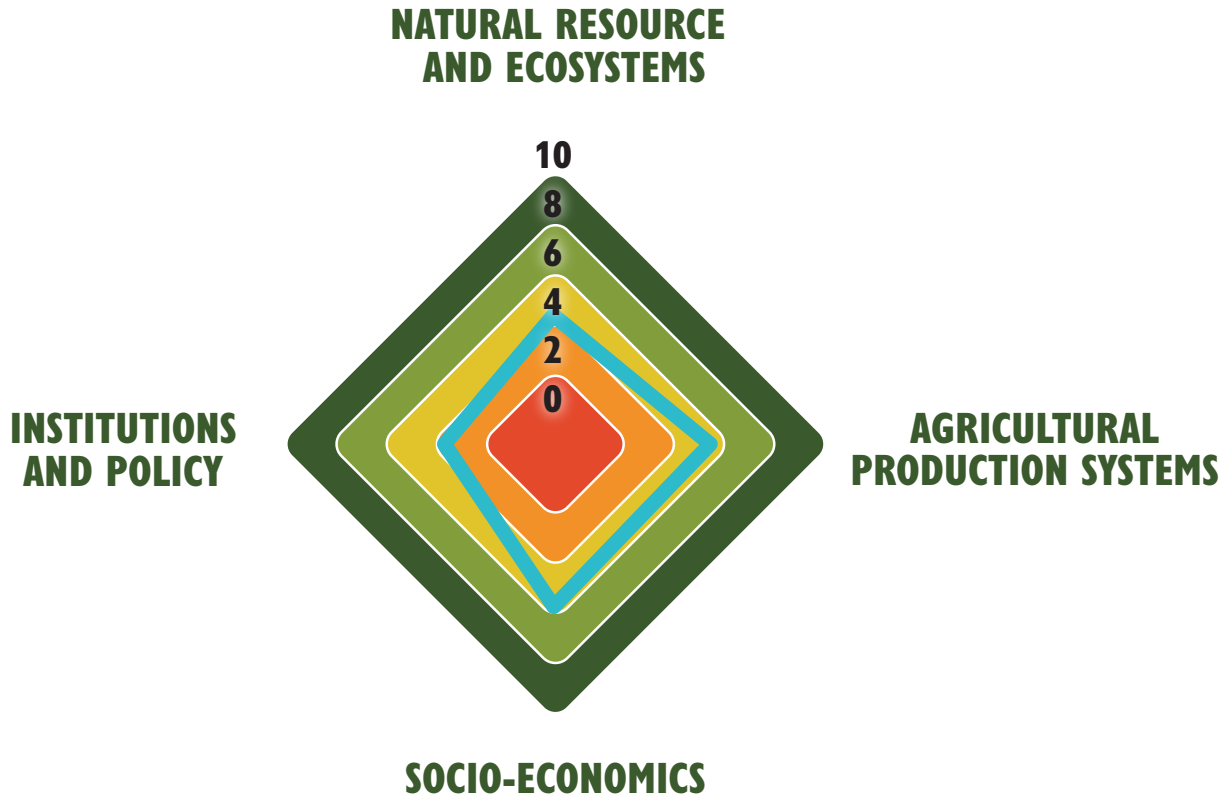
These four main indicator categories are further divided into 16 indicator subcategories with a total of 111 possible indicators. Users are encouraged to modify this list as needed. The first two categories (natural resources and ecosystems and agricultural production systems) are largely outcome-based and refer to actions at local level, whereas the second two (socio-economics and institutions and policy) are largely process-based and focus at national level. For quantitative comparisons of vulnerability or adaptation, the use of outcome indicators is recommended because process indicators are largely qualitative and context-specific. Within these categories are numerous subcategories of indicators. Guidance on

scoring and a scale of 0–10 are provided. By calculating the average of the weighted scores of the indicators included in the subcategories, users have a score that allows them to identify strengths and weaknesses of specific adaptation processes and actions.

Strengths

- This publication proposes a concrete methodology for monitoring adaptation and resilience in the agricultural sectors with recommended indicators and guidance on scoring.
- The assessment, mapping and scoring of indicators within the framework of the four basic overarching categories is relatively straightforward and provides a visual representation of progress that is simple to interpret (Figure 2).

Figure 2: Hypothetical example of the assessment and mapping of the performance of the main indicator categories



Source: FAO (2017c)

Limitations

- The guidance should not be used to compare adaptation progress in different countries. It is highly country-specific, unless identical sets of indicators and weights are chosen; but as the authors note, the use of qualitative indicators to compare countries or regions requires expert judgement.

2.1.5 FAO: Economic and Policy Analysis of Climate Change (EPIC) programme–metrics of Climate-Smart Agriculture (2017)

The Economic and Policy Analysis of Climate Change (EPIC) programme (Ignaciuk, 2017)[16] supports countries in evidence-based policy-making through sound economic and policy analysis to reform policies, institutions and investments on climate change, in connection with agricultural development and food security. The programme supports partner countries in part by using their analysis of and contributions to the development of CSA strategies. Its CSA approach merges heterogeneous information under categories for data collection such as household data and climate data.

The EPIC programme suggests the metrics listed in Table 8 for each CSA pillar (Ignaciuk, 2017).

Table 8: FAO EPIC programme's suggested CSA metrics by pillar

Pillar 1	Pillar 2	Pillar 3
Measuring food security: · productivity of crops, livestock, fisheries, forestry products (yield (crop yield (t/ha/yr)) · weight gain (kg/time) · milk production (L/cow/day)	**Altering exposure:** · impact assessment maps · changing cropping patterns	**Net GHG emissions** · tonnes CO_2eq per year (for a given geographic scale or operating entity: nation state, subsectors, projects, etc.) · GHG emissions intensity per product unit (for production stage or entire life cycle) · advanced composite indicators can be derived on a case by case basis (net GHG emissions per GDP may serve as an approximation of green growth)
Improvements in agricultural or total income: · net present value · household energy costs (USD/yr) - net returns (USD/ha/yr) · availability of a diverse & nutritious diet - consumption (Kcal/pers/day) - food deficit (Kcal/pers/day) - diet diversity score (number of categories of food consumed/X days) · access to market	**Reducing sensitivity:** · improve landscape management · crop diversification	
	Improve adaptive capacity · national or regional adaptive strategies developed · income diversification	

Source: Ignaciuk (2017)

2.1.6 CGIAR–CCAFS: Best practices for monitoring adaptation to enhance food security (2013)

The Consultative Group on International Agricultural Research (CGIAR) Research Program on Climate Change, Agriculture and Food Security (CCAFS) has published a working paper reviewing approaches to M&E in climate adaptation as well as approaches specific to monitoring food security impacts of climate adaptation projects, and recommended an approach for future M&E for food security (Chesterman and Ericksen, 2013).[17]

According to their analysis, food security is not an explicit focus of many adaptation projects, thus summarising best practices and most reliable indicators to assess impacts on food security proves difficult. In addition, the analysis concluded that - given the wide range of evaluation needs – it is very difficult to devise a universal set of indicators for adaptation.

Outcome indicators are insufficient to evaluate adaptation because dynamic changes associated with climate change occur over longer timeframes; thus it is necessary to incorporate process indicators. However, these do not provide quantitative evidence of change in and of themselves either (Spearman and McGray, 2011).

With regard to food security, current methodological approaches do not break food security into its component parts when evaluating interventions. Quantitative and qualitative approaches commonly use agriculture as the core theme, over which "food security" is identified as a broad overarching goal.

Thus the Adaptation Logic Model (ALM) was proposed to integrate food systems by providing an outcome-oriented methodology to compare outputs and outcomes against programme purpose and objectives. This type of model also allows the underlying assumptions to be examined, as well as the logic of the objectives. The evaluation focuses on contribution instead of attribution by demonstrating the contribution of an intervention to the outcome rather than attempting to link specific outcomes or impacts (Pringle, 2011). This approach shows how interventions target adaptive actions or adaptive capacity. The next step is to examine the food system interactions, which is crucial for making decisions on indicators.

The analysis states that evidence of food security projects with direct food security indicators can be found, but very limited examples of direct food security indicators for use in adaptation evaluations exist. Using the wrong indicators can lead to linking increases in food security with production increases, which does not necessarily demonstrate the success of an adaptation project in addressing food security. The authors note that it is important to understand concepts surrounding food security, and that proxies may need to be used that measure, for example, "inadequate access" rather than food availability or utilization.

The framework proposes using a logic model approach, which shows how interventions target adaptive actions or adaptive capacity. It requires a preliminary assessment of the food system interactions to gain an understanding of how food system activities lead to food system outcomes. This assessment also gives a better understanding of both food security and food insecurity, which then facilitates the selection of appropriate indicators.

The authors explain that an agriculture adaptation project may regard food security as an issue of increasing production but reminds us that production should be viewed alongside other activities such as distribution and market elements. A logical model intended to show how adaptation will affect outcomes must also account for trade-offs among these different outcomes, and acknowledge that there may be non-linear changes. Tables 9 and 10 illustrate "how a logic model can be combined with process, outcome and impact indicators to monitor and evaluate how adaptation interventions interact with food security goals".

Table 9: Implementing a logic model approach to food system objectives

Key food system objective	Strategies to achieve this	Process indicator	Outcome indicator	Impact indicator
Enhance nutritional value	More nutritious food grown	Farmers' crop choices change	Foods with greater nutritional value harvested	Lower rates of micronutrient deficiencies
	Price of nutritious food reduced	Pricing policies implemented	Households purchase more nutritious food	Lower rates of micronutrient deficiencies
More efficient use of scarce resources	Revise input prices	Pricing policies implemented	Fertilizers use modified	Less fertilizer waste
	Implement land tenure	Tenure policies designed and implemented	Land tenure more secure	Land used more efficiently

Source: Chesterman and Ericksen (2013)

Table 10: Methodology example

Thematic area covered	Food system activities and outcomes targeted	Example indicators
Agriculture, food aid	Production	· Yield (kg/ha % increase X adoption (ha)) · Value of the yield (USD/ha and % increase in adoption)
	Value chain	· On-farm added value (USD/kg and USD/HH) · Off-farm added value (USD/kg)
	Market regulation	· Price difference with producers and consumers (could further disaggregate rural and urban contexts)
	Land security	· Number of farmers with certificate · Area certified · Number of farmers renting land (both out and in) · Number of farmers with access to credit

Source: Chesterman and Ericksen (2013)

Strengths

- This approach elaborates further on the argument that a focus on attribution is not as beneficial for M&E as a focus on the generation of evidence that can help to determine the type, nature and level of contribution from an intervention; the authors also point out that the approach is more balanced because it calls on users to identify potential synergies and tensions starting at the planning stage.
- The authors propose six main recommendations for CCAFS and programmes such as CCAFS.[18]
- Table 7 (p. 39) of the report lists a range of food security indicators by component.

Limitations

- Focus is on food security.
- There are no case studies or examples of the framework's application yet.

2.1.7 CGIAR–CCAFS: Climate readiness indicators (2015)

The capacity to manage, plan, implement and monitor climate finance and activities relating to climate change is a condition known as climate readiness (Wollenberg, Zurek and De Pinto, 2015).[19] CCAFS notes that each sector has specific requirements for readiness and that it is highly variable for agriculture. Readiness is important because preliminary capacity building is often necessary. Its purpose is to support programmes for CSA, which in turn aim to:

1. support the use of CSA practices;
2. create conditions conducive to CSA innovations among farmers and those supporting them;
3. use climate-related goals and development pathways in decision-making (process-based approach).

Although CSA can be implemented in a variety of ways, and no single method fits all circumstances, Table 11 provides an example of a framework for climate readiness to inform how countries, donors or finance organisations think about building programmes for CSA. These indicators are based on experiences from REDD+ readiness and are categorized under five work areas (see Wollenberg, Zurek and De Pinto, 2015, for full list of readiness indicators).

Table 11: Examples of climate readiness indicators for agriculture

Work area	Example indicators
Effective governance and stakeholder engagement	Lead ministry or interministerial body designated to manage and coordinate climate-ready activities with clear decision-making processes and transparency Institutional roles are clear in agencies and local jurisdictions
Knowledge base and information services	Vulnerability and adaptation needs of farmers and agriculture sector assessed Classification exists of current agricultural production systems relating to adaptation needs and mitigation opportunities
Climate-Smart Agriculture strategy and implementation framework	Agreed vision and goals exist for the agriculture sector that balance food security, adaptation and mitigation and help to meet UN SDGs Maps and other analysis of the social and biophysical suitability of CSA interventions are available
National and subnational capabilities to develop sustainable CSA infrastructure and investment strategies and practices	Rural credit is available for CSA practices Capacity exists to support access to seed banks and make adapted seeds available to farmers
National information system for monitoring and accounting in agriculture	Criteria and measurable indicators for resilience, climate change mitigation and productivity or food security identified Monitoring systems for climate threats and vulnerability assessments exist

Source: Wollenburg, Zurek and De Pinto (2015)

2.1.8 CGIAR–CCAFS: A monitoring instrument for resilience (2015)

CCAFS has developed a monitoring instrument for efficiently tracking changes in resilience in agricultural initiatives to support an understanding of how effective investments have been at building resilience. In particular, the instrument aims to balance the demands for M&E with the limited time and information that is typically available from development initiatives (Hills *et al.*, 2015).[20]

A change in resilience is considered as an outcome rather than an impact, based on the argument that resilience is a useful predictor of relative impact (Brooks *et al*., 2005; Brooks *et al*., 2014) rather than an impact in and of itself. The authors note that the concept of adaptive capacity is the best representation of resilience in climate change adaptation.

The authors cite UNFCCC (2010) in their mention of the following as the main reasons why the characterisation of success from adaptation investments has been challenging:

- The lack of agreed metrics; as vulnerability is context and site-specific it is particularly difficult to find meaningful metrics that can be aggregated to national or global level (e.g. unlike mitigation which can be universally measured as CO_2eq).
- The nature of adaptation; adaptation can occur either proactively or in response to change, stresses and shocks, so both scenarios need to be accommodated in a performance framework.
- The latency of resilience; as resilience is a latent characteristic (i.e. it does not manifest itself prior to a change, stresses and shocks), it is difficult to be certain of the relative importance of the factors that underpin this characteristic.
- The risk of unintended negative impacts; referred to as "maladaptation" in cases where an adaptation of an activity in one sector or area (e.g. coastal management) may have a negative impact in another (e.g. reducing the resilience of local fisheries).

Some variables are more resource intensive to monitor regularly, such as household income. Therefore, the instrument proposes proxy indicators to ease resource requirements. The three indicator categories each have a "menu" of subcategories (indicator dimensions), within which there are indicator examples that are potential proxies.

The instrument has three indicator categories:

1. capacity of people to adapt (people);
2. enhanced livelihoods and farm functioning (livelihood and farm systems);
3. ecosystem services that foster resilience (ecosystems).

Within these categories nine indicator dimensions are proposed, as listed in Table 12. The selection of these dimensions considered are:

- best practice principles for indicators for climate change adaptation;
- characteristics of resilience;
- sensitivity of the indicators to early change detection, such as behavioural and early-stage physical changes expected within a 5–10 year time frame.

A rationale is provided for each indicator category with an explanation for each indicator, followed by a "how to" guide for project managers in Section five, which outlines six steps. Under Step 2, "Select or create 3–5 indicators", a checklist is provided for selecting indicators to accommodate resilience. This checklist includes the following guidance:

1. *Link to theory of change* (TOC): Is the relationship between the indicator and the TOC clear?
2. *Appropriate temporal and spatial scales*: Is it clear which scale the indicator is working at (i.e. household, community, landscape, institutional and national)? Is change in the indicator expected over the project cycle (even in the absence of a shock)?
3. *Applicability of thresholds*: Are there thresholds that can be considered for the indicator? Will such thresholds be linked to a specific management decision?
4. *Efficiency*: Can the indicator make appropriate use of secondary data? Is a more efficient proxy indicator available?

5. *Double-counting*: Is there a strong causal relationship between this and any of the other indicators selected? Can the risk of double-counting be removed by using an alternative indicator?
6. *Learning and knowledge*: Can progress against this indicator be validated through a more rigorous approach? Does the indicator facilitate social learning, including flexibility for updating of indicators?

Table 12 presents the hierarchy of proposed resilience indicators.

Table 12: Hierarchy of proposed indicators

Indicator categories	Indicator dimensions	Description
Increasing capacity of people to adapt	1. Awareness and knowledge of, and access to, locally relevant resilience-building approaches 2. Commitment of leadership 3. Capacity to learn and self-organise 4. Engagement and responsive governance	1. Level of farmer participation in awareness raising/training, demonstrated knowledge of practices that improve individual and household resilience and/or access to practices 2. Level of awareness of risks by leaders, and commitment to the planning and implementation of solutions 3. Presence of processes that underpin innovation and learning 4. Level of consultation across all relevant groups prior to decision-making and evidence of use of information from consultation
Enhanced livelihoods and farm functioning	5. Asset abundance 6. Asset diversity 7. Production efficiency	5. Availability and access to human, physical and financial capital 6. Diversity of human, physical and financial capital 7. Production efficiency
Ecosystem services that foster resilience	8. Regulating services 9. Supporting, provisioning and cultural services	8. Value of benefits associated with regulation of ecosystems based on ecosystem type and quality 9. Value of services, products and non-material benefits provided by ecosystems based on ecosystem type and quality

Source: Wollenberg, Zurek and De Pinto (2015)

Strengths

- As the authors note, the instrument is able to accommodate the diverse meanings of the related concepts of adaptive capacity and resilience, and the context-specific factors that enhance or reduce resilience.
- The authors also note that the instrument is able to separate the contribution of ecosystem services towards building resilience.
- The instrument provides information on the rationale for each indicator category and indicator.

Limitations

- This is not a stand-alone instrument; it must be embedded within a generic M&E system and the development of a theory of change/results framework is required.

2.1.9 CGIAR–CCAFS: Climate-Smart Agriculture guide website (2016)

CCAFS has created a comprehensive website devoted to CSA covering the background on CSA, development of CSA plans, finance, M&E and learning (ME&L), as well as case studies and additional resources. In their own words, the ME&L component "develops strategies and tools to track progress of implementation, evaluate impact, as well as facilitate iterative learning to improve CSA planning and implementation" (CGIAR–CCAFS, 2016).[21]

CCAFS advises that outcomes should be measured using indicators that account for at least two key principles:

7. A minimum set of high-level indicators at programme level to facilitate comparability with additional more granular indicators specific to projects (a high-level set of indicators is being formulated by various actors including World Bank and was set for release in 2016).
8. Indicators should follow the "SMART" principles and be specific, measurable, achievable, realistic, time-bound.

A decision tree can assist users in determining which types of indicator should be chosen: readiness, process or outcome indicators. Indicators are then chosen for each of the three CSA pillars, and examples are provided. Table 13 contains these example indicators for each pillar.

Table 13: CCAFS example indicators for CSA, by pillar

Pillar	Indicators
Productivity	· Yield (e.g. product per unit of land, water, energy, nutrients, labour) · Income (e.g. gross margin, net present value) · Labour (e.g. person hours, labour allocations by gender)
Productivity – extended to measure food security	· Per capita food consumption in terms of e.g. calories, protein, dietary diversity · Food deficits, such as number of hungry months · Food prices · Percentage of income spent on food · Children's nutritional status (e.g. upper arm measurements to indicate wasting or stunting)
Adaptation and resilience	Social indicators · Access to capital (financial, human, social/political, physical, natural) · Access to services (particularly climate information services) · Level of skills, knowledge and access to extension on climate change · Diversity in livelihoods and income sources · Market access (for food, agricultural inputs and agricultural product markets) · Gender equity (e.g. labour, income differences) Biophysical indicators · Biodiversity (e.g. Shannon diversity index, N %) · Pests/pathogens (e.g. % loss, damage rates) · Erosion/soil loss (e.g. kg/ha) · Soil quality (e.g. changes in C, N, soil water balance, etc.) Economic indicators · Income levels · Savings · Access to credit · Land rights/tenure · Access to insurance · Proportion of income from climate-prone sources Institutional indicators · Enabling policy and regulation environment · Incentive systems · Subsidies (directed away from maladaptive practices towards resilience practices) · Safety net schemes · Early warning systems and disaster recovery strategies
Mitigation	· Emissions of methane, nitrous oxide and carbon dioxide from all agricultural sources including energy, soils · Removals and accumulation of carbon in biomass and soils · Changes in land use, particularly conversion of high-C land uses, such as forests and peatland · Fuel wood consumption · Biofuel use

Source: CSA Guide website (CGIAR–CCAFS. 2016)

Box 4 summarises the CCAFS Climate-Smart Village (CSV) programme.

BOX 4

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS): Participatory identification of Climate-Smart Agriculture priorities (2016)

CCAFS has produced a preliminary working paper entitled *Participatory identification of Climate-Smart Agriculture priorities* (Duong, Simelton and Le, 2016),[22] which documents the CCAFS Climate-Smart Village (CSV) programme that began (globally) in 2011 and in Southeast Asia in 2014. The CSVs serve as a testing ground for CSA methodologies and approaches to document and evaluate CSA practices in the field in order to identify scalable practices. The first part contains a framework for identifying and assessing CSA in the field with a long list of CSA indicators. The report also provides a cost-benefit analysis of certain climate-smart practices as well as a participatory process to prioritize CSA options carried out in the villages. The compiled long list of indicators is provided in Table 14.

Table 14: CCAFS long list of CSA indicators by category

Category	Indicators
Food security/livelihoods	• Increased yields • Increased income • Stabilized yields (reduced difference between seasons) • Stabilized incomes (reduced variability over the year/between years) • Diversified nutrient intake • Business development started (income generation) • New marketable products developed (market-smart) • Improved capacity of farmers to take action (knowledge smart) • Interventions contributed to intra-household equal labour/income distribution (gender smart)
Adaptation	• Reduced losses due to cold spell • Reduced losses due to hot spell • Reduced losses due to drought • Reduced losses due to flooding • Reduced losses due to landslide, soil erosion • Reduced losses due to salt water intrusion/salinity • Reduced storm impact • Micro-climate regulation • Increased soil moisture content

Mitigation	• Reduced GHG emissions or increased carbon stocks via:
	  . Reduced/more efficient use of fertilizer
	  . Reduced methane gas emissions
	  . Increased tree cover
	  . Reduced soil erosion/soil loss
	  . Reduced tillage
	  . Increased number of permanent plants
	  . Reduced fossil fuel/energy consumption
	• Number of interventions linked to REDD+
	• Number of interventions linked to INDC reporting

Source: Duong, Simelton and Le (2016)

2.1.10 CCAFS/USAID: Climate-Smart Agriculture Programming and Indicator Tool (2016)

In collaboration with the United States Agency for International Development (USAID) Feed the Future, CCAFS has developed the CSA Programming and Indicator Tool (Quinney, Bonilla-Findji and Jarvis, 2016),[23] a Microsoft Excel-based self-assessment tool to increase the effectiveness of CSA interventions. It is intended to help answer the following questions:

- How climate smart is your programming/how well is it working?
- How can it be improved?

The tool is organised by the three CSA pillars and provides a framework to determine the extent to which a programme addresses each of the pillars. It supports the selection of appropriate indicators to measure progress and track CSA outcomes. The tool also helps to strengthen the planning phase of interventions to ensure that all potential CSA-related outcomes (beyond the agricultural productivity pillar) are included in the M&E design.

The CSA-related indicators (378) were gathered from several international development agencies and institutions, including FAO, the UK Department for International Development (DFID), IFAD-ASAP, World Bank, USAID and CCAFS, and compiled in a database. The indicators cover all three CSA pillars.

The tool has three steps:

1. Assessing the scope and intentionality of desired outcomes (users respond to specific questions relating to the three CSA pillars; the main objective is to help users to systematically check for potential co-benefits and/or unintended outcomes (in more than one pillar).
2. Selection of intended scale of action (household/farm, subnational, national) and indicator type based on the current stage of the intervention.
3. Results summary and visualization: leads to a proposed set of relevant indicators that can be used to inform the design and M&E plan of future interventions.

The three main types of indicator are readiness, process, and outcome/impact. Climate readiness indicators are covered in more detail in Section 2.1.7. Process indicators provide information on implementation processes such as interaction with communities and gender and diversity. Outcome/impact indicators aid in the understanding of the impacts on all three CSA objectives.

Strengths (of CCAFS body of work on CSA indicator development)

- Accounts for all three CSA pillars and for the potential co-benefits and/or unintended outcomes in more than one pillar.
- Includes a readiness component.
- Tool provides concrete indicator recommendations as well as a graphical visualization to help users interpret results.

Limitations (of CCAFS body of work on CSA indicator development)

- In particular for the agricultural productivity pillar, the emphasis is on yields, income and livelihood security. There is a gap on indicators relating to policy and legal frameworks to improve food security, availability and access.
- Authors note that classifying indicators as process versus outcome indicators can be challenging, as there is no clear agreement in the literature on how this classification should be approached.
- Few indicators specifically address seed varieties, crop insurance and financial indicators geared towards the adoption of CSA technologies and practices.

2.1.11 World Bank: Climate-Smart Agriculture indicators (2016)

According to the World Bank, the set of indicators currently in place to measure agricultural performance, natural resources management, climate change, and a variety of variables relating to food security and nutrition are not sufficient to evaluate all dimensions of CSA or to guide policy formulation. The World Bank indicators attempt to fill these gaps and provide "a framework for implementing the necessary policy, technical, and M&E framework to make CSA fully operational" (World Bank, 2016).[24]

The purpose of the framework is to help identify viable climate-smart options, select appropriate technologies and practices, monitor results and assess policies and enabling activities for CSA. The indices will guide investment decisions

and assist countries in assessing their readiness to implement CSA, as well as the productivity and climate benefits of CSA. The proposed framework uses an "impact pathway" instead of the frequently used logical framework which relies upon an if-then logic. Impact pathways provide a holistic view and a more flexible approach to investigate change processes. They track how project outputs result in behavioural changes from a range of stakeholders. This is seen as a determining factor because it is only through this behaviour change that impacts can be sustained into the future.

The methodology for selection and development of indicators involved extensive literature review, consultation of the World Bank's core sector indicators and expert consultations. There are three types of indicator:

1. Policy indicators may be used for evaluating the extent to which countries have adopted climate-smart policies.
2. Technology indicators can be used for selecting climate-smart technologies for widespread dissemination in World Bank and other projects, and for evaluating the extent to which newly generated technologies are climate smart.
3. Results indicators can be used to measure the outputs and outcomes of development projects/activities on the three dimensions of agricultural productivity, resilience and mitigation.

Table 15 summarises the three CSA indices with their strengths and limitations.

Table 15: Summary of the three CSA indices: CSA Policy Index (CSA-Pol Index), CSA Technology and Practices Index, and CSA Results Index

Indices	Description	Strengths	Limitations
CSA Policy Index	Three themes, 14 indicators, and 31 sub-indicators (national level; ex-post) Measures countries' institutional readiness to support CSA interventions	· Provides a ranking of a country's adoption of CSA policies relative to other countries · Allows users to gauge how a country's enabling environment for CSA is changing over time. · Identifies gaps in supporting CSA implementation · Provides opportunity to develop benchmarks for reform · Indicators can be used individually, allowing users to compare single indicators across countries or across time, identify strengths and weaknesses, and prioritize specific intervention areas	· Does not measure the performance or quality of various policy measures and coordination mechanisms to support implementation · Does not cover the full range of policies and services for CSA implementation in any country
CSA Technology and Practices Index	27 indicators clustered into three main themes: productivity, resilience, mitigation (project level, ex-ante) Reveals how project interventions can lead to productivity gains and environmental benefits Useful in identifying the most appropriate technologies for a CSA project during its planning and design stages	· Potential to improve decision-making by helping users to diagnose the relative contextual importance of the triple-win priorities · Built for "minimal indicator use" – project leaders can use as few as three indicators for their project	· Provides separate and aggregate scores for the productivity, resilience and mitigation (PRM) areas based only on the data provided by the project team, without any information available from other sources · Does not recommend any specific technologies nor does it recommend the size or composition of any investment; it merely points to the PRM requirements in the proposed project area
CSA Results Index	22 indicators, clustered in three categories and eight topics (project level, ex-post) Meant to help project leaders to measure an agricultural project's performance towards achieving CSA triple-wins individually and jointly Three categories have been identified according to whether the indicators measure direct output of a CSA project intervention, the enabling environment, or the medium- to long-term outcomes of an intervention	· Can be applied to measure the project's performance during and after project completion. · Can customize and adjust for context-specificity.	· Although the flexibility for users to choose their own indicators can be beneficial, it complicates comparing CSA-Res indices across projects since the underlying data and their meaning may vary significantly · There may be difficulties in determining whether an enabling environment is a result of the CSA intervention or of other externalities · For some indicators, the CSA-Res Index does not provide information about the quality of systems or about impacts at project level · The index captures the project's performance as a number and does not give concrete actionable advice on how it could be improved

Source: World Bank (2016)

According to the key findings of the CSA indices' test application in the World Bank Climate-Smart Agriculture Indicators Report (World Bank, 2016),[25] a 1 percent increase in the CSA-Policy Index is predicted to lead to a 0.4 percent decline in the proportion of undernourished population; cereal yields increase 47 kg per hectare for every 1 percent increase in the CSA-Policy Index, and public expenditure for services and infrastructure could be more important than readiness mechanisms and coordination mechanisms for achieving CSA goals.

Strengths of the World Bank indicators and indices (overall)

- Indices are a flexible and robust tool for a wide range of agriculture and rural development projects.
- Framework can accommodate new data and indicators, yet allows consistent comparison and analysis.
- Framework is user friendly, cost effective, and can be incorporated into various phases of a project.

Limitations of the World Bank indicators and indices (overall)

- As mentioned in the limitations for each index above, users must exercise caution in attempting to compare indices across projects.
- Attribution is difficult (in particular to determine whether the enabling environment has been created as a direct result of the CSA intervention).
- Indices provide a number, which must be then translated into actionable advice on how to improve the project.

2.2 Programme/project level

2.2.1 IFAD: Adaptation for Smallholder Agriculture Programme 1/2 (2013)

The International Fund for Agricultural Development (IFAD) Adaptation for Smallholder Agriculture Programme (ASAP),[26] launched in 2012, is IFAD's flagship and the world's largest climate change adaptation programme for channelling climate and environmental finance to smallholder farmers. The first phase, from 2012 to 2017, programmed USD 305 million in grants to 41 countries to support 8 million smallholders. The second phase, ASAP 2 (IFAD, 2017), has a target of USD 100 million, and has received contributions of USD 9.5 million from the Norwegian Agency for Development Cooperation (NORAD) and USD 5.9 million from the Swedish International Development Agency (SIDA). ASAP provides an M&E Framework that summarises relevant adaptation results, indicators and corresponding investment options. Project design teams who are working with ASAP financing apply the framework during the project design phase and select indicators and targets to incorporate into the results framework of the underlying IFAD investment.

The framework has two mandatory impact indicators: (1) household assets and (2) malnutrition under age 5. Other indicators can be chosen from a predetermined list. A survey is conducted at three points during the lifetime of a project – benchmark, midterm, and completion. First-level results measure financial and physical progress at the activity or output level of a project's results framework, are reported annually, and are mostly quantitative. Second-level results measure improved functionality or behavioural change (short and medium-term results), should be provided from the mid-term of the project onwards, and are mostly quantitative. IFAD introduced new indicators in 2015 for projects/programmes that have climate risk management objectives.

In 2013, a number of critical adaptation indicators were included in IFAD's Results and Impact Management System (RIMS). The RIMS is an automated process for recording indicators, but is only a component of the M&E system and not a substitute for it (RIMS does not encompass all of the information an M&E system would need to evaluate a project). It is made up of a standardised list of common indicators used on all IFAD projects/programmes.

When selecting projects to fund, IFAD evaluates their potential contribution towards the following indicators, which are aggregated globally to help assess progress towards the 2020 goals (IFAD, 2015).

- Number of poor smallholder household members whose climate resilience has been increased because of ASAP gender-disaggregated data.
- Percentage of new investments in Environment and Natural Resource Management (ENRM) in IFAD 9th replenishment compared with IFAD 8th replenishment.
- Leverage ratio of ASAP grants versus non-ASAP financing.
- Percentage increase in number of non-invasive on-farm plant species per smallholder farm supported.
- Tonnes GHG emission (CO_2eq) avoided and/or sequestered.
- Increase in hectares of land managed under climate-resilient practices.
- Percentage change in water use efficiency by men and women
- Number of community groups involved in ENRM and/or disaster risk reduction (DRR) formed or strengthened.
- USD value of new or existing rural infrastructure made climate resilient.
- Number of international and country dialogues where IFAD or IFAD-supported partners make an active contribution.

Strengths

- ASAP 2 (second phase of programme) links strategic objectives with the ten indicators, data sources and relevant SDGs (IFAD, 2017).[27]

Limitations

- The framework does not offer explicit guidance on the standard indicators or on choosing additional project-specific indicators.

2.3 Private sector

2.3.1 WEF: Putting the new vision for agriculture into action: a transformation is happening (2009)

The World Economic Forum (WEF) New Vision for Agriculture (NVA) sets goals of 20 percent improvement per decade on each of its three goal areas: (1) economic growth and opportunity; (2) food security and nutrition; and (3) environmental sustainability (WEF, 2009).[28] The vision is led by 26 global partner companies.[29] McKinsey and Company serves as project advisor. Partners are FAO, the Harvard Kennedy School's Corporate Social Responsibility Initiative and the International Food Policy Research Institute.

Partners note that the currently available indicators are inadequate in representing the real complexity of the global food system, and that there is a shortage of high-quality data and measurement tools to measure progress, particularly for nutritional status and environmental sustainability. In WEF's framework, the most crucial driver is improving the productivity of all farms while balancing their environmental footprint.

Two regional platforms were launched following the start of the NVA, Grow Africa and Grow Asia. These platforms have provided support to 19 countries in these regions.[30] Each country-led initiative is unique but in all cases they rely heavily on a network of 1 400 individual and 500 institutional system leaders, who have built multistakeholder interactive leadership

structures to accelerate change at regional, country and state levels. The leaders have three roles to play: (1) cultivating a shared vision for change; (2) empowering widespread innovation and action; and (3) enabling mutual accountability.

One of the key components under the third role is to measure and report on mutually agreed indicators. The network is currently working to identify a small number of indicators that are cost-effective to monitor on a regular basis. These indicators would be project- and location-specific, and would be an addition to the initial set of seven core indicators and two optional indicators already defined by the NVA. The core indicators are intended for country partnerships to track progress across the three goals of food security, environmental sustainability and economic opportunity, and to support the measurement and aggregation of results from project level up.

The core indicators are (Table 16):

- dollars invested (actual) and committed to specific projects;
- number of farmers engaged (by gender);
- percentage and metric tonnage change in yield per hectare;
- percentage change in farmer net income;
- percentage change in water use per tonne of production in areas under irrigation;
- number of hectares adopting improved technologies, practices and solutions through the project;
- proportion of project area covered by landscape-level biodiversity management plans;
- percentage change in rate of greenhouse gas emissions (optional);
- soil health, e.g. depth of top soil, pH, soil organic matter (SOM) and nutrient levels (optional).

Table 16: World Economic Forum New Vision for Agriculture: example indicators to measure progress on three goals

	Global indicators	Local indicators (examples)
Economic opportunity	Farmer income (proportion of rural inhabitants living on less than USD 1.25/day)	Wealth distribution (GINI coefficient)
Food security	Food produced (tonnes) Undernutrition prevalence – wasting, stunting (% of children <5 years who are underweight, under height)	Undernutrition and over nutrition prevalence– wasting, stunting, obesity (% of children <5 years who are underweight, under height) BMI
Environmental sustainability	GHG emissions productivity (tonnes of GHG emissions per tonnes of food produced) Water use efficiency or "crop per drop" (tonnes of food produced per cubic metre of water)	Water quality – sediment, nutrients, bacteria (totals of water-borne pathogens (suspended solids, concentrations of N and P, fecal coliforms))

Source: WEF (2009)

Strengths

- Each NVA partnership platform has its own unique structures based on local circumstances, meaning that there is the potential for a good balance between top-down (core indicators) and bottom-up management and successful tracking of progress.
- The NVA appears to have been successful at setting up an extensive network of system leaders with clear roles.
- The regional platforms seem to be successful in supporting individual countries.

Limitations

- At this time, the NVA does not provide a well-developed M&E or indicator framework, nor does it provide very much explicit guidance on choosing project-specific indicators (nor any detailed guidance on measuring the core indicators).

2.3.2 WBCSD: Climate-Smart Agriculture Action Plan 2020 (2015/2017)

At the Paris COP in 2015, the World Business Council for Sustainable Development (WBCSD) Climate-Smart Agriculture Working Group members put forward a shared Statement of Ambition on CSA for 2030, which built on WBCSD's broader CSA Action Plan 2020 (WBCSD, 2015; Vermeulen and Frid-Nielsen, 2017):[31]

Make 50% more food available and strengthen the climate resilience of farming communities whilst reducing agricultural and land-use change emissions from commercial agriculture by at least 3.7 Gt CO_2eq/year by 2030 (50%). By 2050, the target is to achieve a 65% emissions reduction.

To achieve this, four action areas were identified:

1. building smallholder resilience/family farmer;
2. scaling up investment in CSA;
3. improving businesses' ability to trace, measure and monitor CSA progress;
4. implementing agriculture-driven zero deforestation commitments.

Under action area 3, WBCSD has pledged to: maintain and build capacity within national government agencies to implement monitoring and measurement of indicators relevant to the three CSA pillars, to share this information and collaborate with the private sector to strengthen these systems, and invest further in building the skills of academic institutions and government staff on monitoring and measuring indicators relating to CSA at national and subnational levels (WBCSD, 2015).

Since release of the action plan, the Climate Change, Agriculture and Food Security Programme (CCAFS) has led much of the work in action area 3. It was acknowledged that the public and private sectors need to invest further in the development of metrics in order to monitor CSA progress and help countries to make progress under the UNFCCC Global Stocktake process. Delivery on action area 3 is based on:

- encouraging and building the capacity of companies to integrate CSA metrics into regular M&E protocols;
- sharing these M&E efforts across value chains and landscapes;
- facilitating transparent disclosure;
- helping with the uptake of decision-support tools to boost CSA uptake.

Building on this, the Global Alliance for Climate-Smart Agriculture (GACSA)[32] fosters a global effort to bring partners together across public and private sectors to build and share metrics, and to develop a common CSA framework. Global learning and evidence exchange events help to build the capacity of partners and staff implementing projects to use monitoring and evaluation tools developed by CCAFS and others (GACSA, 2016).[33] GACSA held a joint workshop entitled Metrics for Climate-Smart Agriculture for their Investment, Knowledge, and Enabling Environment Action Groups in 2017, following up on a need expressed by GACSA's Knowledge Action Group in 2016. This meeting confirmed the growing need for effective metrics to monitor the inputs of public and private finance flowing into CSA as well as the outcomes of these investments, given the increased CSA programming. The groups acknowledged the difficulty in finding a common language around metrics. This work will continue, focusing next on the development of a roadmap (GACSA, 2017). Training workshops are scheduled to take place for the WBCSD CSA Working Group in 2018 and 2019 to enhance companies' capacity for M&E. Work will be done to improve metrics and to harmonize these efforts with those of the International Center for Tropical Agriculture (CIAT) and GACSA.

CCAFS has conducted a stocktake of WBSCD member companies (see Box 5) and the main results were that for Pillar 1 (agricultural productivity) member companies are exceeding targets for global food production. For Pillar 2 (resilience) there is not enough company or global data to monitor resilience. For Pillar 3 (mitigation) member companies are not succeeding in meeting targets on agricultural and food system emissions (Vermeulen and Frid-Nielsen, 2017).[34] Table 17 presents a summary of company data for Pillar 2.

BOX 5

Stocktake on WBCSD companies' progress, 2010–2015

To assess progress by WBCSD member companies,[35] CCAFS has developed a simple framework with recommended indicators to measure CSA at the company vs global level and a framework for measuring progress towards the 2030 Statement of Ambition, then assessed progress under each of the three pillars between 2010 and 2015. The purpose was to inform future individual and collective monitoring and reporting on CSA among member companies.

CCAFS combined bottom-up reporting available from companies with a top-down perspective using available global data sets to estimate progress towards 2030 targets. By projecting global trends from 2010 to 2015, they developed a simplified comparison between the current business-as-usual (BAU) projection and the WBCSD members' target performance. From this stocktake, they discovered inconsistencies on how companies track progress of their indicators (such as absolute vs relative progress). This study thus provided justification for a common set of indicators.

Table 17: Summary of company data for Pillar 2

Component of WBCSD Pillar 2	Indicator categories used by companies	Data available from WBCSD members	Data from WBCSD members that would improve the analysis
2.1 Implement agro-ecological approaches	Total water use	Most companies report total water use (m^3) for both 2010 and 2015	Reporting of e.g. hectares covered by agro-ecological practices
2.2 Improve rural incomes and livelihoods	Livelihoods improved	Three companies provide a headcount of livelihood improvements in 2015 and one in 2010	Common units for measuring livelihood improvements More comprehensive data on e.g. income or assets
2.3 Maintain long-term fair relationships with smallholder suppliers	Farmer loans	One company measures total value of loans (USD) for 2010 and 2015	More companies reporting
2.4 Empower women in smallholder farmer communities	Female farmers trained	Three companies report, with only one company providing 2015 data for number of female farmers trained	Data relating to empowerment outcomes for female farmers, e.g. income, assets, etc.
2.5 Transfer skills and knowledge to smallholder famers	Farmer training	Three companies report number of farmers trained (not women or smallholders specifically) in 2010 and 2015	More companies reporting Clearer distinction between farmers and smallholders
2.5 Transfer skills and knowledge to smallholder famers	Youth engagement	Two companies report for 2015, one for both 2010 and 2015	More companies reporting
2.5 Transfer skills and knowledge to smallholder farmers	Smallholders trained	Three companies report number of smallholders trained in 2015, one of these in 2010	More companies reporting Clearer distinction between farmers/stakeholders

Source: CCAFS (2017)

Strengths

- The framework developed by CCAFS to harmonize top-down global and bottom-up corporate data provided at least a simplified comparison between BAU and WBCSD members' target performance that shed light on the inconsistencies in tracking progress.

Limitations

- Reconciling metrics between CSA indicators based on global data (FAO, IFAD, World Bank) and those used by WBCSD companies (CCAFS used the Global Reporting Initiative (GRI) and Carbon Disclosure Project (CDP) to find company reporting) was difficult (for example, WBCSD companies do not explicitly track activities under agro-ecology).
- There are no quantitative CSA targets for Pillar 2 (resilience), nor relevant global data that match the indicators that companies use for resilience. And few companies report on resilience indicators.

2.3.3 Syngenta Good Growth Plan (2018)

Syngenta's ambition is to increase food security through a global increase in farm productivity, reaching 8 million large-scale (over 100 ha) and 450 million smallholder farmers (2 ha or less).

Syngenta has put forward a "Good Growth Plan: more food, less waste; more biodiversity, less degradation; more health, less poverty" (Syngenta, 2018a).[36] The plan contains six commitments and clusters that echo the CSA pillars and have linkages with the SDGs. Since 2014, Syngenta has collected and published a broad range of data on the six commitments of the Good Growth Plan. Table 18 contains the six commitments with possible indicators.

Table 18: Syngenta Good Growth Plan – six commitments and their indicators

Make crops more efficient (link to SDG12)	Rescue more farmland (link to SDG 13, 15)	Help biodiversity flourish (link to SDG 13, 15)	Empower smallholders (link to SDG 1, 8)	Help people stay safe (link to SDG 1, 3, 8)	Look after every worker (link to SDG 8)
- Land productivity - Tonnes of production per hectare - Nutrient efficiency – Tonnes of production per kilogram of nutrients applied - Pesticide efficiency - Tonnes of production per kilogram of pesticides applied - Application efficiency - Tonnes of production per number of applications - Water efficiency - Tonnes of production per litre of water applied - Energy efficiency - Tonnes of production per joule used	- Data on the number of hectares of farmland implemented using the following practices: - Minimum soil disturbance - Crop rotation - Cover crops - Nutrient management - Water use optimization - Reduction of soil compaction	- Data on the number of hectares of farmland implemented using the following practices: - Field margins - Species conservation areas - Riparian forest conservation - Landscape connectivity - Wetland conservation	- Directly, sales of products and packs specially designed for smallholder farmers - Indirectly, training jointly offered to smallholders on: • farm safety and health projects • market access • financial solutions • mobile phone-based solutions	- Number of people receiving safe use training - Countries with established Syngenta product toxicovigilance programmes	- Suppliers included in Fair Labor Program - Syngenta seed producing countries included in Syngenta Fair Labor Program - Seed supply farms included in Syngenta Fair Labor Program - Chemical suppliers included in Supplier Sustainability Program - HSE audits at chemical suppliers - HSE audits at formulation, fill and packaging suppliers and seed toll manufacturing - HSE audits at warehouse/logistics service providers - Commercial flower farms with valid global good agricultural practices (GAP) certification - Commercial flower farms with valid global risk assessment on social practice (GRASP)

Source: Syngenta (2018a)

Sharing agriculture open data is Syngenta's contribution to developing a collaborative and unbiased approach. Syngenta is partnering with the Open Data Institute and applying best practice standards to share farm-level data and make it user-friendly and accessible to all. All data released as open data has an Open Data Certificate from the institute. This is the first time information at crop level, including resource efficiency data, has been made public in this way by a commercial organisation. Syngenta also works with an independent data collection agency to collect, analyse and benchmark data, comparing them with growers in their region. This process of local benchmarking helps to identify areas for improvement.

Farmers are working with field experts to share knowledge and pilot new solutions on over 1 400 reference farms across 22 crops in 42 countries. There are over 2 600 additional benchmark farms. Farmers in the reference farm network track GHG emissions reductions and how much water, land, pesticide, fuel and labour goes into producing their harvest. Information on agricultural efficiency is collected on over 3 700 farms. This type of information can be highly valuable when aggregated on a massive scale.

Strengths

- Provides a link with CSA pillars and SDGs reporting.
- Syngenta could be a good partner to explore thinking on topic of indicators and/or how to align with existing frameworks.
- Provides a potential good base of field/farmer data from benchmark/pilot farms that might be used to inform indicators in other initiatives.

Limitations

- This framework is intended to monitor food security levels and progress on sustainable agriculture and does not have an explicit focus on climate change adaptation in agriculture.

2.4 Community level

2.4.1 CARE: Community-Based Adaptation Framework and Project Toolkit (2011)

The Cooperative for Assistance and Relief Everywhere (CARE) Community-Based Adaptation (CBA) Framework (CARE, 2011)[37] focuses on sustainable livelihoods and adaptive capacities within communities and incorporates rights-based approaches, gender inequality and marginalization to ensure that the most vulnerable groups and people are included. It proposes a range of enabling factors that must be in place for effective CBA. These factors are linked to four strategies:

1. Promotion of climate-resilient livelihoods.
2. Disaster risk reduction strategies to reduce the impact of hazards on vulnerable households.
3. Capacity development for local civil society and governmental institutions.
4. Advocacy and social mobilization to address the underlying causes of vulnerability.

The framework offers a set of proposed milestones and indicators to help project teams to plan and track progress towards achieving the enabling factors. The milestones and indicators are focused on monitoring the adaptive capacity of target populations rather than fixed outcomes, and thus are generally process-based.

The framework acknowledges that in order for local interventions to be successful, the enabling factors must be in place across several scales. It outlines the important factors for successful CBA across scales and provides a selection of indicators for the household/individual level, local government/community level, and national level. Enabling factors, milestones and sample indicators for the household/individual level are listed in Table 19.[38]

Table 19: Enabling factor, milestone and sample indicators for the household/individual level

Strategy	Level	Enabling factor	Milestone	Indicators
Climate-resilient livelihoods	Household/individual milestones and indicators for CBA	People are generating and using climate information for planning	People are using climate information in planning livelihoods strategies	· % of people using climate monitoring information to plan their livelihoods strategies (e.g. shifting to early maturing crops) · % of people using seasonal forecasts to plan their livelihoods strategies (e.g. timing of planting) · % of households adopting new, climate-resilient livelihoods strategies based on climate information
Climate-resilient livelihoods	Household/individual milestones and indicators for CBA	Households are employing climate-resilient agricultural practices	Households are employing a mix of agricultural and off-farm livelihoods strategies	· % of households with non-agricultural income sources · % of households with three or more different income sources
Disaster risk reduction	Household/individual milestones and indicators for CBA	Households have protected reserves of food and agricultural inputs	Households have increased agricultural production	· % increase in production of key crops
Disaster risk reduction	Household/individual milestones and indicators for CBA	Households have protected reserves of food and agricultural inputs	Households are saving seeds	· % of houses that are saving seeds · # of seed varieties saved

Source: CARE (2011)

Strengths

- The framework provides a "menu" of milestones, indicators and indicator definitions for three different levels that are reflective of the enabling environment that must be in place: household/individual, local government/community and national.

Limitations

- The framework provides an extensive menu of indicators, but does not provide extensive or explicit guidance on selecting indicators based on objectives and priorities.

2.4.2 CARE: Participatory monitoring, evaluation, reflection and learning for community-based adaptation (2014)

An expert working group was convened by CARE in partnership with the International Institute for Environment and Development (IIED) in 2011 to develop a participatory monitoring and evaluation (PM&E) framework for local and community-based adaptation. The resulting framework is a participatory monitoring, evaluation, reflection and learning (PMERL) tool with the aim of supporting adaptive decision-making in vulnerable communities (CARE, 2014).[39]

Following the overarching goals of the framework:

- Provide a platform for local stakeholders to articulate their own needs.
- Measure changes in adaptive capacity.
- Support the "adaptive" management of community and local-level CBA strategies and plans.
- Facilitate continuous and joint learning.

PMERL's key indicators are related to three different types of information: (1) CBA practice information; (2) CBA outcomes; and (3) CBA context.

Strengths

- The framework is useful as an internal M&E and learning tool with an emphasis on participatory processes that are designed to support poor, vulnerable and marginalised people according to their own priorities.
- Allows context-specific indicators to be set by vulnerable people.
- Provides an opportunity for the empowerment of groups that would otherwise be excluded from the process.

Limitations

- The process is more time and resource intensive than most M&E processes due to the required involvement of many stakeholders, marginalised groups and community members.
- It does not replace an external M&E reporting methodology.
- Conflicting accountability/reporting requirements: donors may require reporting against fixed project cycles with rigid indicators and objectives, whereas this framework is not intended to be overly prescriptive.
- It is difficult to compare communities using this framework, or to develop "best" practices or expertise to scale up.
- The framework does not provide specific or sectoral guidance on indicators; simply guides users through a process of determining possible outcomes and then developing indicators.

2.4.3 IISD:CRiSTAL Food Security 2.0 User's Manual. Community-based risk screening tool – adaptation and livelihoods focus on food system resilience (2014)

CRiSTAL is a project-planning tool that helps users to design activities that support climate adaptation (IISD, 2014).[40] It uses information from desk-based reviews and stakeholder consultations at the local level using participatory methods. Its key outputs are:

- List of livelihood resources that are most affected by climate hazards and most important for responding to climate impacts.
- Proposed adjustments to existing projects and new activities to support climate adaptation.
- List of desired adaptation outcomes and important influencing factors to be monitored.

The original CRiSTAL tool was developed by a group of four international NGOs coordinated by the International Institute for Sustainable Development to respond to the need identified by project planners to integrate risk reduction and climate change adaptation into their work. Following the outcomes of the first phase of the Livelihoods and Climate Change Initiative launched in 2007, it has been applied in over 20 countries in Asia, Africa and the Americas.

CRiSTAL Food Security is a specialized version of the tool. It is a decision-support tool for local-level governments and development practitioners to support the climate resilience of food systems at community level. It aims to help users to understand:

- what the key elements of a food system of a given community are and how they are affected by climate variability and change;
- how resilient different parts of the food system are to climate variability and change, and what can be done to improve resilience;
- what indicators can help to monitor the evolution of community food system resilience over time.

The tool consists of a series of Microsoft Excel spreadsheets from which the main output is a series of automatically generated reports based on entered information.

The food system analysis examines five dimensions: (1) food utilization and consumption; (2) food access; (3) food availability; (4) supporting resources and services; and (5) supporting organisations and policies; while also considering the sensitivity of key food system elements within each dimension to current and future climate hazards. The resilience section uses the same five dimensions and helps users to analyse the resilience of the food system through questions specific to each dimension. The indicators section guides users in the identification of specific, measurable, achievable, realistic, time-bound (SMART) resilience indicators based on this analysis.

Strengths

- Communities and local experts are engaged throughout the entire process.
- A manual provides step-by-step guidance for using the tool.
- The tool is organised in a modular way, so that only parts of it, such as the food system module, need be applied.
- The process takes between two and five days.

Limitations

- It is not a stand-alone vulnerability or risk-assessment tool.
- It does not support the assessment of longer-term, transformational change but rather incremental changes in project design and management.
- It does not provide a menu or list of example indicators.

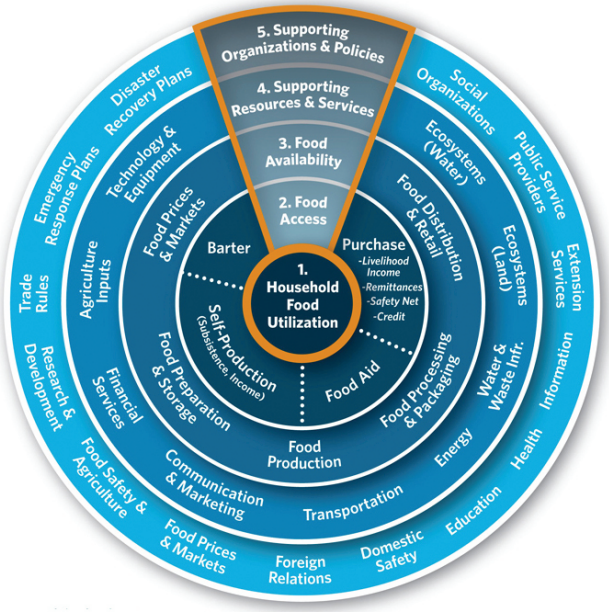
2.4.4 IISD: Climate Resilience and Food Security: a framework for planning and monitoring[41] (2013)

The International Institute for Sustainable Development (IISD) has devised a new framework to analyse community-level food security in the context of climate change, as well as the resilience of food systems on a larger scale. There are two distinct audiences for the application of resilience indicators: one at community level and another at national policy level. In both cases, indicators should rely primarily on existing or readily available data sources; however, indicators used at community level should be few in number so as not to require experts for interpretation, whereas those at national level can be more elaborate and complex.

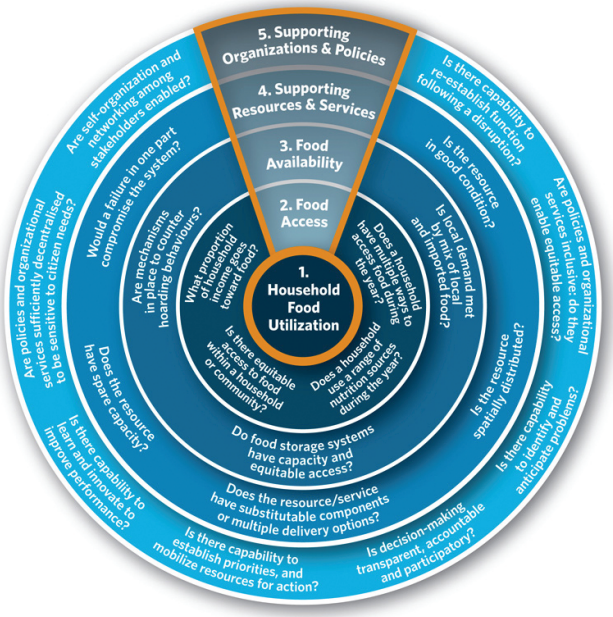
Figure 3 depicts the food system by a series of concentric rings with the household at the centre. Each ring represents one element of the food system. Moving outward from the centre of the wheel with each ring, the figure shows that there are different factors affecting each context. The spinwheels allow users to see how the food system rings might also rotate independently, in order to examine a particular combination of aligned factors.

Figure 3: Spinwheels for food security (Spinwheel 1) and food security and resilience analysis (Spinwheel 2)

Spinwheel 1: Community food security analysis



Spinwheel 2: Community food security & resilience analysis



In both cases, indicator development will start with food security and national assessments. These assessments begin with understanding local food systems (food chain, food cycle, food web, food context) and their outcomes (food utilization, food access, food utilization and food stability). Users use the first pinwheel to help answer the question "Which aspects of the food system are most important in the community, and when?" and the second pinwheel to help answer the question "Are the key aspects of the food system resilient to climate change?" These pinwheels help users to describe the current structure of food systems at both scales, and allow the most important food system elements to be identified. These elements are different at community and national scales, but in both cases they can be assessed for resilience using the tool.

The inner rings of the resilience wheel are more relevant to the household and community levels, whereas the outer rings are important for national policy and infrastructure investment. For the community scale, a small number of easily understood indicators with readily available data can be developed to track changes in resilience.

On the national scale, the user would be able to track community-level indicators by using wider data sets from national surveys, as well as indicators for national policies and resources that support local food security. In the end, the following will be assessed:

- food access resilience analysis;
- food availability resilience analysis;
- resilience analysis of support resources and services (fourth ring);
- resilience analysis of support organisations and policies (fifth ring).

Strengths

- This framework attempts to link the assessment of food security at household and community levels to national policy indicators.
- The two spinwheels are a good visualization tool that can help users to understand the key factors to consider at different levels of analysis.
- At community level, the CRiSTAL Food Security Risk-Screening Tool (discussed in Section 2.4.3) that incorporates the climate food security and resilience frameworks can be used with the spinwheel framework.

Limitations

- The framework provides broad guidance and normative criteria, however its application for indicator development requires that key vulnerabilities have already been identified (details need to come from the local context).

2.5 Household level

2.5.1 FAO: Resilience Index Measurement and Analysis (2008/2016)

FAO has developed the Resilience Index Measurement and Analysis (RIMA I/II)[42] system to analyse the ways in which households cope with shocks and stressors and why some are better equipped for this than others. It enables comparisons between different types of household and gives insight into the dynamics of resilience (FAO, 2008/2016).

RIMA acknowledges the following as fundamental pillars of resilience:

- access to basic services;
- assets;
- social safety nets;
- sensitivity;
- adaptive capacity.

The household is the unit of analysis, and household surveys should include aspects of income and income generating activities, access to basic services, access to infrastructure, productive and non-productive assets, formal and informal safety nets, social networks, shocks, food security indicators, institutional environment, and climate change.

The methodology to measure resilience to food insecurity identifies and weights the different dimensions of households' resilience through an econometric model. FAO divides the pillars of resilience into a physical dimension, capacity dimension and natural environment dimension.

Strengths

- The resilience approach tries to identify how the combined effect of climate changes, economic forces and social conditions have increased the frequency and severity of risk exposure among vulnerable populations.
- Coping strategy indices (from annexes) can be used as possible indicators.

Limitations

- The model is quite technical and complex.
- The focus is limited to resilience.

2.5.2 FAO: Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists (2015)

Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists (SHARP, FAO, 2015b)[43] is a tablet-based climate resilience self-assessment tool for farmers and pastoralists in developing countries conducted at the individual farmer/pastoralist level. It assesses farmers' and pastoralists' current state of resilience to climate change, while helping to tailor actions aimed at increasing their resilience. It combines a farmer's perceptions and assessments with a technical and objective assessment of resilience based on Cabell and Oelofse's resilience indicators (2012). Although it is not a formal or traditional project M&E tool, its design and information could be a valuable addition for tracking the process and impact of a project's interventions.

Levels of resilience are determined for households or farm systems using 13 agro-ecosystem resilience indicator groups: (1) socially self- organised; (2) ecologically self-regulated; (3) appropriately connected; (4) functional and response diversity; (5) optimally redundant; (6) spatial and temporal heterogeneity; (7) exposed to disturbance; (8) coupled with natural capital; (9) reflective and shared learning; (10) globally autonomous and locally interdependent; (11) honours legacy; (12) builds human capital; and (13) reasonably profitable.

To measure these indicators, the tool comprises a set of 20 mandatory questions (out of a possible 40) covering socio-economic, environmental, productive and governance domains of households and farm systems to assess resilience holistically. SHARP can be both an M&E and learning tool that provides immediate results (offline) on the tablets in the field and the capability to further analyse aggregated results at different levels. Data can be disaggregated based on gender, production practice type, and age group. Comparisons can be made across households, within communities, regions and countries.

The tool has been used in the following countries to date: Angola, Burkina Faso, Burundi, Central Asia (regional project), Chad, Costa Rica, the Gambia, Ghana, Côte d'Ivoire, Kenya, Mali, Mozambique, Niger, the Philippines, Senegal, South Sudan, Switzerland, Uganda, Uzbekistan and Viet Nam.

Strengths

- In addition to being an assessment tool, it is also a method for developing local and context-specific resilience goals, indicators and interventions.
- The application is flexible and can be tailored to meet specific needs of projects and communities.
- Data can be disaggregated by gender, production practice type, age group.
- Comparisons can be made across households, and within communities, regions and countries.
- Assessment is based on a combination of factual/objective information and participant perceptions.
- Participatory approach allows flexibility in the development of indicators and empowerment for farmers and pastoralists.
- Using tablets makes interviewing flexible and gives immediate results, and data collected can be shared with a central database.
- The application is free of charge and the data collected are fully available to the users and project managers.

Limitations

- The tool should be integrated with the M&E and information systems to fully take advantage of the information collected.
- Developers are still working to allow climate resilience data to be integrated with broader information on projected changes in climate patterns.
- Training of the enumerators before implementation is needed to ensure the quality and validity of data.
- The time of the short version of the survey (20 modules) could take up to 1.5 hours for completion, so good advance planning should be carried out.

2.5.3 CGIAR–CCAFS: Climate-Smart Agriculture Compendium. The scientific basis of Climate-Smart Agriculture (2016)

With the objective of understanding how switching from conventional agriculture to CSA management practices can change farm-level outcomes for productivity, resilience and climate change mitigation, the World Agroforestry Centre (ICRAF), CCAFS, FAO and CIAT have conducted a meta-analysis of the published scientific literature to date on CSA practices (Rosenstock *et al.*, 2016).[44] The analysis evaluated the impact of 73 farm-level management practices and provided comparisons to baselines (using 55 outcome indicators) in five categories (agronomy, agroforestry, livestock, postharvest management, energy systems) to assess their contributions to the three CSA pillars. This is the largest meta-analysis to date for evidence building.

The compendium was published in 2016 to investigate the following question: "how do farm-level CSA management practices and technologies affect food production and/or farmers' incomes, resilience/adaptive capacity, and climate change mitigation in farming systems of developing countries?" The objective was to evaluate CSA practices in order to improve upon them in the future.

Literature searches were conducted via Web of Science (WoS) and Scopus. Each study included in the review fulfills the four main inclusion criteria: (1) it examines at least one of the chosen CSA management practices or technologies; (2) it includes information on at least one indicator for one outcome relevant to CSA objectives; (3) the study location is in a developing country; and (4) the study design includes primary data with a comparison between a CSA practice and a conventional practice. Table 20 provides indicator examples by pillar/outcome.

Table 20: CSA indicator examples by pillar and outcome

Pillar/outcome	Indicator	Examples
(1) Food production	Yield	Maize yield (kg/ha/yr) Weight gain (kg) Milk production (L/cow/day) Biomass (kg/ha/yr)
	Income	Maize yield (kg/ha/yr) Weight gain (kg) Milk production (L/cow/day) Biomass (kg/ha/yr)
	Food security	Consumption (Kcal/pers/day) Food deficit (Kcal/pers/day)
(2) Resilience/adaptive capacity		
Biophysical	Biodiversity	Number of pollinators Soil microbe diversity
	Soil resources	Soil organic carbon (g/m3) Soil nitrogen (g/m3) Erosion losses (t soil/ha/yr)
Economic	Resource efficiency	Water use efficiency (L/kg) Nutrient use efficiency (g/kg) Protein use (%)
	Labour	Person-hours (hrs/ha/yr) Value of labour (USD/hr)
Social	Gender	Female person-hours (hrs/ha/yr)
(3) Mitigation	GHG emissions	CO_2 flux (mg C m^{-2} hr^{-1}) N_2O flux (mg N m^{-2} d^{-1})
	Emission intensity	GHGs/product (kg CH_4/kg milk or grain)
	Carbon stocks	Aboveground biomass (t/ha) Total soil carbon (t/ha)
	Consumption	Fuelwood consumed (kg/yr)

Source: Rosenstock *et al.* (2016)

2.5.4 CSIRO: Rural Household Multi-Indicator Survey (2017)

The Rural Household Multi-Indicator Survey (RHoMIS) is a household survey tool for measurement and monitoring developed by the Commonwealth Scientific and Industrial Research Organisation in Australia (CSIRO, 2017).[45] It is designed to rapidly characterise a series of standardised indicators relating to agricultural production and market integration, nutrition, food security, poverty and GHG emissions. It captures information on farm productivity and practices, nutrition, food security, gender equity, climate and poverty, and provides up to 20 important performance and welfare indicators and key farm level drivers, livelihood data and management decisions. In this way users can compare changes in farming practices and livelihoods over time. It was piloted in two contrasting agro-ecosystems in the Lushoto district of the United Republic of Tanzania and the Trifinio border region of Guatemala, El Salvador and Honduras.

The survey itself is conducted on a smartphone or tablet, while data are uploaded to a server. The tool contains an analytical engine that runs automated analysis that supports almost real-time information delivery to programme managers. Thus RHoMIS gives a rapid characterisation of farm systems, including household and farm welfare and livelihood strategies that can support the planning and monitoring of CSA projects. The tool uses generic standard indicators, but context-specific adaptation could expand analyses to include specific sectors or subsectors. The standard performance indicators are listed in Table 21.

Table 21: Rural Household Multi-Indicator Survey (RHoMIS) standard performance indicators

Pillars of CSA	Performance indicators
Food security	· Food availability · Farm productivity · Dietary diversity · Food insecurity of access
Adaptive capacity	· Progress out of poverty · Value of farm produce · Off-farm income · Gender equity
Mitigation	· GHG emissions · GHG intensity

Source: Hammond *et al.* (2017)

Strengths

- Tool provides quick feedback to help in understanding the impacts of various farm management processes and how climate smart they are.
- Considered easy to interpret because of modular construction.
- Includes process indicators (progress out of poverty) and a gender indicator.

Limitations

- Not evident how difficult it would be to add indicators to each module.
- Scope limited to household/farm level.

3

3 Non-agriculture-specific monitoring and evaluation (M&E) guidance

This chapter presents M&E frameworks that are not specific to the agriculture sector. These frameworks have been developed by different donor agencies for financing mechanisms (e.g. UNFCCC Adaptation Fund, GEF, IFAD, CIF, GCF), and for adaptation planning (e.g. IIED, UNFCCC, GIZ). Three examples of M&E systems from national adaptation or national climate change plans (e.g. Germany, the Philippines, Morocco) are also highlighted. As in Chapter 2, the strengths and limitations of each framework have been highlighted where possible.

3.1 For financing mechanisms

3.1.1 CIF: Pilot Program for Climate Resilience Monitoring and Reporting Toolkit (2015/2018)

The World Bank's Climate Investment Funds (CIF) Pilot Program for Climate Resilience (PPCR)[46] supports developing countries in building adaptation and resilience to the impacts of climate change by providing assistance to governments to integrate climate resilience into development planning, and by helping to implement those plans through piloting solutions to climate-related risks. The budget for the programme, which has supported 28 countries and two regions,[47] is USD 1.2 billion (World Bank, 2015).

The implementing agencies for PPCR investments are the World Bank Group, the African Development Bank, the Asian Development Bank, the European Development Bank and the Inter-American Development Bank, while the World Bank serves as the Trustee and Administration Unit.

The objectives are to pilot and demonstrate approaches for integration of climate risk and resilience into development policies and planning, strengthen capacities at national level to integrate climate resilience into development planning, scale-

up and leverage climate-resilient investment, build on other ongoing initiatives, and encourage learning by doing and sharing of lessons at country, regional and global levels.[48]

Through the CIF Evaluation and Learning Initiative, PPCR countries have started to conduct evidence-based evaluations to assess the effectiveness of PPCR as a "learning laboratory". Countries engaged in this process so far include Bhutan, Mozambique, Nepal, Saint Lucia, Tajikistan, Uganda and Zambia.

This toolkit supports PPCR country focal points, PPCR units/teams, project/programme implementation units, Multilateral Development Bank (MDB) task teams and other in-country stakeholders in their assessment of progress at both national and project/programme levels.

It includes a score card and scoring criteria for each indicator. Each pilot country is expected to report on the five core indicators over the duration of their investment plan:

1. Degree of integration of climate change in national, including sector, planning.
2. Evidence of strengthened government capacity and coordination mechanism to mainstream climate resilience.
3. Quality and extent to which climate responsive instruments/investment models are developed and tested.
4. Extent to which vulnerable households, communities, businesses and public-sector services use improved PPCR-supported tools, instruments, strategies and activities to respond to climate variability or climate change.
5. Number of people supported by the PPCR to cope with the effects of climate change. The scorecards for core indicators 1 and 2 are to be completed at national level, whereas data for scorecard and tables for core indicators 3, 4 and 5 are gathered at project/programme level and then submitted to the national PPCR focal point for compilation and verification.

Strengths

- In the overview of each core indicator, there is a section indicating the responsibilities of various actors for monitoring and reporting, such as the PPCR country focal point, the lead MDB and the MDB HQ focal points.
- In the annex, there is a useful scoring criteria example for each core indicator that explains each numerical score.

Limitations

- No sector-specific indicators.
- Limited to five core indicators.

3.1.2 World Bank: Operational guidance for monitoring and evaluation (M&E) in climate and disaster resilience-building operations (2013/2017)

This publication presents guidance for M&E of World Bank operations that aim to increase resilience to climate-related natural disasters and long-term climatic changes, through activities including climate change adaptation and disaster risk management components (World Bank, 2013/2017).[49]

The paper identifies the following methodological challenges inherent to resilience M&E:

- Directly measuring the degree of resilience of people, assets, or systems
- Establishing proxy measures (due to the combined effect of multiple stressors, long timeframes and many scales (household, community, provincial, region, watershed, national, etc.)

- Evaluating and attributing intervention results
- Building resilience at one point in time does not always lead to system-level resilience

It suggests four guiding principles:

1. Build innovative and flexible M&E systems that can be improved over time, and expand on accountability to include learning.
2. Emphasize local-contexts and build on participatory approaches.
3. Build from existing reporting frameworks, systems, and requirements to keep data and capacity needs manageable.
4. Integrate multidimensionality, interactions between sectors and actors, and feedback loops to consider the complexity and numerous dimensions of resilience.

Typically, the World Bank results frameworks include both intermediate (i.e. output-focused) and high-level project development objective (PDO) results indicators (i.e. outcome-focused). The resilience-related results indicators conform with these standards to allow measurement at different levels of the results chain:

- Output indicators measure policy changes, products, and services delivered by resilience-building activities.
- Outcome indicators measure the short- and medium-term resilience-related benefits generated for the target group.
- Proxy indicators signal the ability or capacity of people, assets, and systems to be more resilient without directly measuring outcomes. Proxy indicators serve as acceptable substitutes especially when it is too difficult or costly to measure the outcome itself (World Bank, 2013).

Table 22 contains examples of agriculture and rural development indicators from existing World Bank operations. The World Bank's Governance Global Practice is developing sector-specific theories of change and results frameworks, which may also provide sector-specific indicator menus.

Table 22: Examples of sector-specific indicators from existing World Bank operations

Agriculture and rural development
• Reduction in average length of household food insecurity faced by farm households • Reduction in annual crop losses due to weather-related events • Number of households that acquire farm inputs and assets to recover from losses • Provision of increased grain storage capacity in public and household facilities • Agricultural area under improved (resilient) management practices • Agricultural area provided with irrigation and drainage services • Number of farmers adopting improved (resilient) production practices • Number of farmers that have received food vouchers • Amount of improved rice seeds distributed • Increase in number of households whose grain needs can be met

Source: World Bank (2013)

In the appendices, resilience-relevant results indicators for investment projects are listed by sector/theme, including "agriculture and rural livelihoods" indicators: food security and farm income indicators, agricultural production and technologies indicators, and agricultural information and monitoring and forecasting tools indicators.[50]

Strengths

- This framework deals with M&E of resilience-building projects specifically to monitor and assess outputs and outcomes that would ideally be more tailored to specific projects.
- High-level guidance is provided for each step, as well as a reference list for each section with additional information.
- The framework gives both "core" evaluation considerations and "resilience-specific considerations" for each step in the evaluation section.
- The framework gives sample sector-specific indicators from existing World Bank operations.
- The frameworks lists good practices and excerpts from case studies, and recommendations for task team guidance in each section.

Limitations

- The World Bank is involved in the development of sector-specific approaches, but this guidance does not address sector-specific theories of change/results frameworks.
- The focus is limited to resilience.

3.1.3 GEF LDCF/SCCF: Adaptation Monitoring and Assessment Tool (2014)

The Global Environment Facility (GEF) Programming Strategy on Adaptation to Climate Change for the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF) have introduced a revised results framework for the GEF Adaptation Program, structured around three objectives with associated outcomes and indicators (GEF, 2014).

The framework attempts to establish appropriate indicators and methodologies for monitoring progress, and aims for greater consistency with the tools and methodologies used by other funds and agencies.[51]

GEF's mandate under the UNFCCC is to support the preparation of the national adaptation plan (NAP) process. The framework is designed to capture the principal dimensions of support provided through the LDCF and the SCCF for climate change adaptation, and to capture the two objectives of the NAP process, as defined by the Conference of the Parties.[52] It introduces 14 indicators as well as four qualitative scoring methodologies which have been designed to be broadly consistent with those of the CIF Pilot Program for Climate Resilience, discussed in Section 3.1.1 (World Bank, 2015), and the IIED Tracking Adaptation and Measuring Development (TAMD) framework, discussed in Section 3.2.1 (IIED, 2011). Their method targets either adaptive actions or adaptive capacity.

The most recently updated results-based management (RBM) framework for climate change adaptation (2014) aims to address the following needs.[53]

- Enable more comprehensive portfolio-level monitoring and reporting on progress and outcomes, based on more consistent definitions and methodologies.
- Introduce, where appropriate, qualitative tools and methodologies that allow portfolio-level monitoring and reporting to go beyond quantitative outputs.
- Establish appropriate indicators and methodologies for monitoring progress and outcomes in line with evolving guidance by the UNFCCC COP.
- Seek, where appropriate, greater consistency with the tools and methodologies used by other funds, programmes and agencies.

There are 12 African countries (Burkina Faso, Burundi, Ethiopia, Ghana, Kenya, Malawi, Niger, Nigeria, Senegal, Swaziland, Uganda, United Republic of Tanzania) participating in the GEF Food Security Program. For these projects, the first step is to examine the food system interactions in order to understand how the projects assess food system activities, and how these contribute to outcomes through utilization, access and availability of food.

Here is an example from the GEF indicators used in their Adaptation Monitoring and Assessment Tool (AMAT)

Food security indicators:

- Percent change in projected food production in targeted area given existing and projected climate change (tonnes/year).
- Percent change in food availability given existing and projected climate change (tonnes/year).

Adaptive capacity measurement indicators:

- Capacity perception index (score)[54] (disaggregated by gender).

Strengths

- 2014 updates now include revised indicators with explanation of additional details (units of measurement, definitions, guidelines and methodologies); 7 of the 14 indicators now request gender-disaggregated data.
- Revised tool is designed to be more consistent with the results frameworks and logic models of other funds (Adaptation Fund, Pilot Program for Climate Resilience, Green Climate Fund).
- Revised tool now uses four qualitative scoring methodologies in addition to quantitative units of measurement.
- Revised tool incorporates the GEF corporate gender indicators.

Limitations

- It is not intended to replace the more project-specific M&E frameworks (thus there may be an additional reporting burden, as is often the case when reporting to donor funds as well as conducting M&E for other reasons).

3.1.4 Green Climate Fund (2018)

The Green Climate Fund (GCF)[55] states that a good project should demonstrate how it will support the paradigm shift to a low-emission and climate-resilient development pathway. In order to demonstrate that a project is contributing to this goal, a robust monitoring framework with the appropriate types of indicator must be in place (Fayolle and Odianose, 2017).

With the exception of four core indicators – three mitigation indicators and one adaptation indicator – the most recent (soon to be former) performance measurement frameworks (PMFs) do not contain a robust system against which the adequate monitoring of indicators can be accomplished.

The GCF Board decided that, in designing its RBM framework, "the Fund will use the experience of other relevant entities, and, where appropriate, align the framework and indicators with existing best practice models". In considering further development of indicators, the Secretariat is aiming to follow the UNFCCC Adaptation Committee's recommendations that the GCF should:

- keep the indicators simple;
- design indicators that are qualitative as well as quantitative;
- design indicators in such a way as to capture the progress that countries are able to make in integrating adaptation into their development and sectoral planning, policies and actions;
- give countries sufficient flexibility to define their indicators in line with their national and local planning, strategies and priorities.

Starting in the first quarter of 2018, the GCF began work to further develop indicators in PMFs by comparing its own with those of different climate finance mechanisms. The goal is to ensure that GCF is using indicators that are relatively easy to measure, report and verify, and are not too inconsistent with those used by other climate finance mechanisms. The finalized RMF and PMFs will become the primary tools for annual performance reports and will inform assessments of funding proposals.

Specifically, the GCF Secretariat compared adaptation and mitigation key performance indicators (KPIs) and monitoring, reporting and verification systems (MRVs) with those of the Adaptation Fund, Climate Investment Funds, GEF, and the nationally appropriate mitigation action (NAMA) facility. In their review of existing adaptation indicators, the following indicators were retained or added:

- Under expected result 1.0: *Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions.*

  - 1.1 Change in expected losses of lives and economic assets (USD due to the impact of extreme climate-related disasters in the geographic area of the GCF intervention (data should be based on climate models from the Intergovernmental Panel on Climate Change (IPCC) or other reputable scientific organisations; data on the measurement of mortality rates could be gathered from the World Health Organization and other comparable institutions) (GCF level).
  - 1.2 Number of males and females benefiting from the adoption of diversified, climate-resilient livelihood options (GCF level).
- Under expected result 2.0: *Increased resilience of health and well-being, and food and water security.*
  - Number of males and females benefiting from introduced health measures to respond to climate-sensitive diseases (GCF level).
  - Number of food-secure households (in areas/periods at risk of climate change impacts) (GCF level).
  - Number of males and females with year-round access to reliable and safe water supply despite climate shocks and stresses (GCF level).

- Under expected result 3.0: *Increased resilience of infrastructure and the built environment to climate change threats.*
  - Number and value of physical assets made more resilient to climate variability and change, considering human benefits (GCF level).
- Under expected result 4.0: *Improved resilience of ecosystems and ecosystem services.*
  - Coverage/scale of ecosystems protected and strengthened in response to climate variability and change (GCF level).
  - Value (USD) of ecosystem services generated or protected in response to climate change (GCF level).
- Under expected result 5.0: *Strengthened institutional and regulatory systems for climate-responsive planning and development.*
  - A2.1 core indicator – Degree of integration of climate change adaptation approaches in national and sector planning (same or similar indicators used in all three climate finance mechanisms – corresponding to the Least Developed Countries Fund (LDCF)/Special Climate Change Fund (SCCF): Indicators 11, 12 and 13;Climate Investment Funds (CIF) Pilot Program for Climate Resilience (PPCR) Indicator A2.1 (core); and Adaptation Fund (AF): Indicator 7 (country level).
  - B2 core indicator – Evidence of strengthened government capacity and coordination mechanism to mainstream climate resilience (same or similar indicators used in all three climate finance mechanisms – corresponding to the LDCF/SCCF: Indicators 9 and 10; CIF PPCR Indicator B2 (core); and AF Indicator 2 (country level).
- Under expected result 6.0: *Increased generation and use of climate information in decision-making.*
  - CIF-PPCR B.3 – Evidence that climate data are collected, analysed and applied to decision-making in climate-sensitive sectors (project/programme level).
  - GEF Indicator 7 – Number of people/ geographical area with access to improved climate information services (project/programme level).
- Under expected result 7.0: *Strengthened adaptive capacity and reduced exposure to climate risks.*
  - AF Core Indicator 1.2 – Number of early warning systems (project/programme level).
- Under expected result 8.0: *Strengthened awareness of climate threats and risk reduction processes.*
  - 8.1: Number of males and females made aware of climate threats and related appropriate responses (project/programme level).

Strengths

- GCF has further developed indicators to better align with other climate finance mechanisms, reducing burden.
- Indicators are intended to capture countries' progress in integrating adaptation into development and sectoral policies.
- Indicators are both quantitative and qualitative.
- According to the GCF Gender Policy, all project proposals should include qualitative and quantitative gender indicators.

Limitations

- Indicators are broad, generic.

3.1.5 UNFCCC Adaptation Fund: Results framework and baseline guidance (2015)

The UNFCCC Adaptation Fund (AF) developed its results framework and baseline guidance as a tool for project proponents and potential fund applicants to use when designing project or programme level results frameworks and developing baselines to submit to the AF (UNFCCC, 2015a).[56] The framework uses results-based management, which provides for strategic planning and management by improving learning and accountability. The AF divides project design and performance assessment into seven steps:

Step 1: Define the intended effect and scale of interventions;

Step 2: Analyse and formulate project objectives and analyse alternatives;[57]

Step 3: Align project objective(s) with Adaptation Fund Strategic Outcome(s);

Step 4: Include project indicators and select core Adaptation Fund indicators;[58]

Step 5: Set targets;

Step 6: Monitor (collect) data;

Step 7: Review and report data.

The document briefly explains the RBM framework and outlines the AF's 26 standard/core indicators with measurement suggestions and reporting suggestions for outputs and outcomes. It does not provide further analysis guidance or support in selecting or measuring project-specific indicators. The RBM framework includes the long-term goal, outcomes, outputs, and a small set of indicators for the fund.

Table 23 lists the AF's standard/core indicators which could potentially be used as both outcome and process indicators, although there is no discussion of a distinction between the two.

Table 23: UNFCCC Adaptation Fund standard/core indicators

Indicators
1. Relevant threat and hazard information generated and disseminated to stakeholders on a timely basis 1.1 Number and type of projects that conduct and update risk and vulnerability assessments 1.2 Development of early warning systems
2.1 Number and type of targeted institutions with increased capacity to minimise exposure to climate variability risks 2.2 Number of people with reduced risk to extreme weather events 2.1.1 Number of staff trained to respond to, and mitigate impacts of, climate-related events 2.1.2 Capacity of staff to respond to, and mitigate impacts of, climate-related events from targeted institutions increased 2.2.1 Percentage of population covered by adequate risk reduction systems 2.2.2 Number of people affected by climate variability
3.1 Percentage of targeted population aware of predicted adverse impacts of climate change, and of appropriate responses 3.2 Modification of behaviour in targeted population 3.1.1 Number and type of risk reduction actions or strategies introduced at local level 3.1.2 Number of news outlets in the local press and media that have covered the topic
4.1 Development sectors' services responsive to evolving needs from changing and variable climate 4.2 Physical infrastructure improved to withstand climate change and variability-induced stress 4.1.1. Number and type of health or social infrastructure developed or modified to respond to new conditions resulting from climate variability and change (by type) 4.1.2 Number of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change (by type of assets)
5. Ecosystem services and natural assets maintained or improved under climate change and variability-induced stress 5.1 Number and type of natural resource assets created, maintained or improved to withstand conditions resulting from climate variability and change (by type of assets)
6.1 Percentage of households and communities having more secure (increased) access to livelihood assets 6.2 Percentage of targeted population with sustained climate-resilient livelihoods 6.1.1 Number and type of adaptation assets (physical as well as knowledge) created in support of individual or community livelihood strategies 6.1.2 Type of income sources for households generated under climate change scenario
7. Climate change priorities are integrated into national development strategy 7.1 Number, type and sector of policies introduced or adjusted to address climate change risks 7.2 Number or targeted development strategies with incorporated climate change priorities enforced

Source: UNFCCC (2015a)

Strengths

- The standard/core indicators are explained in more detail in Annex III. Guidance is provided for each indicator on its corresponding outputs/outcomes, definition of the overall indicator and specific terms, measurement difficulty, how to measure it (metrics and parameters), why and when to measure it, how to collect the data, how to analyse and interpret the results, strengths and limitations of the indicator, outputs and measures of activities, with an example, references, resources and tools.
- There is a thorough generic discussion of developing baselines.

Additionally, readers interested in approaches to aggregating projects and programmes into an overall portfolio may find this more generic approach useful (Leagnavar, Bours and McGinn, 2015).[59]

Limitations

- There is a limited amount of sector-specific information.
- There is limited discussion of specific data or data complications (access, etc.).
- The document is hard to navigate and follow at times, as it has no table of contents and is over 100 pages.

3.2 For adaptation planning

3.2.1 IIED: Tracking Adaptation and Measuring Development (2011)

Tracking Adaptation and Measuring Development (TAMD) is a two-track framework that measures adaptation success using a combination of process and outcome indicators (Brooks *et al.*, 2011).[60] Track 1 measures a country or its institutions' management of climate risks, while Track 2 measures the success of adaptation interventions in reducing climate vulnerability. It can be used to track adaptation at national, regional, local and project levels. TAMD has been piloted in Kenya, Nepal, Pakistan and Mozambique since 2012, as well as in Cambodia, Ethiopia and Uganda.

TAMD identifies four indicator categories:

1. *Climate risk management indicators:* To assess process and measure the extent and quality of institutional processes and mechanisms for addressing climate-related risks.
2. *Resilience and related indicators:* To assess the results of adaptation activities over short timescales.
3. *Indicators of human well-being:* To evaluate progress in managing climate risks; these indicators are often defined at the impact level and are most suitable for governments to assess progress over the longer term.
4. *Climate indices*: Require historical baselines so that relationships with well-being indicators can be established in order to assess trends.

Table 24 presents the set of TAMD indicators for Track 1 (climate risk management indicators) which may be tailored to different contexts, and indicator possibilities for Track 2 (climate relevant development/vulnerability indicators, which inherently will be more context-specific):

Table 24: TAMD indicators by track

Track 1 indicators	Track 2 indicators
1. Climate change integration into planning	Numbers of beneficiaries of climate change interventions
2. Institutional coordination for integration	Coverage of climate change interventions (proportion of portfolio that includes measures to address climate change)
3. Budgeting and finance	Numbers of people experiencing reductions in vulnerability
4. Institutional knowledge and capacity	Value of assets and economic activities protected or made less vulnerable as a result of adaptation interventions
5. Climate information	Benefit/cost ratios of adaptation options identified/implemented
6. Uncertainty	
7. Participation	
8. Awareness among stakeholders	
9. Vulnerability/resilience	

Source: Brooks *et al.* (2011)

Strengths

- Framework can be used at different levels, from national to community-level.
- Framework can be used for planning and evaluation (ex-ante, ex-post).
- Indicators are measured through scorecards which can be tailored to the context of the application.
- The core indicators are meant to be supplemented by sectoral indicators (Rai *et al.*, 2015).[61]
- Indicators are broad enough to allow an aggregated assessment of progress towards adaptation goals.
- Specific cost and value analysis for the application of TAMD has been conducted.[62]

Limitations

- Indicators provided are high level and would need to be translated into context-specific indicators.

3.2.2 DFID: Building Resilience and Adaptation to Climate Extremes and Disasters (2014); ODI: The 3As: tracking resilience across BRACED (2015)

DFID's Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) programme is striving to improve the integration of disaster risk reduction and climate adaptation methods into development approaches, and to influence policies and practices at the local, national and international level (DFID, 2014).[63] BRACED supports 108 organisations in 15 consortiums in countries in East Africa, the Sahel and Southeast Asia. The three-year grants for projects are managed by a Fund Manager, led by KPMG, and a Knowledge Manager Consortium, led by the Overseas Development Institute (ODI).[64] The Knowledge Manager Consortium conducts monitoring, evaluation, research, learning and communications work, and develops and disseminates resilience knowledge. The Consortium was tasked with "measuring outcomes but also reconciling the diverse visions of resilience embraced by the different projects being implemented in highly varied geographies".[65] As part of this work, ODI has drafted *The 3As: tracking resilience across* BRACED (Bahadur *et al.*, 2015). This

publication presents a conceptual framework for measuring resilient outcomes which accounts for the context specificity of resilience.

The framework is based on three connected resilience capacities: (1) the capacity to adapt; (2) the capacity to anticipate; and (3) the capacity to absorb climate extremes and disasters (the 3As). The framework also presents an approach to analysing transformation and transformative impacts. The definitions used are as follows:

- *Adaptive capacity*: the ability of social systems to adapt to multiple, long-term and future climate change risks, and also to learn and adjust after a disaster.
- *Anticipatory capacity*: Anticipatory capacity is the ability of social systems to anticipate and reduce the impact of climate variability and extremes through preparedness and planning.
- *Absorptive capacity*: The ability of social systems to absorb and cope with the impacts of climate variability and extremes.
- *Transformation*: Within BRACED, transformation refers to the likelihood of human systems to fundamentally and sustainably improve the resilience of vulnerable citizens to the impacts of climate extremes and change.

The authors conducted a literature review to map different ways of understanding resilience outcomes. BRACED project documents were examined with a focus on theories of change, log frames, M&E plans and the metrics and indicators the projects have employed to track changes. The report provides empirical examples of how the BRACED programme tracks and measures the 3As and transformation in order to provide a starting point for understanding how to measure changes in resilience on many different levels, including households, communities, states and markets.

Strengths

- Offers an integrated way to define resilience that accounts for different capacities.
- Provides concrete examples of metrics that have been used to track resilience outcomes in BRACED projects; outcomes can be analysed across the whole BRACED programme.
- Having a more holistic view of resilience allows insights from the BRACED programme to gain traction elsewhere.
- Framework analyses the concept of transformation, linking it to the capacities of resilience.

Limitations

- The framework has been applied only to BRACED projects.
- As the authors acknowledge, each user will interpret the 3As according to their own context and priorities, and develop different sets of indicators; thus it will take time to validate the framework as a useful approach. This also means that indicators can only be standardised or aggregated to a certain extent.

3.2.3 UNFCCC LDC Expert Group: Technical guidelines for the national adaptation plan process[66] (2012) and Monitoring and Evaluation (M&E) Guidebook (2015)

The technical guidelines were developed by the Least Developed Countries Expert Group (LEG) with input from GEF and experts from other organisations to support each component of the NAP process, as requested by the COP. The NAP process supports LDCs in reducing their vulnerability by building adaptive capacity and resilience and through integrating adaptation into development planning. The guidelines address the four elements of the NAP process: laying the groundwork and addressing gaps; preparatory elements; implementation strategies; and reporting, monitoring and review. The guidelines provide sample indicators for monitoring adaptation capacity at national level, categorized by:

- indicators for individual capacity;

- indicators for institutional capacity;
- indicators for societal or systemic capacity.

Otherwise, the original NAP technical guidelines are very brief and generic on M&E and may be applied to any sector. Therefore, in 2015 the LEG and the Adaptation Committee collaborated with GIZ and IISD to develop more detailed guidance for the development of national adaptation M&E systems. The GIZ/IISD guidebook (Price-Kelly *et al.*, 2015) proposes four building blocks for national adaptation M&E systems.[67]

Strengths

- The 2012 guidance builds upon lessons learned from the NAPA process to inform the NAP process.
- The guidance integrates a gender perspective into the NAP process.
- The 2015 guidebook proposes a series of questions to guide the development of national adaptation M&E systems along the four building blocks.
- It provides examples of national adaptation frameworks and references for further reading in each section.
- It provides a flowchart of responsibilities for each step in the process.
- It cites support needs for the NAP process identified by the LEG.

Limitations

- The guidance is not sector-specific.

3.2.4 GIZ: *The vulnerability sourcebook*: concept and guidelines for standardised vulnerability and risk assessments (2014/2017)

The GIZ sourcebook presents step-by-step guidance for designing and implementing a vulnerability assessment, covering the entire life cycle of adaptation interventions (Fritzsche *et al.*, 2014/2017).[68] It was developed by a team of experts who studied guidelines, methodological papers, best-practice examples and vulnerability assessment reviews issued by GIZ and other international organisations, donors and development cooperation agencies.

There is a module on identifying and selecting indicators, which provides guidance for selecting indicators (as well as example indicators) for each vulnerability component (exposure, sensitivity and adaptive capacity) and factors within these components (e.g. precipitation for the exposure component). In 2017, the sourcebook was updated to be compatible with the new risk based framework of the IPCC's Fifth Assessment Report. The sourcebook has been implemented for vulnerability assessments at national and subnational levels in more than a dozen countries (the sourcebook annex provides detailed case studies).

Strengths

- The guidance provides a standardised approach to vulnerability assessments covering a broad range of sectors, different spatial levels (community, subnational, national) and time horizons (current, short-term, medium, long-term).
- Good coverage of indicator selection and stepwise guidance on creating a preliminary and final list for exposure, sensitivity and adaptive capacity indicators, as well as data issues.
- Update in 2017 refers to the climate risk framework of the newest IPCC report.

Limitations

- There is no comprehensive treatment of any one sector. The coverage is broad.

3.2.5 UNFCCC LDC Expert Group: The PEG Monitoring and Evaluation (M&E) tool (2015)

The PEG M&E tool (UNFCCC, 2015b) is an initiative to develop a more generic approach for tracking adaptation actions in NAPs more uniformly. It defines a set of metrics to monitor and assess the process of formulating and implementing NAPs. Metrics are a tool for measuring progress, improving process effectiveness, and demonstrating programme successes and gaps to the UNFCCC/COP, national governments, and other stakeholders.[69] The tool currently focuses on the process, whereas future iterations will address adaptation outcomes after implementation of the plans.

According to the PEG tool, the principles suggested for developing metrics based on a United States National Academy of Sciences Committee on Metrics (NAS, 2005)[70] are the following:

- Good leadership is required if programmes are to evolve towards successful outcomes.
- A good strategic plan must precede the development of metrics.
- Good metrics should promote strategic analysis.
- Metrics should be easily understood and broadly accepted by policy-makers.
- Promoting quality should be a key objective for any set of metrics.
- Metrics should assess process as well as progress.
- A focus on a single measure of progress is often misguided.
- Metrics must evolve to keep pace with scientific progress and programme objectives.
- The development and application of meaningful metrics will require significant human, financial, and computational resources.
- A good set should include all five types of metrics to the fullest extent possible (see below).

The LEG also analysed the different milestones and products emerging from the process of developing and implementing NAPs and identified the ten essential functions (EFs) that should underlie the development of metrics.[71] The LEG then cited its earlier guidance on national adaptation plans of action (NAPAs) to recall their previous identification of ten adaptation–development themes/goals to represent the range of focus areas for adaptation, including agriculture and food security. The overall approach to the development of the tool is "a general set of metrics can be developed and used to measure progress and guide strategic thinking and learning across the entire set of the essential functions of the process to formulate and implement NAPs".

The LEG proposes the following general metrics for NAPs:

- *Process metrics* (measure a course of action taken to achieve a goal): five recommended metrics.
- *Input metrics* (measure available resources to be used by the process to achieve a goal): five recommended metrics.
- *Output metrics* (measure the products and services delivered): five recommended metrics.
- *Outcome metrics* (measure results that stem from use of the outputs and influence stakeholders outside the programme): five recommended metrics.
- *Impact metrics* (measure the long-term societal, economic, or environmental consequences of an outcome): three recommended metrics.

Strengths

- The LEG provides a solid foundation of principles and essential functions upon which metrics can be developed on a more case-specific basis.
- The process outlined aligns with the formulation of NAPs and thus is useful for countries while designing and implementing NAPs.
- A case study is provided to highlight the formulation of all five types of metrics.

Limitations

- The LEG does not yet provide a full case study using all ten essential functions; but it is expected to be provided in the future; more examples of how this framework can be applied are needed.

3.2.6 GIZ: Adaptation made to measure (2013); Repository of adaptation indicators (2014)

The GIZ guidebook, *Adaptation made to measure* (GIZ, 2013a), supports the design and results-based monitoring of adaptation projects. There is an accompanying Microsoft Excel file which lists indicators that have been used in GIZ projects through 2013 by sector and adaptation dimension (adaptive capacity, adaptive action, and sustained development), along with the objective, data needs, data collection method, and costs (medium, high, very high).[72]

Critical to the development of indicators is first identifying and classifying possible results by their contribution to adaptation. Results that can be attributed mostly to adaptive capacity (dimension 1) relate to the development of potential that can lead to adaptation, such as the existence of a national adaptation strategy, or the availability of early warning systems (GIZ, 2013a). The results of adaptation action (dimension 2) relate to whether adaptation has actually occurred and/or whether vulnerability has been reduced. Results that focus on securing development (dimension 3) use indicators that describe the process of development.

In 2014, GIZ published an additional repository with indicators used in national adaptation M&E systems in order to present possible adaptation indicators and their application context (Hammill *et al.*, 2014/2017). It includes indicators from a range of sectors that track different aspects of the adaptation context, process and results to assess whether adaptation interventions are meeting objectives. The indicators are based on national adaptation M&E systems presented in *Monitoring and evaluating adaptation at aggregated levels: a comparative analysis of ten systems* (Hammill *et al.*, 2013).[73] There are hyperlinks with explanations for each indicator (including relevant sectors, focus, unit of measurement, adaptation relevance, potential limitations, indicator example, data needs, data sources and collection methods, calculation methods for the indicator, spatial scale, and disaggregation). Table 25 provides an example of an indicator explanation page. An overview of each national adaptation M&E system is also provided in the form of a factsheet, which allows users to see how an individual indicator is linked to a case study (the factsheets were updated in 2017 and additional countries were added).[74]

Table 25: Example of an explanation page for indicator

Indicator	Uptake of soil conservation measures
Sectors	Agriculture, biodiversity, forestry
Focus of indicator	Adaptation action
Unit of measurement	Number
Adaptation relevance	Preserving good ecosystem service, including productive soil, is essential to promoting sustainable agriculture in a changing climate although climate change is only one driver of erosion
Potential limitations	This indicator could be completed with other indicators to capture the effectiveness of soil conservation measure in a changing climate
Indicator example	Uptake of soil conservation measures (UK)
Reference for indicator example	UK Adaptation Monitoring and Evaluation Framework (2013)
Data needs	Number of solid conservation measures adopted
Data sources, collection methods	Environmental agencies, NGOs, private sector (agro-food business)
Calculation of the indicator	Summation
Spatial scale	Subnational
Disaggregation	By region

Source: GIZ (2017a)

Although the repository does not focus exclusively on agriculture, it does have a strong agriculture component. Table 26 provides a large selection of agriculture-specific indicators in the four main categories addressed in the framework: climate parameters, climate impacts, adaptation action and adaptation results.

Table 26: Agriculture indicators listed by sector for four categories: climate parameters, climate impacts, adaptation action, adaptation results

Climate parameters	Climate impacts
• Change in annual temperature • Mean monthly temperature • Number of hot days • Change in annual precipitation • Monthly precipitation • Extreme precipitation events	• Number of households affected by drought • Percentage of total livestock killed by drought • Number of surface water areas subject to declining water quality due to extreme temperatures • Number of hectares of productive land lost to soil erosion • Percentage of area of ecosystem that has been disturbed or damaged • Areas covered by vegetation affected by plagues or fires • Shift of agrophenological phases of cultivated plants • Losses of GDP in percentage per year due to extreme rainfall
Adaptation action	**Adaptation results**
• Percentage of farmers and fisher folk with access to financial services • Total sum of investments in programmes for the protection of livestock • Number of inventories of climate change impacts on biodiversity • Uptake of soil conservation measures • Percentage of treated wastewater • Percentage of agricultural land with improved irrigation • Number of farmers involved in pilot irrigation messaging projects • Number of women organised in agricultural cooperatives • Cultivation of varieties of red wine that need warmth	• Percentage of poor people in drought-prone areas with access to safe and reliable water • Number of cubic metres of water conserved • Percentage of water demand being met by existing supply • Percentage of livestock insured against death due to extreme and slow-onset weather events • Percentage of farmland covered by crop insurance • Percentage of additional fodder for grazing livestock • Increase in agricultural productivity through irrigation of harvested land • Increase in percentage of climate-resilient crops being used • Percentage of cultivated surface cultivated with drought-resistant varieties • Turnover generated by agricultural cooperatives

Source: Hammill *et al.* (2014/2017)

Strengths of the repository of adaptation indicators

- Lists indicators by focus area, by sector.
- Provides clear definitions and detailed explanations of terms.
- Provides detailed information on each indicator and therefore is a reliable reference for practitioners who need to develop country-specific indicators.
- Microsoft Excel file helps users to organize indicators and serves as a "living document" for future updates.

Limitations of the repository of adaptation indicators

- The repository is only based on ten countries' adaptation M&E systems and therefore not exhaustive; does not delve extensively into sector-specific indicators or information. The repository is not intended to support the standardisation of adaptation metrics.

3.3 For non-state actors and corporate disclosures

3.3.1 FSB: Task Force on Climate-related Financial Disclosures (2018)

For investors, climate change poses financial challenges and opportunities. Corporate risk-return profiles are subject to change due to climate policy, new technologies and the physical impacts of climate change. Transparently disclosing risk relating to climate change helps inform investment decisions. Given that measuring risks relating to climate change is difficult, the Financial Stability Board (FSB) Task Force on Climate-related Financial Disclosures (TCFD) supports the mainstreaming of climate-related issues into annual financial reports. The TCFD recommendations provide a framework for companies to develop more effective climate-related financial disclosures through their existing reporting processes. (TCFD, 2018) They solicit information on the material financial impacts of climate-related risks and opportunities, including those relating to the global transition to a lower-carbon economy. The recommendations can be used by all organisations with public debt or equity in G20 jurisdictions for use in mainstream financial reports.

The recommendations framework is aligned with G20/OECD Principles of Corporate Governance, Carbon Disclosure Project (CDP), Global Reporting Initiative (GRI) and Climate Disclosure Standards Board (CDSB) frameworks (CDSB Climate Change reporting framework and Framework for Reporting Environmental Information & Natural Capital).

The TCFD prepared a status report in 2018 focusing on 2017 climate-related financial disclosures by the largest companies in eight specific groups.[75] The eight groups include four in the financial sector (banks, insurance agencies, asset owners, and asset managers) and four non-financial industries referred to as non-financial groups (energy, transportation, materials and buildings, **and agriculture, food and forest products**).[76] The report concludes that disclosures are in early stages and that further work is necessary for disclosures to provide more decision-useful climate-related information.

The TCFD "knowledge hub" addresses the following themes relating to the four core elements of an organisation's operations, with recommended disclosures and guidance for all sectors. the core elements are: (1) governance; (2) strategy; (3) risk management; and (4) metrics and targets. For *metrics and targets*, the overarching goal is for companies to *"disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material"*. The following disclosures are recommended:

- Disclose the metric used by the organisation to assess climate-related risks and opportunities in line with its strategy and risk management process.
- Disclose Scope 1, Scope 2, and if appropriate, Scope 3 GHG emissions, and related risks.
- Describe the targets used by the organisation to manage climate-related risks and opportunities and performance against targets.

The TCFD Task Force will prepare a second status report for the Financial Stability Board in mid-2019.

3.3.2 Carbon Disclosure Project (CDP) and Global Reporting Initiative (GRI)

CDP, formerly Carbon Disclosure Project, is an international, non-profit organisation started in 2002 providing a global system for companies, cities, states and regions to measure, disclose, manage and share vital information on their environmental performance.[77] CDP supports 827 institutional investors, over 7 000 corporations, and over 600 cities and 100 states and regions in environmental and sustainability reporting. It aims to build a sustainable economy by measuring and understanding the environmental impact of these actors, and strives to ensure that they have embedded a GHG emissions

reduction strategy in their operations. CDP has the most comprehensive global collection of corporate environmental data (GRI and CDP, 2018),[78] which can be used to track progress towards the Paris Agreement and the SDGs.

CDP has integrated the recommendations of the TCFD (see Section 3.3.1) and revised its climate change questionnaires (and water and forests questionnaires) to implement TCFD recommendations, stating that their focus was initially on the "high impact sectors in energy, transport, materials and agriculture" (GRI and CDP, 2018).

The Global Reporting Initiative (GRI) is an independent international organisation formed by the United States of America-based non-profits Ceres (formerly the Coalition for Environmentally Responsible Economies) and Tellus Institute, with the support of UNEP in 1997.[79] The GRI Sustainability Reporting Standards (GRI standards) are a set of modular reporting standards that can be used by any organisation to report its impacts on the economy, the environment, and society. The set includes three universal and 33 topic-specific standards in economic, environmental, and social categories. Thousands of organisations in more than 90 countries currently use the GRI standards to report sustainability information.

The GRI standards are compatible with a wide range of different reporting formats and international frameworks. GRI and CDP have worked together to ensure alignment in disclosures on climate change and energy. The success of this alignment is due in part to the fact that both frameworks have drawn heavily on the Greenhouse Gas Protocol Corporate Standard and Scope 3 (Value Chain) Standard, produced by WRI and WBCSD. This improves consistency and comparability of the data, as well as easing the reporting burden for companies that use CDP's climate change and supply chain programmes as well as the GRI standards. The information they provide can be used in sustainability reports prepared using GRI standards and/or in responding to CDP's climate questionnaire.

3.4 Country-level cases

3.4.1 GIZ/IISD: Monitoring and evaluating adaptation at aggregated levels: a comparative analysis of ten systems (2013)

In response to the argument that much of the discussion to date around M&E of adaptation has focused on project and programme level frameworks and indicator systems with scant focus on M&E at higher or more aggregated levels, this publication aims to showcase experiences in the design and (pilot) implementation of M&E systems at more aggregated, such as national, regional and international levels (Hammill *et al.*, 2013).

The authors present an in-depth comparison of ten aggregated M&E systems and their context, processes and content. Each adaptation M&E system is described in a detailed factsheet (updated in 2017).[80] They summarise the indicator categories used by the eight countries listed in Table 27.

Table 27: Types of indicator used to monitor and evaluate adaptation

	Indicator categories				
	Climate change impacts	Exposure	Vulnerability	Adaptation process	Adaptation outcomes
Australia				X	
France				X	
Germany	X		X	Responses	Responses
Kenya				X	Vulnerability, adaptive capacity
Morocco	X		X	Adaptation	Adaptation
Nepal					X
Philippines				X	X
United Kingdom	X	Risk factors	Adaptation action		

Source: Adapted from GIZ (2013a)

In its analysis of ten systems, the GIZ authors included two countries, the Philippines and Morocco, which have addressed the agriculture sector in their M&E systems, and thus are highlighted in Boxes 6 and 7. To begin, and to provide some background information on the climate change action plan in the Philippines, the Adaptation and Mitigation Initiative in Agriculture (AMIA) programme is highlighted.

BOX 6

The Philippines: Implementing a robust M&E framework for CSA investment: experience from the Adaptation and Mitigation Initiative in Agriculture (AMIA) programme[81]

Climate change adaptation is a key priority for the Government of the Philippines. The country is considered as a global pioneer in mainstreaming climate change into its national laws and policies, because it has advocated the creation of laws that promote increased productivity and climate adaptation dating back to 1991 (CCAFS, 2017a, 2017b).[82] One of these laws laid the foundation for the formulation of the National Framework Strategy on Climate Change in 2010, the adoption of which led to the subsequent formulation of the National Climate Change Action Plan (NCCAP), which defined mitigation and adaptation priorities from 2011 to 2028.

The Philippines Climate Change Commission (CCC) is the lead policy-making body that coordinates and evaluates climate change programmes, whereas the Department of Agriculture (DA) leads food security work. Some examples of climate-smart practices and technologies considered effective for food security and which have been widely implemented are: the use of drought-resistant vegetable varieties; adaptive crop calendars; organic vegetable farming; agroforestry systems; and alternative feeds (forages) for pork.

In 2014, the DA launched the Adaptation and Mitigation Initiative in Agriculture (AMIA) programme as part of the climate-resilient agriculture (CRA) strategic framework. This was in response to the signing of a resolution at the 2012 Asia and Pacific Economic Cooperation (APEC) seminar on climate change adaptation and mitigation potential in agriculture. In 2013, the DA Secretary approved the strategic objectives and seven system-wide programmes (Rudinas *et al.*, 2013)[83] to further strengthen the overarching AMIA objectives, which are: (1) to reduce the risks posed by climate change to project activities, stakeholders and results; (2) to ensure that project or programme activities maximise their contribution to adaptive capacity of target populations and do not inadvertently increase vulnerability to climate change; and (3) to build resilience while achieving development goals.

AMIA is being implemented by the DA's Systems-Wide Climate Change Office (SWCCO) in partnership with DA regional field offices, universities, financial institutions, international organisations and NGOs. The SWCCO serves as a coordinating body for climate change in agriculture. Its intent is to address shortfalls identified in the Philippines' Nationally Determined Contribution (NDC), which highlighted that "capacity and capability are needed in the field of climate-related hazard modeling, science-based risk and vulnerability assessment as well as risk management measures including risk sharing and risk transfer mechanisms" (CCAFS, 2017b). Its implementation began with the country-wide identification of key climate risks and vulnerable areas, alongside an assessment of the current state of CRA, and a cost-benefit analysis of certain CRA practices.

The AMIA programme then established 17 pilot sites for community-level research which received integrated decision-support tools and government services, such as training, credit, insurance and market linkage support. The objective of the programme was to increase the capacity of 9 million individual farmers and fisherfolk by 2022 to use climate support services in order to address food security issues, promote climate-resilient practices and technologies, develop risk-transfer mechanisms and assist in the expansion of climate-resilient agricultural and fisheries infrastructure.

Source: CCAFS (2017a ; 2017b)

BOX 7

The Philippines National Climate Change Action Plan (NCCAP) Results-Based Monitoring and Evaluation System

As illustrated by GIZ, the Government of the Philippines is monitoring at national and sectoral levels with an existing well-operating national, sectoral and local M&E system. The CCC is developing a standard system of indicators to help harmonize the data from existing climate change initiatives to facilitate comparison and decision-making among agencies. Their Results-Based Monitoring and Evaluation System (RBMES) monitors progress towards the implementation of the NCCAP using linear causal result chains that demonstrate how activities are linked to outcomes for seven strategic priorities. There is a focus on both adaptation and mitigation. Climate Change Vulnerability Indices (CCVI) based on a set of common or "core" indicators for measuring local vulnerability and adaptation are being developed based on the NCCAP's thematic priorities. The draft indicator list is mostly focused on the adaptation process, to enable an understanding of progress based on the level of implementation of measures. The Philippines monitors annually and evaluates the adaptation action plan every three years.

There is an M&E technical working group with focal persons from relevant sectoral and technical agencies, as well as local government units (LGUs) and national agencies who support data collection, analysis and reporting. The working group identified output and outcome indicators through consultations with key stakeholders.

Source: GIZ (2017a)

Table 28 provides an example from the Philippines NCCAP. As mentioned in Box 7, the RBMES uses linear causal results chains to link activities to outcomes for seven strategic priorities, one of which is food security. The table shows the matrix for food security, indicating the ultimate outcome first, followed by the intermediate outcome, output area and indicators.

Table 28: Sample of NCCAP's food security matrix

Ultimate outcome: Enhances adaptive capacity of communities and resilience of natural ecosystems to climate change
Intermediate outcome: Ensure food availability, stability, access and safety amidst increasing climate change and disaster risks
Immediate outcome: Enhanced resilience of agriculture and fisheries production and distribution systems from climate change
Output area: Enhanced knowledge on the vulnerability of agriculture and fisheries to the impacts of climate change
Indicators: • Provincial level agriculture and fishery sector vulnerability and risk assessment conducted nationwide • National and provincial agriculture and fisheries climate information and database established • Number of researches conducted on agriculture and fisheries adaptation measures and technologies developed • Number of appropriate climate change adaptation technologies identified and implemented

Source: GIZ (2017a)

Examples of preliminary indicators identified in the NCCAP food security strategic theme are shown in Table 29.

Table 29: Preliminary indicators in NCCAP food security strategic theme

Outcome	Output	Indicators
Immediate outcome 1: Enhanced resilience of agriculture and fisheries production and distribution systems from climate change	Enhanced knowledge on the vulnerability of agriculture and fisheries to the impacts of climate change	Provincial level agriculture and fishery sector vulnerability and risk assessment conducted nationwide
	Climate-sensitive agriculture and fisheries policies, plans and programmes formulated	Climate change responsive agriculture and fisheries policies, plans and budgets developed and implemented
Immediate outcome 2: enhanced resilience of agriculture and fishing communities from climate change	Enhanced capacity for climate change action and disaster risk reduction of government, farming and fishing communities and industry	Number of farmers and fisherfolk communities trained on adaptation best practices

Source: GIZ (2017a)

Box 8 provides a second country-level example, Morocco, whose M&E system was piloted in its most vulnerable sectors (water, agriculture and biodiversity/forests). Morocco has implemented a unique M&E system whereby the government monitors regionally and tracks changes in vulnerability, outcomes (by measuring the impacts of adaptation interventions) and processes (by tracking adaptation measures).

BOX 8

Morocco: adaptation monitoring as part of the Regional Environmental Information System[84]

During the development of its climate change policy, in 2010 the government of Morocco began decentralizing environmental policy planning with the introduction of the Environmental Charta. Regional Observatories on Environment and Sustainable Development (OREDDs) were then established in each region. The OREDDs are independent from the national-level ministry, the Environmental Department in the Ministry of Energy, Mines, Water and Environment. The OREDDs are responsible for monitoring the environment in their regions using a regional environmental information system (SIRE) with support from the Regional Network of Exchanging Environmental Information (RREIE), which is mainly composed of representatives from deconcentrated sectoral services who assist with sectoral data collection and communication.

Morocco's adaptation monitoring was integrated into this existing system, the SIRE, which was a cost-efficient way to gather data through existing networks using already established intersectoral exchange platforms. SIRE was implemented in two regions in order to assess changes in vulnerability in key sectors (agriculture, water and biodiversity/forests), to help monitor adaptation interventions, and to contribute to the formulation of a regional climate change strategy. Indicators were developed using climate change impact and vulnerability chains from the GIZ vulnerability sourcebook (Fritzsche *et al.*, 2014/2017). These regional systems began monitoring changes in vulnerability, as well as monitoring process by tracking adaptation measures, and outcomes by measuring the impacts of adaptation interventions.

The following indicators relevant to the agriculture sector were chosen:

- To monitor process:
  - cultivated surface area with drought-resistant varieties;
  - forested areas covered by territorial plans;
  - number of farmers involved in pilot irrigation services.
- To monitor outcomes:
  - demand for water by sector;
  - share of additional fodder for grazing livestock;
  - poverty rate in rural areas.

During the second phase, the indicator development process incorporated a multistakeholder dialogue with OREDDs and representatives from the RREIE network. Only indicators for which data were already available were used, while others were classified into a B-list of indicators. This avoided high costs and allowed the system to become operational quickly. Since 2013, this approach has been applied across all of Morocco's 16 regions to inform municipal planning processes.

Source: GIZ (2017a)

3.4.2 DAS: Evaluation of the German Strategy for Adaption to Climate Change (2008–2015)

In 2008, the German Federal Cabinet adopted the German Strategy for Adaptation to Climate Change (DAS), which addressed sectors likely to be affected by climate change and proposed basic options to take action. In 2015, an initial progress report containing an indicator-based monitoring report was published (DAS, 2015).[85] The indicator system was created in an interdepartmental process involving numerous experts from federal agencies, scientific and private institutions. The indicator system, whose final version was agreed politically, contains 102 indicators, and a documentation system was developed to support the process of reporting and updating indicators and data sources.

The indicator system consists of climate change impact indicators, response indicators and cross-cutting indicators. The climate impact and response categories originate from the DPSIR approach (driving forces, pressure, state, impact, response) of the European Environment Agency (EEA, 1995), which has been commonly used to structure indicator systems. The climate impact category aims to capture the direct and indirect impacts of climate change, whereas the response category lists activities that support the adaptation process. In a broader interpretation, the DAS indicator system also considers developments that may run contrary to the adaptation process.

DAS addresses 13 action fields, one of which is agriculture, and two cross-sectional issues, outlining possible impacts of climate change, adaptation measures and basic action options (Table 30).

Table 30: DAS agriculture impact and response indicators

Agriculture impact indicators	Agriculture response indicators
• LW*-I-1: Shifting of agricultural-phenological phases • LW-I-2: Yield fluctuations • LW-I-3: Quality of harvested products • LW-I-4: Hail damage in agriculture • LW-I-5: Pathogens * LW: German abbreviation for agriculture.	• LW-R-1: Adaptation of management rhythms • LW-R-2: Cultivation and propagation of heat-loving crops • LW-R-3: Adjustment of the variety spectrum • LW-R-4: Corn varieties according to maturity groups • LW-R-5: Plant protection application • LW-R-6: Agricultural irrigation

Source: DAS (2015)

Strengths

- A fine example for the systematic development of a monitoring system to track the progress of a national adaptation strategy which could serve as an example for countries wishing to emulate this process (the DAS indicator system in the form of a tabular list, collection of indicator and data fact sheets documenting indicators and data sources, user manual for the indicator system and for updating the monitoring report, and a contact list for everyone who participated in the indicator project).
- The indicator and data fact sheets ensure reproducibility of indicators and their calculation and provide strengths and weaknesses of the indicator; fact sheets also determine who has responsibility for updates.
- Microsoft Excel-based system where the data fact sheets can be used to calculate indicator values with already embedded formulas.
- Definition of indicators was cross-checked with data availability and data already being gathered by government agencies and academia and order to reduce the necessary resources

Limitations

- The system focuses more on climate change impacts than on actual climate change adaptation
- There are only few adaptation response indicators per action field which do not present a complete picture of the status of adaptation
- The ongoing maintenance of the system requires time and resources. However it should be noted that a) this holds true for every M&E system, and b) a majority of data/indicators has already been monitored by government agencies, thus the indicators have been agreed upon; this means the ongoing resource needs are relatively small (mainly staff time). Data for indicators needed to be available in all relevant federal states (of which Germany has 16) in order to be considered for the final list.

4 Climate change vulnerability/risk indices

This chapter describes climate change vulnerability/risk indices relevant to adaptation. In general, the indices use several indicators from a number of different components such as vulnerability, adaptive capacity, readiness, exposure, and hazards, to compute an index that rates countries on their vulnerability to the effects of climate change. The indices are limited in their ability to inform the development of M&E frameworks or the development and selection of indicators. For example, it has been shown that countries rank very differently among different indices of climate vulnerability/risk (Leiter *et al.*, 2017).[86] However, the publicly available underlying data may be useful to practitioners because the datasets cover a large number of countries, contain time series that allow trends to be observed, and are collected, maintained and continuously updated by reliable organisations. The following presents five out of numerous available climate change vulnerability/risk indices.

4.1 Notre Dame-Global Adaptation Initiative (2015)

The Notre Dame-Global Adaptation Index (ND-GAIN) Country Index is a free open-source index,[87] which shows a country's current vulnerability to the disruptions that follow climate change, such as floods, droughts, heat waves, cyclones, and security risks. It also demonstrates country readiness to leverage private- and public-sector investment for adaptation actions.

Vulnerability: ND-GAIN compiled over 74 variables to form 45 core indicators to measure the vulnerability and readiness of 192 UN countries from 1995 to the present. To identify indicators that reflect climate vulnerability and adaptation readiness, the ND-GAIN team conducted a literature review and consulted scholars, adaptation practitioners and global development experts.

Readiness: ND-GAIN measures readiness by considering a country's ability to leverage investments to adaptation actions. This includes indicators on, amongst others, the ease of doing business, control of corruption, the rule of law and the level of education.[88]

ND-GAIN's framework breaks the measure of vulnerability into exposure, sensitivity and adaptive capacity,[89] and the measure of readiness into economic,[90] governance and social components.

The six sectors are food, water, health, ecosystem services, human habitat and infrastructure; each sector is represented by six indicators that represent three cross-cutting components (Table 31):

1. exposure of the sector to climate-related or climate-exacerbated hazards;
2. sensitivity of that sector to the impacts of the hazard;
3. adaptive capacity of the sector to cope or adapt to these impacts.

Table 31: ND-GAIN vulnerability indicators

Sector	Exposure component	Sensitivity component	Adaptive capacity component
Food	Projected change of cereal yields	Food import dependency	Agriculture capacity (fertilizer, irrigation, pesticide, tractor use)
	Projected population change	Rural population	Child malnutrition

Source: (ND-GAIN, 2015)[91]

Strengths

- The data selected that quantify the ND-GAIN indicators have the following features to ensure transparency, reliability and consistency:
  - available for a high proportion of UN countries;
  - contain a time-series so that changes and trends in country vulnerability and readiness can be tracked;
  - freely accessible to the public;
  - collected and maintained by reliable organisations that carry out quality checks on their data;
  - are transparent and conceptually clear.

Limitations

- The readiness indicators measure general investment readiness and are not specific to adaptation to climate change.
- Does not use the IPCC's Fifth Assessment Report (2014) framework on climate risk, but the previous (2007) one on vulnerability (for a difference and updated guidance see 3.2.3)
- This index does not provide guidance or tools to support the development of frameworks for M&E or the selection of indicators.

4.2 FERDI: Physical vulnerability to climate change index (2011)

The Fondation pour les études et recherches sur le développment international (FERDI) developed a Physical Vulnerability to Climate Change Index (PVCCI)[92] to measure climate shocks and country exposure to these shocks. The indicator combines ten components, five of which measure climatic shocks while five measure country exposure. The index was computed using data covering the past 60 years for 191 countries and territories (Guillaumont & Simonet, 2011). It was most recently updated in October 2018 using new climate data from CRU TS version 4.01 – University of East Anglia (Harris, Jones, Osborn and Lister, 2014).[93] Trends were recalculated for a longer period of time (1950–2016).

The rationale for the development of this index was the need for a vulnerability indicator to steer the allocation of adaptation finance. According to FERDI, adaptation allocation criteria should specifically reflect the adaptation needs of recipient countries. In creating this index their goal was to combine the allocation of resources for poverty reduction and adaptation to climate change consistently. The index attempts to capture a country's physical vulnerability independent of political will.

Strengths

- Data coverage is extensive (191 countries over 60 years).
- Some of the underlying vulnerability data could be used for vulnerability and ex-ante assessments.

Limitations

- Considers only physical components measured from observed trends in physical variables related to climate change and likely to have a socio-economic impact, but without using socio-economic data. Therefore, it differs from more general environmental vulnerability indices, which include resilience and policy components.

4.3 INFORM: Index for Risk Management (2015)

The Index for Risk Management (INFORM)[94] is a risk-assessment tool used to help understand and measure the risk of humanitarian crises and disasters in order to build resilience and better preparation and response (De Groeve, Poljanšek and Vernaccini, 2015). The results support management decisions and preparedness. INFORM was developed in response to recommendations by several organisations to improve the common evidence basis for risk analysis. The tool can be used at global, national or regional levels. It covers 191 countries at national level and the global INFORM model is comparable between countries. All data are publicly available.

The INFORM model is a composite index. The results are a risk profile for every country containing a value between 0 and 10 for the risk index and its underlying dimensions, categories, components and indicators. The final value of INFORM is calculated using a risk equation, a geometric average of the three risk dimensions with equal weights. The results come from 50 different indicators that measure three dimensions of risk: hazard and exposure, vulnerability and lack of capacity. Each dimension is then made up of risk categories such as natural hazards, and institutional capacity. These categories contain several components, which are sets of indicators that capture a specific topic such as earthquake, inequality, or governance. The indicators are open source, provide consistent and continuous global coverage and are potentially scalable from national to local level at annual or monthly frequency.

Strengths

- The model has global coverage and allows comparison between countries.
- The model is continuously updated.
- The methodology can compensate for a lack in data.
- It can be used to show trends because it is calculated with normalised indicators using fixed minimum and maximum values.

Limitations

- Because it is a composite index, the results are simplified.
- It does not cover the following:
    - extensive hazard events and sudden onset hazard events with a limited geographic extent (such as landslides, forest fires and volcanoes);
    - climate change risks that occur over longer timeframes.

4.4 Global Climate Change Alliance Plus Index (2015)

The Global Climate Change Alliance Plus (GCCA+) Indexis a climate-resilient development index developed by the Joint Research Centre (JRC) of the European Commission (JRC, 2015). It was designed to be consistent with the GCCA initiative objectives and the SDGs. It is publicly available and composed of 34 country-specific indicators on social, economic and environmental factors for climate-resilient development. The objective of the index is to provide information on vulnerability in order to inform national planning processes.

The 34 country-level indicators are categorized under four components: natural hazards, exposure, vulnerability, and capacity, as well as the subcomponents of demography, economic, environment, adaptive capacity, coping capacity, and mitigation capacity. The indicators are chosen based on their compliance with the following criteria: reliability, open source, consistency, scientific robustness, and global coverage. The components are aggregated by applying a mathematical formula to calculate the index.

Strengths

- Designed to be consistent with the SDGs.

Limitations

- Limited country applicability.
- Focused on vulnerability, used for planning purposes and not ex-ante.
- Not a fully-fledged framework or guidance tool for developing M&E framework or indicators.

4.5 Climate Vulnerability Monitor: a guide to the cold calculus of a hot planet (2012)

The Climate Vulnerability Monitor is a conceptual framework to assess vulnerability at national level (DARA, 2012).[95] The monitor contains 34 indicators for the economic, human and ecological effects of climate change and the carbon economy. Indexes behind each indicator allow the relative level of vulnerability for each country to be generated. Each indicator represents a separate grouped set of effects based on independent research and data sets. All effects have been unified using a common mathematical framework and assimilated into indexes that facilitate comparison and analysis between 184 countries.

Each index is based on mortality and/or GDP per capita data and captures climate change or carbon economy effects in isolation, except in the case of the environmental disasters impact area, which combines mortality and GDP to determine vulnerability level. Additional variables are provided for different indicators to allow a more complete understanding of the estimated impacts.

Two assessment reports, released in 2010 and 2012, used the analysis of the monitor detailing the human and economic costs of the climate crisis. These reports were commissioned by the Climate Vulnerable Forum, an international cooperation group established in 2009 for coordination, advocacy and knowledge building among 20 countries facing significant insecurity due to climate change. The second report improved upon the methodology and accuracy with an expanded set of indicators associated with specific economic sectors, such as agriculture, fisheries and forestry and specific resource, health, and environmental impacts. The first edition focused on the effect of "climate" while the second edition added a focus on "carbon", examining the socio-economic impacts of the carbon economy.

Strengths

- There is a complete methodological documentation with technical descriptions for each of its indicators.[96]
- The second edition of the monitor was significantly improved and more comprehensive than the first
- The studies include a description of impacts even given the high uncertainty for the sake of comprehensiveness. These give a fuller picture of potential climate impacts. Given the uncertainties inherent in any understanding and response to climate change, the public benefits by learning about a wide range of potential impacts.

Limitations[97]

- The monitor uses expert judgement and models to construct counterfactuals/baselines as it assumes that the impacts of climate change and the carbon economy are already affecting the system; this baseline is subject to bias and uncertainty, but it is necessary to estimate the impact of climate or carbon on levels of welfare.
- Results are limited by the emission scenario chosen, which for most indicators is not the highest available scenario.
- Several impacts (social and political) are not estimated in the analysis due to methodological difficulties or lack of reference studies.
- The monitor does not factor in the potential costs of future large-scale sudden impacts, nor does it consistently consider some more straightforward costs such as those in the agriculture sector.
- The larger-scale impacts assessed are considered to be more robust than the impacts of lesser macroeconomic significance.
- The study uses the equivalent of a direct-cost approach for estimations, viewing impacts as losses or gains to independent sectors or as discrete losses or gains for those directly affected; this does not account for subsequent gains or losses elsewhere in the system.

5

5 Mitigation frameworks and tools (abbreviated summary)

As mentioned in Section 1.1, for CSA Pillar 3 (mitigation), monitoring is referred to as monitoring, reporting and verification (MRV) under the UNFCCC process, where governments report on their national-level GHG emissions. Although this report is not exhaustive and focuses its review on frameworks addressing Pillar 2 (adaptation and resilience) to address the lack of consensus around common indicators, this short chapter outlines a sampling of frameworks and tools for monitoring GHG emissions in agriculture.

Monitoring and reporting of mitigation at national level is achieved via national GHG inventories. These are submitted annually to UNFCCC by developed countries (Annex I parties), whereas GHG emissions information is included more informally in biennial update reports (BURs) and national communications (NCs) to the UNFCCC by developing countries (non-Annex I parties).[98] Under the Kyoto Protocol (which is binding), GHG emissions reductions achieved through clean development mechanism (CDM) projects are reported using CDM methodologies (UNFCCC, 2018b).[99]

Some common methodologies and tools used for calculation, estimation and monitoring of GHG emissions are provided in Tables 32 and 33.

Table 32: Methodologies and tools for estimating GHG emissions for GHG inventories, projects, policies and actions

Name	Source	Description
2006 IPCC guidelines for national greenhouse gas inventories https://www.ipcc-nggip.iges.or.jp/public/2006gl/	IPCC	Provides general methodologies on data collection, uncertainty evaluation, and reporting for the agriculture, forestry and other land use (AFOLU) sector
Clean development mechanism (CDM) methodologies (started 2006) https://cdm.unfccc.int/methodologies/index.html	CDM	Provides baseline and monitoring methodologies for the calculation of GHG emissions reduction in projects
Estimating greenhouse gas emissions in agriculture: a manual to address data requirements for developing countries http://www.fao.org/3/a-i4260e.pdf	FAO	Manual offering stepwise guidance on estimating GHG emissions from AFOLU following the Tier 1 approach of the 2006 IPCC Guidelines for National Inventories and using FAOSTAT
GHG Protocol and GHG Protocol Agricultural Guidance, WRI (2014a, 2014b) http://ghgprotocol.org/ and https://ghgprotocol.org/sites/default/files/standards/GHG%20Protocol%20Agricultural%20Guidance%20%28April%2026%29_0.pdf	WRI	GHG Protocol provides greenhouse gas accounting standards as a framework for businesses, governments, and other entities to measure and report their greenhouse gas emissions (including the Corporate Value Chain (Scope 3) Standard, Mitigation Goal Standard and Policy and Action Standard (which includes agriculture-specific guidance)
Initiative for Climate Action Transparency (ICAT) Agriculture Guidance https://climateactiontransparency.org/icat-guidance/	WRI, Verra, UNEP-DTU Partnership	ICAT supports improved transparency and capacity building under the 2015 Paris Agreement with ten methodological guidance documents, which provide methods for assessing the potential impact of policies and actions to reduce greenhouse gas emissions, achieving sustainable development outcomes, and driving transformational change.
Verra, formerly verified carbon standard (VCS) methodologies https://verra.org/methodologies/	Verra	Verra develops and manages standards and frameworks to vet environmental and sustainable development efforts, build their capacity and connect them to funding. The verified carbon standard programme is the world's most widely used voluntary GHG programme.

Source: Adapted from NAMA tool,[100] FAO (2015c)

Table 33: Tools and GHG calculators

Tool/calculator	Source	Description
Ex-Ante Carbon Balance Tool (Ex-ACT) (emissions calculation) http://www.fao.org/tc/exact/ex-act-home/en/	FAO	ExACT is an appraisal system developed by FAO providing estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. It is a land-based accounting system that estimates carbon stock changes as well as GHG emissions per unit of land. The tool estimates economic and mitigation benefits to prioritize project activities in mitigation, sustainable land management, product intensification, food security, livestock, and land use change. It is aligned with IPCC categories and guidelines, and can be scaled up to use at programme/sector level and for policy analysis
Cool Farm Tool https://coolfarmtool.org/coolfarmtool/	Cool Farm Alliance	The Cool Farm Tool quantifies on-farm GHGs and soil carbon sequestration. It is farmer-focused and open-source. The estimates it provides are site-specific and management-sensitive
Global Livestock Environmental Assessment Model (GLEAM) http://www.fao.org/gleam/en/	FAO	GLEAM is a GIS-based framework that simulates biophysical processes and activities along livestock supply chains using a life cycle assessment approach with the aim of quantifying environmental impacts of livestock for the assessment of mitigation and adaptation scenarios
FAOSTAT Emissions Database http://faostat.fao.org/	FAO	Provides GHG emissions Tier 1 data for the AFOLU sector at global, regional and national levels

Source: ISO (2018)

Box 9 provides an overview of the International Organization for Standardization (ISO). ISO standards are used to quantify GHG emissions, but are also used for adaptation, finance and other climate change activities.

BOX 9

International Organization for Standardization

The International Organization for Standardization (ISO) is an independent, non-governmental organisation that provides a platform for developing standards and practical tools through common understanding and cooperation with all stakeholders. It also functions as a global network of national standards bodies with one member per country. ISO standards are used for a myriad of activities and processes, including in the GHG markets for cap-and-trade schemes, offsetting credits, carbon neutrality and low-carbon strategies and policies.

ISO has produced over 600 environmental-related standards, including the following key climate-related standards.

For quantifying GHG emissions These standards provide an internationally agreed framework for measuring GHG emissions, verifying claims and accrediting the bodies that carry out such activities to ensure accuracy and completeness.	· ISO 14064, Greenhouse gases · ISO 14065, Greenhouse gases – Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition
For mitigation and adaptation This standard sets out a framework and principles to make adaptation and mitigation schemes more compatible and elaborate on their different approaches	· ISO 14080, Greenhouse gas management and related activities – Framework and principles for methodologies on climate actions
For mitigation and adaptation (under development) Standards are under development to support the way organisations and communities adapt and become more resilient to climate change, including those for vulnerability assessment, adaptation planning and adaptation monitoring and evaluation.	· ISO 14090, Adaptation to climate change – Principles, requirements and guidelines · ISO 14091, Adaptation to climate change – Vulnerability, impacts and risk assessment · ISO 14092, GHG management and related activities: requirement and guidance of adaptation planning for organisations including local governments and communities
Financing climate change activities The standard aims to harmonize the definition of green bonds and specify requirements to evaluate the environmental performance of the assets they finance.	· ISO 14030, Green bonds – Environmental performance of nominated projects and assets
Monitoring climate change This ISO technical committee deals with standardisation in the field of digital geographic information. It collaborates, among other partners, with FAO on standards for satellite mapping and data acquisition and processing and with the World Meteorological Organization (WMO) on standards for meteorological and climatological data.	· This standard sets out a framework and principles to make adaptation and mitigation schemes more compatible and elaborate on their different approaches

6 Challenges

Climate change adaptation monitoring and evaluation (M&E) presents cross-cutting conceptual and methodological challenges that are starkly different from those encountered in M&E of climate mitigation activities (Leiter & Pringle, 2018; Leagnavar, Bours and McGinn, 2015; Spearman & McGray, 2011). First, there is no standard and universal metric to track adaptation like there is for mitigation with the CO_2eq of GHG emissions, and for this reason indicator development is fundamentally challenging. As FAO states, there is a need for frameworks and methodologies specific to agriculture that monitor and capture linkages between processes and outcomes in the agricultural sectors as well as their effects on food security and nutrition (FAO, 2017a), and which identify indicators for all three CSA pillars.

The literature addressing the development of these frameworks generally concurs on the most commonly encountered and significant challenges. Some of the challenges apply to indicators associated with all three CSA pillars, whereas others are more specific to the adaptation pillar. This chapter aims to explain these challenges.

6.1 Aggregation vs context-specific indicators/ comparisons (no one standardised indicator or "one size fits all" framework)

As mentioned, the first challenge elemental to the discussion is the lack of a universal standard indicator to track adaptation. Indicators are highly variable and diverse depending on the objectives of the assessment, the location, the project or action, stakeholder input, donor requirements and the larger goals of the project or programme. This makes the aggregation and comparison of results across different sectors, locations and time periods difficult.

The issue of aggregation vs context specificity is cited in most guidance documents and frameworks developed for adaptation M&E. Indicators should be context-specific because adaptation is highly intervention- and location-specific. However monitoring adaptation actions and outcomes at the local level proves difficult for aggregation to a regional, national or global level. Most frameworks monitoring adaptation outcomes (as opposed to processes) are conducted at project level rather than national level, leading to issues for aggregation and comparison unless identical indicators, weights, and scoring systems are used (Leiter, 2015).[101]

According to the report on the expert meeting on national adaptation goals/indicators and their relationship with the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction in October 2018 (UNFCCC, 2018a),[102] national governments emphasized the point that national adaptation M&E systems should include adaptation actions and information originating from subnational level in order to enhance comparability and standardisation. This would support a better understanding of M&E for adaptation across multiple levels. This meeting also demonstrated that governments have already started linking local M&E systems with national level progress assessments (see also Leiter, 2015). One example presented in this report is the Government of Morocco and its regional monitoring system (see Section 3.4.1).

There was early consensus that adding up indicators from the local level to compute an aggregate number was neither possible nor desirable (Hoffmaister, 2014).[103] In addition, experts have suggested that national-level assessments should measure aspects other than subnational and project-based assessments (Christiansen, Martinez & Naswa, 2018; UNFCCC, 2012).[104] It should be stated that measuring the degree of mainstreaming and coordination does not indicate whether adaptation has actually occurred. Adaptive capacity is only one part of what national adaptation M&E systems are expected to measure.

There is no "one size fits all" framework, although some of the donor funds have tried to create generic adaptation indicators and frameworks to support the selection and/or evaluation of projects. These include the UNFCCC Adaptation Fund (UNFCCC, 2015a), GEF's Adaptation Monitoring and Assessment Tool (AMAT) (GEF, 2014), Climate Investment Funds (CIF)'s PPCR Monitoring and Reporting Toolkit (CIF, 2015) with core indicators, and most recently the Green Climate Fund (GCF, 2018), which is currently finalizing its indicators in an attempt to align with other major climate finance mechanisms. However, there are clearly trade-offs to this more generic approach. Generic indicators facilitate aggregation and comparison across projects and locations, but exclusively using generic indicators makes difficult to accurately assess the true success of specific projects, which is why all of these funds now encourage or require project-specific indicators in addition to the generic ones.

The 2017 UNEP *Adaptation gap report* focused on the issue of aggregation in the context of the global stocktake under the 2015 Paris Agreement, which mandates reporting on collective progress. For the purposes of its report, UNEP interprets aggregation as the extent to which frameworks use indicators that are comparable, consistent, and comprehensive, with the potential for the country-level indicators to be aggregated globally. Achieving this will be far more difficult for adaptation than for mitigation, as countries interpret adaptation and adaptation needs based on their national and subnational circumstances. In the context of measuring progress on adaptation in the agriculture sector, the challenges are significant, albeit less so than for the global adaptation goal. As the UNEP report notes, the data that is collected and assessed at the project, programme and country level is diverse and cannot easily be scaled up or aggregated to assess progress at a global level. The Paris Agreement stipulates that adaptation efforts should be based on a country-driven approach, and Adger *et al.* (2007) note that "vulnerability to climate change is the result of place-specific impacts and sensitivities to risk, and to the socioeconomic and environmental systems that shape capacity to adapt". The UNEP report concludes with recommendations detailing seven steps to formulate assessment frameworks that can be used for both local and global needs.[105] There are different opinions on the contentious issue of how to review the adequacy and effectiveness of adaptation and progress on achieving the global goal on adaptation under the Paris Agreement. The main debate is whether to monitor on a national/subnational vs global basis.Some voice concerns over aggregating across countries given the methodological difficulties, and therefore argue in favour of national or subnational assessment. Others argue in favour of a global assessment of collective progress, while allowing recommendations to be given at country level (Christiansen, Martinez and Naswa, 2018).

It may be difficult to aggregate community-level programme indicators to higher scales or for national- or international-level programmes to capture the effectiveness of interventions at the individual or household level (Leagnavar, Bours and McGinn, 2015).[106] On the other hand, the IISD Climate Resilience and Food Security Framework (IISD, 2013)[107] attempts to marry the two, providing for an assessment of food security at household and community levels that is linked to national policy indicators.

6.2 Different objectives for monitoring and evaluation (M&E) of adaptation

Adaptation activities have been designed with different scopes and scales, and with a wide range of objectives for M&E. Some M&E frameworks directly address vulnerability or resilience, whereas others focus on risk reduction, or on the assessment of national adaptation plans (NAPs) or Climate-Smart Agriculture (CSA).[108]

These objectives for M&E can be conflicting because stakeholders have different requirements. Governments have to report at national level on SDGs, the Paris Agreement and the Sendai Framework. Donors require project/programme level of reporting. Communities, citizens, beneficiaries, and farmers are interested in monitoring at the local level, and in doing so minimally in order to provide a benefit to them while incurring as little cost as possible in terms of effort and time. When M&E is conducted to ensure that donor objectives are being met, efforts and resources are channelled into this type of verification rather than fostering learning, which can be very important during early implementation. Many argue that learning as an objective in and of itself should be valued. Villanueva (2011) suggests that indicator selection should be informed by the ADAPT principles: adaptive, dynamic, active, participatory, thorough.[109] These principles place a larger emphasis on learning and using a participatory approach than the more widely known SMART approach (i.e. specific, measurable, achievable, realistic, time-bound), and are arguably more effective at capturing the complexities of adaptation interventions (Leagnavar, Bours and McGinn, 2015).

6.3 Choosing types of indicator (process and outcome indicators, in particular)

Another challenge lies in choosing the appropriate types of indicator and finding the correct balance in order to achieve the objectives of the assessment. As discussed in the "data challenges" section below, costs for data collection, analysis, reporting, and maintenance can be quite high. The total number of indicators should therefore be chosen in light of the M&E purpose and the resources needed to obtain data whilst also striving to cover all dimensions relevant to adaptation. The indicator types include input, process, output, outcome and impact-based. In general, it is most straightforward to monitor inputs, such as financial investments into adaptation interventions, but even this is not always straightforward. For example, the Multilateral Development Banks (MDBs) track financial flows for adaptation using a different methodology than used for mitigation.[110]

Outcome indicators determine whether an objective has been achieved. However, adaptation is not an outcome in and of itself, so process indicators are needed to measure progress towards the achievement of an outcome (Leagnavar, Bours and McGinn, 2015; Price-Kelly *et al.*, 2015). This is the only way in which to measure increased resilience, for example. It is often a challenge to find appropriate outcome indicators and the data for them. And outcome indicators are then often inadequate in measuring adaptation over longer timeframes because of the dynamic changes inherent to climate change. FAO suggests striking a balance between process and outcome indicators. Considering the difficulty associated with M&E of adaptation, and the fact that each type of indicator has advantages and disadvantages, it would be wise not to limit or choose between the two.

Additionally, the classification of indicators as either process or outcome indicators is challenging as there is no clear agreement in the literature on how this should be done (Chesterman and Ericksen, 2013).[111] As Bours, McGinn and Pringle (2014a, 2014b) point out, the distinction can depend on the programme objective. The authors provide the example that the "number of people trained" may be an outcome indicator if the programme objective is to conduct trainings, while it may be a process indicator if the programme objective is wider in its scope, such as capacity development.

There are indeed advantages and disadvantages of outcome and process indicators. Outcome indicators have the advantage of being more easily integrated with other policy objectives, more familiar to practitioners, and sector-specific; however they may also be above the sector level (e.g. total number of people considered to be better adapted in a country). However, they also carry the risk of being overly prescriptive on adaptation actions and may be inflexible with regard to the introduction of new information. Outcome indicators are often quantitative and require a robust set of data, whereas process indicators are often qualitative. Using qualitative indicators may entail a more complex and labour-intensive approach using surveys, and may also require expert judgement; however the use of expert judgement is inevitable and methods for this have been refined over more than 20 years. There are challenges associated with each approach.

6.4 Public vs private monitoring and evaluation (M&E) frameworks

Most frameworks have been developed by the public sector. There has indeed been recent progress on the development of frameworks by the private sector, including a framework by the World Bank on Climate-Smart Agriculture indicators,[112] the WBCSD Climate-Smart Agriculture Plan 2020, the WEF's New Vision for Agriculture involving 26 global partner companies, and Syngenta's Good Growth Plan (2018), which identifies linkages with the SDGs. However, certain impediments are already clear in the initial implementation of these initiatives, such as the reality that most private companies simply do not explicitly track activities essential to the monitoring of specific agricultural indicators standard to other frameworks (Vermeulen and Frid-Nielsen, 2017).[113] In many cases, these companies have not identified quantitative targets or indicators for resilience, leading to complications in harmonizing with other frameworks and data from the public sector. The progress in the private sector is a solid start, but more engagement is needed. It is also important to note, because governments are responsible for reporting on the SDGs and the Paris Agreement, that actions may be under-reported if private-sector activities are not taken into account. This challenge applies equally to CSA's adaptation and mitigation pillars.

6.5 Attribution

How do we determine whether particular outcomes occurred as a direct result of adaptation activities? Assessing attribution is very difficult, given that it is not often possible to establish a direct causal link, thus confirming that the outcome was successful due to the adaptation action and not to other external factors. In response, several frameworks have recommended focusing on contribution rather than attribution (Chesterman and Ericksen, 2013; Pringle, 2011; Price-Kelly *et al.*, 2015; Spearman and McGray, 2011; UNEP, 2018).

The biggest obstacle to establishing attribution is the limited knowledge about the interactions between climate and human systems, variability and prolonged timeframes (F. Bakhtiari, personal communication, 2019). It is difficult to assess attribution in light of these challenges. Countries are generally moving away from an isolated project focus and increasingly applying their adaptation efforts on multiscale and cross-sectoral strategies (Christiansen *et al.*, 2016).[114] Countries are also increasingly "mainstreaming", meaning that they are incorporating climate adaptation considerations into established development programmes or policies. Although mainstreaming is a move in the right direction, which aims to better and more widely integrate climate change adaptation, it may make attribution more challenging as it can be difficult to define the boundaries of adaptation activities and differentiate them from other development activities.

For example, due to its recently broadened understanding of development, the African Development Bank (AfDB) acknowledges the challenge of attributing development outcomes to a single development institution and posits three main reasons for this challenge: (1) development outcomes are a result of several external factors and actions by a multitude of actors and not just a specific intervention; (2) there is often a delay before development interventions show results; and (3) the data needed to assess outcomes are often lacking and expensive. The AfDB is addressing this obstacle by measuring the results of its interventions at the output level to assess those outputs that can be fully attributed to individual operations completed in the previous three years. The bank is the first MDB choosing to report only on its own contribution and not on the aggregate with co-financiers. The increase in the number of interventions co-financed with other partners means that reporting in the aggregate could raise the likelihood of double-counting and would not appropriately reflect the contributions. Therefore, the outputs are pro-rated to the level of AfDB support against total project costs (AfDB, 2017).[115] It is not always clear how to incorporate adaptation actions that have been "mainstreamed" into existing plans, policies and programmes into the respective M&E frameworks. These existing processes and M&E frameworks are not always sensitive to the need for long timeframes and a unified M&E system (Christiansen *et al.*, 2016). This may further complicate the issue of determining attribution.

The main tool used to determine attribution (or at least to attempt this) is the development of a theory of change, which then informs the entire M&E process. An in-depth analysis of evaluation and theory of change is beyond the scope of this report, but it is indeed worth noting that the most advanced efforts to evaluate adaptation rely on different theories of change.

6.6 Capacity/responsibility for maintaining monitoring and evaluation (M&E) systems, ownership and an emphasis on learning

As the World Resources Institute points out, further work is needed to gain a better understanding of how capacity building can reduce costs associated with stakeholder engagement and participation in M&E (Spearman & McGray, 2011).[116] The authors also make the distinction regarding "ownership" of M&E systems and processes, referencing bottom-up vs top-down systems. Bottom-up approaches reflect the priorities of local communities and governments while top-down methodologies reflect the needs of national governments and international stakeholders. WRI claims that these rarely intersect, leaving one group with a greater sense of ownership than the other. This too can affect several aspects of indicator and M&E development and the likelihood that capacity is developed to maintain these systems. Local communities will feel a greater sense of ownership if the framework produces results that are useful to them. The lack of ownership of top-down frameworks by communities is usually due to a perception that the outputs of the framework do not serve the interests of the community (F. Bakhtiari, personal communication, 2019).

It is worth noting that the responsibility for updating data as well as the frequency of these updates is an issue that must be resolved to ensure the sustainability of the M&E system. Additionally, hiring long-term personnel or at least ensuring there is some longevity and consistency with regard to staff overseeing data processes (and not a high turnover rate) can be a challenge with the allotted funds.

Frameworks that are inherently more participatory, such as community-based adaptation (CBA) frameworks (CARE in their CBA[117] and PMERL[118] frameworks), IISD's community-based risk-screening tool CRiSTAL (IISD, 2012),[119] and SHARP (FAO, 2015)[120] are focused on learning through M&E rather than results validation, and thus place a greater emphasis on inclusion and participation by local communities. Communities are involved upfront in the selection of indicators. They are not restricted by obligations to donor reporting frameworks, which allows them to tailor the system to their needs. Indicators are potentially more likely to be informed by the previously mentioned ADAPT principles (Villanueva, 2011).[121] Stakeholders engaged in operationalising these frameworks probably have a greater sense of investment in, responsibility for and commitment to their maintenance.

6.7 Tracking system-wide capacities across people, organisations, institutions and the enabling policy environment for country-driven climate action

The definition of adaptive capacity means "the ability of systems, institutions, humans and other organisations to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014). Therefore, enhancing the adaptive capacity sustainably also requires efforts of strengthening capacities through a system-wide approach across people, organisations, institutions and the enabling policy environment (FAO, 2017c). The monitoring of system-wide capacities therefore requires tracing changes in capacities across the "system" meaning people, organisations, institutions and the enabling environment around the following questions (FAO, 2015b):

- Are individuals applying knowledge that they acquired through a workshop?
- Are state and non-state organisations performing better to deliver services, or are multistakeholder platforms, cross-sectoral coordination mechanisms inclusively and effectively functioning?
- Are policies, regulatory and institutional frameworks aligned with national priorities and with country commitment in place to support the implementation of desired change processes?

More specifically for climate change and Climate-Smart Agriculture, the CSA sourcebook revised edition provides initial guidance in Section C1-4.3, "Monitoring capacities – How to identify, monitor and evaluate capacity development interventions for Climate-Smart Agriculture" (FAO, 2017c).[122]

6.8 Tracking co-benefits

There is no commonly agreed standard indicator to account for co-benefits associated with adaptation activities. The frameworks that track co-benefits are those that address CSA, such as the FAO *Climate-Smart Agriculture Sourcebook* (FAO, 2013) and *Addressing agriculture, forestry and fisheries in national adaptation plans (supplementary guidelines)* (FAO, 2017a), work by CCAFS such as the CSA Guide website, the CSA Compendium, the CSA Programming and Indicator Tool, the World Bank Report on Climate-Smart Agriculture Indicators, and the FAO EPIC programme (Ignaciuk, 2017). Private-sector frameworks are Syngenta's Good Growth Plan, the WBSCD Climate-Smart Agriculture Plan 2020 and the WEF New Vision for Agriculture. Additionally, community and household-level frameworks tend to focus on a more holistic view and assess co-benefits (SHARP, RIMA, RHoMIS) (see Annex III for comparative table). As GIZ points out, there are projects with an explicit adaptation focus as well as those with adaptation components and those with co-benefits for adaptation (GIZ, 2013a).[123] Adaptation interventions can exhibit a wide range of social, economic or mitigation benefits, some of which can be measured quantitatively while other cannot (Fan, Fei and McCarl, 2017). Frameworks designed with a specific goal of tracking co-benefits are better able to achieve this. Certain multilateral funds or other private/public-sector funds look for specific adaptation co-benefits when initially evaluating projects, such as sustainable development potential or technological spillover (Christiansen, Martinez and Naswa, 2018). In these cases, co-benefit indicators should be robust and well examined to ensure that projects are fairly considered. This also entails considering which specific co-benefits are applicable. For example, in the agriculture sector, co-benefits may change depending on the subsector (F. Bakhtiari, personal communication, 2019).

6.9 Baseline development

Baselines are constantly changing over time due to the dynamic nature and uncertainty of climate change and climate impacts. It is recommended to develop dynamic rather than static baselines and to update them continuously, which may

be resource-intensive. This also drives the need for increased indicator refinement over time (FAO, 2013). Because climate adaptation is cross-sectoral, it can be challenging to collect all the data needed to construct baselines because data may be located in different agencies, ministries and institutions. This can entail higher costs and additional human resources. It is especially resource-intensive to construct a baseline from scratch if one has not already been developed. Because the data used to develop a baseline for adaptation is not monitoring data and is instead obtained via expert judgement, there is increased emphasis on the question of the method.

6.10 Data challenges

6.10.1 High costs

Data collection can be labour-intensive and costly. Assessments of the costs for tracking adaptation must also consider the costs for repeated measurements and consistent monitoring over time. This is a very important and often prohibitive component to implementing a successful M&E system. The *Repository of adaptation indicators* (Hammill *et al*., 2014/2017) includes information on the relative cost of collecting required data.[124] According to GIZ, costs are related to factors such as the scope and size of the sample size needed for surveys, the scope of qualitative assessments, input requirements for interviews, whether there is an already established system to collect data and/or whether a baseline has already or still needs to be constructed. Another issue is the personnel assigned for these processes, and this is addressed below under the issue of capacity.

As mentioned above, adaptation efforts may involve actors at varying levels across multiple sectors. Different stakeholders may have different requirements, leading to the creation of multiple monitoring and information exchange systems. This inflates the costs of data gathering and analysis.

6.10.2 Data availability, access and ownership/institutional data management

Another issue is data availability, access and ownership. Many countries are lacking in the availability and quality of data. Countries and practitioners may also encounter challenges in finding publicly available sectoral data as access is sometimes restricted. In many cases, data sources are indeed free and open to the public, such as FAO data (FAOSTAT, FISHSTAT), OECD, UNCCD, World Bank, UNISDR, and data accessible via UNFCCC reporting mechanisms (national communications). In some cases, however, there may be complications in obtaining data from private entities, or in extracting information from raw data without the relevant tools and information, such as necessary algorithms.

It is preferable that countries rely on their own national data as much as possible for reporting to ensure country ownership (ESA, 2018).[125] However, even locating and accessing data within a national context can prove to be problematic. As FAO points out in its 2017 publication *Tracking adaptation in agricultural sectors*, adaptation tracking often requires combining data gathered for other purposes, which may result in a mismatch of data types according to methodology, format, spatial or temporal scale, or granularity.[126] For example, in the agriculture sector it can be difficult to determine where to obtain data. It may be that certain data are maintained or disseminated by the national statistical office, but perhaps a particular dataset is managed by the Ministry of Agriculture or the Ministry of the Environment. Adding to the challenge is the reality that sometimes these institutions do not communicate readily with each other or share information (UNFCCC, 2014).[127] This may create additional confusion regarding who is responsible for collecting, overseeing, disseminating and archiving certain data.

6.10.3 Multiple international reporting obligations

When developing indicators and frameworks, serious consideration should be given to easing the reporting burden on countries. There are three major international environmental agreements that mandate reporting: the 2015 Paris Agreement under the UNFCCC, the Sendai Framework, and the Sustainable Development Goals. The Sendai Framework's priority two, "Strengthening disaster risk governance to manage disaster risk", mentions agriculture under 28(b): For global and regional levels: "To achieve this, it is important to foster collaboration across global and regional mechanisms and institutions for the implementation and coherence of instruments and tools relevant to disaster risk reduction, such as for climate change, biodiversity, sustainable development, poverty eradication, environment, agriculture, health, food and nutrition and others, as appropriate" (UNISDR, 2009)[128] Streamlining these reporting processes would ease the burden and decrease financial and logistical costs for countries. Achieving this entails the alignment of methodologies, data collection and reporting on indicators with already established methodologies (GIZ, 2017d).[129] It is still early in this process as, for example, the development of methodologies is still underway for the SDGs. Only 93 out of 232 indicators are at a Tier 1 level, meaning that they have a defined methodology (United Nations Statistics Division, 2018). Rodriguez (2018) has identified the contributions of sustainable food systems to the SDGs. He has proposed a set of SDG targets and indicators that are CSA-related and divided them into two groups: group 1 is related to production and the sustainability of production activities of food systems; group 2 is related to consumption, food security and social well-being. Table 34 shows these SDG targets and Tier 1 indicators.

Table 34: SDG targets and Tier 1 indicators relating to CSA production and consumption aspects

SDG	SDG targets (Tier 1 indicators in parentheses) Group 1: Production Sustainability of production activities of food systems	SDG targets (Tier 1 indicators in parentheses) Group 2: Social aspects Food security and social well-being (consumption)
	Production, processing, distribution, use, environmental sustainability	Consumption, availability, access, stability, social well-being
SDG 1		1.1 (1.1.1); 1.2 (1.2.1); 1.5 (1.5.3)
SDG 2	2.a (2.a.2), 2.b (2.b.1)	2.1 (2.1.1); 2.2 (2.2.1, 2.2.2); 2.5 (2.5.1, 2.5.2);
SDG 3	3.9 (3.9.1, 3.9.2, 3.9.3)	3.1 (3.1.2); 3.2 (3.2.1, 3.2.2); 3.4 (3.4.1, 3.4.2);
SDG 4		4.2 (4.2.2)
SDG 6	6.4 (6.4.2); 6.5 (6.5.1); 6.a (6.a.1)	
SDG 7	7.2 (7.2.1); 7.3 (7.3.1);	7.1 (7.1.1, 7.1.2)
SDG 8	8.2 (8.2.1); 8.4 (8.4.2);	8.1 (8.1.1); 8.5 (8.5.2); 8.10 (8.10.1, 8.10.2); 8.a (8.a.1)
SDG 9	9.2 (9.2.1, 9.2.2); 9.4 (9.4.1); 9.a (9.a.1); 9.b (9.b.1)	9.1 (9.1.2)
SDG 10		10.a (10.a.1); 10.b (10.b.1)
SDG 11		11.b (11.b.1)
SDG 12	12.2 (12.2.2); 12.4 (12.4.1);	
SDG 13	13.1 (13.1.2)	
SDG 14	14.5 (14.5.1)	14.4 (14.4.1)
SDG 15	15.1 (15.1.1., 15.1.2); 15.2 (15.2.1); 15.4 (15.4.1, 15.4.2); 15.5 (15.5.1); 15.6 (15.6.1); 15.b (15.b.1)	
SDG 16		16.1 (16.1.1)
SDG 17	17.6 (17.6.2); 17.8 (17.8.1); 17.9 (17.9.1)	17.2 (17.2.1); 17.4 (17.4.1); 17.10 (17.10.1); 17.11 (17.11.1); 17.12 (17.12.1); 7.18 (17.18.3)

Source: Rodríguez (2018)[130]

As far as additional streamlining to facilitate monitoring and reporting, it would also behove countries to use previously existing national M&E systems where possible so that practitioners do not have to "reinvent the wheel".

6.10.4 Diversity of timeframes for assessment

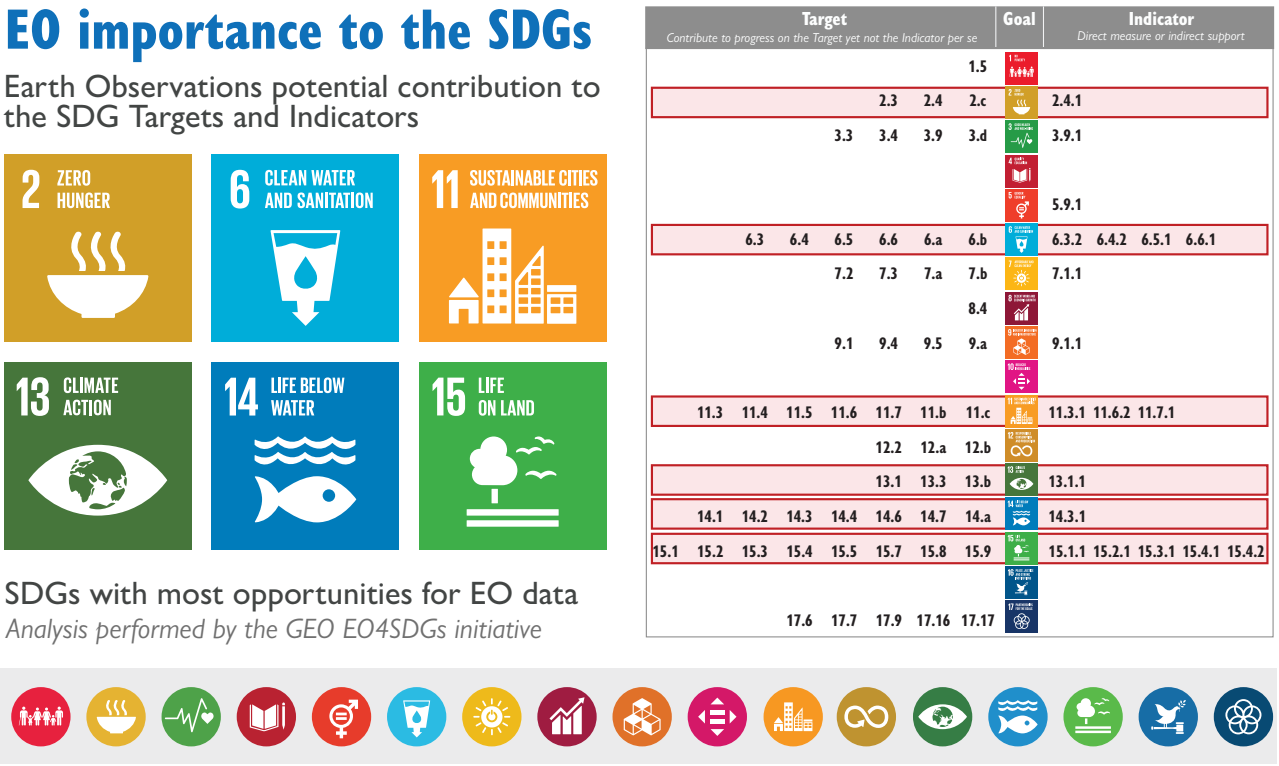
Related to the baseline issue is the need to address both the shorter and longer timeframes of impacts and adaptation. Climate change includes both impacts to be addressed immediately (in the form of changes that are occurring presently, extreme events, etc.) and those ensuing after a much longer timeframe. As FAO (2017c) points out, adaptive capacity encompasses both of these dimensions. Predicting long-term impacts is part of baseline development and is based on

assumptions which may change. Measuring long-term impacts, such as whether a true transformational change has taken place within a society, is often not possible until much later.

6.10.5 Challenges in the collection and dissemination of Earth Observation data

Increasingly, governments and organisations are relying on satellite data for monitoring. National statistical offices have begun implementing systems to integrate EO data with other data for official statistics and reporting on the SDGs. A major focus of EO data analysis is on deriving environmental and agricultural statistics (UNGWG, 2017).[131] A 2016 FAO *Global strategy for improving agricultural and rural statistics* technical report provides guidance on constructing a minimum set of core data (MSCD) that includes EO.[132] For example, EO are used to produce agricultural statistics such as the modelling of crop identification and crop yield , or to calculate statistics on land cover, land use and land use change. The collection and dissemination of EO data faces its own set of obstacles. The Group on Earth Observations (GEO) is an intergovernmental partnership that improves the availability, access and use of EO for a sustainable planet. GEO launched the Earth Observations for the Sustainable Development Goals (EO4SDGs) Initiative in 2016 to organise and realize the potential of Earth observations and geospatial information to advance the 2030 Agenda and achieve societal benefits through the SDGs. The European Space Agency (ESA) is a contributor supporting the effort to track 29 indicators under SDG targets that offer the most opportunities to use EO data. These targets and indicators are listed in Figures 4 and 5. They are not final, however, but a work in progress.

Figure 4: SDG targets and indicators with the highest potential to be informed by EO (work in progress)



Source: UNGWG (2018)

Figure 5: SDG targets and indicators with the highest potential to be informed by EO

Target *Contribute to progress on the Target yet not the Indicator per se*									Goal	Indicator *Direct measure or indirect support*				
						1.4	1.5		1.4.2					
					2.3	2.4	2.c		2.4.1					
				3.3	3.4	3.9	3.d		3.9.1					
							5.a		5.9.1					
	6.1	6.3	6.4	6.5	6.6	6.a	6.b		6.3.1	6.3.2	6.4.2	6.5.1	6.6.1	
				7.2	7.3	7.a	7.b		7.1.1					
							8.4							
				9.1	9.4	9.5	9.a		9.1.1	9.4.1				
					10.6	10.7	10.a							
11.1	11.3	11.4	11.5	11.6	11.7	11.b	11.c		11.1.1	11.2.1	11.3.1	11.6.2	11.7.1	
			12.2	12.4	12.8	12.a	12.b							
				13.1	13.2	13.3	13.b		13.1.1					
	14.1	14.2	14.3	14.4	14.6	14.7	14.a		14.3.1	14.4.1	14.5.1			
15.1	15.2	15.3	15.4	15.5	15.7	15.8	15.9		15.1.1	15.2.1	15.3.1	15.4.1	15.4.2	
							16.8							
17.2	17.3	17.6	17.7	17.8	17.9	17.16	17.17	17.18	17.6.1	17.18.1				

Source: UNGWG (2018)

The ESA cites the following obstacles that may impede the scaling up and operational use of Earth Observation data:

- restrictive data access policies (including cost);
- lack of "fit for purpose" products;
- lack of standardisation of EO data-processing methodologies;
- lack of analysis-ready data;
- difficulties in finding and accessing EO data;
- frequency of observations is insufficient to track changes at appropriate scales;
- lack of clear user-oriented methods and guidelines;
- need for continuity of observations over the long term.

Collect Earth is a free and open source software tool developed by FAO which enables data collection for land use and land cover assessment through Google Earth.[133] Using Google Earth, Bing Maps and Google Earth Engine, users can analyse satellite imagery to monitor agricultural land and urban areas, and to support land use and land use change and forestry assessments, validate existing maps, collect spatially explicit socio-economic data, and quantify deforestation, reforestation and desertification. Some of the challenges mentioned above regarding the use of EO data have been addressed in the development of Collect Earth. First, its user friendliness makes it easy to learn. It is also designed to perform fast, accurate and cost-effective assessments. Users can customize the tool to their specific methodologies and, importantly, they can export the data to commonly used formats and to a tool called Saiku[134] that facilitates data analysis.

6.10.6 Using "big" data

The recent entry of "big" data onto the scene introduces its own set of challenges. Discussions have begun regarding how to further exploit the use of big data in agriculture as more players start to use it. The data community has begun to develop a set of principles to guide the use of this data. For example, it is essential to follow the FAIR principles. The FAIR principles are four foundational principles – findability, accessibility, interoperability, reusability – that serve as "a guide for data producers and publishers and help to maximise the added-value gained by contemporary, formal scholarly digital publishing" (Wilkinson *et al.*, 2016). These principles provide guidance for scientific data management and stewardship, and directly address data producers and data publishers to promote maximum use of research data. They help practitioners to locate and access data more easily. The principles should apply not only to "data" in the conventional sense, but also to the algorithms, tools and workflows that led to those data.

- *Findable*: Data and supplementary materials have sufficiently rich metadata and a unique and persistent identifier.
- *Accessible*: Metadata and data are understandable to humans and machines. Data are deposited in a trusted repository.
- *Interoperable*: Metadata use a formal, accessible, shared and broadly applicable language for knowledge representation.
- *Reusable*: Data and collections have clear usage licenses and provide accurate information on provenance.

Annex I Glossary

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2014).

Adaptive capacity: The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014).

Attribution: The process of evaluating the relative contributions of multiple causal factors to a change or event with an assignment of statistical confidence (Hegerl *et al.*, 2010).

Baseline: The baseline is the state against which change is measured. A baseline period is the period relative to which anomalies are computed (IPCC, 2014).

Co-benefits: The positive effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on overall social welfare. Co-benefits are often subject to uncertainty and depend on local circumstances and implementation practices, among other factors (IPCC, 2014).

Data: Factual information (such as measurements or statistics) used as a basis for reasoning, discussion or calculation (Merriam Webster Dictionary).

Impact: Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended (OECD–DAC, 2002).

Impact indicator: An indicator that measures positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended (OECD–DAC, 2002).

Index: An indicator that maps (or aggregates) a vector of observable variables to one scalar theoretical variable (Hinkel, 2011).

Indicators: Quantitative or qualitative factors or variables that provide a simple and reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of a development actor (OECD–DAC, 2002).

Metrics: Standards of measurement by which efficiency, performance, progress, or quality of a plan, process, or product can be assessed (Business Dictionary) (often used synonymously with indicator).

Monitoring: A continuing function that uses the systematic collection of data on specified indicators to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress, the achievement of objectives, and progress in the use of allocated funds (OECD–DAC, 2002).

Outcome indicator: An indicator that measures the quantity of goods produced and services provided, as well as the efficiency of production and services (Horsch, 1997).

Process indicator: An indicator that measures the ways in which services and goods are provided (GIZ, 2013a).

Readiness (climate): The capacity to manage plan, implement and monitor climate finance and activities related to climate change (CCAFS, 2015).

Resilience: The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation (IPCC, 2014).

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity (IPCC, 2007).

Annex II General guidance documents on adaption monitoring and evaluation (M&E)

WRI/GIZ: Making adaptation count: concepts and options for monitoring and evaluation of climate change adaptation (2011)

The World Resources Institute (WRI) provides a thorough general framework for and overview of issues surrounding adaptation M&E systems, based on a series of case studies and interviews conducted in collaboration with German Corporation for International Cooperation (GIZ). The authors reviewed M&E systems in the planning and implementation stages for several GIZ and KfW Bankengruppe projects (Spearman and McGray, 2011).[135]

Adaptation in the development context can be broadly categorized by three types of efforts – community-based adaptation, programme- and project-based adaptation, and national policy initiatives. These efforts have evolved separately to meet specific needs, and authors argue that M&E systems should be tailored to meet these three categories to a certain extent.

They address finding the right balance of outcome and process indicators, citing advantages and disadvantages of each (Table 35).

Table 35: Outcome and process indicators for adaptation M&E systems

Outcome-based indicators	
Advantages	**Disadvantages**
• Most practitioners and governments are familiar with this approach • Sector-specific • Easier to link them with objectives in other areas	• Inflexible and may be too rigid on adaptation options • Cannot measure certain components of adaptation, which are more process-oriented along a much longer time frame
Process-based indicators	
Advantages	**Disadvantages**
• Flexible approach • Can account for new information • Ultimately necessary to assess aspects of adaptation such as increased resilience and decreased vulnerability • Can help to indicate whether a project is on track even if it is not possible to determine the outcome given the long time frame	• Unfamiliar approach for practitioners • Not likely to be sector-specific • Difficult to integrate with objectives in other areas • Cannot measure the success of the final outcome

Sources: Spearman and McGray (2011); Bours, McGinn and Pringle (2014c)

The underlying reasons for the struggle in finding this balance, the authors claim, are the tensions inherent in determining the purpose of conducting M&E in the adaptation context. They cite the following as key tensions:

- *Learning vs accountability*: Meeting certain protocols and standards is often not conducive to a learning process for those engaged in the project
- *Definition of effective adaptation in terms of project vs outcome*: These approaches can be quite different in how they measure success. Other references have claimed (FAO, 2017c) that tracking agriculture adaptation needs to capture and assess both. However, the authors claim that limited resources lead to incomplete coverage of one or both.
- *Practical vs conceptual M&E approaches*: conceptual M&E approaches can be modelled upon tried and true approaches or practitioners can use untested theoretical frameworks.
- *Ownership of M&E*: bottom-up vs top-down approaches: bottom-up reflects the priorities of local communities and local governments, whereas top-down reflects the needs of national governments and international stakeholders. It is very rare that these intersect, and thus one ends up having more ownership of M&E than the other.

The authors provide generic recommendations and key questions for consideration on developing indicators for building adaptive capacity, implementing adaptation actions, and for sustained development. They cite various examples of indicators chosen for projects (pre-2010), including agriculture.

Strengths

- The guidance incorporates lessons learned from early adaptation efforts.
- The guidance develops the premise of the three dimensions of adaptation (adaptive capacity, adaptive actions, sustained development) and presents concrete guidance for each of the six steps towards adaptation-relevant M&E systems for use in developing countries.
- A thorough discussion of how to choose indicators, as well as the advantages and disadvantages of outcome- and process-based indicators is provided.

Limitations

- The authors acknowledge that the guidance is generic, and that it is limited to the intervention level; different methodologies may be needed to evaluate larger-scale national or sectoral adaptation activities.

Related to the WRI/GIZ publication is the GIZ guidebook *Adaptation made to measure* (2013a) which provides practical steps for project designers on how to operationalise the more theoretical WRI/GIZ publication. It also has an accompanying Microsoft Excel tool (MAAC) that can be used for data gathering and indicator reporting.[136]

UK Climate Impacts Programme (UKCIP) AdaptMe Toolkit (2011)

Formerly known as the UK Climate Impacts Programme, UKCIP is based at the Environmental Change Institute at the University of Oxford, UK. The purpose of the UKCIP Adapt MeToolkit[137] is to provide guidance on designing an evaluation of adaptation progress. It starts with a thorough explanation of the myriad reasons to conduct an evaluation and the different types of evaluation. The authors provide high-level conceptual information to support users in considering every angle and thinking through all potential options while designing an evaluation. They address the challenges and limitations in the establishment of metrics and indicators, stakeholders to involve, and how to communicate the findings of the evaluation.

Strengths

- At the end of each section, the authors provide boxes with "questions to consider" that are directly relevant to designing that particular part of the evaluation, as well as a list of additional resources for further information.
- The authors address the challenges that may be encountered when designing an evaluation by providing several different possible responses.
- Overall, the toolkit provides a thorough conceptual explanation of the components and challenges of developing an evaluation framework.

Limitations

- The guidance is very high level and does not provide specific steps to identifying indicators, nor does it provide a list of possible indicators.
- It also does not discuss any issues at sectoral level.

Villanueva, Learning to adapt (2011)

This paper describes the key challenges for M&E in adaptation and disaster risk management, compares methodological aspects, and presents a new set of principles to "facilitate the development of M&E frameworks for interventions that aim to contribute to integrated adaptation processes."

According to Villanueva, the three key issues that are common to the M&E of adaptation are:

- deterministic approaches focus on inputs/outputs not processes;
- most approaches remain static rather than dynamic;
- efficiency and effectiveness predominate as key principles.

Villanueva argues that recent M&E methodologies for adaptation are lacking a focus on learning and understanding how adaptation and adaptive capacity are developed. The author proposes that the development of M&E frameworks and in particular indicators for adaptation should be revised and refined using the ADAPT principles which emphasize process-based evaluations.

- *adaptive* (learning);
- *dynamic* (monitoring);
- *active* (contribute to building an evidence-based understanding to expand the currently limited understanding of adaptation decision-making);
- *participatory* (approaches for M&E);
- *thorough* (accounting for processes on a range of scales).

The ADAPT principles and indicators are intended to give practitioners a deeper understanding of the processes that may facilitate or constrain the capacity to adapt. However, the objective is not to increase the quantity of indicators but rather the quality of indicators.

Strengths

- The paper elucidates the issues in M&E of adaptation and disaster risk management and critically examines how these might be addressed by thinking through the specific purposes of M&E.

Limitations

- There is no concrete link between the ADAPT principles and indicator development on a sectoral level.

UNEP Programme of Research on Climate Change Vulnerability, Impacts and Adaptation[138] (PROVIA) (2013)

The UNEP Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) is a toolkit of methodological guidance for vulnerability, impacts adaptation assessment, and M&E of adaptation including an overview of a wide range of approaches and tools. The document gives generic guidance for five stages of the adaptation learning cycle:

1. identifying adaptation needs;
2. identifying adaptation options;
3. appraising adaptation options;
4. planning and implementing adaptation options;
5. monitoring and evaluation of adaptation.

PROVIA makes the following general recommendations for defining indicators:

- cost, complexity and/or timing may prevent a result from being measured directly; here, using proxy indicators is recommended;
- using disaggregated data;
- involving stakeholders in the development of indicators;
- distinguishing between quantitative and qualitative indicators;
- limiting the number of indicators.

Strengths

- The guidance takes a comprehensive approach from the planning stage through implementation and eventual monitoring and evaluation

Limitations

- The decision-tree framework does not distinguish between different purposes for adaptation M&E[139] and it does not consistently distinguish between monitoring and evaluation.
- The emphasis is not on developing indicators specifically, and the discussion on indicators is generic.

Guidance Note 1: Twelve reasons why climate change adaptation monitoring and evaluation (M&E) is challenging (2014)

This guidance document (Bours, McGinn and Pringle, 2014a) identifies, explains and offers strategies to address 12 challenges to M&E for climate change adaptation. As emphasized in several publications, the authors point out that adaptation is "a dynamic process that cuts across scales and sectors of intervention, and extends long past any normal project cycle".

The twelve main challenges to M&E for adaptation are the following:

1. Adaptation is not an objective or end point.
2. Long time frames stretch far beyond common programme cycles.
3. Uncertainties are inherent when implementing CCA interventions.
4. Measuring avoided impacts.
5. Diversity of key concepts and definitions.

6. Tracking a "moving target".
7. Climate change is global – but adaptation is local.
8. Adaptation spans multiple scales and sectors.
9. Assessing attribution versus contribution.
10. No one set of indicators or M&E approaches.
11. Causing harm: the "maladaptation" problem.
12. Conflicting purposes and fit: when "sustainable development" and adaptation are not interchangeable.

Strengths

- The paper identifies and offers responses for the main challenges for M&E in adaptation, which is useful from a theoretical level when designing M&E systems.

Limitations

- The paper does not delve too deeply into details on how to design indicators, as the purpose is to specifically address the overall challenges.

Guidance Note 2: Selecting indicators for climate change adaptation programming (2014)

This is a generic guidance document (Bours, McGinn and Pringle, 2014b)[140] following up Guidance Note 1. It provides, among other things, a good overview of how to choose indicators and the advantages and disadvantages of process vs outcome indicators. The authors recommend including more process indicators than outcome indicators because of the long time frames and number of uncertainties inherent to adaptation. As they point out, the significance of adaptation indicators is not what they tell us individually, but rather how they combine to measure an intervention's contribution on a larger scale. Thus a higher than normal number of process indicators should be used than in a more straightforward development programme. There are of course caveats to the use of process indicators as they do not assess whether objectives were achieved (defining a process does not guarantee successful adaptation).

Additionally, the authors warn that indicators should not be used as a short cut to gaining a deeper understanding of climate change adaptation. Adaptation programmes should be designed and evaluated within an analysis of the long-term, complex and dynamic context of climate change, and yet still be tailored to the local context.

Strengths

- The guidance provides a thorough discussion of logic models and of the development and use of indicators.

Limitations

- The guidance is generic and high level on how to design M&E frameworks and indicators, and does not provide examples or sector-specific information.

Annex III Comparative summary tables for monitoring and evaluation (M&E) frameworks

M&E FRAMEWORKS SPECIFIC TO AGRICULTURE

Framework/tool/guidance document	Year	Level/applicability (national, programme/project, private, community, household)	Indicator type (readiness, input, output, outcome, process, impact)	Strong on gender? (Y/N)	Number of indicators (if applicable)	Comments
FAO: Resilience Index Measurement and Analysis (RIMA I/II)	2008/2016	Household	Outcome/process	N	N/A	• Tracks co-benefits
WEF: New Vision for Agriculture	2009	Private sector	Outcome/process	Y	7 core; 2 optional core	• Tracks co-benefits
CARE: Participatory monitoring, evaluation, reflection and learning project for community-based adaptation	2011	Community	Outcome/process	Y	N/A	• Can be used as internal M&E and learning tool • Emphasis on participatory processes designed to support vulnerable and marginalised people • Can be resource- and time-intensive due to involvement of many stakeholders
CARE: Community-Based Adaptation Framework and Project Toolkit	2011	Community (also national, household)	Process/outcome (more focus on process, or measuring adaptive capacity)	Y	Household/individual: 66 Local government/community: 69 National-level: 60	
IISD: *CRiSTAL food security 2.0 user's manual*	2012	Community	Outcome/process	Y	N/A	• Possibility of applying only parts of tool (organised by modules) • Not a stand-alone vulnerability or risk-assessment tool
FAO: *Climate-Smart Agriculture sourcebook*	2013	All levels	Outcome/process	Y	N/A	• Addresses mitigation, co-benefits, and every aspect of CSA
IFAD: Adaptation for Smallholder Agriculture Programme (ASAP 1/2)	2013	Project	Outcome/process	Y	10	• ASAP 2 starting to link 10 indicators with SDGs
IISD: *Climate resilience and food security: a framework for planning and monitoring*	2013	Community	Outcome/process	Y	N/A	• Framework links assessment of food security at community levels to national policy indicators
WRI: *Indicators of sustainable agriculture: a scoping analysis*	2014	National	Outcome/process (categorized specifically here as *policy*, *practice* and *performance*)	N	Agriculture: 7 indicators across *policy*, *practice* and *performance* Soil health: 9 indicators across *policy*, *practice* and *performance*	• Not official framework; conducted as scoping exercise working towards development of environmental sustainability index
FAO: Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists (SHARP)	2015	Household	Outcome/process	Y	13 agro-ecosystem resilience indicator groups (based on Cabell and Oelofse's resilience indicators (2012)	• Tablet-based field data collection provides flexibility and gives immediate results • Note that short version of survey may take 1.5 hours to complete • Tool should be integrated with M&E system to take full advantage of information collected
World Bank Group: Climate-Smart Agriculture Indicators	2016	*CSA Policy Index:* National *CSA Technology and Practices Index:* Project *CSA Results Index:* Project	*CSA Policy Index:* Output/outcome/process *CSA Technology and Practices Index:* Output/outcome/process *CSA Results Index:* Output/outcome/process	Y	3 CSA indices: *CSA Policy Index*: 14 indicators, and 31 sub-indicators *CSA Technology and Practices Index*: 27 indicators *CSA Results Index*: 22 indicators	• Tracks co-benefits
FAO: *Addressing agriculture, forestry and fisheries in national adaptation plans (supplementary guidelines)*	2017	National	Output/outcome/process/impact	Y	N/A	• Provides information on cross-cutting issues and considers co-benefits and externalities • Stresses importance of gender-sensitive indicators
FAO: *Tracking adaptation in agricultural sectors*	2017	National (possibly local)	Output, outcome, process	Y	4 main indicator categories/16 indicator subcategories with 111 possible indicators	• Provides clear methodology and indicators for the agriculture sector
WBCSD: Climate-Smart Agriculture Action Plan 2020	2017	Private sector	Input/output/outcome/process	Y		• Tracks co-benefits
CSIRO: Rural Household Multi-Indicator Survey (RHoMIS)	2017	Household	Output/outcome and process	Y	10 main performance indicators with potential to add more	• Tablet-based tool can provide quick feedback
SYNGENTA: Good Growth Plan	2018	Private sector	Outcome/process	N	33	• Indicators link to CSA pillars and SDG reporting; tracks co-benefits
CGIAR–CCAFS: Best practices for monitoring adaptation to enhance food security	2013	National	Outcome/process/impact	N	N/A	
CGIAR–CCAFS: Climate readiness indicators	2015	National (subnational)	Readiness	N	31 indicator suggestions across 5 work areas	
CGIAR–CCAFS: *A monitoring instrument for resilience*	2015	National (all levels possible)	Outcome/process/impact	N	25 indicators across 3 main categories and 9 dimensions	• Not a stand-alone instrument; must be embedded within generic M&E system
CGIAR–CCAFS: CSA Guide website	2016	National (all levels possible)	Outcome/process	Y	9 indicator dimensions	• Addresses all aspects of CSA, including practices, systems approaches, implementation, funding, mitigation, co-benefits
CGIAR–CCAFS: *CSA Compendium. The scientific basis of Climate-Smart Agriculture. A systematic review protocol*	2016	Household	Outcome	Y	55 outcome indicators in 5 categories (agronomy, agroforestry, livestock, postharvest management, and energy systems)	• Assessed farm-level management practice contributions to all 3 CSA pillars (considers co-benefits); largest meta-analysis of agricultural practices to date
CGIAR–CCAFS: CSA programming and indicator tool	2016	National (all levels possible)	Readiness/outcome/process/impact	Y	378	• Microsoft Excel-based • Addresses all 3 CSA pillars (tracks co-benefits) • Provides concrete indicator recommendations as well as graphical visualization to help users to interpret results
FAO: Economic and Policy Analysis of Climate Change (EPIC) programme	2017	National (all levels possible)	Outcome/process	Y	N/A	• Addresses all 3 CSA pillars, tracks co-benefits

M&E FRAMEWORKS NOT SPECIFIC TO AGRICULTURE

Framework/tool/guidance document	Year	Level/applicability (national, subnational, programme/project, private, community, household)	For financing mechanism	For adaptation planning	Indicator type (readiness, input, output, outcome, process, impact)	Strong on gender? (Y/N)	Number of indicators (if applicable)	Comments
CIF: Pilot Program for Climate Resilience (PPCR) Monitoring and Reporting Toolkit	2015/2018	Project	X		Outcome/process	N	5 (core)	• In the overview of each core indicator, there is a section indicating the responsibilities of various actors for monitoring and reporting
DAS: *Evaluation of the German Strategy for Adaption to Climate Change*	2008 (strategy), 2015 (evaluation)	National (country-level case)	N/A	N/A	Impact (here, direct and indirect impacts of climate change)/Response (here, activities that support or are contrary to the adaptation process)/ Cross-cutting	N	102	• The indicator and data fact sheets explain the strengths and weaknesses of the indicators and indicate who has responsibility for updates • Framework uses Microsoft Excel-based system in which the data fact sheets can be used to calculate indicator values with already embedded formulas
IIED: Tracking Adaptation and Measuring Development (TAMD)	2011, 2014	National, local, project		X	Outcome/process	N	Track 1: 9 proposed indicators Track 2: 5 proposed indicators	• Framework can be used for planning and evaluation (ex-ante, ex-post)
UNFCCC: LDC Expert Group: *Technical guidelines for the national adaptation plan process*	2012	National		X	Process (mainly)	N	N/A	• Provides a flowchart of responsibilities for each step in the process
GIZ &IISD: *Guidebook for the development of national adaptation M&E systems*	2015	National		X	Output/outcome/process	Y	N/A	• Proposes four building blocks and related questions to guide the development of national adaptation M&E systems • Done in collaboration with the LEG and the Adaptation Committee to supplement the NAP technical guidelines
World Bank: *Operational guidance for monitoring and evaluation (M&E) in climate and disaster resilience-building operations*	2013/2017	Project	X		Output/outcome/process	Y	N/A	• The framework gives both "core" evaluation considerations and "resilience-specific considerations" for each step in the evaluation section
Philippines: National Climate Change Action Plan (NCCAP) Results-based Monitoring and Evaluation System	2013	National (country-level case)	N/A	N/A	Output/outcome	N	N/A	• Climate Change Vulnerability Indices (CCVI) are based on a set of common or "core" indicators for measuring local vulnerability and adaptation based on the NCCAP's seven strategic priorities, one of which is food security
Morocco: Adaptation monitoring as part of the Regional Environmental Information System	2013	National (country-level case)	N/A	N/A	Outcome/process	Y	N/A	• Morocco integrated adaptation monitoring into an existing system, the regional environmental information system (SIRE), which was a cost-efficient way to gather data through existing networks using already established intersectoral exchange platforms. SIRE was implemented in two regions first and then extended to all sixteen.
GEF: LDCF/SCCF Adaptation Monitoring and Assessment Tool (AMAT)	2014	Project	X		Outcomes (old framework also monitored outputs)	Y	N/A	• The revised tool is designed to be more consistent with the results frameworks and logic models of other funds (Adaptation Fund, Pilot Program for Climate Resilience (PPCR), and Green Climate Fund), and uses qualitative scoring methodologies in addition to quantitative units of measurement • Incorporates the GEF corporate gender indicators
GIZ: *Vulnerability sourcebook (risk supplement)*	2014/2017	National/subnational/ community		X	Outcome	Y	N/A	• Contains stepwise guidance on creating a preliminary and final list for exposure, sensitivity and adaptive capacity indicators • Applicable to a range of time frames
UNFCCC Adaptation Fund: *Results framework and baseline guidance*	2015	Project		X	Output/outcome/process	Y	26 (core indicators)	
UNFCCC LDC Expert Group: PEG M&E Tool to formulate and implement national adaptation plans	2015	National		X	Input/output/ Outcome/process/impact	N	23 recommended metrics (5 process metrics, 5 input metrics, 5 output metrics, 5 outcome metrics and 3 impact metrics	• A case study is provided for each of the five types of metrics
GIZ: *Adaptation made to measure*	2013	Project		X	Process/outcome	N	N/A	• Proposes a theory of change approach as basis for indicator development • Results-based monitoring closely related to participatory project design
GIZ: *Repository of adaptation indicators*	2014/2017	National/subnational		X	Outcome/process	Y	33 (agriculture)	• Accompanied by a Microsoft Excel file with useful information on each indicator • Rates the cost of data collection for each indicator
GCF: Green Climate Fund	2018	Project	X		Outcome/process	Y		• GCF has further developed indicators to better align with other climate finance mechanisms

Annex IV Additional readings

Footnote 1: The title Dare to Understand and Measure (DaTUM) is inspired by Immanuel Kant, who used the Latin phrase sapere aude! meaning "dare to know". In his 1784 essay, "What is Enlightenment", he wrote about the courage to use one's own intelligence: "Dare to know. Have the courage to use your own understanding". Another inspiration is from Peter Drucker who has been described as "the founder of modern management" and who stated, "What you cannot measure, you cannot manage". ↗

Footnote 2: https://onlinelibrary.wiley.com/doi/full/10.1002/ev.20127 ↗

Footnote 3: SDG tier classification definitions are as follows: Tier 1 – indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 percent of countries and of the population in every region where the indicator is relevant; Tier 2 – indicator is conceptually clear, has an internationally established methodology and standards are available, but data are not regularly produced by countries; Tier 3 – no internationally established methodology or standards are yet available for the indicator, but methodology/standards are being (or will be) developed or tested. These are decided by the Inter-Agency and Expert Group on SDG indicators, a body created by the United Nations Statistical Commission in 2015 with the mandate of developing and implementing the global indicator framework. ↗

Footnote 4: The first steps are to classify the sustainable/not sustainable farms and their associated agricultural area according to the established criteria for each sub-indicator. Then the total agriculture area for each sustainability status is calculated according to the classification of farms/agricultural area for a given subsector. ↗

Footnote 5: http://www.fao.org/3/ca1796en/CA1796EN.pdf ↗

Footnote 6: The data domains are: enteric fermentation, manure management, rice cultivation, synthetic fertilizers, manure applied to soils, manure left on pasture, crop residues, cultivation of organic soils, burning of crop residues and burning of savannah. ↗

Footnote 7: 2017 updates of factsheets on national adaptation M&E systems. https://www.adaptationcommunity.net/monitoring-evaluation/national-level-adaptation/examples-of-national-me-systems/ ↗

Footnote 8: INDCs were "intended" because they were published during the lead-up to COP 21 in December 2015. Once the Paris Agreement was ratified, INDCs became NDCs. ↗

Footnote 9: Benin, Burkina Faso, Comoros, Democratic Republic of the Congo, Lesotho, Mauritania, Morocco, Mozambique, Seychelles, South Africa, Zimbabwe; Bangladesh; Chile, Colombia; Moldova (GIZ, 2017c). ↗

Footnote 10: http://www.fao.org/docrep/018/i3325e/i3325e.pdf ↗

Footnote 11: https://www.wri.org/sites/default/files/wrr_installment_6_sustainable_agruiculture_indicators.pdf ↗

Footnote 12: http://www.fao.org/3/a-i6714e.pdf ↗

Footnote 13: http://www.fao.org/3/a-i4940e.pdf ↗

Footnote 14: https://napmooc.uncclearn.org/ ↗

Footnote 15: http://www.fao.org/3/a-i8145e.pdf ↗

Footnote 16: http://www.fao.org/in-action/epic/en/ ↗

Footnote 17: https://ccafs.cgiar.org/publications/monitoring-adaptation-enhance-food-security-survey-approaches-and-best-practice#.W9iQnmhKjcs ↗

Footnote 18: See p. 36: https://ccafs.cgiar.org/publications/monitoring-adaptation-enhance-food-security-survey-approaches-and-best-practice#.W9iQnmhKjcs ↗

Footnote 19: https://cgspace.cgiar.org/rest/bitstreams/66493/retrieve ↗

Footnote 20: https://ccafs.cgiar.org/publications/monitoring-instrument-resilience#.W9iQw2hKjcs ↗

Footnote 21: https://csa.guide/csa/monitoring-evaluation-and-learning ↗

Footnote 22: https://cgspace.cgiar.org/bitstream/handle/10568/75542/Participatory%20CSA_ICRAF_Final.pdf

Footnote 23: https://ccafs.cgiar.org/csa-programming-2and-indicator-tool#.WT7e7usrJhE%20CSA

Footnote 24: http://documents.worldbank.org/curated/en/187151469504088937/pdf/105162-WP-P132359-PUBLIC-CSAIndicatorsReportweb.pdf

Footnote 25: http://documents.worldbank.org/curated/en/187151469504088937/pdf/105162-WP-P132359-PUBLIC-CSAIndicatorsReportweb.pdf

Footnote 26: https://webapps.ifad.org/members/eb/122/docs/EB-2017-122-R-44.pdf

Footnote 27: https://webapps.ifad.org/members/eb/122/docs/EB-2017-122-R-44.pdf

Footnote 28: https://www.weforum.org/projects/new-vision-for-agriculture

Footnote 29: AgCo, Archer Daniels Midland, BASF, Bayer CropScience, Bunge, The Coca-Cola Company, Diageo, DuPont, General Mills, Heineken, Kraft Foods, Metro, Monsanto Company, Maersk, Mosaic, Nestlé, PepsiCo, Rabobank International, SABMiller, Swiss Re, Syngenta, Teck Resources, Unilever, Vodafone, Wal-Mart Stores, Yara International.

Footnote 30: Grow Africa countries include: Benin, Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda, Senegal, United Republic of Tanzania. Grow Asia countries include: Cambodia, Indonesia, Myanmar, the Philippines, Viet Nam. Other countries are Mexico, India, possibly Brazil and Nicaragua.

Footnote 31: https://docs.wbcsd.org/2017/11/WBCSD_Climate_Smart_Agriculture-Action_Plan_2020-MidTermReport.pdf

Footnote 32: GACSA is an inclusive, voluntary and action-oriented multistakeholder platform on Climate-Smart Agriculture with a vision to improve food security, nutrition and resilience in the face of climate change and to catalyse and help to create transformational partnerships to encourage actions that reflect an integrated approach to the three CSA pillars (agricultural productivity, adaptation, mitigation).

Footnote 33: http://www.fao.org/3/a-bl914e.pdf

Footnote 34: https://ccafs.cgiar.org/fr/node/54321#.W9LlyGgzbcs

Footnote 35: Full list of the 200+ WBCSD member companies: https://www.wbcsd.org/Overview/Our-members

Footnote 36: https://www.syngenta.com/what-we-do/the-good-growth-plan

Footnote 37: https://careclimatechange.org/tool-kits/cba-framework/

Footnote 38: Full list of indicators by level and strategy: https://careclimatechange.org/wp-content/uploads/2015/04/CBA_Framework.pdf

Footnote 39: https://careclimatechange.org/wp-content/uploads/2014/12/2014_PMERL.pdf

Footnote 40: https://www.iisd.org/sites/default/files/publications/cristal_food_security_manual_en.pdf

Footnote 41: https://iisd.org/sites/default/files/publications/adaptation_CREFSCA.pdf

Footnote 42: http://www.fao.org/3/a-i5665e.pdf

Footnote 43: http://www.fao.org/3/a-i4495e.pdf

Footnote 44: https://www.cifor.org/ebf/wp-content/uploads/sites/32/2017/pubs/CSAsystematicmapprotocol.pdf

Footnote 45: https://www.rhomis.org/

Footnote 46: https://www.climateinvestmentfunds.org/sites/cif_enc/files/ppcr_mr_toolkit_july_2018_1.pdf

Footnote 47: Bangladesh, Bhutan, Bolivia (Plurinational State of), Cambodia, Caribbean Region, Dominica, Ethiopia, the Gambia, Grenada, Haiti, Honduras, Jamaica, Kyrgyzstan, Madagascar, Malawi, Mozambique, Nepal, Niger, Pacific Region, Papua New Guinea, the Philippines, Rwanda, Samoa, Saint Lucia, Saint Vincent and the Grenadines, Tajikistan, Tonga, Uganda, Yemen and Zambia.

Footnote 48: Climate Funds Update: https://climatefundsupdate.org/pilot-program-for-climate-resilience/

Footnote 49: http://documents.worldbank.org/curated/en/692091513937457908/pdf/122226-ReME-Operational-Guidance-Note-External-FINAL.pdf

Footnote 50: Appendix 1: An illustrative list of climate and disaster resilience-related results indicators from World Bank investment operations (World Bank, 2013).

Footnote 51: https://www.thegef.org/documents/gef-climate-change-adaptation-tracking-tool

Footnote 52: As defined by the COP: (a) to reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience; and (b) to facilitate the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels, as appropriate (decision 5/CP.17, paragraph 18).

Footnote 53: Climate Adaptation Knowledge Exchange: https://www.cakex.org/tools/adaptation-monitoring-and-assessment-tool-amat

Footnote 54: Score ranges from 1 to 5: 1 = no capacity built; 2 = initial awareness raised (e.g. workshops, seminars); 3 = substantial training in practical applications; 4 = knowledge effectively transferred (e.g. examination, certification); and 5 = ability to apply or disseminate knowledge demonstrated.

Footnote 55: https://www.greenclimate.fund/documents/20182/1087995/GCF_B.20_Inf.01_-_Update_on_the_further_development_of_some_indicators_in_the_performance_measurement_frameworks.pdf/42a9effc-f3eb-08de-a552-c689d8b56c3b; https://cdkn.org/wp-content/uploads/2017/06/GCF-project-development-manual.pdf

Footnote 56: https://www.adaptation-fund.org/wp-content/uploads/2015/01/Results%20Framework%20and%20Baseline%20Guidance%20final%20compressed.pdf

Footnote 57: For this step, the AF recommends using the Project Logical Framework, or log frame, which is a tool (logic model) for strategic planning. It graphically conceptualises the hypothesises cause-and-effect relationships of how project resources and activities will help to achieve objectives or results. Inputs are used to undertake project activities that lead to outputs (goods/services), which in turn lead to outcomes (first level or primary outcomes, second level or secondary outcomes, etc.) that contribute to a project impact and goal. It is then possible to configure indicators and targets, identify data sources and techniques, and assess assumptions for monitoring implementation and results

Footnote 58: The AF has developed a menu of 26 standard indicators to measure and report on fund-level outputs, outcomes and impacts, mostly at project output and outcome levels, to allow comparable data to be aggregated across similar types of projects to fund-wide level. The AF bases recommendations for indicator selection on CIDA's checklist of good indicators.

Footnote 59: https://ukcip.ouce.ox.ac.uk/wp-content/PDFs/SEA-Change-UKCIP-MandE-review-2nd-edition.pdf

Footnote 60: http://pubs.iied.org/pdfs/10031IIED.pdf (initial framework of 2011); guidebooks and country cases: https://www.iied.org/tracking-adaptation-measuring-development-tamd

Footnote 61: In Cambodia, the national adaptation M&E framework has corresponding sectoral indicators for agriculture, health and transport. http://pubs.iied.org/pdfs/10118IIED.pdf

Footnote 62: Examples for Cambodia and Kenya: http://pubs.iied.org/search/?k=tracking+adaptation+and+measuring+development

Footnote 63: http://www.braced.org/

Footnote 64: The Knowledge Manager Consortium includes the Red Cross Red Crescent Climate Centre, the Asian Disaster Preparedness Center, ENDA Energie, ITAD, Thomson Reuters Foundation and the University of Nairobi.

Footnote 65: https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9812.pdf

Footnote 66: https://unfccc.int/files/adaptation/cancun_adaptation_framework/application/pdf/naptechguidelines_eng_high__res.pdf

Footnote 67: http://www.adaptationcommunity.net/?wpfb_dl=268

Footnote 68: https://www.adaptationcommunity.net/vulnerability-assessment/vulnerability-sourcebook/

Footnote 69: http://www4.unfccc.int/nap/Documents%20NAP/50301_04_UNFCCC_Monitoring_Tool.pdf

Footnote 70: http://www.nap.edu/catalog/11292.html

Footnote 71: For more information on the ten essential functions, see p. 12 of the M&E tool: http://www4.unfccc.int/nap/Documents%20NAP/50301_04_UNFCCC_Monitoring_Tool.pdf

Footnote 72: https://gc21.giz.de/ibt/var/app/wp342deP/1443/wp-content/uploads/filebase/me/project-level-me/Climate_change_adaptation_indicator_list_-_GIZ_2013.xlsx

Footnote 73: The ten systems included in the analysis are France, Germany, Kenya, Mekong River Commission (MRC), Morocco, Nepal, Norway, the Philippines, Pilot Program for Climate Resilience (PPCR), and the United Kingdom (see also UNEP'S 2017 Adaptation gap report, Chap. 4). http://www.adaptationcommunity.net/?wpfb_dl=163

Footnote 74: https://www.adaptationcommunity.net/monitoring-evaluation/national-level-adaptation/examples-of-national-me-systems/

Footnote 75: https://www.fsb-tcfd.org/publications/tcfd-2018-status-report/

Footnote 76: The non-financial groups account for the largest proportion of GHG emissions, energy usage, and water usage.

Footnote 77: www.cdp.net

Footnote 78: https://www.globalreporting.org/standards/resource-download-center/linking-gri-and-cdp-how-are-gri-standards-and-cdp-climate-change-questions-aligned/

Footnote 79: www.globalreporting.org

Footnote 80: https://www.adaptationcommunity.net/monitoring-evaluation/national-level-adaptation/

Footnote 81: https://ccafs.cgiar.org/publications/climate-resilient-agriculture-philippines#.W-XAMpNKjcs

Footnote 82: Climate-Smart Agriculture Country Profile: https://ccafs.cgiar.org/publications/climate-resilient-agriculture-philippines#.W9h302hKjcs

Footnote 83: http://www.pdf.ph/downloads/Rural%20Development/Highlights%20of%20Meeting/23%20May%202013/attachments/03-Implementing%20Climate%20Smart%20Agriculture.pdf

Footnote 84: https://www.adaptationcommunity.net/wp-content/uploads/2017/11/05-giz2017-en-factsheet-morocco.pdf

Footnote 85: https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/neuclimate_change_16_2015_evaluation_of_the_german_strategy_for_adaption_to_climate_change_das.pdf

Footnote 86: https://www.adaptationcommunity.net/wp-content/uploads/2017/09/Policy-Brief_Measuring-vulnerability-through-global-indices-GIZ.pdf

Footnote 87: https://gain.nd.edu/

Footnote 88: https://gain.nd.edu/our-work/country-index/methodology/indicators/

Footnote 89: Exposure: The extent to which human society and its supporting sectors are stressed by the future changing climate conditions. Sensitivity: The degree to which people and the sectors they depend upon are affected by climate-related perturbations. The factors increasing sensitivity include degree of dependency on sectors that are climate-sensitive and proportion of populations sensitive to climate hazard due to factors such as topography and demography. Adaptive capacity: The ability of society and its supporting sectors to adjust to reduce potential damage and to respond to the negative consequences of climate events

Footnote 90: Economic readiness: The investment climate that facilitates mobilizing capitals from the private sector. Governance readiness: The stability of the society and institutional arrangements that contribute to the investment risks. A stable country with high governance capacity reassures investors that the invested capitals could grow with the help of responsive public services and without significant interruption. Social readiness: Social conditions that help society to make efficient and equitable use of investment and yield more benefit from the investment.

Footnote 91: https://gain.nd.edu/assets/254377/nd_gain_technical_document_2015.pdf

Footnote 92: http://www.ferdi.fr/en/indicator/index-physical-vulnerability-climate-change

Footnote 93: http://dx.doi.org/10.1002/joc.3711

Footnote 94: http://www.inform-index.org/

Footnote 95: https://daraint.org/wp-content/uploads/2012/09/CVM2ndEd-FrontMatter.pdf; methodology: https://daraint.org/wp-content/uploads/2012/09/CVM2_Methodology.pdf

Footnote 96: https://daraint.org/wp-content/uploads/2012/09/CVM2_Methodology.pdf

Footnote 97: https://daraint.org/wp-content/uploads/2012/09/METHODOLOGY-AND-DATA.pdf

Footnote 98: Countries also include adaptation information in BURs and NCs.

Footnote 99: https://cdm.unfccc.int/methodologies/documentation/1903/CDM-Methodology-Booklet_fullversion

Footnote 100: http://www.fao.org/3/a-i4642e.pdf

Footnote 101: https://onlinelibrary.wiley.com/doi/full/10.1002/ev.20135

Footnote 102: https://unfccc.int/sites/default/files/resource/ac14_indicators.pdf

Footnote 103: https://unfccc.int/files/adaptation/application/pdf/nap_expo_session_v_hoffmaister.pdf

Footnote 104: National-level assessments could measure the degree of coordination and integration of adaptation into national priorities.

Footnote 105: In summary, these are using standardised indicators, articulating assumptions underlying indicator choices, combining activity and results-based indicators, repeated and consistent data collection over time, providing examples of scoring criteria and guidelines for indicators, using theories of change, logic models to justify targets/baselines, focusing on contribution rather than attribution, involving stakeholders in the setting of national targets. For more information, see UNEP (2017). https://wedocs.unep.org/bitstream/handle/20.500.11822/22172/adaptation_gap_2017.pdf?isAllowed=y&sequence=1

Footnote 106: https://ukcip.ouce.ox.ac.uk/wp-content/PDFs/SEA-Change-UKCIP-MandE-review-2nd-edition.pdf

Footnote 107: https://www.iisd.org/sites/default/files/publications/adaptation_CREFSCA.pdf

Footnote 108: The different purposes of undertaking adaptation M&E and their implications for M&E methodologies are outlined in the Adaptation M&E Navigator (Leiter, 2017a). https://link.springer.com/chapter/10.1007/978-3-319-43702-6_18

Footnote 109: https://www.ids.ac.uk/files/dmfile/SilvaVillanueva_2012_Learning-to-ADAPTDP92.pdf

Footnote 110: For more information on MDB climate finance tracking and its complexities, see IADB (2017). https://publications.iadb.org/bitstream/handle/11319/9163/FINAL_2017%20j-MDB%20report%20on%20climate%20finance_Final.pdf?sequence=1&isAllowed=y

Footnote 111: https://ccafs.cgiar.org/publications/monitoring-adaptation-enhance-food-security-survey-approaches-and-best-practice#.W_gFoehKjcs

Footnote 112: The World Bank framework for CSA indicators includes a section which describes the behavioural changes needed for achieving the desired impacts of CSA interventions among six key stakeholder groups: (1) producers; (2) policy-makers and institutions; (3) extension workers; (4) consumers; (5) civil society; and (6) the private sector. The authors write: "Whereas the private sector agents often aim for profits and public perception, favorable behavioral change would include an enhanced interest in supporting CSA-related activities. These may come about by policy or regulatory incentives or by the design of a brand surrounding CSA. As markets and market engagement of smallholders become ever more important, it is relevant to provide outputs that change the private sector's behavior to support CSA."

Footnote 113: https://ccafs.cgiar.org/fr/node/54321#.W9LlyGgzbcs

Footnote 114: http://orbit.dtu.dk/files/157400902/MandE_challenge_guidance_note_01_07_16.pdf

Footnote 115: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/Final_-_RMF_-__Rev.2_Final_.pdf

Footnote 116: http://pdf.wri.org/making_adaptation_count.pdf

Footnote 117: https://careclimatechange.org/tool-kits/cba-framework/

Footnote 118: https://careclimatechange.org/wp-content/uploads/2014/12/2014_PMERL.pdf

Footnote 119: https://www.iisd.org/cristaltool/

Footnote 120: http://www.fao.org/in-action/sharp/en/

Footnote 121: https://www.ids.ac.uk/files/dmfile/SilvaVillanueva_2012_Learning-to-ADAPTDP92.pdf

Footnote 122: http://www.fao.org/climate-smart-agriculture-sourcebook/enabling-frameworks/module-c1-capacity-development/chapter-c1-4/en/

Footnote 123: https://www.adaptationcommunity.net/?wpfb_dl=52

Footnote 124: https://gc21.giz.de/ibt/var/app/wp342deP/1443/wp-content/uploads/filebase/me/project-level-me/Climate_change_adaptation_indicator_list_-_GIZ_2013.xlsx

Footnote 125: http://eohandbook.com/sdg/files/CEOS_EOHB_2018_SDG.pdf

Footnote 126: http://www.fao.org/3/a-i8145e.pdf

Footnote 127: A useful resource outlining the procedures for institutional arrangements for reporting obligations: https://unfccc.int/files/adaptation/application/pdf/adaption_commitee_publication_-_web_high.pdf

Footnote 128: https://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf

Footnote 129: https://www.adaptationcommunity.net/wp-content/uploads/2017/11/giz2017-en-cc-policy-brief-synergies-PA_SDG_SF.pdf

Footnote 130: https://repositorio.cepal.org/bitstream/handle/11362/42356/S1700886_es.pdf?sequence=1&isAllowed=y

Footnote 131: https://unstats.un.org/bigdata/taskteams/satellite/UNGWG_Satellite_Task_Team_Report_WhiteCover.pdf

Footnote 132: http://gsars.org/wp-content/uploads/2016/08/TR_Information-on-Land-in-the-Context-of-Ag-Statistics-180816.pdf

Footnote 133: http://www.openforis.org/tools/collect-earth.html

Footnote 134: https://www.meteorite.bi/

Footnote 135: http://pdf.wri.org/making_adaptation_count.pdf

Footnote 136: https://www.adaptationcommunity.net/monitoring-evaluation/project-level-adaptation-me/

Footnote 137: https://www.ukcip.org.uk/wp-content/PDFs/UKCIP-AdaptME.pdf

Footnote 138: https://www.adaptation-undp.org/sites/default/files/downloads/provia-guidance-nov2013.pdf

Footnote 139: For a critique of the PROVIA guidance approach to M&E, see Leiter (2017a): The Adaptation M&E Navigator. https://link.springer.com/chapter/10.1007/978-3-319-43702-6_18

Footnote 140: https://ukcip.ouce.ox.ac.uk/wp-content/PDFs/MandE-Guidance-Note2.pdf

Annex V Bibliography

Adger, W.N., Agrawala, S., Mirza, M.M.Q., Conde, C., O'Brien, K., Pulhin, J., Pulwarty, R., Smit, B. & Takahashi, K. 2007. Assessment of adaptation practices, options, constraints and capacity. In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E. Hanson, eds. *Climate change 2007: impacts, adaptation and vulnerability*, pp. 717–743. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, Cambridge University Press.

AfDB. 2017. *Results Measurement Framework, 2016–2025: Delivering the high 5s, increasing the bank's impact on development.* Abidjan, African Development Bank. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/Final_-_RMF_-__Rev.2_Final_.pdf

Bahadur, A.V., Peters, K., Wilkinson, E., Pichon, F., Gray, K. & Tanner, T. 2015. *The 3As: tracking resilience across BRACED*. London, Overseas Development Institute. https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9812.pdf

Bours, D., McGinn, C. & Pringle, P. 2013. *Monitoring & evaluation for climate change adaptation: a synthesis of tools, frameworks and approaches*. Phnom Penh, SEA Change Community of Practice, and Oxford, UKCIP. www.ukcip.org.uk/wp-content/PDFs/SEA-change-UKCIP-MandEreview.pdf

Bours, D., McGinn, C. & Pringle, P. 2014a. *Guidance Note 1: Twelve reasons why climate change adaptation M & E is challenging*. Phnom Penh, SEA Change Community of Practice, and Oxford, UKCIP. www.ukcip.org.uk/wp-content/PDFs/MandE-Guidance-Note1.pdf

Bours, D., McGinn, C. & Pringle, P. 2014b. *Guidance Note 2: Selecting indicators for climate change adaptation programming.* Phnom Penh, SEA Change Community of Practice, and Oxford, UKCIP. http://www.seachangecop.org/node/2806 https://ukcip.ouce.ox.ac.uk/wp-content/PDFs/MandE-Guidance-Note2.pdf

Bours, D., McGinn, C. & Pringle, P. 2014c. *Monitoring & evaluation for climate change adaptation and resilience: a synthesis of tools, frameworks and approaches*. 2nd edn. Phnom Penh, SEA Change Community of Practice, and Oxford, UKCIP. https://ukcip.ouce.ox.ac.uk/wp-content/PDFs/SEA-Change-UKCIP-MandE-review-2nd-edition.pdf

Bours, D., McGinn, C. & Pringle, P. 2015. Editors' notes. *Monitoring and evaluation of climate change adaptation.* A review of the landscape, 147: 1–12. https://onlinelibrary.wiley.com/doi/full/10.1002/ev.20127

Braimoh, A., Emenanjo, I., Rawlins, M.A., Heumesser, C. & Zhao, Y. 2016. *Climate-Smart Agriculture indicators*. Washington, DC, World Bank Group. http://documents.worldbank.org/curated/en/187151469504088937/Climate-smart-agriculture-indicators

Brooks, N., Adger, W.N. & Kelly, P.M. 2005. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change*, 15: 151–163.

Brooks, N., Anderson, S., Ayers, J., Burton, I. & Tellam, I. 2011. T*racking adaptation and measuring development.* IIED Climate Change Working Paper No. 1. London, International Institute for Environment and Development. http://pubs.iied.org/pdfs/10031IIED.pdf

Brooks, N., Aure, A. & Whiteside, M. 2014. Final report: assessing the impact of ICF programmes on household and community resilience to climate variability and change. London, Department for International Development, Evidence on Demand. vi + 96 pp. DOI: 0.12774/eod_cr.june2014.brooksetal

Business Dictionary. WebFinance, Inc. [online] http://www.businessdictionary.com/definition/html

Cabell, J.F. & Oelofse, M. 2012. An indicator framework for assessing agroecosystem resilience. *Ecology and Society*, 17(1): 18. http://dx.doi.org/10.5751/ES-04666-170118

CARE. 2011. *Framework of milestones and indicators for community-based adaptation*. Community-Based Adaptation Framework and Project Toolkit. Cooperative for Assistance and Relief Everywhere. https://careclimatechange.org/wp-content/uploads/2015/04/CBA_Framework.pdf

CARE. 2014. P*articipatory monitoring, evaluation, reflection and learning for community-based adaptation: PMERL. A revised manual for local practitioners*. https://careclimatechange.org/wp-content/uploads/2014/12/2014_PMERL.pdf

CCAFS. 2017. Climate-Smart Agriculture country profile. https://ccafs.cgiar.org/publications/climate-resilient-agriculture-philippines#.W9h302hKjcs

CCAFS & USAID. 2016. CSA Programming and Indicator Tool. CGIAR Research Program on Climate Change, Agriculture and Food Security. https://ccafs.cgiar.org/csa-programming-and-indicator-tool#.WT7e7usrJhE%20CSA

CGIAR–CCAFS. 2016. Consultative Group on International Agricultural Research, and Research Program on Climate Change, Agriculture and Food Security. CSA Guide website. https://ccafs.cgiar.org/csa-guide

Chen, C., Noble, I., Hellmann, J., Coffee, J., Murillo, M. & Chawla, N. 2015. *University of Notre Dame global adaptation index*. Technical Report. South Bend, Ind., USA, ND-GAIN.

Chesterman, S. & Ericksen, P. 2013. *Monitoring adaptation to enhance food security: a survey of approaches and best practice*. CCAFS Working Paper No. 51. Copenhagen, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://ccafs.cgiar.org/publications/monitoring-adaptation-enhance-food-security-survey-approaches-and-best-practice#.W9iQnmhKjcs

Christiansen, L., Schaer, C., Larsen, C. & Naswa, P. 2016. *Monitoring & evaluation for climate change adaptation: a summary of key challenges and emerging practice. Understanding, discussing and exemplifying the key challenges of M&E for adaptation*. Copenhagen, Technical University of Denmark. http://orbit.dtu.dk/files/157400902/MandE_challenge_guidance_note_01_07_16.pdf

Christiansen, L., Martinez, G. & Naswa, P. eds. 2018. *Adaptation metrics: perspectives on measuring, aggregating and comparing adaptation results*. Copenhagen, UNEP DTU Partnership. http://www.unepdtu.org/newsbase/2018/03/new-publication-on-adaptation-metrics-released?id=2ee1a180-9012-47a2-a50a-d5316246a814

CIF. 2018. PPCR Monitoring and Reporting Toolkit. Washington, DC, World Bank, Climate Investment Funds https://www.climateinvestmentfunds.org/sites/cif_enc/files/ppcr_mr_toolkit_july_2018_1.pdf

Craft, B. & Fisher, S. 2016. *Measuring effective and adequate adaptation*. London, International Institute for Environment and Development. http://pubs.iied.org/10171IIED/

CSIRO. 2017. *Rural Household Multi-Indicator Survey* (RHoMIS). Canberra, Commonwealth Scientific and Industrial Research Organisation. https://www.rhomis.org/

DARA. 2012. *Climate Vulnerability Monitor:a guide to the cold calculus of a hot planet*. https://daraint.org/wp-content/uploads/2012/09/CVM2ndEd-FrontMatter.pdf; Methodology: https://daraint.org/wp-content/uploads/2012/09/CVM2_Methodology.pdf

DAS. 2015. *Evaluation of the German Strategy for Adaption to Climate Change (DAS) – reporting and closing indicator gaps.* https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/neuclimate_change_16_2015_evaluation_of_the_german_strategy_for_adaption_to_climate_change_das.pdf

De Groeve, T., Poljanšek, K. & Vernaccini, L. 2015. Index for Risk Management – INFORM. Concept and Methodology Version 2016. Ispra, Italy, European Commission, Joint Research Centre. http://www.inform-index.org/

DFID. Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED). London, Department for International Development. http://www.braced.org/

Dikitanan, R., Grosjean, G., Nowak, A. & Leyte, J. 2017. *Climate-resilient agriculture in Philippines*. CSA Country Profiles for Asia Series. International Center for Tropical Agriculture (CIAT), Manila, Department of Agriculture, Adaptation and Mitigation Initiatives in Agriculture, Government of the Philippines. 24 pp.

Duong, M.T., Simelton, E. & Le, V.H. 2016. *Participatory selection of Climate-Smart Agriculture priorities*. CCAFS Working Paper No. 175. Copenhagen, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://ccafs.cgiar.org/publications/participatory-identification-climate-smart-agriculture-priorities#.XLNBm-hKjcs

EEA. 1995. Driving forces, pressure, state, impact, response of the European Environment Agency. *Europe's environment. The Dobris assessment*. State of the Environment Report No. 1/1995. Copenhagen, European Environment Agency. https://www.eea.europa.eu/publications/92-826-5409-5

ESA. 2018. *Satellite Earth Observations in support of the Sustainable Development Goals: the CEOS Earth Observation handbook special 2018 edition*. European Space Agency Committee on Earth Observations Satellites. http://eohandbook.com/sdg/files/CEOS_EOHB_2018_SDG.pdf

Fan, X., Fei, C.J.&McCarl, B.A.2017. Adaptation: an agricultural challenge. *Climate*, 5(3): 56. doi: 10.3390/cli5030056

FAO. 2008/2016. *RIMA–II: Resilience Index Measurement and Analysis–II*. Rome. 70 pp http://www.fao.org/3/a-i5665e.pdf

FAO. 2013. Climate-Smart Agriculture sourcebook. Rome. http://www.fao.org/docrep/018/i3325e/i3325e.pdf

FAO. 2015a. *Voluntary guidelines to support the integration of genetic diversity into national climate change adaptation planning*. Rome, FAO Commission on Genetic Resources for Food and Agriculture. http://www.fao.org/3/a-i4940e.pdf

FAO. 2015b. *Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists* (SHARP). Rome. 145 pp. http://www.fao.org/3/a-i4495e.pdf

FAO. 2015c. *Learning tool on nationally appropriate mitigation actions (NAMAs) in the agriculture, forestry and other land use (AFOLU) sector*. Rome. http://www.fao.org/3/a-i4642e.pdf

FAO. 2017a. *Addressing agriculture, forestry and fisheries in national adaptation plans (supplementary guidelines)*. Rome. http://www.fao.org/3/a-i6714e.pdf

FAO. 2017b. *Food security indicators*. Rome, Economic and Social Development Department. www.fao.org/economic/ess/ess-fs/ess-fadata/en/#.V-jxlvl96Uk

FAO. 2017c. *Tracking adaptation in agricultural sectors: climate change adaptation indicators*. Rome. http://www.fao.org/3/a-i8145e.pdf

FAO. 2018a. T*he Koronivia joint work on agriculture and the convention bodies: an overview*. Rome. http://www.fao.org/climate-change/resources/publications/en/

FAO. 2018b. *FAOSTAT online database*. http://faostat.fao.org/

FAO. 2019. *World food and agriculture statistical pocketbook 2018*. Rome. http://www.fao.org/3/ca1796en/CA1796EN.pdf

FAO PROSA. forthcoming. Third PROSA taskforce presentation, 6 December 2018, Rome.

FAO, UNDP & UNITAR. 2017. NAP-Ag massive open online course on National Adaptation Plans: Building Climate Resilience in Agriculture. FAO, United Nations Development Programme and United Nations Institute for Training and Research. https://napmooc.uncclearn.org/

Fayolle, V. and Odianose, S. 2017. *Green Climate Fund proposal toolkit 2017*. London, Acclimatise, and Climate and Development Knowledge Network.

Fritzsche, K., Scheiderbauer, S., Bubeck, P., Kienberger, S., Buth, M., Zebisch, M. & Kahlenborn, W. 2014/2017. *The vulnerability sourcebook: concept and guidelines for standardised vulnerability assessments*. Bonn and Eschborn, Deutsche Gesellschaft für Internationale Zusammenarbeit. www.adaptationcommunity.net/?wpfb_dl=203

GACSA. 2016. *Knowledge Action Group. Report from the sub-group on integrated planning and monitoring for Climate-Smart Agriculture. Global Alliance for Climate-Smart Agriculture*. http://www.fao.org/3/a-bl914e.pdf

GACSA. 2017. Minutes "Metrics for Climate-Smart Agriculture" Joint Workshop of the Investment, Knowledge, and Enabling Environment Action Groups of the Global Alliance for Climate-Smart Agriculture. Rome, FAO, 15 June 2017.

GCF. 2018. *Update on the further development of some indicators in the performance measurement frameworks*. Green Climate Fund. GCF/B.20/Inf.01. https://www.greenclimate.fund/documents/20182/1087995/GCF_B.20_Inf.01_-_Update_on_the_further_development_of_some_indicators_in_the_performance_measurement_frameworks.pdf/42a9effc-f3eb-08de-a552-c689d8b56c3b

GEF. 2012. *Climate change adaptation* – LDCF/SCCF Adaptation Monitoring and Assessment Tool. Washington, DC, Global Environment Facility. http://www.oecd.org/env/cc/48332185.pdf

GEF. 2014. *Updated results-based management framework for adaptation to climate change under the Least Developed Countries Fund and the Special Climate Change Fund. Washington*, DC. www.thegef.org/sites/default/files/council-meeting-documents/GEF-LDCF.SCCF_.17-05%2C_Updated_RBM_Framework_for_Adaptation_to_Climate_Change%2C_2014-10-08_4.pdf

GIZ. 2013a. *Adaptation made to measure. A guidebook to the design and results-based monitoring of climate change adaptation projects*. 2nd edn (also available in French and Spanish). Bonn and Eschborn, Deutsche Gesellschaft für Internationale Zusammenarbeit/German Corporation for International Cooperation. https://www.adaptationcommunity.net/?wpfb_dl=52

GIZ. 2013b. *Monitoring and evaluating adaptation at aggregated levels: a comparative analysis of ten systems*. Bonn and Eschborn, Deutsche Gesellschaft für Internationale Zusammenarbeit, and Winnipeg, Canada, International Institute for Sustainable Development. (also available in French and Spanish) https://www.climate-eval.org/sites/default/files/blogs/GIZ_2013-M%2BE_of_Adaptation_Comparative_analysis.pdf

GIZ. 2013c. *Monitoring and reporting (M&R) in the pilot program for climate resilience*. www.climateinvestmentfunds.org/sites/default/files/knowledge-documents/09-giz2013-factsheet-ppcr-low-res_0.pdf

GIZ. 2014/2017. *Morocco: adaptation monitoring and evaluation as part of the regional information systems*. https://www.adaptationcommunity.net/wp-content/uploads/2017/11/05-giz2017-en-factsheet-morocco.pdf

GIZ. 2017a. *Examples of national M&E systems*. Updated Factsheet series. (also available in French and Spanish) https://www.adaptationcommunity.net/monitoring-evaluation/national-level-adaptation/examples-of-national-me-systems/

GIZ. 2017b. *Is there a difference between MRV and M&E?* Presentation at Partnership on Transparency in the Paris Agreement (PATPA) Annual Retreat, 7 September 2017. T. Leiter, GIZ Climate Policy Team.

GIZ. 2017c. *The role of the NAP process in translating NDC adaptation goals into action linking NAP processes and NDCs*. http://www.adaptationcommunity.net/wp-content/uploads/2017/10/The-Role-of-the-NAP-Process-in-Translating-NDC-Adaptation-Goals-into-Action.-Linking-NAP-processes-and-NDCs.pdf

GIZ. 2017d. *Synergies in monitoring the implementation of the Paris Agreement, the SDGs and the Sendai Framework*. https://www.adaptationcommunity.net/wp-content/uploads/2017/11/giz2017-en-cc-policy-brief-synergies-PA_SDG_SF.pdf

GIZ & IISD. 2015. *Guidebook for the development of national adaptation M&E systems*. http://edepot.wur.nl/381254

GRI & CDP. 2018. *Linking GRI and CDP: how are the GRI sustainability reporting standards and CDP's 2017 climate change questions aligned?* Global Reporting Initiative and Carbon Disclosure Project. https://www.globalreporting.org/standards/resource-download-center/linking-gri-and-cdp-how-are-gri-standards-and-cdp-climate-change-questions-aligned/

GSARS. 2016. *Information on land in the context of agricultural statistics.* Global Strategy on Improving Agricultural and Rural Statistics Technical Report. http://gsars.org/wp-content/uploads/2016/08/TR_Information-on-Land-in-the-Context-of-Ag-Statistics-180816.pdf

Guillaumont, P. & Simonet, C. 2011. *Designing an index of structural vulnerability to climate change.* Clermont-Ferrand, France, Fondation pour les études et recherches sur le développement international (FERDI). http://www.ferdi.fr/en/indicator/index-physical-vulnerability-climate-change

Hammill, A., Dekens, J., Leiter, T., Olivier, J., Klockemann, L., Stock, E. & Gläser, A. 2014/2017. *Repository of adaptation indicators. Real case examples from national monitoring and evaluation systems*. Bonn and Eschborn, Deutsche Gesellschaft für Internationale Zusammenarbeit. (also available in Spanish) www.adaptationcommunity. net/?wpfb_dl=221

Hammill, A., Dekens, J., Olivier, J., Leiter, T. & Klockemann, L. 2013. *Monitoring and evaluating adaptation at aggregated levels: a comparative analysis of ten systems*. Bonn and Eschborn, Deutsche Gesellschaft für Internationale Zusammenarbeit, and Winnipeg, Canada, International Institute for Sustainable Development. (also available in French and Spanish) http://www.adaptationcommunity.net/?wpfb_dl=163

Hammond, J., Fraval, S., van Etten, J., Suchini, J.G., Mercado, L., Pagella, T., Frelat, R., Lannerstad, M., Douxchamps, S., Teufel, N., Diego Valbuena, D. & van Wijk, M.T. 2017. The Rural Household Multi-Indicator Survey (RHoMIS) for rapid characterisation of households to inform climate smart agriculture interventions: description and applications in East Africa and Central America. *Agricultural Systems*, 151, p. 225–233. 10.1016/j.agsy.2016.05.003

Harris, I., Jones, P.D., Osborn, T.J. & Lister, D.H. 2014. *Updated high-resolution grids of monthly climatic observations – the CRU TS3.10 dataset*. CRU TS version 4.01 University of East Anglia (p. 102). doi:10.1002/joc.3711 http://dx.doi.org/10.1002/joc.3711

Hedger, M.M., Mitchell, T., Leavy, J., Greeley, M., Downie, A. & Horrocks, L., 2008. *Evaluation of adaptation to climate change from a development perspective, desk review*. Institute of Development Studies (IDS) / AEA Group. www.seachangecop.org/node/128

Hegerl, G.C. *et al.* 2010: Good practice guidance paper on detection and attribution related to anthropogenic climate change. In T.F. Stocker *et al*., eds. *Meeting report of the Intergovernmental Panel on Climate Change expert meeting on detection and attribution of anthropogenic climate change*. Bern, IPCC Working Group I Technical Support Unit, University of Bern. 8 pp.

Hills, T., Pramova, E., Neufeldt, H., Ericksen, P., Thornton, P., Noble, A., Weight, E. *et al.* 2015. *A monitoring instrument for resilience*. CCAFS Working Paper No. 96. Copenhagen, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://ccafs.cgiar.org/publications/monitoring-instrument-resilience#.W9iQw2hKjcs

Hinkel, J. 2011. *Indicators of vulnerability and adaptive capacity. Towards a clarification of the science-policy interface. Global Environment Change*, 21, pp. 198–208. http://dx.doi.org/10.1016/j.gloenvcha.2010.08.002

Hoffmaister, J. 2014. *Adaptation Committee monitoring and evaluation of adaptation: summary of lessons and key messages from the AC's workshop on M&E of adaptation*. Adaptation Committee, Co-Chair Bonn, NAP Expo 2014. https://unfccc.int/files/adaptation/application/pdf/nap_expo_session_v_hoffmaister.pdf

Horsch, K. 1997. *Indicators: definition and use in a results-based accountability system*. Harvard Family Research Project Brief Series. Cambridge, Mass., USA. www.hfrp.org/publications-resources/browse-our-publications/indicators-definition-and-use-in-a-results-based-accountability-system

IADB. 2018. *Joint report on multilateral development banks' climate finance*, 2018. Washington, DC, Inter-American Development Bank. https://publications.iadb.org/bitstream/handle/11319/9163/FINAL_2017%20j-MDB%20report%20on%20climate%20finance_Final.pdf?sequence=1&isAllowed=y

I**CAT.** 2018. *Series of Guidance*. Washington, DC, World Resources Institute, Initiative for Climate Action Transparency. https://climateactiontransparency.org/icat-guidance/

IFAD. 2015. *International Fund for Agricultural Development Adaptation for Smallholder Agriculture Programme*. https://www.ifad.org/documents/38714170/40213192/asap.pdf/b5a8c1f9-f908-4a68-ad30-e3d5eeb17c31

IFAD. 2017. *Second phase of IFAD's Adaptation for Smallholder Agriculture Programme (ASAP2) – concept note*. International Fund for Agricultural Development. https://webapps.ifad.org/members/eb/122/docs/EB-2017-122-R-44.pdf

Ignaciuk, A. 2017. Presentation on "Metrics of CSA: EPIC's approach". Economic and Policy Analysis of Climate Change (EPIC) programme. Rome, FAO. http://www.fao.org/in-action/epic/en/

IIED. 2011. *Tracking Adaptation and Measuring Development (TAMD), a framework for assessing climate adaptation and development effects*. London, International Institute for Environment and Development. http://pubs.iied.org/pdfs/10031IIED.pdf

IISD. 2013. *Climate resilience and food security: a framework for planning and monitoring*. Winnipeg, Canada, International Institute for Sustainable Development. https://www.iisd.org/sites/default/files/publications/adaptation_CREFSCA.pdf

IISD. 2014. *CRiSTAL food security 2.0 user's manual. Community-based risk screening tool – adaptation and livelihoods: focus on food system resilience*. Winnipeg, Canada, International Institute for Sustainable Development. https://www.iisd.org/sites/default/files/publications/cristal_food_security_manual_en.pdf

IPCC. 2006. 2006 *IPCC guidelines for national greenhouse gas inventories*, Prepared by the National Greenhouse Gas Inventories Programme. H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara & K. Tanabe, eds. Kanagawa, Japan, Institute for Global Environmental Strategies.

IPCC. 2007. *Climate change 2007: impacts, adaptation and vulnerability*. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, eds. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, Cambridge University Press. 976 pp. https://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4_wg2_full_report.pdf

IPCC. 2014. *Climate change 2014: impacts, adaptation, and vulnerability. Part B: regional aspects*. In V.R. Barros, C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee *et al.*, eds. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, Cambridge University Press. 688 pp. www.ipcc.ch/pdf/ assessment-report/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf

ISO. 2018. *ISO and climate change*. Geneva, International Organization for Standardization. https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100067.pdf

JRC. 2015. Global Climate Change Alliance Plus Index (GCCA+). Brussels, European Commission, Joint Research Centre. http://www.gcca.eu/global-climate-change-alliance-plus-gcca-index

Kato, T. & Ellis, J. 2016. Communicating progress in national and global adaptation to climate change. Organisation for Economic Co-operation and Development/IEA Climate Change Expert Group Papers, No. 2016/01. Paris, OECD Publishing. http://dx.doi.org/10.1787/5jlww009v1hj-en

Lamhauge, N., Lanzi, E. & Agrawala, S. 2012. *Monitoring and Evaluation for Adaptation: Lessons from Development Co-operation Agencies*. OECD Environment Working Paper No. 38. Paris, Organisation for Economic Co-operation and Development. http://www.oecd-ilibrary.org/docserver/download/5kg20mj6c2bw-en.pdf

Leagnavar, P., Bours, D. & McGinn, C. 2015. *Good practice study on principles for indicator development, selection and use in climate change adaptation monitoring and evaluation*. Climate-Eval Community of Practice. https://www.climate-eval.org/sites/default/files/studies/Good-Practice-Study.pdf

Leiter, T. 2015. Linking monitoring and evaluation of adaptation to climate change across scales: avenues and practical approaches. *New Directions for Evaluation*, 147: 117–127. https://onlinelibrary.wiley.com/doi/full/10.1002/ev.20135

Leiter, T. 2017a. The Adaptation M&E Navigator. A decision support tool for the selection of suitable approaches to monitor and evaluate adaptation to climate change. In J.I. Uitto, J. Puri & R.D. van den Berg, eds. *Evaluating climate change action for sustainable development*, pp. 327–341. Springer Publishing. http://link.springer.com/chapter/10.1007/978-3-319-43702-6_18

Leiter, T. 2017b. Country-specific assessments of adaptation progress. In *The adaptation gap report 2017. Towards global assessment*. Nairobi, United Nations Environment Programme. https://www.unenvironment.org/resources/adaptation-gap-report-2017

Leiter, T., Olivier, J., Kranefeld, R., Helms, J. & Brossmann, M. 2017. *Can climate vulnerability and risk be measured through global indices?* Policy Brief. Bonn and Eschborn, Deutsche Gesellschaft für Internationale Zusammenarbeit. https://www.adaptationcommunity.net/wp-content/uploads/2017/09/Policy-Brief_Measuring-vulnerability-through-global-indices-GIZ.pdf

Leiter, T. & Pringle, P. 2018. Pitfalls and potential of measuring climate change adaptation through adaptation metrics. In L. Christiansen, G. Martinez & P. Naswa, eds. Adaptation metrics: perspectives on comparing, measuring and aggregating adaptation results. Copenhagen, UNEP DTU Partnership. http://www.unepdtu.org/newsbase/2018/03/new-publication-on-adaptation-metrics-released?id=2ee1a180-9012-47a2-a50a-d5316246a814

Möhner, A., Leiter, T. & Kato, T. 2017. Adaptation in the Paris Agreement and provisions for review and reporting. In *The adaptation gap report 2017. Towards global assessment*. Nairobi, United Nations Environment Programme. https://www.unenvironment.org/resources/adaptation-gap-report-2017

NAS. 2005. *Thinking strategically: the appropriate use of metrics for the Climate Change Science Program*. Washington, DC, National Academy of Sciences. http://www.nap.edu/catalog/11292.html

Naswa, P., Traerup, S., Bouroncle, C., Medellín, C., Imbach, P., Louman, B. & Spensley, J. 2015. *Good practice in designing and implementing national monitoring systems for adaptation to climate change*. Denmark, Climate Technology Centre & Network.

ND-GAIN. 2013. Notre Dame Global Adaptation Index. Detailed methodology report. Environmental Change Initiative. South Bend, Ind., USA. http://www3.nd.edu/~nchawla/methodology.pdf https://gain.nd.edu/

ND-GAIN. 2015. University of Notre Dame Global Adaptation Index Country Index Technical Report (November 2015) Notre Dame Global Adaptation Initiative. South Bend, Ind., USA. https://gain.nd.edu/assets/254377/nd_gain_technical_document_2015.pdf

OECD. 2001. *Results-based management in the development co-operation agencies: a review of experiences background report*. Paris, Organisation for Economic Co-operation and Development. https://www.oecd.org/dac/evaluation/dcdndep/31950852.pdf

OECD. 2008. *Glossary for evaluation and results-based management*. Paris, Organisation for Economic Co-operation and Development.

OECD. 2017. *Insights from national adaptation monitoring and evaluation systems*. Climate Change Expert Group Paper No. 3. Paris, Organisation for Economic Co-operation and Development. https://www.oecd.org/environment/cc/Insights%20from%20national%20adaptation%20monitoring%20and%20evaluation%20systems.pdf

OECD–DAC. 2002. Glossary of key terms in evaluation and results based management. Paris, Organisation for Economic Co-operation and Development–Development Assistance Committee. https://www.oecd.org/dac/evaluation/2754804.pdf

Price-Kelly, H., Hammill, A., Dekens, J., Leiter, T. & Olivier, J. 2015. *Developing national adaptation monitoring and evaluation systems: a guidebook*. Bonn and Eschborn, Deutsche Gesellschaft für Internationale Zusammenarbeit, and Winnipeg, Canada, International Institute for Sustainable Development (also available in French and Spanish). http://www.adaptationcommunity.net/?wpfb_dl=268

Pringle, P. 2011. AdaptME toolkit for monitoring and evaluation of adaptation activities. United Kingdom Climate Impacts Programme (UKCIP) manual. www.seachangecop.org/node/116

PROVIA. 2013: *PROVIA guidance on assessing vulnerability*, impacts and adaptation to climate change. Nairobi, United Nations Environment Programme. 198 pp. http://www.unep.org/provia

Quinney, M., Bonilla-Findji, O. & Jarvis, A. 2016. *CSA Programming and Indicator Tool: 3 steps for increasing programming effectiveness and outcome tracking of CSA interventions*. CCAFS Tool Beta version. Copenhagen, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://ccafs.cgiar.org/csa-programming-and-indicator-tool#.WT7e7usrJhE%20CSA

Rai, N., Brooks, N. & Nash, E. 2015. *Tracking adaptation and measuring development: a manual for national governments*. London, International Institute for Environment and Development. http://pubs.iied.org/10134IIED/

Rai, N., Brooks, N., Ponlock, T., Baroda, N. & Nash, E. 2015. *Developing a national M&E framework for climate change.Tracking adaptation and measuring development (TAMD) in Cambodia*. London, International Institute for Environment and Development. http://pubs.iied.org/pdfs/10118IIED.pdf

Reytar, K., Hanson, C. & Henninger, N. 2014. *Indicators of sustainable agriculture: a scoping analysis*. Working Paper, Installment 6 of Creating a Sustainable Food Future. Washington, DC, World Resources Institute. https://www.wri.org/sites/default/files/wrr_installment_6_sustainable_agruiculture_indicators.pdf

Rodríguez, A.G. 2018. Agenda 2030 para el desarrollo sostenible y sistemas alimentarios sostenibles una propuesta para la formulación de políticas integradoras. Comisión Económica para América Latina y el Caribe (CEPAL).

Rosenstock, T.S., Lamanna, C., Chesterman, S., Bell, P., Arslan, A., Richards, M., Rioux, J. *et al.* 2016. *CSA Compendium. The scientific basis of Climate-Smart Agriculture. A systematic review protocol*. CCAFS Working Paper No. 138. Copenhagen, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://www.cifor.org/ebf/wp-content/uploads/sites/32/2017/pubs/CSAsystematicmapprotocol.pdf

Rudinas, J.S., Godilano, E.C. & Ilaga, A.G. 2013. *Implementing climate smart agriculture. Ridge – River – Reef: the Philippine adaptation and mitigation initiative for agriculture*. Paper presented to the ASEAN– FAO– GIZ Regional Expert Forum on Climate Change: Agriculture and Food Security in ASEAN. 2-3 May 2013, Bangkok, Thailand. http://www.pdf.ph/downloads/Rural%20Development/Highlights%20of%20Meeting/23%20May%202013/attachments/03-Implementing%20Climate%20Smart%20Agriculture.pdf

Spearman, M. & McGray, H. 2011. *Making adaptation count: concepts and options for monitoring and evaluation of climate change adaptation*. Bonn and Eschborn, Deutsche Gesellschaft fur Internationale Zusammenarbeit. http://pdf.wri.org/making_adaptation_count.pdf

Syngenta. 2018a. Good Growth Plan. https://www.syngenta.com/what-we-do/the-good-growth-plan

Syngenta. 2018b. Fair Labor Program. https://www.syngenta.com/who-we-are/our-stories/rural-work-must-be-fair

TCFD. 2018. *2018 status report*. Task Force on Climate-related Financial Disclosures. https://www.fsb-tcfd.org/publications/tcfd-2018-status-report/

Tubiello, F.N., Condor-Golec, R.D., Salvatore, M., Piersante, A., Federici, S., Ferrara, A., Rossi, S. *et al.* 2015. *Estimating greenhouse gas emissions in agriculture: a manual to address data requirements for developing countries*. Rome, FAO.

UKCIP. 2011. UK Climate Impacts Programme. AdaptMe Toolkit. Oxford, UK. https://www.ukcip.org.uk/wp-content/PDFs/UKCIP-AdaptME.pdf

UNEP. 2017. *The adaptation gap report 2017. Towards global assessment*. Nairobi, United Nations Environment Programme. https://wedocs.unep.org/bitstream/handle/20.500.11822/22172/adaptation_gap_2017.pdf?isAllowed=y&sequence=1

UNFCCC. 2010. *Synthesis report on efforts undertaken to monitor and evaluate the implementation of adaptation projects, policies and programmes and costs and effectiveness of completed projects and views on lessons learned, good practices, gaps and needs*. FCCC/SBSTA/2010/5. GE. 10-60656.

UNFCCC. 2011. United Nations Framework Convention on Climate Change. https://unfccc.int/sites/default/files/conveng.pdf

UNFCCC. 2012. *National adaptation plans. Technical guidelines for the national adaptation plan process*. Bonn, United Nations Climate Change Secretariat, Least Developed Countries Expert Group. https://unfccc.int/files/adaptation/cancun_adaptation_framework/application/pdf/naptechguidelines_eng_high__res.pdf

UNFCCC. 2014. *Institutional arrangements for national adaptation planning and implementation*. Thematic Report. Adaptation Committee. https://unfccc.int/files/adaptation/application/pdf/adaption_commitee_publication_-_web_high.pdf

UNFCCC. 2015a. *Results framework and baseline guidance. General M&E frameworks on adaptation tracking and indicators*. Adaptation Fund. https://www.adaptation-fund.org/wp-content/uploads/2015/01/Results%20Framework%20and%20Baseline%20Guidance%20final%20compressed.pdf

UNFCCC. 2015b. *Monitoring and assessing progress, effectiveness and gaps under the process to formulate and implement national adaptation plans: the PEG M&E tool*. Bonn, United Nations Climate Change Secretariat, Least Developed Countries Expert Group. http://www4.unfccc.int/nap/Documents%20NAP/50301_04_UNFCCC_Monitoring_Tool.pdf

UNFCCC. 2016. Paris Agreement. http://unfccc.int/paris_agreement/items/9485.php

UNFCCC. 2018a. *Report on the expert meeting on national adaptation goals/indicators and their relationship with the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction*. Fourteenth meeting of the Adaptation Committee Bonn, Germany, 24–26 October 2018. AC/2018/13 16 October 2018 Agenda item 7(c). https://unfccc.int/sites/default/files/resource/ac14_indicators.pdf

UNFCCC. 2018b. *CDM methodology booklet*. https://cdm.unfccc.int/methodologies/documentation/1903/CDM-Methodology-Booklet_fullversion

UNGWC. 2017. *Satellite task team report*. White Paper. New York, United Nations Global Working Group. https://unstats.un.org/bigdata/taskteams/satellite/UNGWG_Satellite_Task_Team_Report_WhiteCover.pdf

UNGWG. 2018. *United Nations Global Working Group on Big Data for Official Statistics report to the United Nations Statistical Commission for 2017*. Earth Observations for Official Statistics Satellite Imagery and Geospatial Data Task Team report, 5th December 2017. https://unstats.un.org/bigdata/taskteams/satellite/UNGWG_Satellite_Task_Team_Report_WhiteCover.pdf

UNISDR. 2009. Sendai Framework for Disaster Risk Reduction 2015–2030. United Nations International Strategy for Disaster Reduction. https://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf

United Nations Statistics Division. 2018. Tier Classification for Global SDG Indicators. https://unstats.un.org/sdgs/iaeg-sdgs/tier-classification/

Vallejo, L. 2017. *Insights from national adaptation monitoring and evaluation systems*. OECD/IEA Climate Change Expert Group Paper 2017(3). Paris, Organisation for Economic Co-operation and Development.

Vermeulen, S.J. & Frid-Nielsen, S.S. 2017. *Measuring progress towards the WBCSD statement of ambition on Climate-Smart Agriculture: improving businesses' ability to trace, measure and monitor CSA*. CCAFS Working Paper No. 199. Copenhagen, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://ccafs.cgiar.org/fr/node/54321#.W9LlyGgzbcs

Verra methodologies. 2019. [online] https://verra.org/methodologies/

Villanueva, P.S. 2011. *Learning to ADAPT: monitoring and evaluation approaches in climate change adaptation and disaster risk reduction – challenges, gaps and ways forward*. SCR Discussion Paper 9. Strengthening Climate Resilience (SCR). https://www.ids.ac.uk/files/dmfile/SilvaVillanueva_2012_Learning-to-ADAPTDP92.pdf

Vincent, K. & Ofwona, E. 2018. *Measuring progress on climate adaptation: from concepts to practical application*. Background paper prepared for COP 23. Ottawa, International Development Research Centre (IDRC).

WBCSD. 2015. *Climate-Smart Agriculture Action Plan 2020: mid-term report*. World Business Council on Sustainable Development. https://docs.wbcsd.org/2017/11/WBCSD_Climate_Smart_Agriculture-Action_Plan_2020-MidTermReport.pdf

WEF. 2009. P*utting the New Vision for Agriculture into action: a transformation is happening*. Geneva, World Economic Forum. https://www.weforum.org/projects/new-vision-for-agriculture

Wilkinson, M.D., Dumontier, M., Aalbersberg, I.J.J., Appleton, G., Axton, M., Baak, A., Blomberg, N. *et al.* 2016. The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3: 160018.

Wollenberg, E., Zurek, M. & De Pinto, A. 2015. *Climate readiness indicators for agriculture*. CCAFS Info Note. Copenhagen, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://cgspace.cgiar.org/rest/bitstreams/66493/retrieve

World Bank. 2008. Pilo t Program for Climate Resilience (PPCR). Washington, DC. https://climatefundsupdate.org/pilot-program-for-climate-resilience/

World Bank. 2013. World Development Indicators 2013. Washington, DC. http://documents.worldbank.org/curated/en/449421468331173478/pdf/768240PUB0EPI00IC00PUB0DATE04012013.pdf

World Bank. 2013/2017. *Operational guidance for monitoring and evaluation (M&E) in climate and disaster resilience-building operations*. Washington, DC. http://documents.worldbank.org/curated/en/692091513937457908/pdf/122226-ReME-Operational-Guidance-Note-External-FINAL.pdf

World Bank. 2016. Climate-Smart Agriculture Indicators. World Bank Group Report Number 105162-GLB. Washington, DC. http://documents.worldbank.org/curated/en/187151469504088937/pdf/105162-WP-P132359-PUBLIC-CSAIndicatorsReportweb.pdf

WRI. 2014a. Greenhouse Gas Protocol. Washington, DC, World Resources Institute. http://ghgprotocol.org/

WRI. 2014b. *GHG Protocol Agricultural Guidance: interpreting the corporate accounting and reporting standard for the agricultural sector*. Washington, DC, World Resources Institute. https://ghgprotocol.org/sites/default/files/standards/GHG%20Protocol%20Agricultural%20Guidance%20%28April%2026%29_0.pdf

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