AGRICULTURE GLOBAL PRACTICE

# CLIMATE-SMART AGRICULTURE INDICATORS

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# CLIMATE-SMART AGRICULTURE INDICATORS

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

1818 H Street NW
Washington, DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org
Email: feedback@worldbank.org

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**Cover photos:**

**Top Left:** Man scattering rice grains. Sta. Cruz, Laguna, Philippines. Credit: Danilo Pinzon/World Bank
**Top Right:** Farmers sort tomatoes. Ethiopia. Credit: Stephan Bachenheimer/World Bank
**Bottom:** Women at work in Sri Lanka. Credit: Lakshman Nadaraja/World Bank

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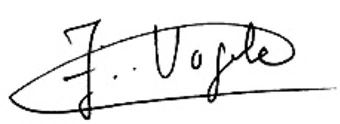
# FOREWORD

There is by now substantial consensus within the development community over the need for a more climate smart agriculture, which consists of three defining principles: enhancing agriculture's resilience to climate change, reducing agricultural greenhouse gas emissions, and sustainably increasing production. With 795 million people still not getting their minimum dietary requirements, there is little scope for trade-offs between increasing production and improving agriculture's environmental impacts. Making climate smart agriculture operational will rely on our ability to measure production, resilience, and emissions in a way that informs decision makers about the policies, technologies, and practices that most effectively promotes each. In addition to the direct results of an improved activity or practice, longer term outcomes can lead to fundamental changes in the way that producers, consumers, investors, and others behave—and what they base their production, consumption, and investment decisions on. The indicators described in this document were developed for this purpose.

Applying the indicators to examine the agricultural performance of different countries reveals a number of correlates relating to institutions, legal frameworks, and the relationships between agriculture and other sectors like water and energy. Applying them to projects affirms the important advantages of approaches that employ appropriate technologies and that incorporate broader, landscape-based perspectives that recognize and allow for competing demands for land and water resources.

The type of highly practical empirical evidence that will be amassed by monitoring these indicators is going to be pivotal in mitigating agriculture's large ecological footprint, in capitalizing on its potential to provide environmental services, and in guiding the forms of intensification that lead to substantially higher and more sustainable production.



**Juergen Voegele**
Senior Director
Agriculture Global Practice
The World Bank

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AFOLU | Agriculture, Forestry and Other Land Use |
| ARI | Agricultural research intensity |
| ASTI | Agricultural Science and Technology Indicators |
| CAIT | Climate Analysis Indicators Tool |
| CC | Climate change |
| CCAFS | CGIAR Research Program on Climate Change, Agriculture and Food Security |
| $CO_2$-e | Carbon dioxide equivalent |
| CSA | Climate-smart agriculture |
| CSA-Pol | CSA-Policy Index |
| CSA-Res | CSA-Results Index |
| CSA-Tech | CSA-Technology Index |
| CV | Climate variability |
| DRR | Disaster risk reduction |
| EAP | East Asia and Pacific |
| ECA | Europe and Central Asia |
| FAO | Food and Agriculture Organization |
| GDP | Gross domestic product |
| GEF | Global Environment Fund |
| GEO | Global Environment Objective |
| GHG | Greenhouse gas |
| ha | Hectare |
| HANCI | Hunger and Nutrition Commitment Index |
| ICT | Information communication technology |
| IEM | Integrated ecosystem management |
| IFC | International Finance Corporation (of the World Bank) |
| IFPRI | International Food Policy Research Institute |
| IPCC | International Panel on Climate Change |
| ISFM | Integrated soil fertility management |
| kg | Kilogram |
| LAC | Latin America and the Caribbean |
| M | Mitigation |
| M&E | Monitoring and evaluation |
| MDG | Millennium Development Goal |
| MENA | Middle East and North Africa |
| MMT | Million metric tons |
| NAMA | Nationally Appropriate Mitigation Actions |
| NAPA | National Adaptation Programs for Action |
| NCCSC | National Climate Change Steering Committee |
| NCCTC | National Climate Change Technical Committee |
| ND-GAIN | University of Notre Dame Global Adaptation Index |
| NRM | Natural resource management |
| P | Productivity |
| PDO | Project Development Objective |
| R | Resilience |
| RAI | Rural Access Index |
| R&D | Research and development |
| RAI | Rural Access Index |
| SA | South Asia |
| SLM | Sustainable land management |
| SMART | Specific, Measurable, Achievable and Attributable, Relevant and Time Bound |
| SSA | Sub-Saharan Africa |
| SSN | Social safety net |
| t | Ton |
| 3H Basin | Huang-Huai-Hai Basin |
| UNFCCC | United Nations Framework Convention on Climate Change |
| WRI | World Resources Institute |
| WTO | World Trade Organization |

# EXECUTIVE SUMMARY

**Agriculture accounts for 40 percent of the land area and 70 percent of the freshwater resources that humans use, and 24 percent of human-induced greenhouse gas emissions.** In addition to its role as a contributor to climate change, agriculture, with its direct reliance on natural resources, is also the sector of the economy that is the most vulnerable to the impacts of climate change. And the pressures that population growth and urbanization are putting on the sector are growing at the same time that many of the resources that agricultural production depends on are diminishing throughout much of the developing world. The human population is projected to increase to 9.5 billion people by 2050, and agricultural demand for water may increase by 30 percent by 2030. The proportion of the human population that resides in water-stressed or water-scarce areas is likely to increase from about 18 percent today to 44 percent by 2050. The increased risks associated with higher frequencies of drought, flooding, and heat stress will have significant impacts on agricultural production systems, resulting in lower yields, rising food prices, and increased greenhouse gas emissions. For every degree Celsius of global warming, yields are at risk of declining by 5 percent, leading to further insecurity for the 805 million already food insecure.

**Agriculture is also the most vital sector of the economy for food security, and employs some 2.6 billion people worldwide.** More than any other sector in developing countries, growth in the agricultural sector is associated with poverty reduction. The growth in gross domestic product (GDP) that takes place in agriculture is at least twice as effective in reducing poverty as the growth that takes place in other sectors, and its significance to poverty rates increases roughly in proportion to the size of its role in the larger economy. In the largely agriculture-based economies of the developing world, where poverty rates are the highest and the largest ratios of poor people live in rural areas, its significance is the greatest.

**Climate-smart agriculture (CSA) in its broadest usage refers to a global agenda with three fundamental elements.** The first element is to increase agricultural production and incomes to meet increasing demand while ensuring the sustainability of the soil and water resources used. The second is to make production systems more resilient and better able to withstand weather variability and climate shocks, a set of objectives referred to as adaptation to the effects of climate change. The third element is to reduce the greenhouse gases emitted by agriculture and to promote the sequestration of greenhouse gases in agricultural soils and plants, a set of objectives referred to as mitigation. It should be noted that sequestration of greenhouse gases is not the only mitigation method and the quantity of GHG sequestered is not limitless. Although carbon sequestration can be large to begin with, the sinks decline as a maximum equilibrium value is reached (World Bank 2012). Empirical evidence suggests that these sinks saturate at between 10 and 100 years, depending on practices applied, soil type, and climate zone (IPCC 2006). Because sinks are also reversible, sequestration practices must be maintained even when the sinks are saturated. The benefit of carbon sequestration is that it can provide "breathing space" to make room for other technologies that reduce emissions to come on the scene.

Because the CSA perspective considers sustainable food production, adaptation, and mitigation simultaneously, those interventions that are likely to yield benefits in all three are often referred to as "triple wins." CSA tends to assign a high premium to interventions and activities that achieve synergies between more than one set of objectives. It also recognizes trade-offs when one set of objectives is prioritized at the relative expense of another. The level of analysis that is employed often extends to the larger landscape or watershed in which the intervention is planned. In addition to CSA-related interventions themselves, however, this integrated perspective is intended to inform the formulation of policies, the development of technologies, and the planning and design of investments with a more thorough awareness of the wider impacts that the policy, technology, or investment is likely to have.

**Achieving climate-smart agricultural outcomes will require transformations at different scales, governance levels, and time horizons.** A range of indicators is currently in place to measure agricultural performance, natural resources management, climate change, and a variety of variables relating to food security and nutrition. These are used to reflect facts and trends at the global, regional, national, and local scales. They may concern United Nations agencies such as the Food and Agriculture Organization (FAO) and the World Bank, regional forums such as the African and Asian Development banks, national and local governments, private investors, universities and research institutions, and civil society and nongovernmental organizations. They may cover baseline snapshots of initial conditions or trends and developments over the immediate-, short-, medium-, or long-term period. Whereas these indicators do measure some dimensions of CSA, most are not sufficient to guide policy formulation, prioritize production systems, or gauge how successful the adoption of a CSA intervention has been. The World Bank CSA indicators address these shortcomings and provide policy makers and development practitioners with a framework for implementing the necessary policy, technical, and monitoring and evaluation (M&E) framework to make CSA fully operational.

**The CSA Indices are based on a range of CSA indicators in the areas of policy, technology, and results.** The development of the CSA indicators was informed by an encompassing CSA impact pathway that traces how project outputs can result in behavioral change (project outcomes). The CSA indicators aim to capture direct project outputs and behavioral changes from a range of stakeholders such as producers, policy makers, and civil society. Behavior change is seen as a determining factor because only when a key group of stakeholders has changed their behavior can the impacts achieved through a CSA intervention be sustained into the future. The methodology for the selection and development of the indicators encompassed an extensive literature review, a review of the World Bank's Core Sector Indicators, and a number of expert consultations. These allowed for the development of a comprehensive set of indicators that can potentially provide the empirical basis for identifying viable climate-smart options, select contextually relevant technologies and practices, monitor results, and assess policies and the necessary enabling activities for CSA.

## STRUCTURE OF CSA INDICATORS

**There are three CSA indices: the CSA Policy Index (CSA-Pol Index), the CSA Technology Index (CSA-Tech Index), and the CSA Results Index**

**(CSA-Res Index).** The CSA-Pol Index is established on the national level and measures countries' institutional readiness to support CSA interventions. In contrast, the CSA-Tech and CSA-Res Indices are applied on the project level. The CSA-Tech Index serves as an ex ante measure of the ability of CSA interventions to reach the CSA triple-win goals. The CSA-Res Index can be applied to measure a project's success to reach its goals in the CSA triple-win areas.

**The CSA Policy Index comprises three themes, 14 indicators, and 31 subindicators**. The first theme, *Readiness Mechanisms*, refers to the capacity of countries to plan and deliver adaptation, mitigation, economic readiness, governance readiness, and social readiness programs in ways that are catalytic and fully integrated with national agricultural development priorities. The second theme, *Services and Infrastructure*, reflects the ability to leverage agricultural investments through the provision of services and enabling environment such as extension, research and development, roads, social safety nets, GHG inventory and risk management systems, and adaptive capacity. The third theme, *Coordination Mechanisms*, assesses collaboration for disaster risk management, and coordination among sectors involved in CSA. The CSA Policy indicators enable policy makers and other users to gauge how a country's enabling environment for CSA is changing over time. They are also useful in identifying gaps in the implementation of CSA activities and in developing benchmarks for reform.

**The CSA Technology and Practices Index comprises 27 indicators clustered into three main themes: Productivity (P), Resilience (R), and Mitigation (M).** Ex ante application of the index reveals how project interventions can lead to productivity gains and environmental benefits. It is particularly useful in identifying the most appropriate technologies for a CSA project during its planning and design stages.

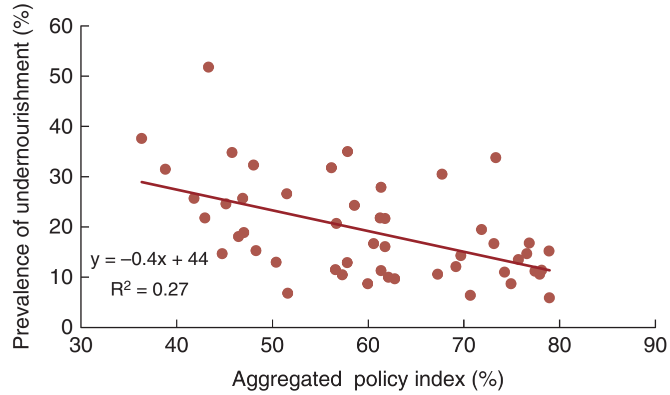
**The CSA Results Index comprises 22 indicators, clustered in three categories and eight topics, intended to help project leaders measure an agricultural project's performance toward achieving the CSA triple wins individually and jointly.** The three categories have been identified according to whether the indicators measure direct output of a CSA project intervention, the CSA enabling environment, or the medium- to long-term outcomes of a CSA intervention. The eight topics include beneficiaries, land use/cover, livestock, enabling environment, natural resources, emission, yield, and benefits and welfare. In addition, the indicators are assigned to the CSA triple-win areas P, R, and M. The CSA-Res Index can be applied to measure the project's performance after project completion, as well as during project implementation. The CSA-Res Index gives project teams the flexibility to customize the index and adjust it to the context specificity of their CSA intervention.

## KEY FINDINGS OF CSA INDICES' TEST APPLICATION

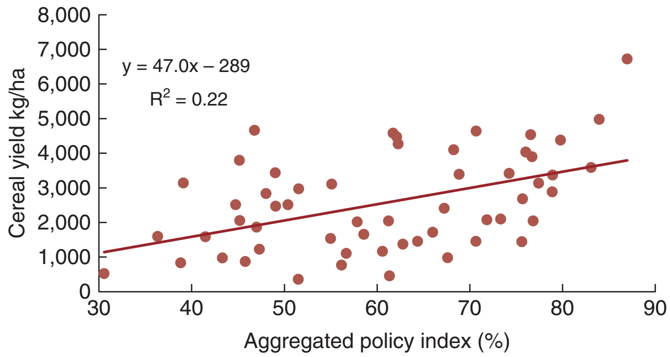
### 1. CSA POLICY INDEX COUNTRY ASSESSMENTS

**This report highlights the importance of adopting CSA policies to address food insecurity under changing climatic conditions**. A 1 percent increase in the CSA-Pol Index is predicted to lead to a 0.4 percent decline in the proportion of undernourished population (figure ES.1). Cereal yields increase 47 kilograms per hectare (kg/ha) for every 1 percent increase in the CSA-Pol Index (figure ES.2). A 1 percent increase in CSA-Pol Index is predicted to lead to a 0.08 decrease in coefficient of variance of cereal yield (figure ES.3).

**FIGURE ES.1.** RELATIONSHIP BETWEEN CSA-POL INDEX AND UNDERNOURISHMENT (*n* = 50)

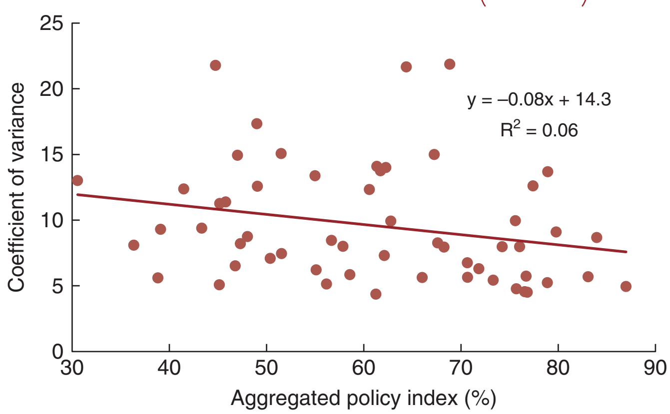


## FIGURE ES.2. RELATIONSHIP BETWEEN CSA-POL INDEX AND CEREAL YIELD (*n* = 56)




*Note:* Cereal yield refers to the average yields (2010 to 2013) for wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains.

## FIGURE ES.3. RELATIONSHIP BETWEEN CSA-POL INDEX AND CEREAL YIELD VARIANCE (*n* = 56)

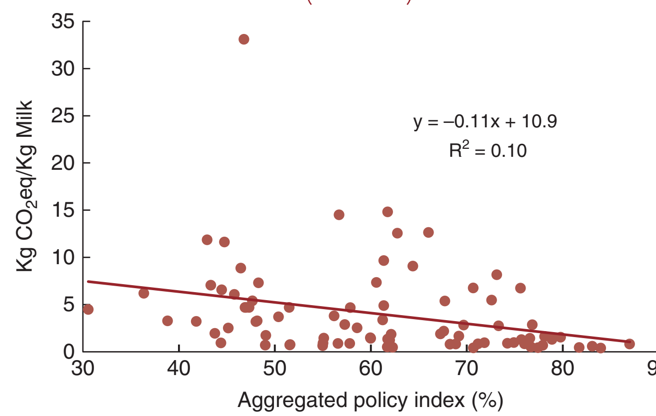



*Note:* Cereal yield variance refers to the coefficient of variance of yields from 2010 to 2013 expressed in percentage.

**This report also highlights the importance of adopting CSA policies to reducing GHG intensity in various agricultural products**. A 1 percent increase in the CSA-Pol Index is predicted to decrease GHG intensity of milk by 0.11 kilogram of carbon dioxide equivalent per kilogram (kg $CO_2$-e/kg) (figure ES.4). A 1 percent increase in the CSA-Pol Index is also predicted to decrease GHG intensity of chicken by 0.11 kg $CO_2$-e/kg (figure ES.5). GHG intensity of paddy rice will decrease 0.02 kg $CO_2$-e/kg (figure ES.6).

**Country assessments (*n* = 88) revealed countries to be at varying stages of adoption of policies and mechanisms to support CSA,** with the CSA Policy Index ranging from 31 percent for Sudan to 87 percent for Chile. Latin American and Caribbean (LAC) countries such as Chile, Mexico, and Brazil outperformed other country groups on the CSA Policy Index scores. CSA Policy Index's services and infrastructure support thematic indicators tend to increase with higher levels of income. This suggests that national investments in services such as crop insurance and market information systems may yield greater productivity and environmental wins than investments in readiness or coordination mechanisms.

## FIGURE ES.4. RELATIONSHIP BETWEEN CSA-POL INDEX AND GHG EMISSIONS INTENSITY OF MILK (*n* = 84)




## FIGURE ES.5. RELATIONSHIP BETWEEN CSA-POL INDEX AND GHG INTENSITY OF CHICKEN (*n* = 84)

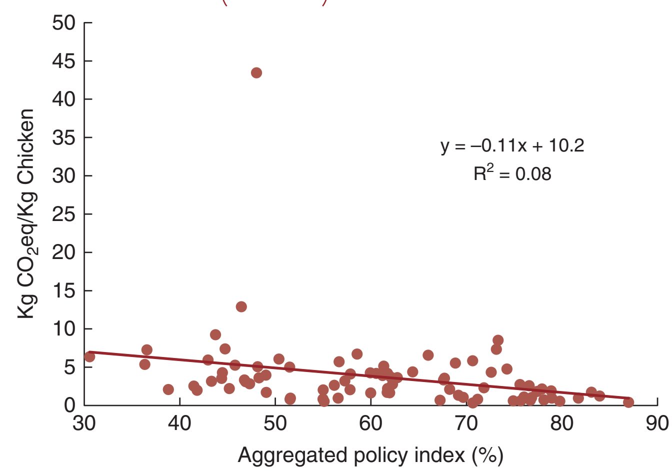
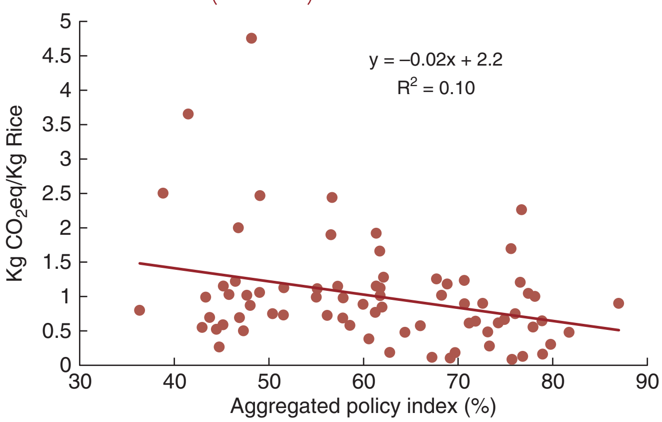


**FIGURE ES.6.** RELATIONSHIP BETWEEN CSA-POL INDEX AND GHG INTENSITY OF PADDY RICE ($n$ = 74)




**Low-income countries are fully capable of formulating policies that are highly amenable to the implementation of CSA.** For these countries, government commitment through national climate change policies and strategies can be as important as services in creating an enabling environment for CSA. Tanzania, for instance, emerged among the top performers in Sub-Saharan Africa (SSA) using the CSA Policy Index. The country has built strong institutional frameworks through a multisectorial approach to support CSA that is facilitated by the National Climate Change Technical Committee (NCCTC) and National Climate Change Steering Committee (NCCSC).

**In our sample of 88 countries, petroleum-based economies are among the lowest performers on the CSA Policy Index.** As a result of heavy reliance on petroleum revenues, nonpetroleum-based sectors in these countries remain critically underdeveloped. The lack of diversification of the economy and underdevelopment of the agricultural sector may have contributed to weak institutional mechanisms for supporting CSA implementation. In many cases, these countries also lack National Action Plans for Adaptations (NAPAs), for example, to support CSA implementation. A noteworthy exception is Nigeria, which has established policies recognizing climate change as a threat to development and has incorporated adaptation strategies for CSA.

## 2. TESTING RESULTS FOR CSA TECHNOLOGY INDEX

**As part of the test application of the CSA-Tech Index, case studies were developed on five select projects in Armenia, Burundi, Bhutan, Brazil, and China to demonstrate how the tool can be used to select highly appropriate existing technologies to achieve triple wins**.

### Case Study 1. Armenia: Second community agriculture resource management and competitiveness project

To reduce Armenia's dependence on agricultural imports and to strengthen value chains in the country, links between producers and processors need to be strengthened, food safety promoted, and processing and marketing supported. The findings of the assessment also led to a recommendation for an increase in the capacity of public sector institutions to support improved market access and selected value chain development. Coverage of the pasture-based livestock system should be extended.

### Case Study 2. Burundi: Agricultural rehabilitation and sustainable land management project

Development of productive infrastructure facilities such as small-scale water-management schemes, irrigation schemes, and agro-processing infrastructures are identified to improve yields and soil fertility in the state-controlled cash crop sector. Off-farm income-generating activities that support agriculture include repairing and manufacturing agricultural tools and small equipment, possible subjects for training workshops.

### Case Study 3. Bhutan: Land management project

The assessment led to recommendations for an increase in physical investments such as measures to conserve vegetative cover, terracing, forest and rangeland regeneration, and reforestation at the farm and community levels, where necessary, to achieve national commitment to environment sustainability. Sustainable land management (SLM) activities must be adopted and implemented.

### Case Study 4. Brazil: Caatinga conservation and management—Mata Branca

The assessment pinpointed investment in the rehabilitation of degraded areas as a key recommendation. Potential investments included reforestation, development of small grazing corridors, direct vegetation planting, application of organic fertilizer, and introduction of agro-forestry techniques. The assessment findings also pointed to development of drought-management projects, terrace development, and the introduction of integrated soil and water–management practices to reverse current trends of deforestation and unsustainable irrigation practices.

### Case Study 5. China: Integrated modern agriculture development project

Owing to the country's lack of available water and high rate of fertilizer use, the project assessment revealed that more efficient water-saving irrigation technologies and integrated soil fertility management (ISFM) can help increase agricultural productivity and improve soil quality and the efficiency of fertilizers and other inputs.

## 3. TEST RESULTS FOR CSA RESULTS INDEX

**CSA-Res Index assessments were performed on five World Bank projects in the areas of agriculture, rural development, and natural resource management.** All projects have been completed and the Implementation Completion and Results reports are consulted for data/information on the indicator target values and values at project completion. The CSA-Res Index for P, R, and M and jointly is thus derived for the project's performance in the last project year. A summary of results for each case study follows.

### Case Study 1. Armenia: Natural resource management and poverty reduction project

- **Project objectives:** Adoption of sustainable natural resource management practices helps avert further deterioration of natural resource and stabilizes incomes in the local communities.
- **Assessment results:** The overall CSA-Res Index, as an average of the index for P, R, and M, gives a value of 3.9. This indicates that the majority of indicators have reached or (highly) exceeded those targets that measure the CSA successes at project completion.

### Case Study 2. Bhutan: Sustainable land management project

- **Project objectives**: Institutional and community capacity must be strengthened for anticipating and managing land degradation in Bhutan. This can contribute to more effective protection of trans-boundary watersheds in a manner that preserves the integrity of ecosystems in Bhutan.
- **Assessment results:** Two indicators ("Tseri land shifted to sustainable land cover," "Degraded forestland regenerated and grazing lands improved in pilot geogs") demonstrated mitigation benefits and achieved an average score of 5, implying that expectations were highly exceeded. The project achieved an overall average score of 4.8.

### Case Study 3. Brazil: Rio de Janeiro sustainable integrated ecosystem management in production landscapes of the north-northwestern Fluminense (GEF) project

- **Project objectives:** Promote an integrated ecosystem management (IEM) approach to guide the development and implementation of SLM practices. Improved capacity and organization for natural resource management (NRM) and increased adoption of IEM and SLM concepts and practices are expected for the primary target group (smallholder families and communities).
- **Assessment results:** The overall average CSA Results Index for the project is 2.9. This figure needs to be interpreted with caution because the areas of Resilience and Mitigation contain a range of indicators that largely exceed expectations. In contrast, the area of Productivity has one indicator that falls short of meeting the target. For achieving the CSA goals, these results may indicate that more focus could be placed on the aspect of Productivity.

### Case Study 4. Burundi: Agriculture rehabilitation and sustainable land management project

- **Project objectives:** Restore the productive capacity of rural areas through investments in production and sustainable land management and through capacity building for producer organizations and local communities.
- **Assessment results:** The overall average score for Productivity performed below expectation; however, the average score for Mitigation exceeded the target value by more than 20 percent. The overall average CSA Results Index score is thus 3.3—the project has satisfactorily achieved targets related to CSA triple-win goals.

### Case Study 5. China: Irrigated agriculture intensification project III

- **Project objectives:** Increase water and agricultural productivity in low- and medium-yield farmland areas; raise farmers' income and strengthen their competitive capacity under post–World Trade Organization (WTO) conditions; and demonstrate and promote sustainable participatory rural water resources management and agro-ecological environmental management in the Huang-Huai-Hai (3H) Basin
- **Assessment results:** Each indicator reaches or exceeds the target. The overall average CSA Results Index score is thus 3.6, demonstrating that the project has satisfactorily reached all targets related to achieving the CSA triple wins

## CONCLUSION

The CSA indicators were useful insights into the impacts and outcomes of climate-smart policies and interventions and can be applied with significant flexibility, although all three indices require some degree of further development and refinement. The CSA Policy Index, for instance, will need to be developed further to capture the performance and coordination of the services that are provided to support CSA policies. For both the CSA Technology and CSA Results Indices, the diversity of indicators implies that care must be exercised when comparing projects based on index scores because the scores are relative and the underlying indicators and their meaning may vary significantly from project to project.

# CHAPTER ONE
# BACKGROUND

## CLIMATE CHANGE AND AGRICULTURE

Global agriculture has a lot on its plate. It is self-evidently the sector that will be most instrumental in feeding nine billion people by the year 2050 and in addressing the needs of the 795 to 805 million people who are food insecure today. It also provides livelihoods for some 2.6 billion people worldwide and accounts for between 20 and 60 percent of the gross domestic product in most developing countries. No other sector of the economy is as effective in raising people out of poverty. And no other sector is as directly reliant on its natural resource base, the land and water resources that are the fundamental elements of crop and livestock production. The sector consumes 40 percent of global land area and 70 percent of global freshwater. The other fundamental element is the climate. And no other sector is as vulnerable to the effects of a changing climate. Throughout much of the world, for instance, grain yields will decline by 5 percent with each degree Celsius the temperature warms.

The vulnerability of agricultural systems to climate change are chiefly described in terms of risk, in what is already an exceptionally risky sector. Much of this involves the increased risk associated with more frequent instances of heat stress, drought, and flooding, or what are generally referred to as *production risks* (as opposed to *market* or *commodity price risks*). The price hikes between 2008 and 2010 were caused by natural disasters like wildfires in some of the world's largest food exporting regions. Severe droughts in the summer of 2012 pushed prices even higher.

This vulnerability to the effects of climate change has a dramatic counterpoint in the massive effects that agricultural production has on climate change. Crop and livestock production, including land use change and the use of synthetic fertilizers are a colossal source of greenhouse gas emissions, and the principal source of greenhouse gases with exceptionally high carbon equivalence like nitrous oxide and methane. Agriculture accounts for 52 percent of methane emissions and 84 percent of nitrous oxide emissions in addition to its role as the principal driver of global deforestation. Agriculture and agriculture-driven land-use change contribute 24 percent of anthropogenic global greenhouse gas emissions. Agricultural practices in their current "business as usual" form are projected to account for up to 70 percent of total human-induced emissions by 2050 if global warming is successfully limited to two degrees Celsius (WRI 2014).

Depleting resources further strains agricultural systems. Water scarcity may also result from changes in the global distribution of rainfall in a context of increasing competition for water from other users such as households and industries. The demand for water for agriculture may rise by over 30 percent by 2030 within another larger context of declining availability. Projections indicate that the population living in water-stressed and water-scarce countries will increase from about 18 percent today to about 44 percent by 2050. Extreme variability of precipitation may place 2.8 billion people at risk of water shortages.

Yet agriculture possesses at least one other unique quality. Including forestry, it is the only economic sector that can be purposefully employed to actively sequester atmospheric carbon and reliably store it in soils and plant tissues, *if production is climate smart.* Although agriculture emits a large volume of greenhouse gases, its biomass and especially its soils also sequester carbon out of the atmosphere, and this role as a carbon sink and as a carbon store can be strategically optimized through proven farming techniques and methods that simultaneously reduce emissions. It should be noted that sequestration of greenhouse gases is not limitless. Although carbon sequestration can be large to begin

**FIGURE 1.1.** GLOBAL LAND USE CHANGE AND AGRICULTURE GREENHOUSE GAS EMISSIONS

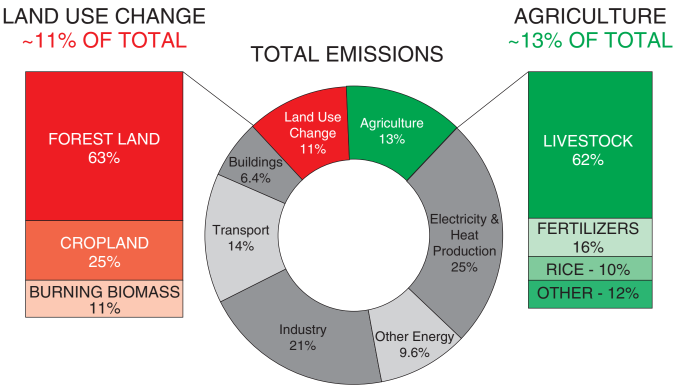
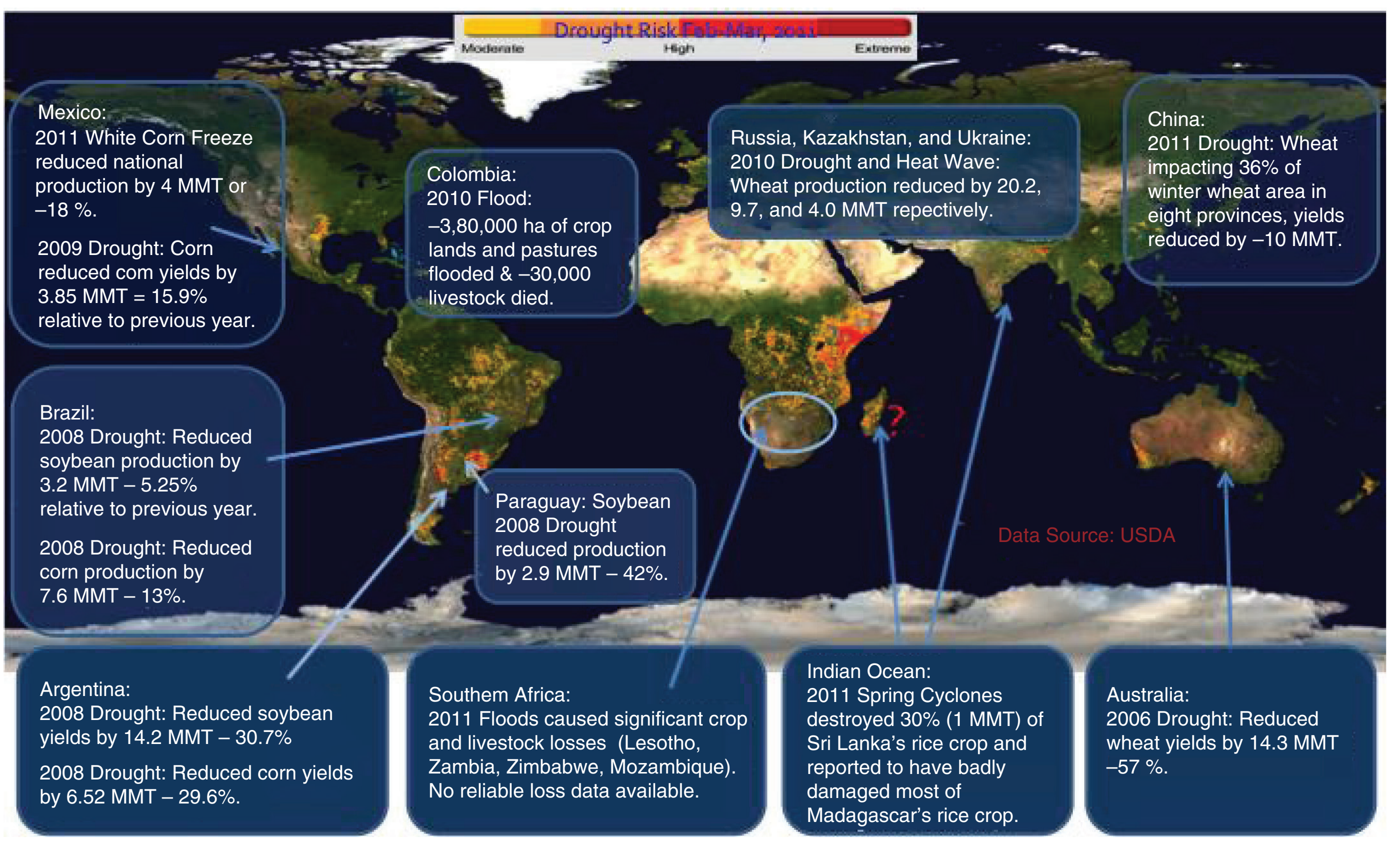



**FIGURE 1.2.** CLIMATE-RELATED GLOBAL GRAIN SHOCKS




*Note:* MMT = Million Metric Tons.

with, the sinks decline as a maximum equilibrium value is reached (World Bank 2012). Empirical evidence suggests that these sinks saturate at between 10 and 100 years, depending on practices applied, soil type, and climate zone. (IPCC 2006). Because sinks are also reversible, sequestration practices must be maintained even when the sinks are saturated. The benefit of carbon sequestration is that it can provide "breathing space" to make room for other technologies that reduce emissions to come on the scene.

Agricultural mitigation can be achieved through improved cropland and grazing land management, restoration of degraded land, restoration of cultivated organic soils, and reduced food waste. Agricultural mitigation potential is cost effective, ranging from 7.18 to 10.60 gigatons carbon dioxide equivalent ($CO_2$-e) per year at carbon prices up to $100 per ton of $CO_2$-e, about a third of which can be achieved at prices up to $20 per ton of $CO_2$-e.

The technical elements of CSA are by now well understood. In addition to their technical feasibility, they can be highly productive and profitable (Lipper et al. 2014). CSA can reverse trends of land degradation and negative ecological footprint, sustain food production, enhance resilience, and sequester carbon. CSA is an approach for developing the technical, policy, and investment conditions to achieve sustainable agricultural development for food security under climate change. CSA identifies synergies and trade-offs among food security, adaptation, and mitigation as a basis for informing and reorienting policy in response to climate change. It is a transition to agricultural production systems that are more productive and efficient; more resilient to risks, shocks, and long-term variability; and that reduce GHG emissions and sequester carbon. CSA is composed of three main pillars:

1. Sustainably increasing agricultural productivity and incomes;
2. Adapting and building resilience to climate change; and
3. Reducing agricultural emissions or optimizing production to sequester and store carbon.

## INDICATORS FOR CLIMATE-SMART AGRICULTURE

A variety of attempts have been made in recent years to set a global agenda for investments in agricultural research and innovation geared toward climate change adaptation and mitigation potential. This has become the focus of partnerships that bring agriculture, environment, and economic development into the same dialogue, and that are well positioned to generate knowledge, raise awareness, and disseminate news about best practices to agriculturists and their counterparts in other sectors. This type of cooperation and partnership is best served by having indicators that can be readily monitored over time to track progress, measure impacts, and guide investments and policies, assessing their effectiveness. The World Bank CSA indicators are designed to provide users with a framework that guides actions to support CSA implementation while acknowledging country and project contexts. The CSA indicators are divided into three indices: *Policy, Technology,* and *Results.*

Table 1.1 lists a range of selected existing indicators and indices relating to agriculture and climate change and identifies their limitations. A detailed review can be found in appendix A.

## OBJECTIVES AND SCOPE OF THE REPORT

This report seeks to support countries and project teams in establishing the necessary policy, technical, and monitoring framework to operationalize sustainable agriculture practices under changing climatic conditions. The success and the legitimacy of their efforts will depend, primarily, on how these stakeholders implement their programs or policy. The indicators, formulated in this report, will guide investment decisions and assist countries to assess their readiness to implement CSA, and also assess the productivity and climate benefits of climate-smart agriculture.

The *Policy indicators* may be used for evaluating the extent to which countries have adopted climate-smart policies. The *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. Lastly, the *Results indicators* can be used to measure the outputs and outcomes of development projects/activities on the three dimensions of productivity, resilience, and mitigation (table 1.2).

## TABLE 1.1. OVERVIEW OF EXISTING INDICATORS

| Category | Index | Purpose | Limitations |
|---|---|---|---|
| **Food Security** | **Global Food Security Index** | Assesses food security of 109 countries. The indicators are categorized in three groups—food affordability, availability, and quality and safety. | Calculating the composite index is too complex and a theoretical framework is lacking that explains the rationale for the selection of indicators for the composite index. |
| | **Hunger and Nutrition Commitment Index** | Ranks governments on their political commitment to tackling hunger and undernutrition | Assessing country progress for tracking hunger and nutrition through the index from year to year is difficult. |
| | **Agricultural Science and Technology Indicators** | Provides information on agricultural research and development (R&D) systems across the developing world | Does not provide a composite index that provides a ranking at one glance |
| **Climate Change** | **WRI—CAIT** | Benchmark and provide information on countries' contribution and vulnerability to climate change and other environment-related information | Neglects the interdependencies of agricultural productivity and resilience |
| | **WRI Global Forest Watch** | Interactive platforms provide indicators such as tree cover state, loss and gain by country | No composite index is provided. |
| | **University of Notre Dame Global Adaptation Index (ND-GAIN)** | The ND-GAIN shows a country's current vulnerability to the disruptions that will follow climate change, such as floods, droughts, heat waves, cyclones, and security risks. It also demonstrates their readiness to leverage private and public sector investment for adaptation actions. This study incorporates the readiness index of the ND-GAIN. | |
| **M&E for CSA** | **Global Donor Platform for Rural Development** | Indicators for agriculture and rural development | Does not track climate change mitigation and resilience to climate change |
| | **CCAFS Resilience** | Provides project-level indicators for monitoring and evaluation projects that seek to increase adaptive capacity, enhance livelihood and farm functioning | Agricultural production and land use management, as well as farmers' potential to adapt to and mitigate climate change are not addressed. |
| | **World Bank Land Quality and Sustainable Land Management** | Indicators tackle ecological resilience excluding the resilience and adaptive capacity of households | Only partially allows for monitoring the mitigation potentials of agriculture |
| **Baseline information for CSA** | **CSA Profiles by CCAFS** | A set of CSA country profiles for Latin America and the Caribbean, which are based on the CSA pillars of productivity, adaptation, and mitigation | It is difficult to derive policy recommendations from them or recommendations as to which technology may be the most suitable at the project level. |

*Note:* CAIT = Climate Analysis Indicators Tool; CCAFS = CIGIAR Research Program on Climate Change, Agriculture and Food Security; WRI = World Resources Institute.

**TABLE 1.2.** THE THREE CSA INDICES

| Indices | Rationale |
|---|---|
| Policy Support and Institutional Readiness Index (CSA-Pol) | The level of adoption of CSA practices depends on the enabling environment that is a function of policy and institutional context in the country. Responding to climate change requires national food security adaptation and mitigation strategies. Building farmers' adaptive capacity requires considerable investments above the farm level. |
| Technology Index (CSA-Tech) | The applied CSA technologies need to be context specific and prioritized in different landscapes/farming systems. Indicators should be able to capture changes in **P**, **R**, and **M** caused by changes in technologies. |
| Results Index (CSA-Res) | The relative benefits of CSA adoption need to be measured. A portfolio of indicators appropriate for the particular intervention is needed. |

The report is structured as follows: Chapter 2 discusses the impact pathway and theory of change used to develop the indicators. Chapter 3 discusses the criteria for selection of indicators, organization, and procedure for using the indices. Chapter 4 summarizes major findings for the CSA-Pol Index country assessments. Chapter 5 tests the usage of the CSA-Tech Index and the CSA-Res Index to current World Bank projects. Finally, chapter 6 provides a conclusion and a view to the future.

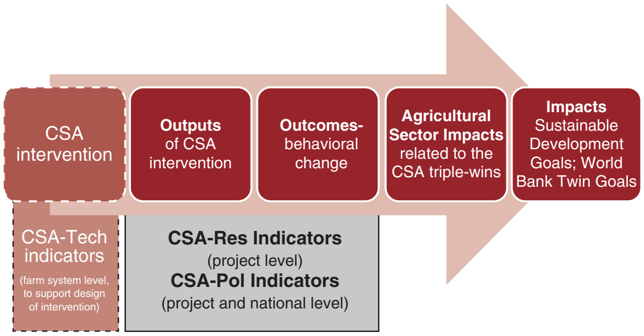
## CHAPTER TWO

# IMPACT PATHWAY AND THEORY OF CHANGE

The CSA indices are informed by an impact pathway and provide a framework for measuring the outputs and outcomes of a CSA intervention highlighting behavioral change that will support the achievement of the CSA triple-wins. The impact pathway is a theoretical framework that helps guide program planning, management, and evaluation. In contrast to the frequently used logical framework, which describes the project by proceeding from inputs and activities to outputs and outcomes to the ultimate goals by an if-then causal logic, the impact pathways provide a more holistic view of the change process. It is a flexible approach that allows investigating change processes independent of concrete interventions by articulating hypotheses as to how impacts are being achieved (Kim et al. 2011). It can incorporate the views of different stakeholders and it is assumed that it can evolve over time, as more knowledge is gained about agricultural innovation processes (Springer-Heinze et al. 2003).

To understand which indicators and indices are relevant to monitor and measure the success of a CSA intervention in terms of achieving the CSA triple-win goals, we developed an impact pathway. The pathway is general in nature and does not relate to specific project activities. Instead, we captured how stakeholders' behavior could change (see the section "Outcomes—Behavioral Change" for further description)—on a project and national scale—to support the achievement and sustainability of CSA goals and impacts in the agricultural sector (see the section "Agricultural Sector Impacts") and how these relate to the sustainable development goals and the World Bank's twin goals of shared prosperity and ending extreme poverty. Although we recognize that these relations are partial in nature, it is important to note the sustainability of the CSA impacts can only be achieved when stakeholders change their behavior. Thus, the impact pathway provides a conceptual framework for determining a clustered set of indicators, which allow measurement of behavioral change (project outcomes), direct project outputs, and aspects of the enabling policy and institutional environment that may be necessary to support the CSA intervention and subsequently

**FIGURE 2.1.** IMPACT PATHWAY FOR CSA INTERVENTIONS AND RELATION TO CSA INDICATORS




achieve the long-term development outcomes.[1] Some of the project outputs are assumed to be approximate measures of behavioral change. The assigned indicators are part of the CSA Results and CSA Policy Indices, which can be used after a specific intervention (see figure 2.1). The CSA Technology Index can be used at the beginning of an intervention to support the choice of a CSA technology.

# AGRICULTURAL SECTOR IMPACTS

This section discusses and describes the long-term outcomes that CSA interventions typically aim to achieve. The behavioral changes from different stakeholder groups that may lead to these long-term outcomes are described in the next section.

## INCREASING PRODUCTIVITY

Increasing productivity is a dedicated goal of CSA. For instance, in many African countries yield levels of many commodities are still below the world average. Such low levels of productivity are mainly attributable to scarce knowledge of agricultural practices, low-level use of improved seed, low-level fertilizer use, inadequate irrigation, and the absence of strong institutions and policies (IFPRI 2012). It has been demonstrated that increasing productivity can increase food availability and access, as well as rural incomes.

There are three interrelated benefits for society from enhancing agricultural productivity: (i) economic growth and poverty reduction, (ii) food and nutrition security and (iii) environmental sustainability (FAO 2013). It is well established that growth in agriculture is twice as effective in reducing poverty as growth originating from other sectors (World Bank 2007). Productivity growth in agriculture creates income and employment and generates demand for other rural goods. This also leads to stimulating growth in other parts of the economy. Productivity determines the price of food, which in turn determines wages and competitiveness of the tradable sector (WDR 2008).

Sustainable production systems are knowledge intensive, such that investment in intellectual capital, typically acquired through research and development and dissemination of agricultural technologies and management practices, and human capital, acquired through education, training, and extension services, will be relevant to achieve sustainable and climate-smart agriculture. To achieve high levels of investment in human, social, and natural capital, action on the national and international levels is needed (FAO 2013). The 2008 World Development Report suggested several activities that can increase agricultural productivity:

- » Improve price incentives and increase the quality and quantity of public investment;
- » Improve the functioning of producer markets;
- » Improve access to financial services and reduce exposure to uninsured risk;
- » Enhance performance of producer organizations;
- » Promote innovation through science and technology; and
- » Make agriculture more sustainable and a provider of environmental services.

These efforts demand broader policy and strategic frameworks that encompass agro-industrial and agribusiness services along with farming (IFPRI 2012).

## ENHANCING RESILIENCE

Increasing occurrence of erratic and extreme weather events and increasing volatility of food prices and

[1] Note direct outputs are not described in detail in the impact pathway presented here. This is a general CSA impact pathway, in which we do not describes outputs, activities, and inputs of specific CSA interventions. The indicators, however, may describe outcomes or outputs.

uncertainties related to the development of global markets and policies can have a negative impact on food security and agricultural income of consumers, farmers, and entire countries. Smallholder farmers who have the largest role to play in achieving food and nutrition security are largely "climate dependent" but have the weakest capacity to adapt to this increasingly volatile world. Their resilience needs to be strengthened, through targeted policies, investments, and institutions (Fan 2014). Enhancing resilience, at every scale and from environmental, economic, and social perspectives, is a crucial goal of CSA interventions.

There are many definitions of resilience. The International Panel on Climate Change (IPCC) (2014) refers to resilience as "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." As social, economic, and environmental landscapes change, resilience has to be regarded as a dynamic process rather than a static state (Frankenberger et al. 2014). In the social system, resilience may refer to the ability of communities to withstand and recover from stress such as environmental, social, economic, or political changes. Social systems can plan according to real or perceived changes, thus avoiding damages, minimizing losses, and taking advantage of opportunities. For natural systems, resilience is indicated by how much disturbance an ecosystem can handle without shifting into a qualitatively different state. The complexities and relation and interdependence of both systems have to be considered when building resilience to climate change (IFPRI 2009).

To enhance resilience of smallholder farmers, it is relevant to facilitate their access and use of productive assets, such as land and water and production inputs. Strengthening of land and water rights may encourage farmers to invest, build assets, and diversify. Enhancing access to water, through on-farm water harvesting, the enhancement of soil's capacity to hold moisture, on-farm water retention, and more systematic access to groundwater or supplementary irrigation can have a positive impact on household's resilience (FAO 2013).

Further investment in both technological and political innovations is needed. This may include research, development and dissemination of drought-tolerant seed varieties and bio-fortified crops, replacement of inefficient subsidies, provision of social safety nets, and risk management tools that support household livelihood strategies and preparedness, prevention, response, and recovery activities in response to shocks and climate change–related occurrences (Frankenberger et al. 2014). But enhancing resilience also entails strategies such as improving the sustainability of forest management. This not only increases the forest's resilience but also contributes to improving water management, protecting the soil from erosion, and conserving agro-biodiversity (FAO 2013).

### REDUCING GREENHOUSE GAS EMISSIONS

Reducing greenhouse gas emissions resulting from agriculture is one of the main aims of CSA. A CSA intervention should lead to sustainable reductions of agricultural GHG emissions. On the global scale, the Agriculture, Forestry and Other Land Use (AFOLU) sector is responsible for approximately a quarter of anthropogenic GHG emissions—mainly from deforestation, livestock, and poor soil and nutrient management. Mitigation opportunities include both demand-side and supply-side strategies. The demand-side strategies include reducing food waste and losses, changes in diet, and reducing wood consumption. On the supply side, strategies reduce GHG emissions through improved management of land and livestock. Carbon sequestration in soils and biomass lead to increased levels of terrestrial carbon stocks (IPCC 2014).

As the global population continues to grow, agricultural production is also expected to increase, especially in developing countries. By improving efficiency and decoupling production growth from emission growth, as well as by enhancing carbon sinks, agriculture can contribute to climate change mitigation and be in line with the "food security first" objective (FAO 2013).

## OUTCOMES—BEHAVIORAL CHANGE

As noted earlier to sustainably achieve the desired impacts of CSA, the proposed intervention must influence behavior change. This section describes the behavioral 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.

## 1. PRODUCERS

CSA interventions and projects aim to induce the following observable behavioral changes in producers:

i. Producers adopt appropriate CSA technologies and inputs such as seed, fertilizer, pesticides, and risk management tools. This outcome demonstrates that producers have taken up the outputs of a specific CSA intervention into their daily practice.

ii. Producers demonstrate improved knowledge on the costs, benefits, and trade-offs of adopting CSA. To ensure a sustainable adoption of these CSA practices, knowledge and capacity of producers must be developed. This supports the resilience as well as the productivity of farming systems.

iii. Producers engage with extension services, which is crucial if the desired impacts are to be achieved because such engagement has the potential to empower them to make decisions.

iv. Producers adopt income improvement strategies including income diversification and access to improved financial instruments and services.

v. Producers integrate into new markets and engage with value chains. Access to markets is essential for smallholder producers to generate income, strengthen food security, and contribute to sustainable livelihoods.

## 2. POLICY MAKERS AND INSTITUTIONS

CSA interventions and projects aim to induce the following behavioral changes in policy makers and institutions:

i. Policy makers monitor and oversee CSA compliance. The institutional commitment and support of policy makers is crucial to ensure the sustainable adoption and application of CSA not only at the farm level but also at the landscape and national levels.

ii. Institutions cooperate in developing and disseminating information. CSA demands a landscape approach and CSA implementation requires cooperating across different sectors. Decision makers from various ministries and research institutes with different thematic focuses must work together to gather and provide timely and relevant information. This behavioral change in policy makers and institutions aims to facilitate the future availability of data and information on CSA within a landscape approach.

iii. Policy makers utilize a diversity of instruments, information, and stakeholder inputs for creating incentives and building capacity of producers to implement CSA in an intersectorial manner and across various stakeholders including technical, research, and extension staff, as well as nongovernmental stakeholders and international partners.

iv. Policy makers establish an institutional framework for CSA implementation. Policy makers establish the legal and regulatory frameworks to promote and mainstream CSA. This behavioral change conveys the commitment and frame for implementing CSA. Within this framework, policies and regulations that aim at promoting CSA are drafted.

v. Government agencies implement, enforce, and monitor and evaluate CSA polices. Thus it is crucial that policy makers monitor and oversee CSA compliance across various sectors and institutions.

vi. Government should also commit to regional and global agreements and mechanisms to support climate change adaptation and mitigation. This outcome supports the goal of mitigating GHG caused by agriculture.

## 3. EXTENSION WORKERS

Extension workers should also engage in multilateral knowledge sharing and strive to be up to date with the latest knowledge on CSA from a variety of sources including the farmers themselves. Extension services are one of the key channels through which information on new technologies and practices will be disseminated, and are therefore an important supporting service for CSA implementation.

## 4. CONSUMERS

Consumers support CSA practices in consumption decisions. Value is captured and determined by consumers when they buy the product, which then benefits other segments in the value chain. Hence consumers, in particular those in developed countries, have a large degree of power. Consumers' behavior should reflect raised awareness regarding reduction, reuse, and recycling of food that is still fit for human or animal consumption or other purposes (for example, compost or biogas) (FAO 2013). Their behavior should also be reflected in an increased demand for goods that stem from integrated, sustainable value chains that build on CSA practices. Their demand will support farmers (and value chains) to promote sustainable production.

## 5. CIVIL SOCIETY

Civil Society supports CSA-related activities and the sector goals of improved productivity, enhanced sustainability and resilience, and reduced GHG emissions. Civil society plays a crucial role in mainstreaming CSA activities to achieve the desired impact. Civil society institutions readily foster bottom-up engagement and have considerable potential to exercise influence in decision-making processes, for instance, becoming vocal about local concerns and demand measures or services (FAO 2013). Civil society's engagement can take place on a local to international level, and has considerable potential to support the achievement of the desired impacts.

## 6. PRIVATE SECTOR

The private sector engages in CSA-related activities and supports an environment that furthers the sector goals of improved productivity, enhanced sustainability and resilience, and reduced GHG emissions. The key private sector agents may include farmers themselves, producer cooperatives, national and international agribusinesses, commercial consultancies, and banks and credit and savings institutions. Private sector actors provide research, development, education, and extension. 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.

**CHAPTER THREE**

# INDICATOR SELECTION AND APPLICATION

The selection and development of the indicators encompassed an extensive literature review, the development of an impact pathway (desirable impacts in the agricultural sector and behavioral changes leading up to it) and theory of change, and three expert consultations. The project team also examined and selected some World Bank Core Sector Indicators that were eventually included in the CSA Results Index. Nearly 80 experts from the World Bank Group and development partners participated in the consultations.

A key to an effective assessment of the "CSA-ness" of a project is to strategically select the most accurate indicators for the project of interest. Although there are several indicators that could potentially work, it may be impractical to use more than a few. Effective indicators should be the following (FAO 2010):

» **Relevant:** The indicator reveals something that you want to know about the system.
» **Precise:** You can reliably trust the information that the indicator provides.
» **Sensitive:** As the system changes, the indicator changes in a predictable fashion.
» **Easy to understand:** The indicator is intuitive to laypersons and decision makers.
» **Measurable:** The indicator is based on accessible data that are already available or can be collected and interpreted with relatively easily.

In the process of indicator selection, indicators were chosen to ensure that indicators are Specific, Measurable, Achievable and Attributable, Relevant and Time Bound (SMART). These attributes are defined as follows:

i. Specific: Indicators should reflect simple information that is communicable and easily understood
ii. Measurable: Information can be readily obtained. Are changes objectively verifiable?
iii. Achievable and Attributable: Indicators and their measurement units must be achievable and sensitive to change during the life of the project.

iv. Relevant: Indicators should reflect information that is important and likely to be used for management or immediate analytical purposes.
v. Targeted: Progress can be tracked at a desired frequency for a set period of time.

Although SMART is a helpful criterion, indicators should be more than that and include a precise definition, be feasible, and be useful for decision making. The technical notes of the CSA-Pol, CSA-Res, and CSA-Tech indicators typically include information about their justification, unit, frequency, data source, and calculation method (please see the appendixes for the complete list of indicators and technical notes).

The first expert consultation in May 2014[1] discussed the suitability of the initial large set of indicators for developing the three CSA indices, the structure of the indices, and approaches for scoring and aggregating indicators. The results from this consultation led to the development of peer-reviewed lists of indicators for each index and relevant methods for scoring the indicators.

The second expert consultation held in October 2014[2] sought feedback and built consensus on the indicators selected for each CSA index, methodologies applied for scoring and aggregating indicators, and the structure and design of the CSA Index web tool.

The third and final expert consultation held in January 2015[3] in collaboration with the International Food Policy Research Institute (IFPRI) assessed the global relevance and utility of the indicators, and also identified the possible synergies between the World Bank and IFPRI's effort in this area.

Combined with the literature review, these expert consultations allowed the project team to develop a comprehensive set of indicators that could potentially provide the evidence base for identifying viable climate-smart options, selecting contextually relevant technologies and practices, monitoring results, and assessing policies and the necessary enabling activities.

The CSA indicators website (http://csai.worldbank.org) summarizes the findings of the CSA-Pol Index and allows easy derivation of P, R, and M for CSA-Res and CSA-Tech indicators.

# CSA POLICY INDEX

## PURPOSE

A country's policies and the capacity of its institutions to implement and administer those policies are vital determinants of whether an enabling environment is in place for making CSA a practical, operational reality. This will require substantial coordination between public institutions such as agriculture and environment ministries, as well as research institutions and extension services. Entities, whether public or private sector, that provide producers with financial and risk management services, marketing opportunities, and infrastructure likewise play very important roles in defining the environment in which CSA-related activities and initiatives are carried out (Branca et al. 2011b). The enabling landscape for CSA will look different from one country to the next depending on the existing policy landscape, socioeconomic conditions, level of agricultural development, and the specific challenges that climate change presents.

The CSA Policy Index is a collection of indicators, each with subindicators, that are used to assess the enabling environment for making CSA operational at the national level in terms of policies, legal frameworks, and the capacity of important stakeholders such as farmers, investors active in value chains, extension agents, research administrators, regulators, and others. The index is designed to provide a kind of overview of a country's readiness to

[1] The first consultation included experts from the following institutions: aWhere, Conservation International, Croplife International, FAO, Field to Market, Global Environment Fund (GEF), Inter-American Development Bank, International Fund for Agricultural Development, International Finance Corporation (of the World Bank (IFC), IFPRI, International Life Sciences Institute, U.S. Agency for International Development, and World Bank.

[2] The second consultation included experts from the following institutions: aWhere, Conservation International, GEF, IFC, IFPRI, U.S. Department of State, World Bank, and WRI.

[3] The third consultation included experts from the following institutions: ASTI, Conservation International, GEF, HarvestChoice, IFC, IFPRI, and World Bank.

## TABLE 3.1. STRUCTURE OF THE CSA-POL INDEX

| Themes | Indicators | CSA Triple-Win Alignment |
|---|---|---|
| **Readiness Mechanisms** | **1. Agricultural adaptation policy** *(3 subindicators)* | R |
| | **2. Agricultural mitigation policy** *(3 subindicators)* | M |
| | **3. Economic readiness** | R |
| | **4. Governance readiness** | R |
| | **5. Social readiness** | R |
| **Services and Infrastructure** | **6. Extension services** *(2 subindicators)* | P, R, M |
| | **7. Agriculture R&D** *(2 subindicators)* | P, R, M |
| | **8. Rural Access Index (RAI)** | P, R |
| | **9. Social safety nets** | R |
| | **10. National GHG inventory system** *(2 subindicators)* | M |
| | **11. National agricultural risk management systems** *(6 subindicators)* | P, R |
| | **12. Adaptive capacity** | P, R |
| **Coordination Mechanisms** | **13. Disaster risk management coordination** *(3 subindicators)* | R |
| | **14. Coordination mechanism** *(4 subindicators)* | P, R, M |

undertake a program of climate-friendly initiatives, and of what needs to happen to improve that readiness. It also provides a useful framework with which to compare agricultural policy regimes in different countries, potentially encouraging competition and giving public officials who champion CSA an important source of leverage in promoting it.

The 14 indicators of the CSA-Pol Index (table 3.1) are clustered into three themes: *Readiness Mechanisms*, *Services and Infrastructure*, and *Coordination Mechanisms*, and each indicator is aligned with the CSA triple win of Productivity (P), Resilience (R), and Mitigation (M). Technical Notes on the indicators and subindicators of the CSA Index can be found in appendix B.

## DERIVATIVE OF THE INDEX

In assessing a country's institutional arrangements and readiness mechanisms to support CSA implementation, indicators were selected covering three broad themes: (i) readiness mechanisms; (ii) services and infrastructure; (iii) coordination mechanisms.

## SCORING CSA-POL INDICATORS

The CSA policy scores were calculated using the average of the 14 indicator scores. Binary scoring was used for the qualitative indicators in the index, and quantitative scores were normalized to between 0 and 1. The final score of the indicators was determined as the product of the assigned weight and the normalized indicator score. Final indicator scores were calculated as the average of this product to a single index score between 0 and 1. In some cases no data could be obtained for the indicator and therefore a score of 0 was assigned.

## CSA THEME: READINESS MECHANISMS

National policies and strategies represent the readiness mechanisms for support of CSA implementation.

This aspect for enabling CSA implementation is measured across five indicators and focused on the following subthemes:

*Indicators #1 and #2—Agricultural Adaptation Policy and Agricultural Mitigation Policy*

The multiple challenges of climate change will require a major transformation of the agricultural sector. The integration of these challenges and opportunities into agricultural development planning is critical and requires enabling policies to guide this integration (FAO 2010, 2012). For example, policy support for agricultural systems adapted for climate change must consider the barriers to adoption of climate-smart practices, and reduce the impact of income losses associated with extreme climatic events so as to guarantee food security for the more vulnerable households (FAO 2012). A focus on policy for CSA implementation makes sense given that policies are a blueprint for strategies and action plans that support CSA implementation and mainstreaming (Duguma et al. 2014). Actions to address climate change in the agricultural sector are likely to have the greatest impact if they are nested in agriculture policy because this would suggest that there is some kind of consensus among decision makers on how climate change should be addressed. However, recent analysis of enabling conditions for climate change mitigation and adaptation measured by Duguma et al. (2014) suggest that the urgency of addressing climate change has resulted in the formulation of strategies and action plans prior to the development or reform of policies. Strategies and action plans that address CSA are therefore considered part of the policy mix. In assessing a country's policy support for CSA, the index includes subindicators that examine how a country's intent to support CSA are integrated at the national level across agricultural policies, country development strategies, and other national climate change policies including National Action Plans for Adaptation and Nationally Appropriate Mitigation Actions.

*Indicator #3—Economic Readiness*

The inclusion of private sector actors along the agriculture and agribusiness continuum tends to improve the whole range of activities in agricultural value chains (production, processing, and marketing) and promote competitiveness by improving productivity, value addition, marketing, and infrastructure (World Bank 2013). The private sector is recognized as an important actor for CSA investments, as well as in supporting the development of CSA technology. This indicator assesses whether the enabling environment is conducive to agriculture-led growth, agribusiness investment, and competitiveness. This indicator builds on work currently ongoing at the World Bank to develop Agribusiness Indicators.[4]

*Indicator #4—Governance Readiness*

The governance readiness subindicators capture several aspects of governance: (i) political stability and nonviolence—the relationship between foreign financial inflow and political stability and violence suggests that a stable political environment is more attractive to general investment from outside a country, including the adaptation investment; (ii) control of corruption—corruption is known to have a negative impact on foreign investment and measuring the control of corruption implies government integrity and accountability; (iii) regulatory quality—the quality of regulation measures the performance of country institutions, an important factor in deploying adaptation actions and adaptation-related policies; (iv) rule of law is a quality of society that encourages foreign investment in general, hence the adaptation investments (Chen et al. 2015).

*Indicator #5—Social Readiness*

The social readiness subindicators use socioeconomic measures to assess society's overall readiness for adaptation. The subindicators include the following elements: (i) Social inequality causes skewed distribution incomes and vulnerability, and the exaggerated impacts on the poorest may further skew income distribution. Thus, social inequality exacerbates a country's capacity to adapt to climate change. (ii) Information communication technology infrastructure (ICT) enables

[4] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTARD/0,,contentMDK:23184287~pagePK:148956~piPK:216618~theSitePK:336682,00.html.

knowledge integration and learning and key ingredients of adaptive capacity, provides technical support for early warning systems, and can strengthen local organizations that implement adaptation. (iii) Education is considered an important strategy to build up adaptive capacity and identify adaptation solutions appropriate to local context. (iv) Innovation is the fundamental force behind capacity building and climate change adaptation because research and technology are necessary to define adaptation solutions (Chen et al. 2015).

## CSA THEME: SERVICES AND INFRASTRUCTURE

Several supporting services need to be available for implementing and mainstreaming CSA. Many of these services are already available in some countries, and CSA practices will require improving and strengthening these as necessary where they are already available, and ensuring that there is coordination among deliverers of services for efficiency. Significant financial investments will be needed for providing the supporting services for CSA. Supporting services are measured across seven indicators:

*Indicator #6—Extension Services*

To ensure a sustainable adoption of these CSA practices, knowledge and capacity of producers have to be developed because many CSA interventions are considerably knowledge intensive. The index includes an indicator to assess the capacity of national extension services to provide relevant information and advice to farmers for dealing with the impacts of climate change on their production system. The index examines policies to support this effort as reflected in national agricultural extension services policies and the systems that are in place to provide this information such as national programs for disseminating weather and climate services to agriculture producers.

*Indicator #7—Agricultural R&D*

The Food and Agriculture Organization (FAO) of the United Nations reports that boosting agricultural production to the levels needed to feed an expanded world population will require a sharp increase in public investment to research and development, and widespread adoption of new technologies, farming techniques, and crop varieties (FAO 2009). Sustained investment in research is necessary for achieving longer-term goals such as food security, poverty reduction, and economic growth.

Research and extension services are a major component of the enabling environment for CSA as climate change impacts will, in many cases, require the adaptation of current agricultural systems to manage and mitigate impacts. The current agriculture system will need to take advantage of viable, profitable options with manageable levels of risk. Adaptation will require investments in information—for example, increasing fertilizer, pesticide, and water use efficiencies requires mapping water use over time and calculating where and when inputs are necessary (FAO 2013). A strong science and technology system involving the public and private sectors is recommended for collecting and collating the necessary information, and for disseminating information to producers through extension mechanisms.

Improving the use of climate science data for agricultural planning can increase the capacity of farmers and agricultural planners to allocate resources effectively and reduce risks associated with climate change (FAO 2010, 19). Accordingly, there is need for translators of climate information who can bridge the divide between climate science and field application and the means of disseminating this 'translated' information (FAO 2010, 19). Extension services are one of the key channels through which this information will be disseminated, and are therefore an important supporting service for CSA implementation.

*Indicator #8—Rural Access Index*

The Rural Access Index estimates the proportion of the rural population with adequate access to the transport system. Measurement of rural access is based on household survey data to estimate the number of people who live within 2 kilometers (or about 25 minutes of walking time) of the nearest all-weather road. In the absence of such data, however, road network models are also applied to calculate the proportion of rural habitable areas that are within 2 kilometers of all-weather roads as an approximation. This provides an indicator of transport access for a broader set of rural livelihoods.

*Indicator #9—Social Safety Nets*

Social safety nets (SSNs) are noncontributory transfers in cash or in kind targeted at the poor and vulnerable that can have an immediate impact on reducing poverty and on boosting prosperity by putting resources in the hands of those members of society (World Bank 2014). In countries experiencing increased exposure to disasters and climate change consequences, there is a growing recognition of the role SSNs play in providing resilience. SSNs can help to ensure that during times of hardship, such as during flooding and drought events, farming communities can access resources (money, food, and so on) to maintain or improve their living standard. Public works programs that guarantee employment when needed would effectively build resilience to climate change impacts. Agriculture-related public works activities, such as hillside terracing or soil and water conservation, can improve farm yields and generate sustainable benefits for household food security. They can also create community assets and infrastructures that are critical for adaptation (FAO 2013). The World Bank identifies five different types of SSNs: conditional cash transfers, unconditional cash transfers, conditional in-kind transfers, unconditional in-kind transfers, and public works expenditure.

*Indicator #10—National GHG Inventory System*

National GHG accounting systems may include national GHG inventories. An accurate understanding of GHG emissions allows governments, companies, and other entities to identify opportunities to manage emissions, enhance removals, evaluate the success of low-carbon growth strategies over time, and ensure that resources are targeted toward effective solutions.

*Indicator #11—National Agricultural Risk Management Systems*

Climate change can be an important threat multiplier to food security. It also introduces another source of risk and uncertainty into food systems from the farm to the global level (Branca et al. 2011). CSA promotes the incorporation of risk management tools into agricultural systems. Tools identified by the FAO as being important in this regard include buffer stock, emergency grain reserves, warehouse receipt systems, tariffs and quotas, market information systems, weather forecasts, early warning systems, and index-based insurance (FAO).

*Indicator #12—Adaptive Capacity*

Adaptive capacity describes the availability of social resources to reduce exposure and sensitivity. In some cases, these capacities reflect sustainable adaptation solutions. In other cases, they reflect the ability of a county to put newer, more sustainable adaptations into place to address the needs of a particular sector (ND-GAIN 2015). It is important to note that the adaptive capacity score considers not only adaptive capacity within the agricultural sector, but also within the sectors of water, health, infrastructure, transport, and environment, and therefore provides a broad measure of a country's adaptive capacity to climate change impacts.

## CSA THEME: COORDINATION MECHANISMS

Given their crosscutting nature, climate policies may be embedded in several sectors. There is need for coordination among policies for promoting and implementing CSA. The key requirements for an enabling policy environment to promote and implement CSA are greater coherence, coordination, and integration between climate change, agricultural development, and food security policy processes (FAO 2010). Coordination, planning, and support for CSA are measured across two indicators:

*Indicator #13—Disaster Risk Management Coordination*

As part of adaptation strategies to climate change, the index also examine whether a country integrates the agricultural sector into disaster risk reduction (DRR) planning, or, conversely, how DRR is integrated into the agricultural sector. Disaster risk reduction and management that focus on reducing people's exposure and sensitivity to climate change impacts and increasing their adaptive capacity to better manage climate change helps to build the resilience of those people to the impacts of climate change. In an agricultural context, building the resilience of people (producers); the production system (farms); and the agricultural value chain promotes the "increasing resilience" goal of CSA. Policy support for DRR can help to support a systematic and coordinated effort in preparing national systems to be able to predict and anticipate impending disasters, and to respond to disasters in a timely manner that does not result in setback of development efforts (FAO 2013, 414). An examination of a country's disaster management or its agricultural policies is required.

*Indicators #14—Coordination Mechanism*

CSA implementation requires coordination across agricultural sectors (for example, crops, livestock, forestry, and fisheries) and other sectors such as energy and water. Cross-sector development is essential to capitalize on potential synergies, reduce trade-offs, and optimize the use of natural resources and ecosystem services (FAO 2013). Implementation of CSA will require cooperation of four main groups of stakeholders within these sectors: (1) government policy and decision makers to establish the legal and regulatory frameworks for CSA and to promote and mainstream CSA in an intersectorial manner; (2) government technical, research, and extension staff to develop and disseminate CSA practices; (3) agribusinesses including nongovernmental research and extension organizations for supporting government efforts to implement CSA; and (4) producers that actually implement CSA practices. Cooperation among stakeholders in these four groups has the potential to improve the design and implementation of CSA policies by allowing various stakeholders to voice their needs and concerns, to be more aware of and responsive to the needs and concerns of other actors, and to create opportunities for knowledge exchange (World Bank 2011). Such cooperation should be the standard among stakeholders in the agricultural sector; however, cooperation in many countries is challenged by opportunistic behavior among stakeholders, lack of trust, lack of incentives for cooperation, difficulty in setting and enforcing rules, policies that are imposed without local participation, conflicting interests among land users, lack of harmony and coordination between legal bodies and procedures, poor identification of and inadequate consultation with stakeholders, and uncoordinated planning (World Bank 2011; FAO 2013). Given that the stakeholder groups identified herein are the same stakeholders responsible for development and innovation in the agricultural sector, it is expected that within some countries CSA planning implementation would be challenged by low capacity or little cooperation.

## APPLICATION

The benefit of the CSA Policy Index is that it provides a ranking of a country's adoption of CSA policies relative to other countries. However, beyond assigning a ranking, the CSA-Pol indicators can allow policy makers and other users to compare how a country's enabling environment for CSA is changing over time; identify gaps in supporting CSA implementation; and provide opportunity to develop benchmarks for reform. Indicators can also be used individually, allowing users to compare single indicators across countries or across time, identify strengths and weaknesses, and prioritize specific areas for intervention. In this regard, the CSA Policy Index represents a useful tool for initiating or furthering policy dialogue and planning on how to adequately and efficiently deal with climate change in the agricultural sector.

## LIMITATIONS

Although the index represents a useful tool for identifying policies and institutional arrangements that are critical for enabling CSA, it currently does not measure the performance or quality of various policy measures, services, and coordination mechanisms to support implementation. For example, a country may have agro-meteorological services or programs for building farmers' resilience to climate change; however, the index does not assess the efficacy of the program or the extent to which farmers are able to access agro-weather information and advisories and adopt new practices and technologies as a result of the agro-meteorological programs. Furthermore, although the index assigns a composite score for each country based on the institutional arrangements for enabling CSA interventions, it does not provide an aspirational number for supporting CSA implementation. It is also worth noting that the index does not cover the full range of policies and services for CSA implementation in any country. In developing reforms to support CSA implementation, policy makers should consider measures to assess the quality of services and performance of coordination and institutional mechanisms to support implementation.

## CSA TECHNOLOGY INDEX

### PURPOSE

The value of the CSA Technology Index comes from its potential to improve decision making. The index contains a set of indicators, formulated as survey questions, with the strategic intent of diagnosing the relative significance of each of the triple-win (P, R, M) priorities in the proposed intervention area. By being able to diagnose the relative contextual importance of the triple-win priorities, project task team leaders can choose which CSA technologies are most appropriate for their proposed project. Considering CSA in the global context, the CSA Technology indicators were developed to meet the following criteria:

1. Relevance and suitability at the farming system level
2. Measurability
3. Acceptability to many stakeholders

### DERIVATION OF THE INDEX

The CSA Technology Index contains a set of 27 indicators clustered into three main themes: Productivity, Resilience, and Mitigation. In choosing indicators, it is recommended that project leaders make their own choices on the selection of indicators based on their perception of the project needs. Taking this into account, the CSA Technology Index is built for "minimal indicator use" and project leaders can use as few as three indicators for their project. Table 3.2 provides an overview of the CSA Technology indicators. Technical Notes on the CSA-Tech Index can be found in appendix C.

### SCORING CSA-TECH INDEX

To generate a final score, we assign each indicator a raw (measured) score and a target score based on whether optimal conditions have been met. If the raw score is greater than the target score, we assign a score of 1 for that indicator; if equal, we assign a score of 0; and if it is smaller than the target score, we assign a score of −1. We then map each indicator score to R, P, and M themes to generate an R score, P score, and M score. Each of these scores is generated by the share of "exceed" and "just met" indicators out of total numbers of indicators in that theme. Finally, we calculate the average of three theme scores to generate the CSA-Tech Index that ranges from 0 to 1—the larger, the better.

Twenty of the CSA indicators use the Likert scoring system (1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree, 5. Strongly agree). The target score for the Likert-based indicators is 3. The remaining seven indicators use actual numbers for the raw score and target score. For instance, the 14th indicator in table 3.2 is Crop Yield (which is based on a "% increase" measurement). For the actual number indicators, the users need to input their raw scores and their target scores. The recommendation on which practice to implement in a particular area is based on the aggregated score of surveyed indicators, with the highest-scoring CSA practice recommended.

### APPLICATION

As part of the project preparation process, after the project area and context have been defined, the CSA-Tech Index survey should be distributed to stakeholders (farmers, extension workers, policy makers, academics) familiar with the project area or similar farming systems. The results from the survey should then be collated and project task team leaders can then assign a relative score for each of the CSA priorities (P, R, M) and an aggregate score. The relative score of the triple-win areas, among other factors, will help project teams to diagnose, for example, the type and combination of climate-smart technologies to be implemented by the project; the intensity of capacity-building efforts for smallholders; the magnitude of income diversification activities needed in the project area; and the mitigation strategies for the project.

There is a range of technologies that project task team leaders can select based on the project context and farming system (irrigated, wetland rice, rain fed, coastal artisanal fishing, urban, or dualistic). This report identifies five key categories[5] of CSA technology applicable to eight

[5] Similar categories are also used in CCAFS country profiles.

## **TABLE 3.2.** STRUCTURE OF THE CSA-TECH INDEX

| Themes | Subthemes | Indicators |
|---|---|---|
| **Productivity (P)** | Crop system | 1. The technology leads to an increase in yields of the producers (%).<br>2. The technology reduces the share of agricultural land classified as having moderate to severe water erosion/wind risk (%).<br>3. The technology enhances soil fertility (%).<br>4. The technology enhances biodiversity of the farming landscape in comparison with current interventions in similar farming systems. |
| | Water use | 5. The technology increases the share of irrigated agricultural land as a result of the technology (%).<br>6. The technology reduces water withdrawal for agriculture use as a share of total water withdrawal (%). |
| | Energy | 7. The technology reduces the agriculture energy use as a share of total household energy use (%). |
| | Pest management | 8. The technology increases the share of agricultural land on which integrated pest management practices are adopted (%). |
| | Livestock system | 9. The technology improves livestock diversification in comparison with current interventions in similar farming systems.<br>10. The technology improves livestock resource management in comparison with current interventions in similar farming systems.<br>11. The technology improves feed production in comparison with current interventions in similar farming systems.<br>12. The technology leads to the diversification of livelihood activities in comparison with current interventions in similar farming systems. |
| **Resilience (R)** | Robustness | 13. The technology will improve the human capital (technical skill levels) of producers in the target area.<br>14. The technology will increase the stability of agricultural production needed to help producers meet their own basic food security and income needs.<br>15. The technology will promote the diversification of the income and asset bases of producers.<br>16. The technology will promote crop diversification in the target area.<br>17. The technology will involve the incorporation of site-specific[a] knowledge in its application.<br>18. The producers in the target area will have appropriate access to IPRs needed for the deployment of the CSA technology. |
| | Self-organization | 19. The technology will facilitate cooperation and networking among producers.<br>20. The technology will foster local and regional production and supply chains.<br>21. The intervention will provide opportunities for feedback from extension workers.<br>22. The CSA service will narrow existing power differentials in the community.<br>23. The technology will contribute to reducing existing gender inequalities. |
| | Cropping system | 24. The technology will increase the resilience of the cropping system to drought. |
| | Livestock system | 25. The technology will increase the resilience of the livestock to drought. |
| **Mitigation (M)** | Emissions intensity | 26. The technology meets emissions intensity targets. |
| | Sequesters carbon | 27. The technology sequesters carbon in comparison with current interventions in similar farming systems. |

[a] Indigenous knowledge: "local, orally transmitted, a consequence of practical engagement reinforced by experience, empirical rather than theoretical, repetitive, fluid and negotiable, shared but asymmetrically distributed, largely functional, and embedded in a more encompassing cultural matrix" (Buchmann and Darnhoffer 2010).

broad categories of farming systems that project task teams can select to achieve their desired project goals.

**Five Key Technologies**

- » Water-Smart Technologies
- » Energy-Smart Technologies
- » Nutrient-Smart Technologies
- » Stress-Tolerant Technologies
- » Climate-Smart Livestock Technologies

**Eight Broad Farming Systems (FAO & World Bank 2001)**

- » Irrigated farming systems, embracing a broad range of food and cash crop production;
- » Wetland rice–based farming systems, dependent on monsoon rains supplemented by irrigation;
- » Rain-fed farming systems in humid areas of high resource potential, characterized by a crop activity (notably, root crops, cereals, industrial tree crops—both small scale and plantation—and commercial horticulture) or mixed crop-livestock systems;
- » Rain-fed farming systems in steep and highland areas, which are often mixed crop-livestock systems;
- » Rain-fed farming systems in dry or cold low-potential areas, with mixed crop-livestock and pastoral systems merging into sparse and often dispersed systems with very low current productivity or potential because of extreme aridity or cold;
- » Dualistic (mixed large commercial and smallholder) farming systems, across a variety of ecologies and with diverse production patterns;
- » Coastal artisanal fishing, often mixed farming systems; and
- » Urban-based farming systems, typically focused on horticultural and livestock production.

These categories are not intended to be an exhaustive list but rather provide a broad view of the technologies available to implement CSA.

Although project teams may not be able to use all CSA-Tech indicators in their projects, we propose a set of core CSA-Tech indicators for projects:

1. Cereal Yield: The technology leads to an increase in the yields of the producers (%);
2. Emissions Intensity: The technology meets emissions intensity targets;
3. Agricultural Irrigated Land: The technology increases the share of irrigated agricultural land because of the technology (%); and
4. Yield Variance.

For the CSA-Tech Index, the raw score (also known as actual score) refers to the relative number assigned to an indicator based on the evidentiary assessment of a particular technology. This raw score is derived from evidence from literature, smallholders, policy makers, and extension workers, in the project area or in a similar farming system. The target score is the aspirational number against which the raw score for the assessed technology, in the project area, is graded. For example, a raw score of 4 against a target score of 2 for a specific indicator, in the targeted area, shows that the technology is suitable for that specific intervention. In the case of the Likert score, we usually use 3 because that is the midpoint in the Likert scale (1–5) and anything above that demonstrates a strong correlation.

## COSTS AND BENEFITS OF MONITORING CSA-TECH INDICATORS

The fundamental criterion for choosing to monitor an indicator is that the benefits from doing so must exceed the costs. A decision maker (a farmer, project leader, or policy maker) will essentially choose to monitor only those indicators that they consider to be beneficial.

Whatever the underlying benefits, the key point is the indirectness of benefits arising from improved decision making. This is fundamentally different from benefits arising, for example, from a new production technology. The benefits of monitoring sustainability indicators arise solely from changing decisions concerning which of the existing production technologies should be used. This has profound implications, as pointed out below.

The benefits of monitoring a CSA Technology indicator are conceptually no different from the benefits of other types of monitoring, which are routinely conducted by farmers and governments. To a farmer, the gross benefit of monitoring a sustainability indicator depends primarily on the scale of production to which it is relevant (for example, the area of land for which the information is useful) and the benefit per unit of production (for example, the benefit per hectare of relevant land). For a government, there is an additional consideration in the level of adoption that is achieved (for example, the number of farmers who choose to monitor the indicator and the area over which they apply the results).

### LIMITATIONS

The CSA Technology Index is designed as a diagnostic tool to assist project preparers in making investment decisions with a focus on the triple-win areas of CSA. The index provides separate and aggregate scores for the Productivity, Resilience, and Mitigation areas based only on the data provided by the project team, without taking into account any information that may be available from any other sources. The scores are relative, so, for instance, a zero score for mitigation does not mean that the proposed project does not have any mitigation needs. The CSA Technology Index does not recommend any specific technologies nor does it recommend the size or composition of any investment; it merely points to the P, R, M requirements in the proposed project area. Project managers should also be mindful that changes toward improved CSA technology uptake should build on indigenous knowledge to allow flexibility and innovation to improve the livelihoods of the land users. The major challenges to CSA implementation in developing countries are the following:

- The lack of adequate labor owing to competing interests and poor well-being is present.
- Low levels of access to inputs and equipment such as machinery, seeds/seedlings, fertilizers, and so on is present.
- All land users have limited knowledge related to CSA technologies.

## CSA RESULTS INDEX

### PURPOSE

The CSA Results Index measures an agricultural project's performance in terms of agricultural productivity, adaptation (or resilience), and mitigation—both individually and jointly. The CSA Results Index can be applied to measure the project's performance during projects implementation or after the project has been completed. The calculation of the index is based on the set of available CSA indicators (table 3.3), but can be performed with similar agricultural and rural development indicators that are typically used in projects' results frameworks. It allows answering the following questions: How has the project performed in reaching its targets in one or all CSA triple-win areas over time? Has it performed better in one of the areas over another? How many indicators in the P, R, M areas have reached or exceeded their targets?

### DERIVATION OF THE INDEX

The CSA-Res Index is composed of 22 indicators (table 3.3), which can be used in projects' results framework. The indicators are clustered in three main categories: The first category measures the scope of the CSA intervention and focuses on the outputs of the direct project intervention; the second category shows how well the enabling environment for CSA in the project area is developed, which allows actors to sustainably implement their CSA intervention; and the third category indicates the medium- to long-term outcomes of the CSA intervention, which may depend on the activities measured by I and II. Besides the categories, eight themes have been identified: benefits, land use/cover, livestock, enabling environment, natural resources, emissions, yields, benefit, and welfare. For the calculation of the CSA-Res Index, the indicators have been assigned to the P, R, M areas. In table 3.3, the default assignment is suggested, which is further explained in the Technical Notes in appendix D. However, it is important to note that users assign different P, R, M areas as considered appropriate for their project. Several of the CSA-Res indicators are closely related to the World Bank Core Sector Indicators. The description, justification, and technical details concerning the indicators are further explained in the Technical Notes in appendix D.

Although project teams may not be able to use all CSA-Res indicators in their projects, we propose five core CSA-Res indicators for projects focused on crops and livestock, respectively, which have been identified as crucial for monitoring the performance and measuring the success of achieving the CSA goals:

1. Number of agricultural actors who adopted CSA practices promoted by the project (R)

2a. Land area where CSA practices have been adopted as a results of the project (P, M)

2b. Number of livestock units subject to CSA practices as results of the project (P, M)

## **TABLE 3.3.** STRUCTURE OF THE CSA-RES INDEX

| Categories | Topics | Indicators | CSA Triple-Win Alignment |
|---|---|---|---|
| **Indicators measuring the direct outputs of a CSA intervention** | Beneficiaries | 1. *Number of agricultural actors who adopted CSA practices promoted by the project* | R |
| | Land use/ cover | 2. *Land area where CSA practices have been adopted as a result of the project* | P, R, M |
| | | 3. *Land area provided with new or improved irrigation and drainage services* | P (R, M) |
| | | 4. *Area restored or re/afforested as result of the project* | R, M |
| | | 5. *Land area covered by forest* | R, M |
| | | 6. *Land area under land uses or land cover* | R, M |
| | Livestock | 7. *Number of livestock units subject to CSA practices as result of the project* | P, M |
| **Indicators measuring the CSA enabling environment** | Enabling environment | 8. *Client days of training on CSA provided* | R |
| | | 9. *Number of agricultural actors who use ICT services for obtaining information on weather and climate, CSA practices, and market (price) information* | R |
| | | 10. *Number of agricultural actors who are members of an association* | R |
| | | 11. *Number of agricultural actors using: financial services of formal banking institutes or nonbank financial services* | R |
| | | 12. *Number of agricultural actors employed in agriculture in the project area* | R |
| | | 13. *Target population with use or ownership rights recorded as a result of the project* | R |
| **Indicators measuring the medium- to long-term consequences of CSA intervention** | Natural resources | 14. *Annual total volume of groundwater and surface water withdrawal for agricultural use, expressed as a percentage of the total actual renewable water resources (in the project area)* | R |
| | | 15. *Land area affected by medium to very strong/severe soil erosion in the project area* | P, R, M |
| | Emission | 16. *Net carbon balance (GHG emission in tons of $CO_2$-e emission/ha/year) of project* | M |
| | | 17. *GHG emission intensity* | P, M |
| | Yield | 18. *Crop yield in kilograms per hectare and year as result of the project's CSA intervention* | P, R |
| | | 19. *Yield variability per hectare and year and crop* | R |
| | | 20. *Yield per livestock unit and year as result of project* | P, R |
| | Benefits and welfare | 21. *Annual household income from agricultural activity* | R |
| | | 22. *Number of beneficiaries who consider themselves better off now than before the intervention* | R |

3. Client-days of training on CSA provided (R)
4. Net carbon balance (GHG emission in tons of $CO_2$-e emission/ha/year) of project (M)

5a. Crop yield in kilograms per hectare and year as results of the project (P)

5b. Yield per livestock unit and year as results of the project (P)

To each triple-win area, two core CSA-Res indicators are assigned.

## APPLICATION

The CSA-Res Index can be applied to measure the project's performance after project completion, as well as during project implementation. For the calculation, CSA-Res indicators or similar rural development, agricultural, or climate change–related indicators that reflect CSA activities can be used. For each indicator, we have suggested whether it is most suitable to measure one or all of the triple-win areas to measure productivity, resilience, or mitigation. The user is free to vary the assignment of P, R, or M that he or she considers most appropriate for the project. Thus, the CSA-Res Index method gives project teams the flexibility to customize the index and adjust it to the specific context of their CSA intervention. This diversity in indicators also implies that care must be exercised when comparing projects based on the index score, as the underlying indicators and their meaning may vary significantly. However, the CSA-Res Index allows comparison of the performance of one project over time to give indications of which triple-win areas performed well over time or which other areas could be strengthened.

The set of CSA-Results indicator will be the basis for the calculation of the CSA-Res Index, which provides stakeholders with an indication of how the respective project has *performed in reaching its performance targets in the CSA triple-win areas*—resilience, mitigation, and productivity—separately and jointly. To derive the index, the following steps are required:

1. **The results framework is designed and the indicators are chosen.** A project team designs a results framework and chooses indicators to measure the Project Development Objective and the projects' intermediate results. Ideally, CSA indicators are applied if suitable. For calculating the index, the users are recommended to use the core CSA-Res indicators (see page 22).
2. **Target values are defined.** For each indicator, a baseline value and a target value to be reached at the end of the project, and for each fiscal year or other relevant time interval, are set.
3. **The indicators are assigned to the CSA triple-win areas.** The chosen indicators are assigned to the triple-win areas—productivity, resilience, and mitigation, thus indicating that the outputs or outcomes that are monitored contribute in particular to these specific CSA goals. For the set of CSA indicators, a default assignment has been proposed (see table 3.4 and Technical Notes in appendix D). However this default assignment can be changed according to the project's goals or needs and multiple assignments of a single indicator are possible.
4. **The indicators are scored.** In the next step, the indicators are scored according to whether they have reached the proposed target value, exceeded it, or failed to reach it. More specifically, the following scoring rule is proposed:
We propose a threshold of 20 percent to determine whether an indicator has achieved a score of 2 or 4. The scoring can take place at the end of

### TABLE 3.4. SCORING TABLE FOR THE CSA-RES INDEX

| Score | Level of Performance | Interpretation |
|---|---|---|
| 1 | Very unsatisfactory | The indicator's observed value falls short of the target value by more than 20%. |
| 2 | Rather unsatisfactory | The indicator's observed value falls short of the target value between 1% and 20%. |
| 3 | Satisfactory | The indicator's observed value is equal to the indicator's target value. |
| 4 | Exceeding expectations | The indicator's observed value exceeds the target value between 1% and 20%. |
| 5 | Highly exceeding expectations | The indicator's observed value exceeds the target value by more than 20%. |

the project, or throughout project implementation whenever new M&E data are available.

5. **The scores for each triple-win area are averaged.** In the next step, for each triple-win area, P, R, M, the scores of the indicators that have been assigned to the area in step 3 are averaged, yielding an overall score for the triple-win area. Users are recommended to use the core CSA-Res indicators. This allows comparing in which area the project has achieved satisfactory or unsatisfactory results or results exceeding expectation, and thus where there is room for improvement.
6. **The average score over the triple-win area is calculated.** In a last step, the average score over the triple win areas is calculated, providing an overall estimate as to how well the project has jointly achieved the CSA goals.[6]

## LIMITATIONS

There are some limitations to the CSA-Result indicators, which are discussed for each indicator in the Technical Notes in appendix D. Although the CSA-Results Index presents a useful tool to measure a project's performance toward achieving the CSA triple-win areas, it has some limitations. Whereas a core set of CSA indicators is proposed to calculate the index, users are given the flexibility to select a range of additional indicators from the list of CSA-Res indicators or other indicators related to agriculture, resilience, and climate change. Although this enables the application of the index for a range of projects, it complicates comparing CSA-Res indices across projects as the underlying data and their meaning may vary significantly. Thus, the focus of application should be to compare the project's progress over time. Similarly, users are flexible to choose a project-specific assignment of P, R, M categories for their indicators, other than the proposed categories in this text, which may make it more difficult for the index to be compared across projects. To demonstrate the progress of the project in achieving its targets in the triple-win areas, it is recommended that at least two indicators in each area be used, which are ideally different in meaning and not subcategories of one indicator. Finally, although the index can be assessed over the time of project implementation and after project completion, and it can capture the project's performance in the form of a number, it does not give action-oriented advice as to how the performance could be improved.

[6] A web page has been set up (http://csai.worldbank.org) that allows easy derivation of P, R, and M for CSA-Res and CSA-Tech indicators.

**CHAPTER FOUR**

# KEY FINDINGS FOR THE CSA POLICY INDEX

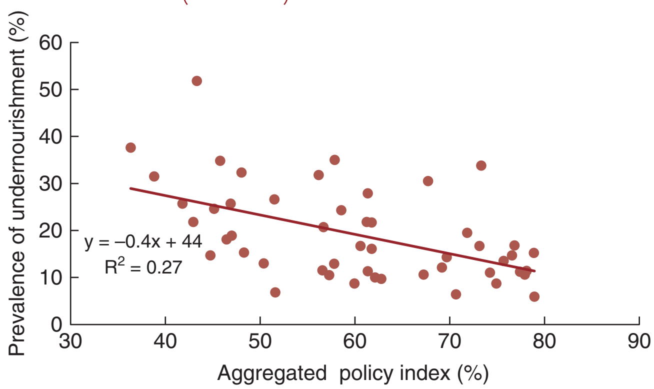
An assessment of the adoption of CSA policies was performed on 88 countries including 32 countries in Sub-Saharan Africa (SSA), 22 in Latin America and the Caribbean (LAC), 12 in Europe and Central Asia (ECA), 9 in East Asia and the Pacific, 8 countries in the Middle East and North Africa, and 5 countries in South Asia. For each country, a composite CSA-Pol Index score was calculated using the weighted average of 31 subindicators.

This report highlights the importance of adopting CSA policies to address food insecurity under changing climatic conditions. A 1 percent increase in the CSA-Pol Index is predicted to lead to a 0.4 percent decline in the proportion of undernourished population (figure 4.1). Cereal yields increase 47 kilograms per hectare for every 1 percent increase in the CSA-Pol Index (figure 4.2). Appropriate policies, institutions, and support services targeted at farmers can include measures aimed at building economic resilience at farm level by increasing productivity and income, enabling saving, and promoting diversification. A 1 percent increase in CSA-Pol Index is predicted to lead to a 0.08 decrease in coefficient of variance of cereal yield (figure 4.3).

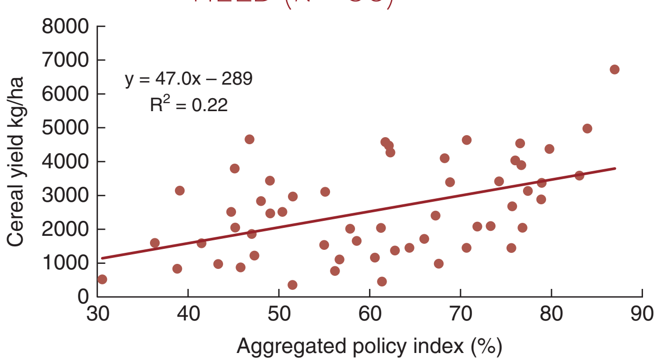
A 1 percent increase in the CSA-Pol Index is predicted to decrease GHG intensity of milk by 0.11 kg $CO_2$-e/kg (figure 4.4). A 1 percent increase in CSA-Pol Index is also predicted to decrease GHG intensity of chicken by 0.11 kg $CO_2$-e/kg (figure 4.5). GHG intensity of paddy rice will decrease by 0.02 kg $CO_2$-e/kg (figure 4.6).

Countries in the assessment are at varying stages of the adoption of policies to support CSA implementation—the CSA-Pol Index ranged from 31 percent for Sudan to 87 percent for Chile (figure 4.7). CSA-Pol Index, readiness mechanisms, and services and infrastructure support scores increase with increasing level of income (figure 4.8). This suggests that national investments in services that support CSA such as agriculture crop insurance, social safety nets, and market information systems may yield greater returns in terms of strengthening the country's enabling environment for CSA than investing in policies or coordinating mechanisms.

## FIGURE 4.1. RELATIONSHIP BETWEEN CSA-POL INDEX AND UNDERNOURISHMENT (*n* = 50)

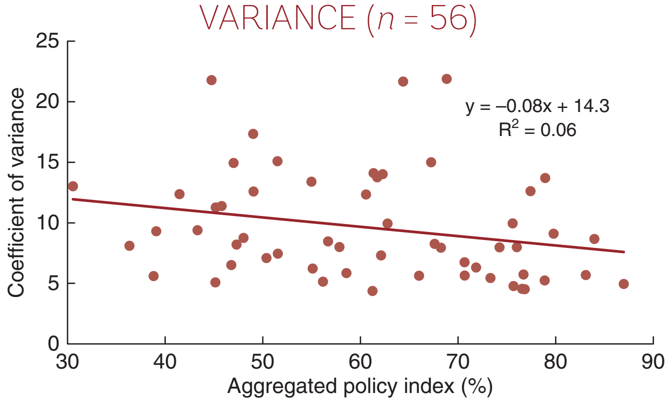



## FIGURE 4.2. RELATIONSHIP BETWEEN CSA-POL INDEX AND CEREAL YIELD (*n* = 56)



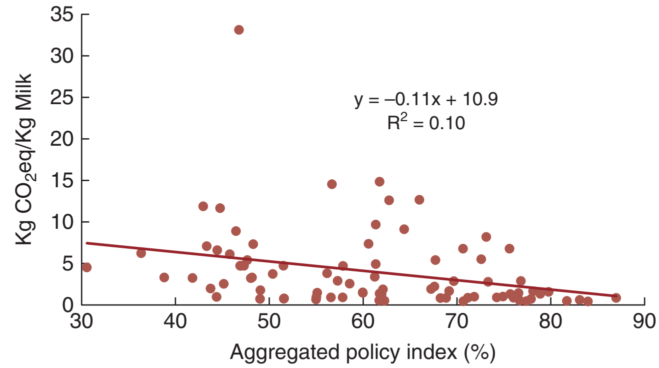

*Note:* Cereal yield refers to the average yields (2010 to 2013) for wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains.

## FIGURE 4.3. RELATIONSHIP BETWEEN CSA-POL INDEX AND CEREAL YIELD VARIANCE (*n* = 56)

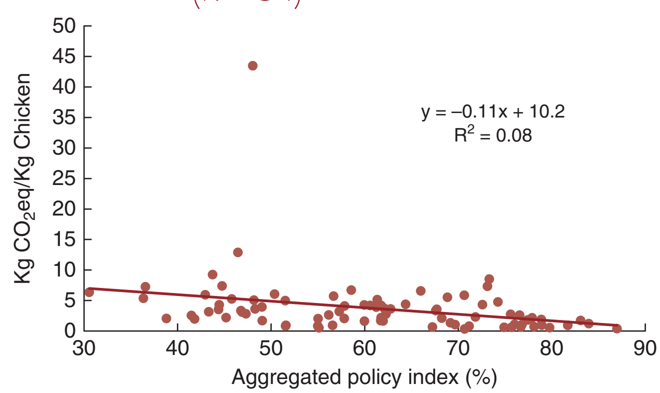



*Note:* Cereal yield variance refers to the coefficient of variance of yields from 2010 to 2013 expressed in percentage.

## FIGURE 4.4. RELATIONSHIP BETWEEN CSA-POL INDEX AND GHG EMISSIONS INTENSITY OF MILK (*n* = 84)




## FIGURE 4.5. RELATIONSHIP BETWEEN CSA-POL INDEX AND GHG INTENSITY OF CHICKEN (*n* = 84)




## FIGURE 4.6. RELATIONSHIP BETWEEN CSA-POL INDEX AND GHG INTENSITY OF PADDY RICE (*n* = 74)

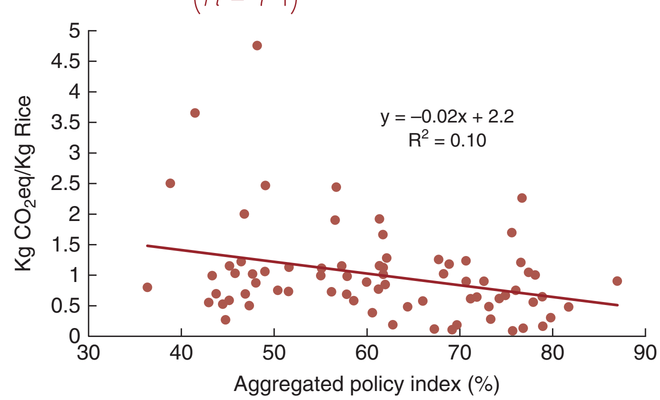


**FIGURE 4.7.** CSA-POL INDEX FOR A SAMPLE OF COUNTRIES: TOP 15 SCORES; MIDDLE 15 SCORES; BOTTOM 15 SCORES

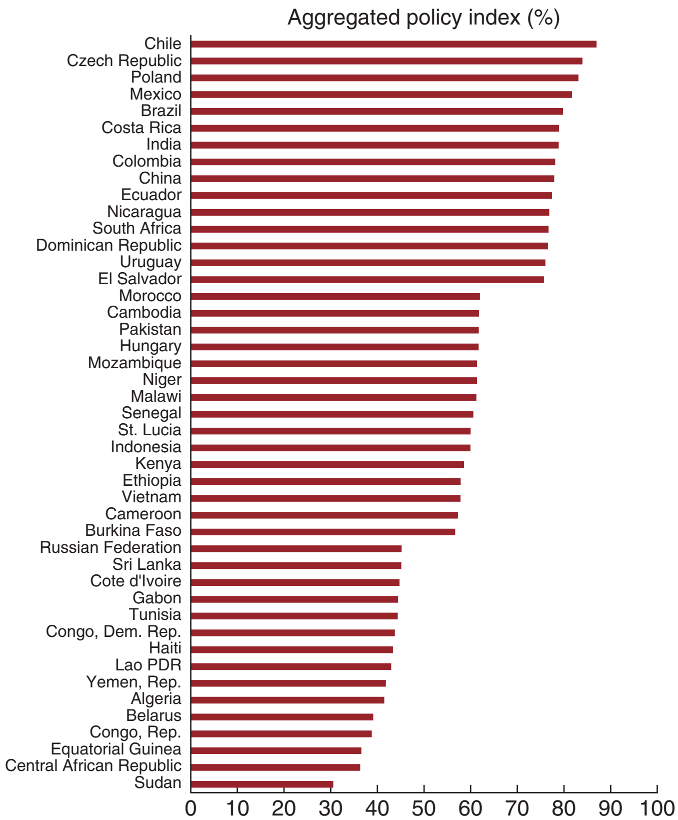
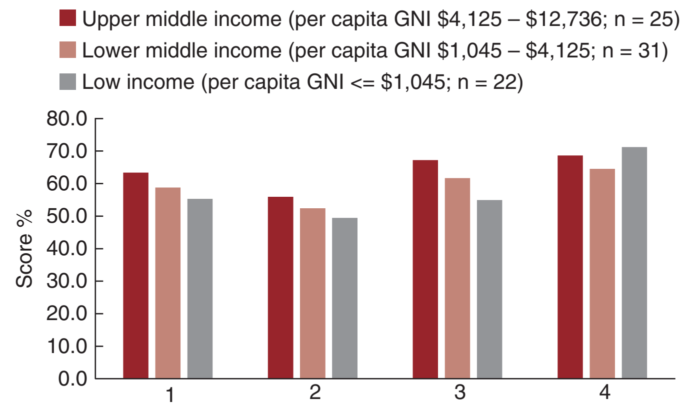



**FIGURE 4.8.** AVERAGE AGGREGATE SCORES FOR COUNTRIES GROUPED BY INCOME ACROSS FOUR CATEGORIES OF INDICATOR AGGREGATION.




*Note:* (1) CSA-Pol Index; (2) Indicators of theme “Readiness Mechanisms”; (3) Indicators of theme “Services and Infrastructure”; (4): Indicators of theme “Coordination Mechanisms.”

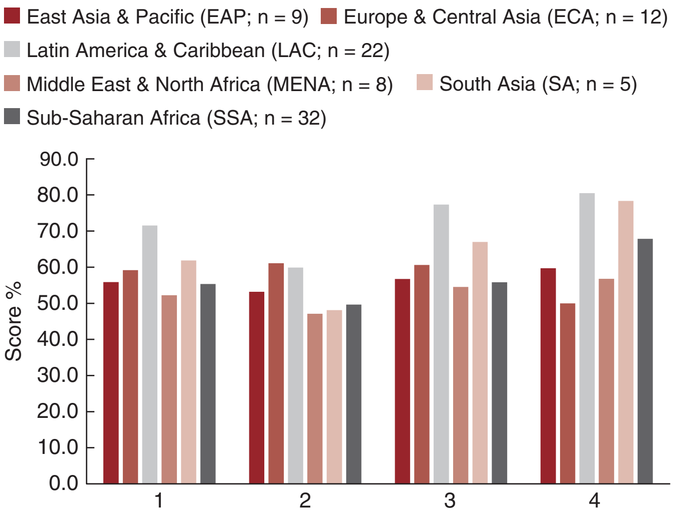
Although the level of economic development in a country appears to be a strong determinant of its ability to provide strong legal frameworks to support services and infrastructure for CSA implementation, a commitment from the government—demonstrated through national climate change policies and strategies—is as important as services for creating an enabling environment for CSA. For example, Madagascar emerged among the top performers in SSA. The country has built strong institutional frameworks through regional arrangements supported by the Indian Ocean Islands to integrate adaptation strategies and disaster risk response to climate change in national policies and other strategies.

The bottom performers on the CSA Policy Index in our sample included countries whose economies rely heavily on petroleum revenues (Republic of Congo, Gabon, and Russia). In many cases, these countries also lacked NAPAs, for example, to support CSA implementation.

## TOP AND BOTTOM PERFORMERS FOR THE CSA POLICY INDEX

- Middle-income countries with strong agricultural export markets (Chile, Brazil, Mexico, and South Africa) emerged as the highest performers for the CSA Policy Index. These markets are supported by services and infrastructure such as market information systems, agriculture crop insurance, warehouse receipts systems, and early warning systems for weather and pest management that are critical for well-functioning markets and create a strong enabling environment for CSA. The high performers also apply a collaborative multisectorial applied approach to addressing climate change that is well integrated into national strategies and policies.
- The lowest performers for the CSA Policy Index are primarily countries heavily reliant on oil-producing industries (Republic of Congo, Gabon, and Russia). As a result, nonpetroleum-based sectors such as agriculture remain critically underdeveloped (with the exception of Nigeria). The lack of diversification in the economy and underdevelopment of the

**FIGURE 4.9.** AVERAGE AGGREGATE SCORES FOR COUNTRIES GROUPED BY REGION ACROSS FOUR CATEGORIES OF INDICATOR AGGREGATION.




***Note:*** (1) CSA-Pol Index; (2) Indicators of theme "Readiness Mechanisms"; (3) Indicators of theme "Services and Infrastructure"; (4): Indicators of theme "Coordination mechanisms."

agricultural sector reflects weak institutional mechanism and enabling environment for CSA.

## DIFFERENCES IN CSA-POL INDEX AMONG REGIONAL GROUPINGS

Countries in the LAC region outperformed all of the other country groups on the CSA-Pol Index (figure 4.9). Analysis of the top and bottom performers in this region reveals, among other things, that a strong commitment from the government is also as important as services for creating an enabling environment for CSA. In the following sections, trends in index scores of countries in the LAC and SSA regional groupings are analyzed with a view to understanding the factors that led to some countries performing well and others poorly. We selected countries in the LAC and SSA regional groupings because each group accounted for a large diversity of countries, from which several lessons could be extracted.

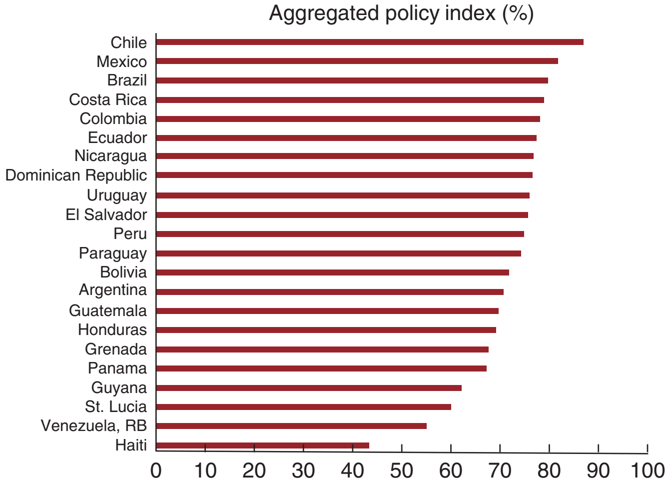
## TOP POLICY INDICES IN LATIN AMERICA AND THE CARIBBEAN

Chile, Mexico, and Brazil are among the highest performers in the LAC region for the CSA Policy Index (figure 4.10). Through a combination of well-defined legal and institutional frameworks, strong political will (Mexico is the only country to have submitted five national communications to the United Nations Framework Convention on Climate Change [UNFCCC]), and evidence of a multisectorial and interdisciplinary approach to addressing climate change that is well integrated in national policies and strategies, these countries have created a strong, enabling environment for climate-smart agriculture.

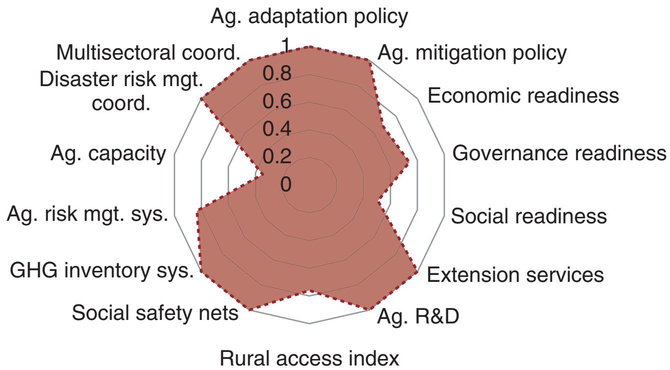
Chile is the highest performer in LAC. The agricultural sector is identified as one of the priority lines for adaptation to climate change in the National Climate Change Action Plan. Agricultural products accounts for a quarter of export revenues in the Chilean economy. The export markets are supported by services and infrastructure such as market information systems and agriculture insurance that have created an enabling environment for CSA. Through multisectorial committees such as the Climate Change and Agriculture Council, composed of professionals from the academic, private, and public sectors, the government has created an enabling environment for coordination among different sectors and actors involved in CSA. Figure 4.11 illustrates the specific CSA-Pol Index scores for Chile.

Mexico's strong political will to address climate change is well integrated into its national policies and strategies. The National Strategy for Climate Change includes as one of its pillars adaptation measures to climate change in the agricultural sector. There is also an Inter-Ministerial Commission on Climate Change responsible for coordinating and incorporating national climate change strategies in sector-specific programs. The committee is composed of seven ministries, including the Ministry of Agriculture, and works with various stakeholders including civil society and the private sector to address climate change. In addition, Mexico has well-developed agricultural export markets that are supported by services and infrastructure such as market information systems, warehouse receipts systems for grain markets, and agriculture insurance schemes that also have created an enabling environment for CSA. Figure 4.12 illustrates the specific CSA-Pol Index scores for Mexico.

## FIGURE 4.10. CSA-POL SCORES FOR COUNTRIES IN LATIN AMERICA AND THE CARIBBEAN

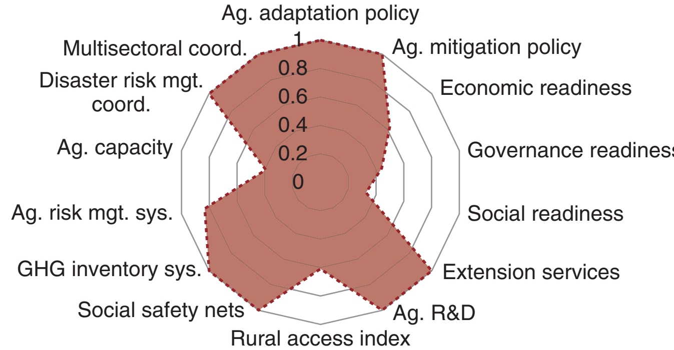



## FIGURE 4.11. CSA-POL INDEX SCORES—CHILE

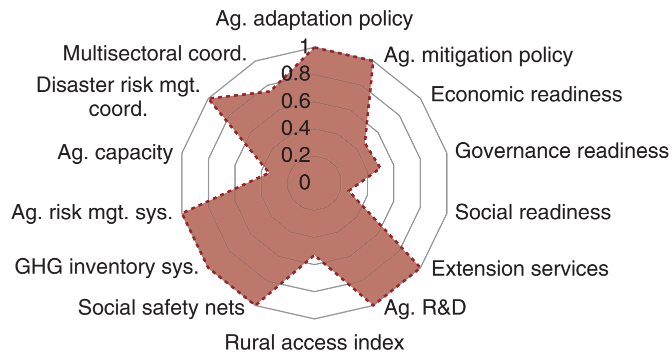



Brazil has created a strong institutional framework for CSA that is backed by a high level of investment in crop research and farming systems adapted to climate change. It has also declared a number of commitments to enhance land and water management and carbon sequestration through its Reducing Emissions from Deforestation and Forest Degradation programs. Similarly, the agricultural zoning of climate risk (Zonamento Agrícola de Risco Climatico) is used as a policy instrument to address climate risk and disasters in the agricultural sector. These commitments are also backed by strong services and infrastructure to support CSA, including weather monitoring and forecasting, R&D, and collaboration among multiple stakeholders and

## FIGURE 4.12. SPECIFIC CSA-POL INDEX SCORES—MEXICO




## FIGURE 4.13. SPECIFIC CSA-POL SCORES—BRAZIL



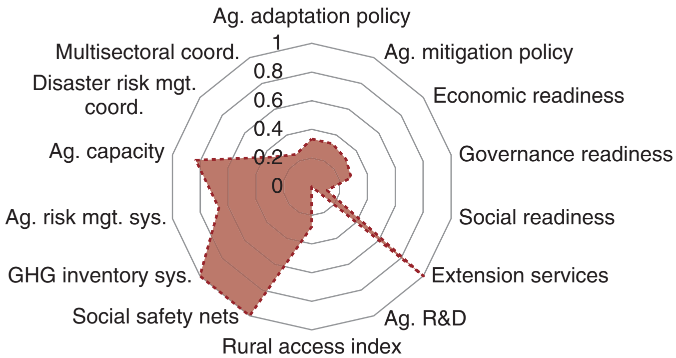

institutions. Figure 4.13 illustrates the specific CSA-Pol Index scores for Brazil.

## LOWEST POLICY INDICES IN LATIN AMERICA AND CARIBBEAN REGION

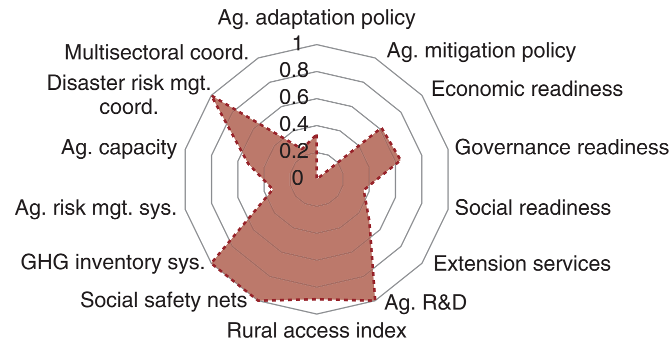
Haiti, Venezuela, and St. Lucia are the bottom three performers in LAC for the CSA Policy Index (figure 4.10). The countries have expressed commitment to adaptation and mitigation to climate change in the agricultural sector; however, beyond intent there is no evidence of well-defined strategies or mechanisms to support these goals.

Haiti scored lowest in readiness mechanism (27 percent) in support of CSA. The National Agriculture Policy (2010) and Agriculture Investment Plan (2010) place a greater emphasis on rebuilding the country's irrigation infrastructure and developing agricultural markets through rural credit and postharvest management

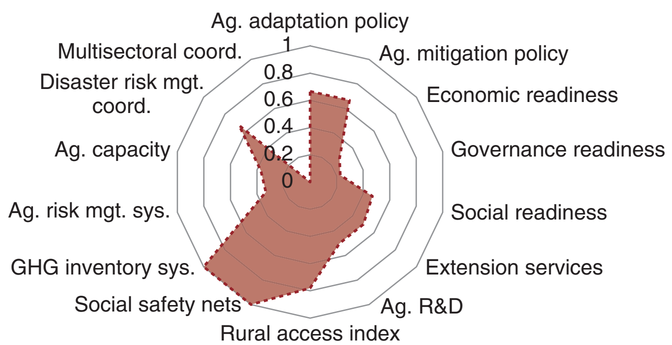
## FIGURE 4.14. SPECIFIC CSA-POL INDEX SCORES—HAITI




## FIGURE 4.16. SPECIFIC CSA-POL INDEX SCORES—ST. LUCIA




## FIGURE 4.15. SPECIFIC CSA-POL INDEX SCORES—VENEZUELA




but there is minimal focus on defining strategies for addressing the country's vulnerability to climate change. However, the country has strengthened services and infrastructure for disaster risk management in recent years through the establishment of early warning systems for pests and climate, and defined clear guidelines for agricultural crop insurance. Haiti scored a zero in agricultural R&D (figure 4.14).

There exists ample room for improvement for strengthening coordination mechanisms among different sectors involved in CSA in Venezuela. The agriculture policy lacks a clear focus on climate change and there is no multisectorial committee for enabling implementation of CSA strategies. Generally, there does not appear to be a strong political will to address CSA; the country has submitted only one national communication to the UNFCCC and there is no national adaptation plan of action to address climate change. Like its oil-producing counterparts in SSA, Venezuela's dependence on oil revenues has caused other sectors of the economy such as the agricultural sector to remain undeveloped, which has accounted for a weak institutional mechanism and enabling environment for CSA. Venezuela scored a zero in multisectorial coordination (figure 4.15).

St. Lucia is heavily dependent on banana production for its economy and there is room for creating a stronger enabling environment to support CSA. However, beyond intent, there are no well-defined strategies and actions plans for CSA. Despite its low aggregate score, St. Lucia received a high (74 percent) score in services and infrastructure including an agriculture research program focused on climate change, early warning systems for weather and climate conditions, and presence of agricultural risk insurance for banana farmers. St. Lucia scored a zero in agricultural mitigation policy (figure 4.16).

## TOP POLICY INDICES IN SUB-SAHARAN AFRICA

South Africa (77 percent) and Tanzania (76 percent) emerged as the top two performers for the CSA Policy Index, whereas Rwanda placed third at 73 percent (figure 4.17).

South Africa has built a strong institutional framework through the National Climate Change Response Policy (2011) and National Development Plan (NDP) 2030 to support CSA. For example, the NDP Vision 30 outlines

**FIGURE 4.17.** CSA POL-INDEX FOR COUNTRIES IN SUB-SAHARAN AFRICA

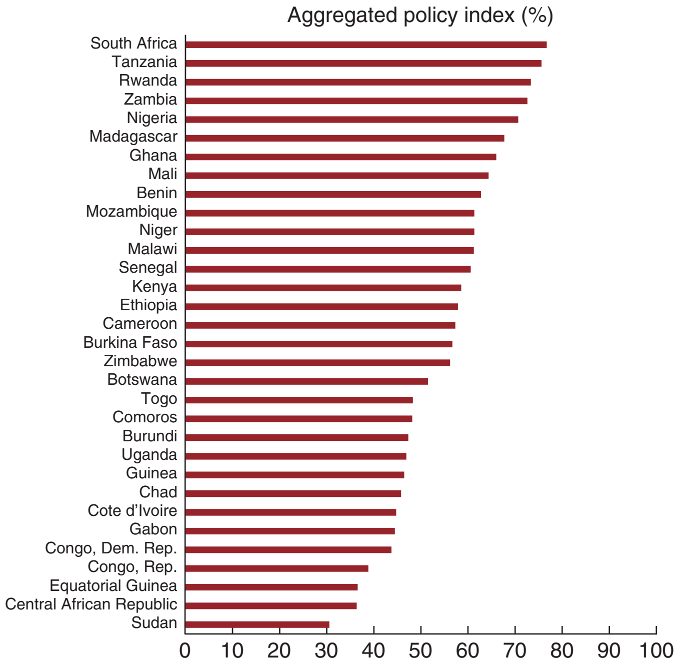
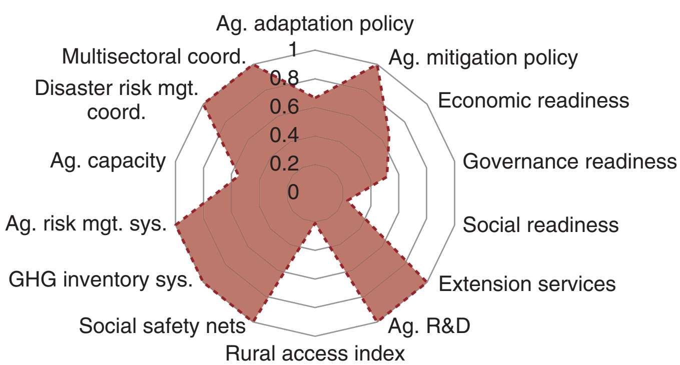



**FIGURE 4.18.** SPECIFIC CSA-POL INDEX SCORES—SOUTH AFRICA




the government vision for low-carbon development and a resilient economy by 2030. The policy includes a mandate for building an evidence-based M&E framework to provide up-to-date emissions data and establishing a system for reporting implementation of adaptation measures at the sector level. The country has also invested in strong research capacity backed by legislation to support research on climate change. This has fostered strong coordination across different sectors involved in CSA and earned SA a perfect score (100 percent) in coordination mechanisms

**FIGURE 4.19.** SPECIFIC CSA-POL INDEX SCORES—TANZANIA

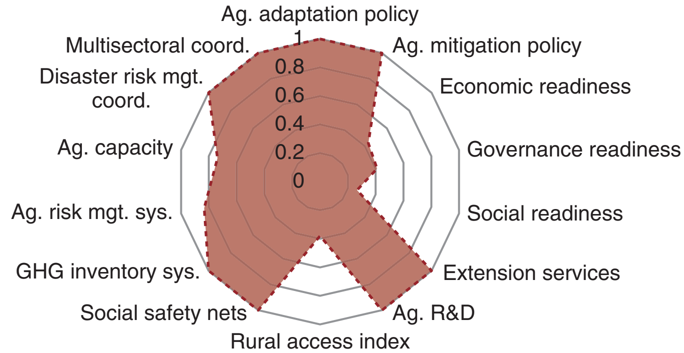
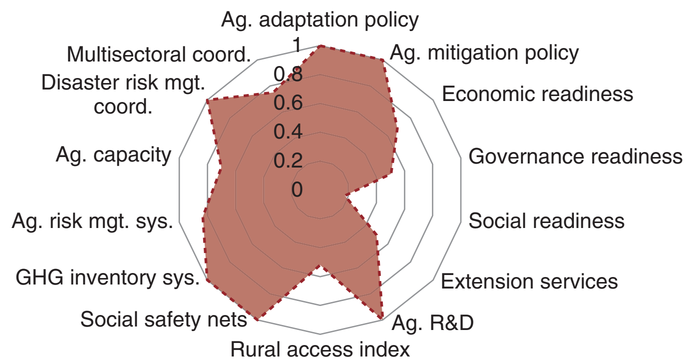



**FIGURE 4.20.** SPECIFIC CSA-POL INDEX SCORES—RWANDA




supporting CSA. Figure 4.18 illustrates the specific CSA-Pol Index scores for South Africa.

Tanzania's high score is driven primarily by its high subscore in services and infrastructure (78 percent) and coordination mechanisms (100 percent). A commitment to addressing adaptation and mitigation to climate change in the agricultural sector is reflected in Tanzania's NAPA and National Climate Change Strategy. Beyond these two plans, the National Strategy for Growth and Reduction of Poverty (MKUKUTA in Swahili) also incorporates climate change as a crosscutting issue. A multisectorial approach is used to support CSA and is facilitated by the NCCTC and NCCSC. Tanzania scored 100 percent for seven indicators (figure 4.19).

Rwanda's commitment to CSA is reflected in the National Strategy for Climate Change and Low Carbon Development (2011). The strategy includes a

**FIGURE 4.21.** SPECIFIC CSA-POL INDEX SCORES—SUDAN

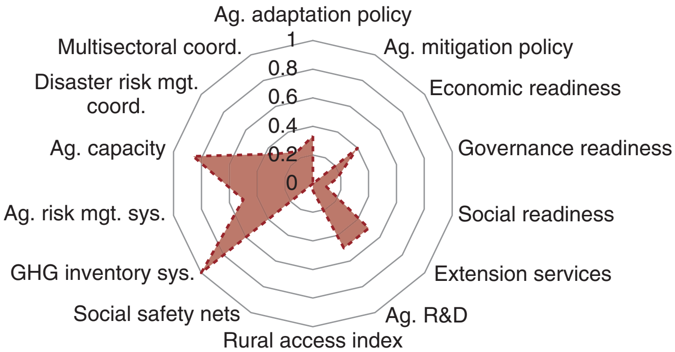
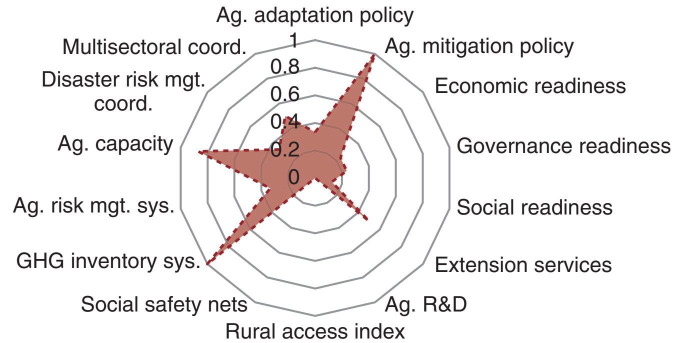



**FIGURE 4.22.** SPECIFIC CSA-POL INDEX SCORES—CENTRAL AFRICAN REPUBLIC




monitoring framework for its mitigation and adaptation programs and involves various ministries including the Ministry of Agriculture and Animal Resources, Ministry of Infrastructure, municipal authorities, and so on. The country has also established several public-private partnerships to develop services and infrastructure such as crop insurance and collateral management systems that have the potential to create a strong enabling environment for CSA. Rwanda scored top scores in agricultural adaptation policy, agricultural mitigation policy, agricultural R&D, social safety nets, national GHG inventory system, and disaster risk management coordination (figure 4.20).

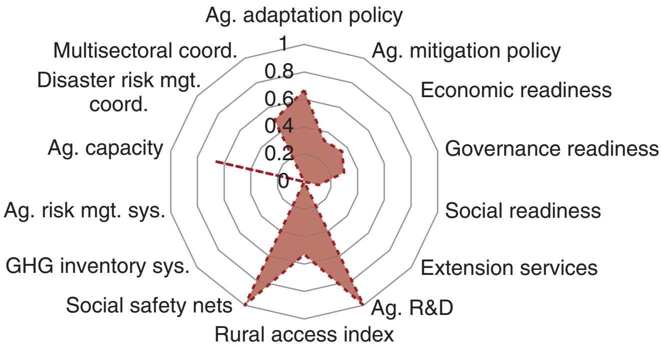
## BOTTOM POLICY INDICES IN SUB-SAHARAN AFRICA

Sudan (31 percent), Central African Republic (36 percent), and Equatorial Guinea (37 percent) are the lowest performers in SSA for the CSA Policy Index. The countries were also assigned a high uncertainty rating in the reporting of the policy score given the high observed frequency of no data that could be gathered from secondary desk research; however, important lessons and observations emerged in the reporting of the policy scores. The Republic of Congo and Gabon are categorized as lower- and upper-middle-income countries, respectively, according to the World Bank income classification. The countries are among the top five oil-producing countries in the region with economies heavily dependent on oil revenues. Nonpetroleum-based sectors, such agriculture, remain critically underdeveloped.

Sudan has expressed commitment to addressing adaptation to climate change through its NAPA; however, there are no well-defined strategies to address this goal. The country also lacks services and infrastructure to support adaptation strategies in the agricultural sector. The county is, however, taking steps to create a stronger enabling environment. For example, through the Agricultural Revival Program, launched in 2008, the country aims to address structural weaknesses in the sector and many of the priority areas of intervention coincide with the NAPA objectives. There are also some services in place with the potential to create a strong enabling environment for CSA such as the Sudanese Food & Agriculture Market Information System, which collects and disseminates crop, livestock, and horticultural and animal product prices to market participants on a weekly basis. As depicted in figure 4.21, Sudan scored exceptionally low in agricultural mitigation policy, rural access index, and social safety nets.

Central African Republic does not have a national adaptation plan of action for climate change but has submitted two national communications to the UNFCCC (2003 and 2015). The country lacks legislation or policy on disaster risk reduction in the agricultural sector, but has an emergency response project for the food crisis and relaunch of the agricultural sector. The country has not committed to adding climate change in agricultural R&D given its current level of agricultural development. Central African Republic scored zero in two indicators, agricultural R&D and social safety nets (figure 4.22). Data were not available for a rural access index.

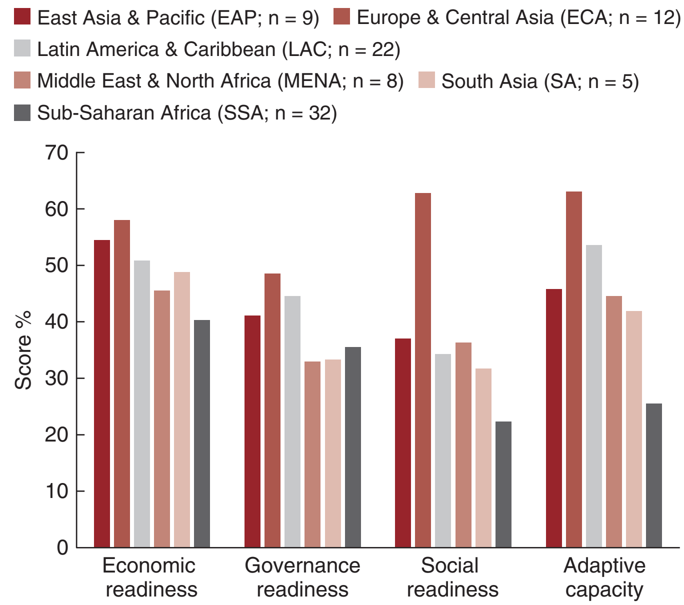
**FIGURE 4.23.** SPECIFIC CSA-POL INDEX SCORES—EQUATORIAL GUINEA




Equatorial Guinea has National Adaptation Plan Actions in Ministry of Environment and Fisheries. It states the mechanisms to implement and monitor activities to address adaptation and mitigation to climate change in the agricultural sector. The NAPA also expresses the commitment to address climate change research in particular related to fisheries, environment, and conservation. However, according to current documents and information, there are no strategies or policy plans on social safety nets and agricultural risk management systems. Equatorial Guinea scored zeros in four indicators: extension services, national GHG inventory systems, agricultural risk management systems, and disaster risk management coordination (figure 4.23).

Of the 14 policy indicators, the average values of Economic readiness (48 percent), Adaptive capacity (42 percent), Governance readiness (40 percent), and Social readiness (34 percent) are lowest for the 88 countries in the sample. The ECA region ranks the highest for these four indicators with an average score of 63 percent for Social readiness and Adaptive capacity, 58 percent for Economic readiness, and 49 percent for Governance readiness. Economic readiness (40 percent), Adaptive capacity (26 percent), and Social readiness (22 percent) are the lowest for SSA, whereas MENA has the lowest Governance readiness (33 percent) (see figure 4.24).

**FIGURE 4.24.** AVERAGE AGGREGATE SCORES FOR COUNTRIES GROUPED BY REGION ACROSS FOUR INDICATORS: ECONOMIC READINESS, GOVERNANCE READINESS, SOCIAL READINESS, AND ADAPTIVE CAPACITY



# CHAPTER FIVE

# TESTING OF PROJECTS WITH THE CSA TECHNOLOGY INDEX AND THE CSA RESULTS INDEX

The CSA-Tech Index and the CSA-Res Index measure a project's achievements in the CSA triple-win areas. Each indicator in the CSA-Tech and CSA-Res Indices are aligned to one, two, or all of the triple-win P, R, and M goals. To show how the CSA-Tech and CSA-Res Indices cay be applied to projects, the report selected and tested projects from five countries across the world (figure 5.1). These projects were selected for their diverse representation in location and project objectives.

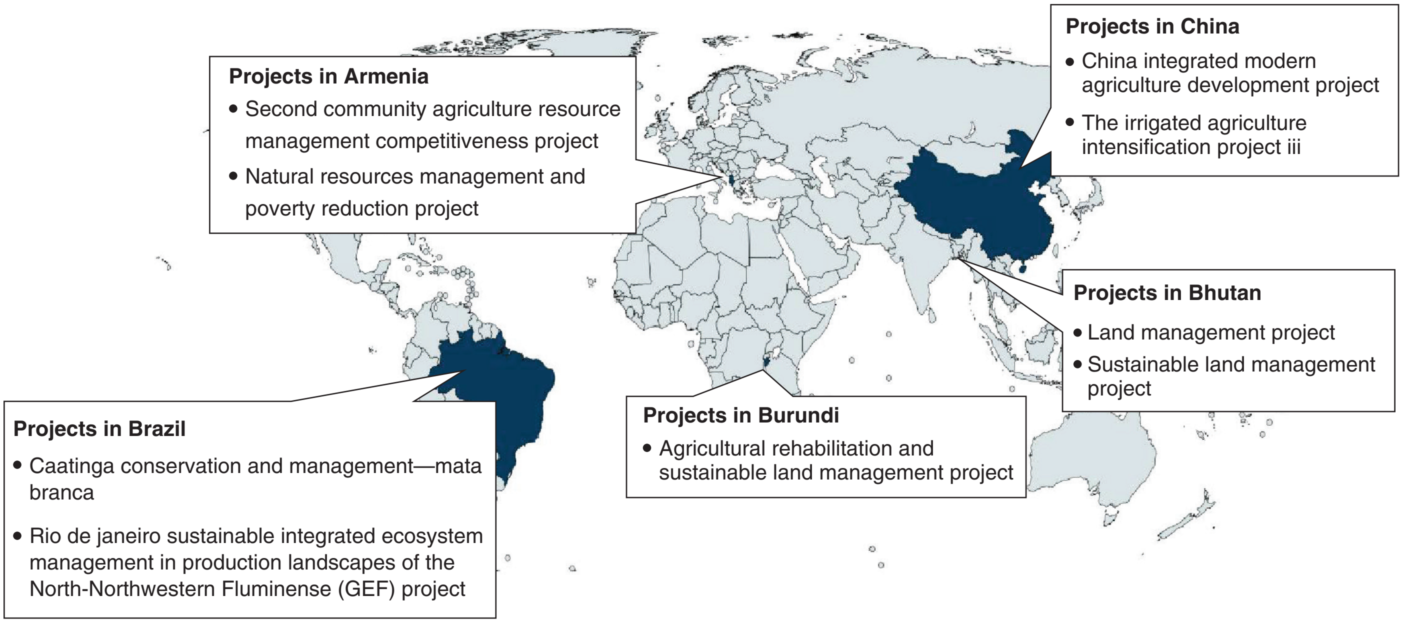
Based on the testing results, case studies were developed to determine the appropriate climate-smart technologies for the proposed project. The results from the index testing are described in the following sections.

## TESTING OF PROJECTS USING THE CSA-TECH INDEX

The testing of the CSA-Tech Index has yielded the following insights:

1. Monitoring a CSA-Tech indicator involves establishment costs with benefits occurring at some later time.
2. To calculate the value of a CSA-Tech indicator, it is necessary to determine a short list of optimal technologies in the proposed context.
3. There is likely to be wide variation between the values of different CSA indicators in a given situation, and a variation in the value of a given indicator in different situations. Each must be assessed separately in different farming systems.
4. In many cases, the costs of using the CSA-Tech Index would fall over time as uncertainty is reduced.
5. The gross value of the CSA-Tech Index can never be negative. At worst, its value would be zero if no values exist.
6. The greater the current level of uncertainty about a variable, the greater is the value of monitoring, as long as monitoring does lead to reductions in uncertainty.

**FIGURE 5.1.** LOCATION OF SELECTED PROJECTS FOR TESTING




## CASE STUDY 1: ARMENIA—SECOND COMMUNITY AGRICULTURE RESOURCE MANAGEMENT AND COMPETITIVENESS PROJECT (P133705)

### Project context

Agriculture remains vital to the Armenian economy. In 2012, including agro-processing, it accounted for about 23 percent of GDP, 17 percent of export earnings, and about 44 percent of employment. Rapid economic growth over the past decade has generated new opportunities for the agricultural sector, which has grown by more than 6 percent annually since 1997 despite the downturn in 2009–10. Exports of agricultural products have doubled since 2005, mostly beverages and to a lesser extent fruit and vegetable products. A significant but proportionally small increase in the export of live animals was seen in 2011. However, the sector has been unable to capitalize fully on the opportunities associated with economic growth and expanding consumer demand for agricultural products. As a result, much of this demand has been met by a substantial increase in imported products, which have outstripped exports and led to an increasing gap between imports and exports. Overall, Armenia is a net importer of agricultural products with imports of US$700 million in 2011 compared with exports of about US$230 million.

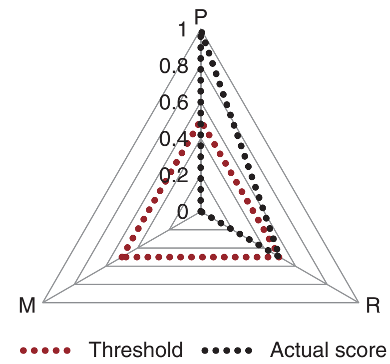
Productivity has grown substantially in the agricultural sector in the past decade. The Crop Production Index more than doubled from 2002 to 2009, although there was a substantial drop in 2010 because of inclement weather conditions. During the same period, the Livestock Production Index increased by about 60 percent. Crop production typically accounts for about two-thirds of the gross agricultural output, whereas livestock accounts for one-third. About 60 percent of the agricultural land in Armenia is pasture and grassland. Livestock production is the most important economic activity in the country's mountainous areas. Productivity increases have been supported by increased access to inputs, finance (including some foreign investment capital), market linkages, and by the improving knowledge and skills of producers. Nevertheless, yields are far from their potential, with cereals averaging only 2.5 tons per hectare and cow milk yields approximately 2,000 liters per head based on official statistics, although these figures are substantial improvements over the 1990s figures of 2 tons per hectare and 1,400 liters per head, respectively. Livestock productivity is constrained mainly by unmanaged and unsustainable use of pasture resources, with severe overgrazing and degeneration of nearby pasture areas and underutilization of remote pasture areas, poor quality and shortage of winter fodder, animal health problems, and poor genetic resources. Livestock productivity could be increased by 40 percent with improved animal husbandry, feeding, and veterinary care, whereas crop yield increases of 60 percent would be feasible in the medium term, with better varieties and improved management, including soil fertility.

Agriculture in Armenia is dominated by smallholders, with some 335,000 households with an average landholding of about 1.4 hectares and a generally diversified production system involving both crops and livestock. Only a relatively small proportion can be considered truly commercial, and many farmers, especially those in more remote areas, are among the most vulnerable with about one-third still living in poverty and in some of the regions this figure reaches as high as 46 percent. A shift toward increased commercialization in the sector has been taking place in recent years. Some farmers (approximately 15 percent) now cultivate leased land, although a third of farmers do not cultivate all their land, mainly because of poor land quality, lack of water, or distance from the farm. New agro-processors and small rural businesses are appearing, an increasing number of contractual arrangements between processors and producers are in place, and producer associations and cooperatives are helping to consolidate production and markets. Nevertheless, the links between the food-processing industry and agricultural producers remain weak, and many rural enterprises lack technology and know-how that could improve their competitiveness.

## CSA-Tech testing

The proposed project should (a) extend the coverage of the pasture-based livestock system; (b) support the development of selected value chains important to Armenia by providing targeted subproject investments to help strengthen links between producers and processors, promote food safety, and support processing and marketing; and (c) increase the capacity of public sector institutions that can support improved market access and selected value chain development (see figure 5.2 and table 5.1).

**FIGURE 5.2.** ARMENIA'S CSA-TECH P, R, M SCORES




## CASE STUDY 2: BURUNDI—AGRICULTURAL REHABILITATION AND SUSTAINABLE LAND MANAGEMENT

### Project context

Agriculture is the mainstay of the economy, employing more than 90 percent of the active population and accounting for 50 percent of GDP and more than 80 percent of export earnings. Most agricultural production is subsistence oriented, with the exception of coffee, tea, rice, sugar, and cotton, which are oriented toward export markets. Traditionally, Burundi has been self-sufficient in food production, but during the past decade production has not kept pace with population growth. The low productivity is attributable to declining soil fertility, low use of modern inputs, and adverse incentives for investments in the state-controlled cash crop sector. Together, these had already set in motion a decline in yields before the political crisis in the early 1990s.

Land fragmentation has not been compensated by sufficient increases in agricultural productivity. Agricultural techniques in Burundi remain extremely basic, using handheld tools and few modern inputs. Fertilizer use is very low, and with farm households cultivating on average only 0.7 hectare, the country has reached the limit of traditional land cultivation and has achieved little or no economic diversification. Pressure on the environment has reached a critical point and requires urgent attention. Intensive demographic pressure has led to the utilization of marginal land, the shortening of fallow periods, and the conversion of pasture and natural forest into cropland.

**TABLE 5.1.** RESULTS FROM THE ARMENIA SECOND COMMUNITY AGRICULTURE RESOURCE MANAGEMENT COMPETITIVENESS PROJECT

| Theme | Subject | Indicator | Indicator Description | Type | Raw Score | Target Score | R | P | M | Final Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Productivity | Livestock System | Resource Management | The technology improves livestock resource management in comparison with current interventions in similar farming systems. | Likert (1–5) | 4 | 3 | | 5 | | |
| Resilience | Self-organization | Local Market Networks | The technology will foster local and regional production and supply chains. | Likert (1–5) | 4 | 3 | 5 | | | |
| Resilience | Robustness | Income and Food Security | The technology will increase the stability of agricultural production needed to help producers meet their own basic food security and income needs. | Likert (1–5) | 3 | 3 | 3 | | | |
| Resilience | Self-organization | Cooperation and Networks | The technology will facilitate cooperation and networking among producers. | Likert (1–5) | 2 | 3 | 1 | | | |
| Mitigation | Mitigation Benefits | Emissions Intensity | The technology meets emissions intensity targets. | Likert (1–5) | 1 | 3 | | | 1 | |
| Mitigation | Mitigation Benefits | Sequesters Carbon | The technology sequesters carbon in comparison with current interventions in similar farming systems. | Likert (1–5) | 1 | 3 | | | 1 | |
| | | | | | | | **3** | **5** | **1** | **3.00** |

A stock of existing technological innovations can be adopted by smallhold farmers to generate productivity increases. However, agricultural research needs to be more closely geared to addressing farmers' priorities and concerns. The ongoing generation of new technological solutions requires a dynamic agricultural research system with strong capacity to orient, select, and program research projects.

Natural resource degradation must be addressed. Environmental challenges have reached a critical turning point in Burundi because of high (2.9 percent) annual population growth, small average plot sizes, weakening soil fertility, shortening fallow periods, and soil erosion. Unless interventions are rapidly implemented, these environmental threats may very well have a profoundly negative effect on economic growth, and hamper any poverty reduction achieved by transitional support lending.

The government is convinced that the private sector must be the engine that drives economic growth. It intends to disengage from agricultural production and privatize state enterprises. In conjunction with the implementation of the poverty-reduction strategy, the government has called on professional organizations and the private sector to assume a greater role in the conceptualization and management of development programs and strategies.

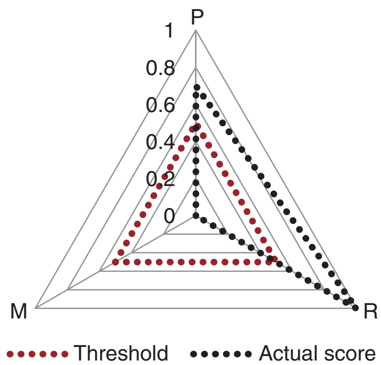
## Testing results

The desk testing for the Burundi project revealed that Productivity (3.8) and Resilience (5) are the key areas the project task team needs to focus on with Mitigation (0) being less of a concern (table 5.2). This result only reflects the data available at the project appraisal stage and is not indicative of any data that may be available during project implementation. The spider diagram in figure 5.3

## TABLE 5.2. RESULTS FROM THE BURUNDI AGRICULTURAL REHABILITATION AND SUSTAINABLE LAND MANAGEMENT PRACTICE

| Theme | Subject | Indicator | Indicator Description | Type | Raw Score | Target Score | R | P | M | Final Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Productivity | Water Use | Irrigated Agricultural Land | The technology increases the share of irrigated agricultural land (hectare) because of the technology (%). | % change from baseline | 10 | 10 | | 3 | | |
| Productivity | Water Use | Water Withdrawal for Agriculture | The technology reduces water withdrawal (liter/day) for agriculture use as a share of total water withdrawal (%). | % change from baseline | 7 | 5 | | 5 | | |
| Productivity | Crop System | Crop Yield (% increase) | The technology leads to an increase in yields of the producers (%). | % change from baseline | 15 | 15 | | 3 | | |
| Productivity | Livestock System | Resource Management | The technology improves livestock resource management in comparison with current interventions in similar farming systems. | Likert (1–5) | 4 | 3 | | 5 | | |
| Productivity | Livestock System | Feed Production Technologies | The technology improves feed production in comparison with current interventions in similar farming systems. | Likert (1–5) | 3 | 3 | | 3 | | |
| Resilience | Robustness | Human Capital | The technology will improve the human capital (technical skill levels) of producers in the target area. | Likert (1–5) | 4 | 3 | 5 | | | |
| Resilience | Robustness | Site-Specific Knowledge | The technology will involve the incorporation of site-specific knowledge in its application. | Likert (1–5) | 4 | 3 | 5 | | | |
| Resilience | Self-organization | Cooperation and Networks | The technology will facilitate cooperation and networking among producers. | Likert (1–5) | 4 | 3 | 5 | | | |
| Resilience | Self-organization | Local Market Networks | The technology will foster local and regional production and supply chains. | Likert (1–5) | 4 | 3 | 5 | | | |
| Mitigation | Mitigation Benefits | Emissions Intensity | The technology meets emissions intensity targets. | Likert (1–5) | 2 | 3 | | | 1 | |
| Mitigation | Mitigation Benefits | Sequesters Carbon | The technology sequesters carbon in comparison with current interventions in similar farming systems. | Likert (1–5) | 2 | 3 | | | 1 | |
| | | | | | | | **5** | **3.8** | **1** | **3.27** |

**FIGURE 5.3.** BURUNDI'S CSA-TECH P, R, M SCORES




shows the relationship between the triple-win priorities for the Burundi project.

The project should promote sustainable land use by seeking options that yield increasing returns from environmentally sustainable approaches (including integrated pest and nutrient management), to proactively support improved natural resource use (wetland and dry land resource use planning protection areas and buffer zones), and to provide incentives to smallholders to use land sustainably and protect ecosystem services.

### Proposed technologies

Investments in the proposed project should include productive infrastructure facilities, including support for (i) installation of agricultural production-related infrastructures such as small-scale water-management schemes (for example, small irrigation schemes) and small dams or any other water resource management facilities; (ii) improvement of small-scale agro-processing infrastructures and investments for existing and new agricultural and livestock products, especially for nontraditional export crops such as fruits, flowers, vegetables, essential oils, sugar, rice, and palm oil; and (iii) off-farm income-generating activities supporting agriculture, such as workshops for repairing/manufacturing agricultural tools and small equipment.

## CASE STUDY 3: BHUTAN—LAND MANAGEMENT PROJECT

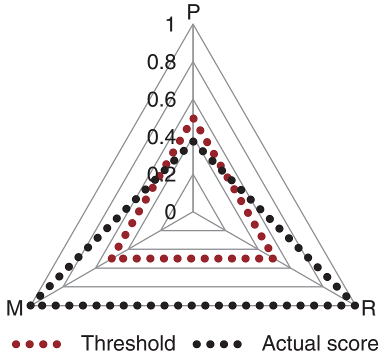
### Project context

Bhutan represents a key environmental asset in the ecologically sensitive Eastern Himalayan ecological region, with an outstanding range of biodiversity and ecosystems concentrated in a small area. Bhutan's record of good governance and long-standing commitment to environmental sustainability are widely recognized. Since 1974, the country's forest policy has operated under a royal mandate stipulating that at least 60 percent of Bhutanese territory must remain forested in perpetuity. Commercial logging was nationalized in 1978 in response to concerns about overexploitation, and the timber industry remains tightly regulated. One-quarter of the country's area has been set aside as protected (although not all sites have yet come under management plans). A recent "Gift to the Earth" has offered another 9 percent for wildlife corridors to prevent habitat fragmentation.

Notwithstanding its focus on environmental sustainability, Bhutan is facing "*emerging ecological pressures from rapid urbanization and development*," which pose an increasingly severe threat to the natural environment and which is not adequately addressed by present approaches and institutions (Kinzang Dorji 2002). Population density per square kilometer of arable land has reached 520, nearly equal to the level found in South Asia as a whole, more than one-third higher than Sub-Saharan Africa, and double the level of Latin America and the Caribbean.

Bhutan's urban growth rate of 6.7 percent has had to be accommodated on forested slopes, scarce agricultural land, and wetlands. With arable land accounting for less than 8 percent of its land area, agriculture is faced with limited productive land to help feed a growing population. Erosion is increasingly evident as farming and horticulture, as well as urban and industrial needs, exhaust flatland areas and shift on to steeper slopes. This is exacerbated by deforestation on steep slopes, geologically unstable soils, and intense monsoon rains. Land degradation is having measurable impacts; with 10 percent of agricultural land now affected by water erosion, urban settlements such as Pemagatshel are slipping down the unstable slopes on which they were sited, rural households in Trashigang Dzongkhag have had to be relocated to safer areas following landslides and ravine formation, local and seasonal water shortages are becoming more frequent, and there is evidence of increasing sediment loads in Bhutan's extensive river system. The latter is a threat to the rapidly growing hydropower industry, which needs a reliable

**FIGURE 5.4.** BHUTAN'S CSA-TECH P, R, M SCORES




water supply to sustain much-needed revenue that currently underwrites some 40 percent of Bhutan's development budget.

## CSA-Tech testing

Based on the project context, the chosen technologies should help both to prevent and reverse land degradation and to mainstream sustainable land management into its development-planning framework. The technologies should also help the Bhutan government to protect its valuable forests and biodiversity, contribute to sustainability of agricultural productivity, and help improve livelihoods and well-being of its people.

The results (figure 5.4 and table 5.3) show that the project will need to finance physical investments at the farm and community levels, which might include forest conservation measures, terracing, forest and rangeland regeneration, reforestation, and so on, where necessary.

## Proposed technologies

The project should finance a range of activities including capacity building for community decision making and planning, training of extension staff to plan and implement SLM activities in a multisectoral manner, investments at the community and farm levels to strengthen the adoption of SLM practices, monitoring and evaluation to validate SLM investments, and national- and regional-level workshops to discuss results and scaling-up implementation. Physical investments at the farm and community levels might include vegetative conservation measures, terracing, forest and rangeland regeneration, reforestation, and so on, where necessary.

# CASE STUDY 4: BRAZIL—CAATINGA CONSERVATION AND MANAGEMENT—MATA BRANCA

## Project context

In the subequatorial zone, between the Amazon Forest and the Atlantic Forest, is the Caatinga of the Brazilian Northeast. The word "Caatinga" originates from the Tupi indigenous language, meaning *mata branca*, or "white forest" (*caa*: forest; *tinga*: white, open). The Caatinga is the largest dry forest in South America and is one of the richest dry forests in the world. Comprising an area of approximately 800,000 square kilometers, it covers approximately 11 percent of the national territory, extending throughout the states of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia, and Minas Gerais. The climate is semi-arid, with average annual temperatures between 27°C and 29°C, and with pluviometer averages less than 800 millimeters. Rainfall is irregular in temporal and spatial distribution; rivers are intermittent; and soils, situated over crystalline rocks, are shallow, making even superficial drainage a serious problem.

The 1977–79 drought resulted in widespread food scarcity, the death of an estimated 500,000 people (4 percent of the Brazilian population at the time), and the out-migration of 3 million others from the region. More recently, the drought of 1979–83 affected 18 million people; almost 80 percent of crop yields were lost in some parts of the Northeast, and the government spent approximately US$1.8 billion in emergency programs. Historically, the periodic droughts, the erratic character of the rainfall, soil limitations, and other environmental constraints did not allow the establishment of intensive agriculture, but stimulated grazing animal production. Presently, about 19 percent of the cattle herd, 50 percent of the sheep herd, and 90 percent of the goat herd in Brazil are raised in the Caatinga. The system is predominantly extensive, overgrazing is the dominant factor, and production indices are the lowest in the country.

In the past two decades, desertification has advanced quickly, caused by the removal of vegetation through charcoal production, overfarming, overgrazing, soil erosion,

**TABLE 5.3.** RESULTS FROM THE BHUTAN LAND MANAGEMENT PRACTICE

| Theme | Subject | Indicator | Indicator Description | Type | Raw Score | Target Score | R | P | M | Final Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Resilience | Robustness | Human Capital | The technology will improve the human capital (technical skill levels) of producers in the target area. | Likert (1–5) | 4 | 3 | 5 | | | |
| Resilience | Robustness | Site-Specific Knowledge | The technology will involve the incorporation of site-specific knowledge in its application. | Likert (1–5) | 5 | 3 | 5 | | | |
| Resilience | Self-organization | Cooperation and Networks | The technology will facilitate cooperation and networking among producers. | Likert (1–5) | 4 | 3 | 5 | | | |
| Resilience | Self-organization | Feedback from Extension Workers | The intervention will provide opportunities for feedback from extension workers. | Likert (1–5) | 5 | 3 | 5 | | | |
| Productivity | Crop System | Crop Yield (% increase) | The technology leads to an increase in yields of the producers (%). | % change from baseline | 8 | 10 | | 2 | | |
| Productivity | Crop System | Enhances Biodiversity | The technology enhances biodiversity of the farming landscape in comparison with current interventions in similar farming systems. | Likert (1–5) | 3 | 3 | | 3 | | |
| Mitigation | Mitigation Benefits | Emissions Intensity | The technology meets emissions intensity targets. | Likert (1–5) | 4 | 3 | | | 5 | |
| Mitigation | Mitigation Benefits | Sequesters Carbon | The technology sequesters carbon in comparison with current interventions in similar farming systems. | Likert (1–5) | 4 | 3 | | | 5 | |
| | | | | | | | **5** | **2.5** | **5** | **4.17** |

and slash-and-burn practices by smallholder farmers and ranchers. Deforestation and unsustainable irrigation practices have added to the salinization of the soils and increased the incidence of drought. Desertification has resulted in disruptions of water flows and poor quality of water sources, which in turn affects the health of human and animal populations. Rural poverty is deep, with the poor surviving through short-cycle types of subsistence farming, animal breeding in extensive systems, extractive activities (wood and nontimber products), temporary farm employment, and seasonal migration to urban areas. In addition, less than 1 percent of the Caatinga biome is protected, and of the few established conservation units, many are inoperative due to lack of consolidation.

### CSA-Tech testing

This project should support investments in the following areas: (a) rehabilitation of degraded areas; (b) conservation and sustainable use of biodiversity; (c) water and land resources management; (d) development of sustainable and cost-effective productive systems; (e) cultural and social development; and (f) fostering environmental incentives (figure 5.5 and table 5.4).

### Proposed technologies

Potential investments include reforestation, development of small grazing corridors, direct vegetation planting, application of organic fertilizer, introduction of agroforestry techniques, development of drought-management projects, development of terraces, and the introduction of integrated soil and water–management practices.

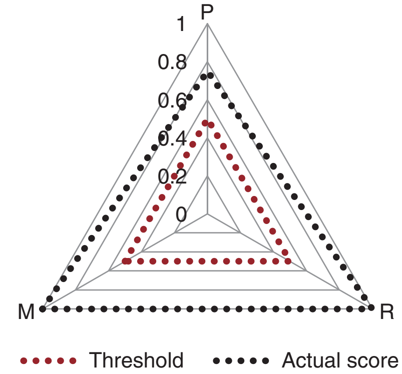
Livestock investments should also include training rural producers on small animal livestock management, ruminant grazing as an alternative livelihood practice to slash and burn, and managing herds to avoid environmental degradation.

## CASE STUDY 5: CHINA—INTEGRATED MODERN AGRICULTURE DEVELOPMENT PROJECT

### Project context

Since 1978, China has gradually shifted from a centrally planned to a market-led economy. During this period, the economy has grown at a remarkable annual rate of about

**FIGURE 5.5.** BRAZIL'S CSA-TECH P, R, M SCORES




10 percent and more than 500 million people have been lifted out of poverty. To sustain this rapid pace of development, China still has to address a number of challenges, including (a) maintaining high growth rates in the face of a complex external environment still reeling from the global economic crisis; (b) managing the resource demands and the environmental consequences of rapid growth; and (c) reducing high inequalities in incomes and opportunities.

The effects of a changing and variable climate are already visible and are expected to accelerate in the future. Average annual surface temperature increased by 1.2°C over the past 50 years, and the increase occurred much faster in the northern and northeastern provinces. Extreme climatic events are also becoming more severe, with longer droughts occurring in the north and more severe floods affecting the southern part of the country. Coping with the significant variability of future climatic impacts may require geographic shifts in agricultural production and more flexible and efficient water resources management. It also requires building the capacity of agricultural support institutions and related stakeholders (for example, research, extension, agro-meteorology), and improving the services delivery mechanisms to provide sound and real time advice to farmers.

Overall, China ranks with the **bottom 25 percent of countries in water availability per capita**. The share in total water use by agriculture is 64 percent. Over-exploitation of water resources, including withdrawals from rivers and overdraft of groundwater resources causing a drop in water tables, is a common problem, particularly in the dry northern regions of the country. Raising

## **TABLE 5.4.** RESULTS FROM BRAZIL CAATINGA CONSERVATION AND MANAGEMENT—MATA BRANCA

| Theme | Subject | Indicator | Indicator Description | Type | Raw Score | Target Score | R | P | M | Final Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Mitigation | Mitigation Benefits | Emissions Intensity | The technology meets emissions intensity targets. | Likert (1–5) | 4 | 3 | | | 5 | |
| Mitigation | Mitigation Benefits | Sequesters Carbon | The technology sequesters carbon in comparison with current interventions in similar farming systems. | Likert (1–5) | 4 | 3 | | | 5 | |
| Productivity | Livestock System | Resource Management | The technology improves livestock resource management in comparison with current interventions in similar farming systems. | Likert (1–5) | 3 | 3 | | 3 | | |
| Productivity | Crop System | Crop Yield (% increase) | The technology leads to an increase in yields of the producers (%). | % change from baseline | 9 | 10 | | 2 | | |
| Productivity | Crop System | Soil Erosion | The technology reduces the share of agricultural land classified as having moderate to severe water erosion/wind risk (%). | % change from baseline | 6 | 5 | | 4 | | |
| Productivity | Crop System | Soil Fertility | The technology enhances soil fertility (%). | % change from baseline | 7 | 5 | | 5 | | |
| Resilience | Cropping System | Resilience to Adverse Weather | The technology will increase the resilience of the cropping system to drought. | Likert (1–5) | 4 | 3 | 5 | | | |
| Resilience | Livestock System | Resilience to Adverse Weather | The technology will increase the resilience of the livestock to drought. | Likert (1–5) | 4 | 3 | 5 | | | |
| Productivity | Water Use | Irrigated Agricultural Land | The technology increases the share of irrigated agricultural land (hectare) because of the technology (%). | % change from baseline | 9 | 7 | | 5 | | |
| Productivity | Water Use | Water Withdrawal for Agriculture | The technology reduces water withdrawal (liter/day) for agriculture use as a share of total water withdrawal (%). | % change from baseline | 10 | 7 | | 5 | | |
| Resilience | Robustness | Human Capital | The technology will improve the human capital (technical skill levels) of producers in the target area. | Likert (1–5) | 4 | 3 | 5 | | | |
| Productivity | Livestock System | Feed Production Technologies | The technology improves feed production in comparison with current interventions in similar farming systems. | Likert (1–5) | 3 | 3 | | 3 | | |
| Productivity | Livestock System | Diversification of Livelihood Activities | The technology leads to the diversification of livelihood activities in comparison with current interventions in similar farming systems. | Likert (1–5) | 4 | 3 | | 5 | | |
| | | | | | | | **5** | **4** | **5** | **4.67** |

irrigation system efficiencies and improving water productivity are key to better managing water resources in agriculture. Average water productivity for grains is reported to be approximately 0.7–0.8 kg/m$^3$, which is much lower than the levels of 2.0–2.5 kg/m$^3$ recorded in the more industrialized countries. More efficient and productive water use may be achieved through the rehabilitation and improvement of outdated, dilapidated, and old irrigation and drainage infrastructure, ensuring adequate operation and maintenance of irrigation systems, promoting water-saving irrigation technologies, adopting enhanced agricultural water-management practices, and strengthening the capacity of farmers, water user associations, and other stakeholders involved.

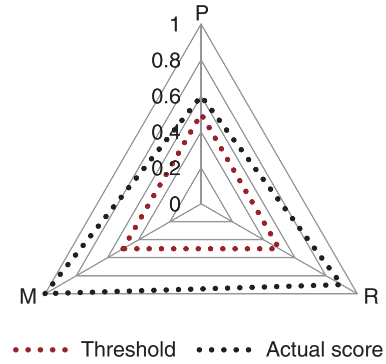
China has one of the highest rates of fertilizer and pesticides utilization in the world. The intensive use of chemical inputs has led to (a) degradation of soil fertility; (b) pollution of water systems; (c) higher GHG emissions GHG; (d) lower profits to farmers; and (e) increasing concerns about food safety. **Field evidence suggests that fertilizer use in some areas could be cut by 30–60 percent with little or no loss of crop yields.** An integrated nutrient management approach that incorporates technical measures (soil and water testing, nonpoint source pollution monitoring), capacity building (extension and training to farmers), policy aspects (revisiting the subsidies for fertilizers' manufacturers), and institutional interventions (role of farmers' groups in knowledge transfer) is required to address this problem.

## CSA-Tech testing

The appropriate CSA technologies will need to improve farmland infrastructure and the reliability and efficiency of irrigation and drainage systems and promote the use of low nitrogen inputs. For this case study, we ran the CSA-Tech toolkit to determine the most appropriate climate-smart technologies for the proposed project. The CSA-Tech Index uses a survey method to determine the most appropriate technology, by comparing the project context with available solutions, for the project region.[1] The users of the index have to set their thresholds

[1] The CSA-Tech Index does not directly recommend specific practices. It serves as a decision support tool and its functionality is limited to comparing different technologies for interpretation by the users.

**FIGURE 5.6.** CHINA'S CSA-TECH P, R, M SCORE




(usually 3 for the Likert scale) and a predetermined percentage (for the percentage-based indicators) grounded in evidence from the project area or a similar Agro-Ecological Zone. For this case study, we used the input from several World Bank experts on CSA to complete the CSA-Tech survey. The results (figure 5.6 and table 5.5) show that water-saving irrigation (drip, sprinklers, and low-pressure pipelines) technologies are climate smart and should be implemented in the project. The project should also look into implementing local water resource storage systems, farm ponds, and water-monitoring and measurement structures and equipment (flow-measurement devices, groundwater monitoring). The project should consider using approaches such as integrated soil fertility management. ISFM is a set of agricultural practices adapted to local conditions to maximize the efficiency of nutrient and water use and improve agricultural productivity. ISFM strategies center on the combined use of mineral fertilizers and locally available soil amendments (for example, lime and phosphate rock) and organic matter (for example, compost and green manure) to replenish lost soil nutrients. This improves both soil quality and the efficiency of fertilizers and other agro-inputs. Also, ISFM promotes the use of crop rotation or intercropping with legumes (a crop that also improves soil fertility).

## Proposed technologies

The main proposed agricultural technologies for this project, based on the CSA-Tech index testing results, are (a) on-farm water-saving technologies, including need-based irrigation; (b) adaptation-oriented agronomic practices

**TABLE 5.5.** RESULTS FROM THE CHINA INTEGRATED MODERN AGRICULTURE DEVELOPMENT PROJECT

| Theme | Subject | Indicator | Indicator Description | Type | Raw Score | Target Score | R | P | M | Final Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Resilience | Robustness | Human Capital | The technology will improve the human capital (technical skill levels) of producers in the target area. | Likert (1–5) | 4 | 3 | 5 | | | |
| Resilience | Robustness | Crop/Livestock Diversification | The technology will promote crop diversification in the target area. | Likert (1–5) | 4 | 3 | 5 | | | |
| Resilience | Self-organization | Local Market Networks | The technology will foster local and regional production and supply chains. | Likert (1–5) | 3 | 3 | 3 | | | |
| Resilience | Self-organization | Feedback from Extension Workers | The intervention will provide opportunities for feedback from extension workers. | Likert (1–5) | 5 | 3 | 5 | | | |
| Resilience | Cropping System | Resilience to Adverse Weather | The technology will increase the resilience of the cropping system to drought. | Likert (1–5) | 5 | 3 | 5 | | | |
| Productivity | Crop System | Crop Yield (% increase) | The technology leads to an increase in yields of the producers (%). | % change from baseline | 20 | 20 | | 3 | | |
| Productivity | Crop System | Soil Fertility | The technology enhances soil fertility (%). | % change from baseline | 20 | 20 | | 3 | | |
| Productivity | Water Use | Irrigated Agricultural Land | The technology increases the share of irrigated agricultural land because of the technology (%). | % change from baseline | 50 | 50 | | 3 | | |
| Productivity | Water Use | Water Withdrawal for Agriculture | The technology reduces water withdrawal for agriculture use as a share of total water withdrawal (%). | % change from baseline | 40 | 40 | | 3 | | |
| Productivity | Pest Management | Pest Management | The technology increases the share of agricultural land on which integrated pest management practices are adopted (%). | % change from baseline | 40 | 30 | | 5 | | |
| Mitigation | Mitigation Benefits | Emissions Intensity | The technology meets emissions intensity targets. | Likert (1–5) | 5 | 3 | | | 5 | |
| Mitigation | Mitigation Benefits | Sequesters Carbon | The technology sequesters carbon in comparison with current interventions in similar farming systems. | Likert (1–5) | 5 | 3 | | | 5 | |
| | | | | | | | **4.6** | **3.4** | **5** | **4.33** |

such as ISFM strategies; (c) agro-ecological activities to improve the resilience of the farm landscape and increase carbon sequestration; and (d) research on technical and policy issues related to climate change adaptation and mitigation.

## TESTING OF PROJECTS USING THE CSA-RESULTS INDEX

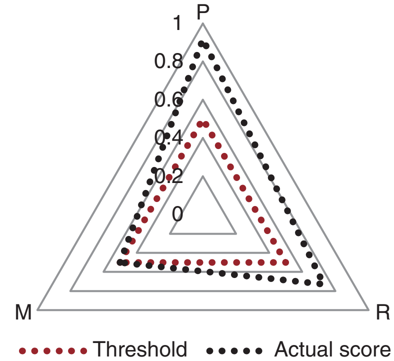
To illustrate the calculation and interpretation of the CSA-Res Index, we derived a CSA-Res Index for five World Bank projects in the areas of agriculture, rural development, and natural resources management. All projects have been completed and the Implementation Completion and Results reports were consulted for data/information on the indicator target values and values at project completion. The CSA-Res Index for P, R, and M and jointly is derived for the project's performance in the last project year. Some of the reviewed projects have a large number of indicators in their results framework (up to 38), of which only a selection of indicators is used for the calculation of the CSA-Res Index. These indicators were chosen based on their similarity with the CSA-Res indicators and on how well they seemed to reflect components and behavioral change as described in the theory of change of implementing CSA. The following examples serve to exemplify how the index was derived, not to compare the climate smartness of projects. The index is less suitable for comparing projects with one another, because the projects may not be using the same indicators, than it is for comparing how well a project is performing over time in reaching its CSA triple-win goals.

The testing process for the CSA-Res indicators is described in the final section of chapter 3.

### CASE STUDY 1: ARMENIA—NATURAL RESOURCES MANAGEMENT AND POVERTY REDUCTION PROJECT (P057847, P069917)

The project's development objective was the adoption of sustainable natural resource management practices and alleviation of rural poverty in mountainous areas where degradation has reached a critical point. The project will help avert further deterioration of natural resources

**FIGURE 5.7.** ARMENIA'S CSA-RES P, R, M SCORES




(soil, water, forest, fisheries, and biodiversity) and stabilize incomes in the local communities. The Global Environment Objectives (GEOs) were to preserve the mountain, forest, and grassland ecosystems of the Southern Caucasus through enhanced protected area and mountain ecosystem conservation and sustainable management.

The project had six Project Development Objective (PDO) indicators, two GEO indicators, and eight intermediate results indicators. For illustrative purposes, the CSA-Res Index was calculated for a section of indicators, presented in figure 5.7 and table 5.6. The project had one indicator that measured Productivity ("Increased crop and livestock productivity in project villages compared with nonproject villages"), which was collected separately for each crop and exceeded the target (compared with villages that were not participating in the project) for each crop.

The indicators exceeded the target values between 14 and 33 percent, thus achieving scores of 4 and 5, and a total score for the area P of 4.6, implying that the project exceeded expectations in reaching Productivity goals. For the CSA goal of Resilience, all of the following indicators were used to make up the score of 3.9. Thus, the majority of indicators reached or exceeded their target value. For the category Mitigation, three indicators were used, which achieved an average score of 3 because two of three indicators reached or highly exceeded their targets. The overall CSA-Res Index, as an average of the index for P, R, and M, gave a value of 3.9, indicating that the majority of indicators reached or (highly) exceeded their targets that measured the CSA successes at project completion.

## TABLE 5.6. SELECTED INDICATORS FOR ARMENIA—NATURAL RESOURCES MANAGEMENT AND POVERTY REDUCTION PROJECT

| Indicator | P, R, M | Target Value at Project Completion | Value Observed at Completion | Score |
|---|---|---|---|---|
| Increase in income (or expenditure) in project villages compared with nonproject villages | R | AMD 542,300 | AMD 599,000 | 4 |
| Increased crop and livestock productivity in project villages compared with nonproject villages (collected separately for wheat, barley, milk, wool, sheep, cattle weight) | P, R | Values to exceed nonproject villages | Exceeded between nonproject villages by 14% and 33% | 5 |
| Reduction in illegal activities destroying forest cover | R, M | Regulatory framework in place and implemented | Illegal Logging Action Plan developed and implemented | 3 |
| Reversal of degradation in pasture vegetation cover | R, M | 9,500 ha | 7,125 ha | 1 |
| Increased quality, quantity, and productivity of forest cover in the project area | R, M | 70,000 ha | 128,000 ha | 5 |
| Community capacity for sustainable use of common resources developed | R | At least 20 communities report participation in natural resources management decisions | 40 Communities have participated and implemented protective activities on common natural resources in a participatory approach | 5 |
| Measures for effective protection of mountain biodiversity at watershed level effectively implemented | R | Up to 50 small grants for biodiversity conservation | 24 small grant schemes and 4 awareness-raising grants implemented | 1 |

*Note:* AMD: Armenian dram.

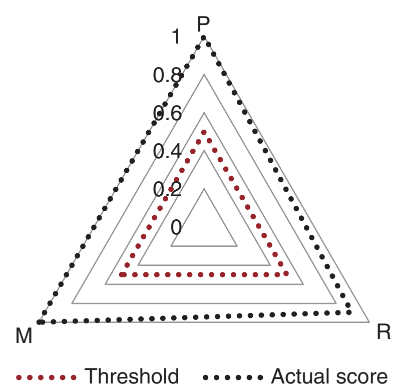
## CASE STUDY 2: BHUTAN—SUSTAINABLE LAND MANAGEMENT PROJECT (P087039) (2006–2012)

The PDO was to strengthen institutional and community capacity for anticipating and managing land degradation in Bhutan. The Project Global Objective was to contribute to more effective protection of transboundary watersheds in a manner that preserves the integrity of ecosystems in Bhutan.

The project had three PDO-level indicators and eight intermediate indicators. Out of these, seven indicators were identified as measuring the CSA triple-win areas. Their P, R, M assignments are shown in figure 5.8, and the indicators are presented in table 5.7. All but one indicator exceeded its target, achieving a score of 4 or 5.

One indicator ("Tseri land converted to sustainable land cover") measured Productivity, which achieved a score of

### FIGURE 5.8. BHUTAN'S CSA-RES P, R, M SCORES




5; for the area Resilience, an average score of 4.57 was achieved, indicating that the majority of indicators that measured aspects of Resilience highly exceeded their targets. Two indicators ("Tseri land shifted to sustainable land cover," "Degraded forestland regenerated and

## TABLE 5.7. SELECTED INDICATORS FOR BHUTAN—SUSTAINABLE LAND MANAGEMENT PROJECT

| Indicator | P, R, M | Target Value at Project Completion | Value Observed at Completion | Score |
|---|---|---|---|---|
| Increase in farmers practicing SLM techniques in pilot geogs[a] | R | 650 farmers | 1,805 farmers | 5 |
| 10% reduction in sediment flows in selected watersheds in pilot geogs | R | 10% reduction | 44% reduction | 5 |
| Degraded forestland regenerated and grazing lands improved in pilot geogs | R, M | 666 acres improved | 2,039 acres improved | 5 |
| Tseri land (now 5,132 ha) (shifting cultivation lands) converted to sustainable land cover | P, R, M | 4,000 acres | 9,173 acres | 5 |
| RNR staff, DYT and GYT members trained in multisectoral SLM planning | R | Plus 80% of staff | Plus 93% of staff | 4 |
| Farmers trained in application of SLM technologies | R | 4,500 farmers | 17,237 farmers | 5 |
| Sector policies and legislation incorporating SLM principles | R | At least 5 | 5 | 3 |

[a] *Geog/Gewog:* Local government administrative area (block) or lowest level of local administration in Bhutan, set up between village level (*Chiog*) and district level (*Dzongkhag*).

*Note:* DYT = Dzongkhag Yargay Tshogdu (district development committee); GYT = Geog Yargay Tshogchhung (geographic development committee).

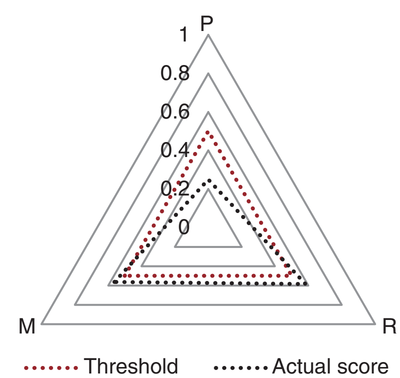
grazing lands improved in pilot geogs") demonstrated Mitigation benefits and achieved an average score of 5, implying that the expectations were highly exceeded. The project achieved an overall average score of 4.8.

## CASE STUDY 3: BRAZIL—RIO DE JANEIRO SUSTAINABLE INTEGRATED ECOSYSTEM MANAGEMENT IN PRODUCTION LANDSCAPES OF THE NORTH-NORTHWESTERN FLUMINENSE (GEF) PROJECT (P075379) (2005–2011)

The development objective of the proposed project was to promote an IEM approach to guide the development and implementation of SLM practices in the North and Northwest (NNWF) regions of Rio de Janeiro State. The desired principal outcomes for the primary target group (smallholder families and communities) were the following: (a) improved capacity and organization for NRM, and (b) increased adoption of IEM and SLM concepts and practices.

The project had 9 indicators at the global level and 20 indicators measuring intermediate results. We chose 11 main indicators for the analysis. Out of these, one indicator was assigned to the CSA area Productivity ("Change

### FIGURE 5.9. BRAZIL'S CSA-RES P, R, M SCORES




in total land area characterized by biodiversity-friendly agricultural practices that enhance soil structure stability in microcatchments"), achieving a score of 5. All indicators were identified as contributing partially to increasing Resilience of social or natural systems.

The majority of indicators reached or achieved the set targets (figure 5.9 and table 5.8), such that an overall score of 3.3 was assigned, which implies satisfactory results. For the area Mitigation we identified four indicators, of which two failed to reach the target by less than 20 percent and two

**TABLE 5.8.** SELECTED INDICATORS FOR BRAZIL—RIO DE JANEIRO SUSTAINABLE INTEGRATED ECOSYSTEM MANAGEMENT IN PRODUCTION LANDSCAPES OF THE NORTH-NORTHWESTERN FLUMINENSE

| Indicator | P, R, M | Target Value at Project Completion | Value Observed at Completion | Score |
|---|---|---|---|---|
| Change in total land area characterized by biodiversity-friendly agricultural practices that enhance soil structure stability in microcatchments | P, R, M | 32,000 ha | 31,650 ha | 2 |
| Total area of riparian and other native forests rehabilitated for biodiversity conservation and hydrology stabilization objectives | R, M | 1,440 ha | 1,332 ha | 2 |
| Area of biodiversity conservation-friendly land use mosaics established on private lands supporting corridor connectivity in project watersheds | R | 1,240 ha | 792 ha | 1 |
| Reduction in erosion and downstream sedimentation in at least three microcatchments, | R | 3 | 2 | 1 |
| and amount of $CO_2$ sequestered. | M | 1.5 tons/ha | 80 tons/ha (air) and 5 tons/ha (soil) | 5 |
| By PY4, 40 rural community organizations created that have adopted and implemented IEM/SLM strategies in 40 microcatchments | R | 40 | 48 | 4 |
| Education, training, and awareness building of beneficiary stakeholders, project executors, and schools—by type of stakeholders: | | | | |
| beneficiaries | R | 3,000 | 5,730 | 5 |
| executors | R | 150 | 370 | 5 |
| schools | R | 25 | 20 | 2 |
| IEM and SLM practices adopted, reversing land degradation and improving livelihoods by PY5 (by type): | | | | |
| at least 1,900 farmers in 40 communities | R | 1,900 farmers in 40 communities | 2,254 farmers in 48 communities | 4 |
| microcatchments | R, M | 40 catchments | 48 catchments | 4 |
| Microcatchment Development Plans (PEM) and related individual farm-level plans (PID) developed in at least 40 microcatchments | R | 40 catchments | 48 catchments | 4 |
| By PY4, 40 rural community organizations created that have adopted and implemented IEM/SLM strategies in 40 microcatchments | R | 40 catchments | 48 catchments | 4 |
| At least 200 project executors trained throughout life of the project | R | 200 executors | 370 executors | 5 |
| At least 3,000 participants in environmental education events, including stakeholders from 5 project microcatchments (24 municipalities) | R | 3,000 | 5,730 | 5 |

*Note:* PY = Program year.

exceeded and highly exceeded the expectation. The average score was thus above satisfactory at 3.25. The overall average CSA Results Index for the project was 2.9. It needs to be interpreted with caution, though, because the area's Resilience and Mitigation contain a range of indicators, largely exceeding expectations, whereas the area of Productivity has one indicator that fell short of meeting the target. For achieving the CSA goals, these results may indicate that more focus could be placed on Productivity.

## CASE STUDY 4: BURUNDI—AGRICULTURE REHABILITATION AND SUSTAINABLE LAND MANAGEMENT PROJECT (P064558, P085981)

Project Development Objectives were to restore the productive capacity of rural areas through investments in production and sustainable land management and through capacity building for producer organizations and local communities. Beneficiaries would also include war-distressed returnees and internally displaced persons. The project also had a set of Global Environment Objectives. The GEF operational program addressed the causes of land degradation by accelerating locally driven sustainable land management practices, contributing to maintenance of critical ecosystem functions and structures (including maintaining agro-ecosystems, stabilizing sediment storage and release in water bodies, and improving carbon sequestration through increase in vegetation cover).

The project had 3 indicators at the PDO level and 12 intermediate results indicators, as well as subindicators at the PDO level to measure productivity if several crops. Table 5.9 presents the indicators that we selected for testing and

**FIGURE 5.10.** BURUNDI'S CSA-RES P, R, M SCORES

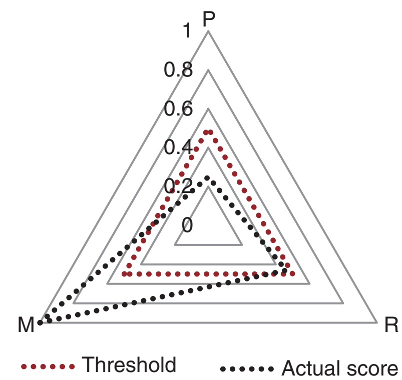



**TABLE 5.9.** SELECTED INDICATORS FOR BURUNDI—AGRICULTURE REHABILITATION & SUSTAINABLE LAND MANAGEMENT

| Indicator | P, R, M | Target Value at Project Completion | Value Observed at Completion | Score |
|---|---|---|---|---|
| Productivity increase of main agricultural and livestock products in project area: | | | | |
| beans | P, M | 0.9 | 0.7 | 1 |
| irrigated rice | P, M | 5 | 4.2 | 2 |
| onions | P, M | 15 | 6.3 | 1 |
| tomatoes | P, M | 15 | 7 | 1 |
| cassava | P, M | 12 | 10 | 2 |
| palm oil | P, M | 3 | 3 | 3 |
| milk | P, M | 7 | 5.5 | 1 |
| Increase in beneficiaries' net profit (%) | R | 30 | 26 | 2 |
| Area of selected watershed under SLM practices | R, M | 9,000 ha | 11,279 ha | 5 |
| Number of productive investment subprojects approved and being implemented | R | 3,300 | 3,744 | 4 |
| Area under irrigation | P | 1,224 ha | 1,573 ha | 5 |
| Number of beneficiaries (including women and coffee growers) | R | 102,000 | 245,258 | 5 |
| Number of trees, including local varieties | R, M | 52,000,000 | 71,904,786 | 5 |
| Number of persons day trainings | R | 108,000 | 275,388 | 5 |

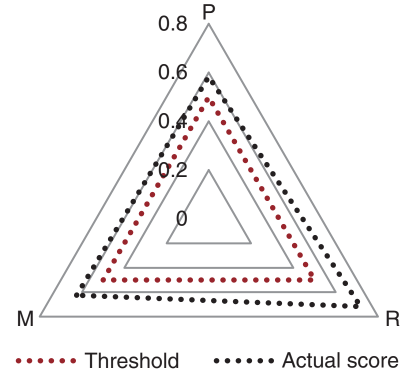
figure 5.10 shows the P, R, M assignments. All, except one ("productivity increase of palm oil"), indicators in the category P failed to reach the target, two indicators ("productivity increase of irrigated rice" and "cassava") failed to reach the target by equal to or less than 20 percent, and four indicators failed to reach the target by more than 20 percent.

The overall average score for Productivity indicates that the project performed below expectations in achieving the CSA goal of increasing Productivity. For the area of Resilience, six indicators were assigned, which on average achieved a score of 2.8, indicating that seven indicators failed to reach the target (the majority of those are the same as for the area Productivity), whereas the remaining six achieved or highly exceeded the target. The overall result was thus satisfactory. For the area Mitigation, two indicators were assigned that exceeded their target value by more than 20 percent. The overall average CSA Results Index score was thus 3.3—the project satisfactorily achieved the targets related to CSA triple-win goals.

## CASE STUDY 5: CHINA—IRRIGATED AGRICULTURE INTENSIFICATION PROJECT III—A MAINSTREAMING CLIMATE CHANGE ADAPTATION IN IRRIGATED AGRICULTURE PROJECT (P084742, P105229)

The project's PDO was to increase water and agricultural productivity in low- and medium-yield farmland areas; raise farmers' income and strengthen their competitive capacity under post-WTO conditions; and demonstrate and promote sustainable participatory rural water resources management and agro-ecological environmental management in the 3H Basin. The Global Environment Objective was to enhance adaptation to climate change in agriculture and irrigation water-management

**FIGURE 5.11.** CHINA'S CSA-RES P, R, M SCORE




practices through awareness raising, institutional and capacity strengthening, and demonstration activities in the 3H Basin. This would assist in mainstreaming climate change adaptation measures, techniques, and activities into the national Comprehensive Agricultural Development Program that is China's largest national investment program in irrigated agriculture.

This project had 6 PDO indicators, 6 GEO indicators, and 38 intermediate results indicators. Therefore, we chose a range of distinctly different indicators (table 5.10) to assess the project's performance toward the CSA goals.

As is evident from figure 5.11 and table 5.10, each indicator reached or exceeded or highly exceeded the target. For the category Productivity, the average score was 3.3; for Resilience, the average score was 3.9; and for Mitigation, the average score was 3.5. The overall average CSA results Index was thus 3.6, demonstrating that the project satisfactorily reached all targets related to achieving the CSA triple-wins.

## **TABLE 5.10.** SELECTED INDICATORS FOR CHINA—IRRIGATED AGRICULTURE INTENSIFICATION PROJECT III

| Indicator | P, R, M | Target Value at Project Completion | Value Observed at Completion | Score |
|---|---|---|---|---|
| Increase per capita income of typical farm households | R | Y 2,207 | Y 3,290 | 5 |
| Increase high-quality/value and nonpolluting/green crop production (million ton [mt]) | P R | 4.2 mt | 4.2 mt | 3 |
| Increase water and agricultural productivity (kg/m$^3$) | P, R | 1.45 kg/m$^3$ | 1.55 kg/m$^3$ | 4 |
| New established no. of Water User Associations (/ha) | R | 1,014 | 1,022 | 4 |
| New established no. of FAs and member coverage (/ha) | R | 70,400 | 95,400 | 5 |
| Climate change adaptation awareness of farmers, technical staff, officials (percentage of people) | R | 47 | 56 | 4 |
| Relevant CC adaptation measures implemented in selected demonstrated areas (ha) by participatory stakeholders (number of households) | R | 186,424 | 208,152 | 4 |
| Increase per capita income of typical farm households because of adaptation measures applied | R | 1,501 | 1,570 | 4 |
| Change in the production per unit of ET (KG/ET) | P, R | 114,000 | 114,000 | 3 |
| Total improved area of low- and medium-yield farmland (ha) | P, R, M | 505,505 | 505,505 | 3 |
| Water-saving irrigated area (ha) | P, R | 380,456 | 392,525 | 4 |
| Number and quality WUAs established and operating | R | 1,014 | 1,022 | 4 |
| On-farm forest belts established (ha) | R, M | 27,847 | 30,714 | 4 |
| Number of counties with groundwater-management plans adopted | R | 19 | 19 | 3 |
| Number of farmers' professional cooperative organizations' demonstration pilots | R | 19 | 20 | 4 |
| Farmers' training (man/month) | R | 66,036 | 74,455 | 4 |
| Quality seed coverage (%) | P, R | 100 | 100 | 3 |
| Increase per capita income of typical farm households | R | 2,207 | 3,290 | 5 |
| Increase high quality/value and nonpolluting/green crop production (mt.) | P R | 4.2 | 4.2 | 3 |
| Increase water and agricultural productivity (kg/m$^3$) | P, R | 1.45 | 1.55 | 4 |
| New established no. of WUA(/ha) | R | 1,014 | 1,022 | 4 |
| New established no. of FAs and member coverage (/ha) | R | 70,400 | 95,400 | 5 |

*Note:* ET = evapo-transpiration; FA = farmer associations; WUA = water user associations.

## CHAPTER SIX

# CONCLUSION AND THE WAY FORWARD

The report identified three indices to support policy makers and development practitioners in identifying and implementing the necessary policy, technical, and monitoring framework to enable and operationalizing CSA.

**The CSA-Pol Index** allows policy makers and other users to compare how a country's enabling environment for CSA is changing over time; identifies gaps in supporting CSA implementation; and to develop benchmarks for reform. **The CSA-Tech Index** helps to guide thinking about the values of technology, specifically looking at its potential to improve decision making. **The CSA-Res Index** measures an agricultural project's performance toward achieving the CSA triple wins individually and jointly.

The development of the CSA indicators was informed by the impact pathway and theory of change. It presented the rationale for the selection of the indicators that included a range of policies, technologies, and practices focused on the CSA pillars. To achieve the medium- and long-term goals of environmental sustainability, CSA interventions must be regarded within a landscape approach that is cognizant of the competing demand for land, water, and natural resources use and that equips farmers with an understanding of the cost-benefits or trade-offs of adopting certain practices and technologies.

## REPORT HIGHLIGHTS

- Adopting CSA policies to address food insecurity under changing climatic conditions is critical. A 1 percent increase in the CSA-Pol Index is predicted to lead to a 0.4 percent decline in the proportion of undernourished population. Cereal yields increase 47 kilograms per hecatre for every 1 percent increase in the CSA-Pol Index.
- Public expenditure for services and infrastructure could be more important than readiness mechanisms and coordination mechanisms for achieving CSA goals.

- Low-income countries may benefit more by focusing on policies that provide for effective CSA implementation.
- The results from the CSA-Tech Index assessment shows how the tool can be used to select contextual ready technologies to achieve triple wins.
- The results from the CSA-Res Index assessment showed how the tool can be used to assess triple wins to project objectives.

Although noting their utility in informing national policies and project development and monitoring, there are also some limitations to the indices. For instance, although the CSA-Pol Index reflects the most significant aspect for enabling CSA at the national level, it does not measure the performance or quality of various policy measures, services, and coordination mechanisms to support implementation. Although the CSA-Pol Index does not look at national budgets, it should be noted that actual budgets dedicated to CSA are critical for converting "readiness" into action. Some limitations of the CSA-Res Index were also noted, which included difficulties in determining whether an enabling environment is a consequence of the CSA intervention or of other externalities. For some indicators, the CSA-Res Index does not also convey information about the quality of systems or impact of an intervention at the project level.

The CSA indicators have been designed with great flexibility in mind. Unlike many of the existing indicators and indices related to agriculture and food security, the CSA indicators are a robust tool for a full range of agriculture and rural development projects. It can accommodate new data and indicators, yet allow for consistent comparison and analysis. The tool is user friendly, cost effective, and can be incorporated into various phases of a project.

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**APPENDIX A**

# REVIEW OF EXISTING INDICES RELATING TO AGRICULTURE AND CLIMATE CHANGE

A range of indicator and index initiatives exists. These inform about agriculture and climate change topics, rank countries accordingly, and allow for recommendations toward policy and project-level CSA interventions. However, as the review of indictors shows here, very rarely are the CSA dimensions of food security, agricultural productivity, resilience, climate change mitigation, and sustainable use of natural resources addressed in one indicator.

Achieving food security is a determined aim of CSA. There is a range of indicators and indices that capture the state of food security and nutrition in developing countries. The available indicators often point toward gaps in the provision of food and nutrition and highlight the importance of good governance to support agricultural development. However, these indicators and indices typically fail to capture the interdependencies between food security and productivity; environmental and natural resources management; or agriculture's impact on climate change or the need for increasing resilience toward climate-induced risks. A prominent example is the Global Food Security Index (from the Economist Intelligence Unit, which comprises 18 indicators and assesses food security of 109 countries). The indicators are categorized in three groups—food affordability, availability, and quality and safety. The index encompasses various dimensions of food demand, production volatility, rural poverty, and nutrition.[1] The complexity of calculating the composite index is frequently cited as a weakness because it makes recommendations for policy interventions based on an index score difficult. In addition, a theoretical framework is lacking that explains the rationale for the selection of indicators for the composite index.[2]

In contrast to measuring the status of food and nutrition security, the HANCI attempts to assess governance and political will to reduce undernutrition and hunger. HANCI is a project of the Institute of Development Studies with funding from Irish Aid, UKAid,

[1] http://foodsecurityindex.eiu.com/Home/Methodology.

[2] http://www.zef.de/uploads/tx_zefportal/Publications/wp108.pdf.

and Children's Investment Fund Foundation that ranks governments on their political commitment to tackling hunger and undernutrition. It includes 22 indicators that cover three themes—laws, policies, and spending—to assess government direct and indirect interventions that relate to creating an enabling environment to address hunger and nutrition.[3] Although the indicator is well accepted, there is some criticism that assessing country progress for tackling hunger and nutrition through the index from year to year is difficult. Indicators that focus too closely on legal frameworks such as constitutional rights are not useful tools for practitioners to use to track from year to year and thus diminish the usefulness of the index.

Another noteworthy initiative is the Agricultural Science and Technology Indicators initiative. Information about research and development in agriculture is crucial for an understanding of the enabling environment for CSA. ASTI is led by the International Food Policy Research Institute and provides information on agricultural R&D systems across the developing world. In contrast to other index initiatives, it conducts primary surveys to collect data from government, academia, and private and nonprofit agencies. It thus covers information on funding sources, spending levels and allocations, and human resources capacities at both country and regional levels. The index provides a benchmarking tool to conduct country rankings. However, it does not provide a composite index that provides a ranking at one glance.

There is another category of indicators and indices that typically focuses on climate change and natural resources management, but at the same time often neglects the interdependencies of agricultural productivity and resilience. Prominent examples in this category are indicators provided by the World Resources Institute, which benchmark and provide information on countries' contribution and vulnerability to climate change and other environment-related information. For instance, the CAIT Climate Data Explorer provides a comprehensive collection of global GHG emission data, partially dating back 160 years. From 1990 onward it provides a multisector GHG inventory analysis that includes data from the agricultural sector.[4] A similar inventory is provided by FAO agricultural emissions data, which allows users to differentiate emission by agricultural practice and land use.[5] Both inventories provide an understanding of agriculture's impact on climate change and the mitigation potential of several practices on a global scale, thus providing insights in the choice of agricultural practices and technologies. However, the data do not provide support in the selection of CSA technologies in specific country or project contexts because the regional context in terms of suitability and enabling environment for the technology is not considered.

The Global Forest Watch, provided by WRI, shares important information on land use and land cover management, a relevant dimension of CSA. The interactive platforms provide indicators such as tree cover state, loss, and gain by country. Although no composite index is provided, the country profiles include qualitative information on the policy and institutional environment of forest management. WRI also provides data on an aqueduct project and maps production areas under water stress. The overarching goal of the tool is to help companies, investors, governments, and other users to understand where and how water risks and opportunities are emerging.

Another set of indicators is suitable to inform the results framework and can constitute M&E indicators for CSA interventions. For instance, the Global Donor Platform for Rural Development includes a set of agricultural and rural development indicators, but does not track climate change mitigation and resilience to climate change.[6] The resilience indicators instruments from the Consultative Group for International Agricultural Research and CCAFS[7] provide project-level indicators for monitoring and evaluation projects that seek to increase adaptive capacity and enhance livelihood and farm functioning. It focuses on the provision and access to environmental services that foster resilience. Agricultural production and

[3] http://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/4090/ER78%20HANCI.pdf?sequence=5.

[4] http://cait2.wri.org/wri#Country GHG Emissions.

[5] http://faostat3.fao.org/browse/G1/*/E.

[6] https://openknowledge.worldbank.org/handle/10986/6200.

[7] https://cgspace.cgiar.org/handle/10568/56757.

land use management, as well as farmers' potential to adapt to and mitigate climate change, are not addressed. Another indicator set is the World Bank indicators for Land Quality and Sustainable Land Management.[8] These indicators tackle ecological resilience excluding the resilience and adaptive capacity of households. Furthermore, it only partially allows for monitoring the mitigation potentials of agriculture.

The need to combine all dimensions of climate-smart agriculture has been addressed by a recent initiative of the CGIAR Research Program on Climate Change, Agriculture and Food Security. CCAFS produced a set of CSA country profiles for Latin America and the Caribbean, which are based on the CSA pillars of productivity, resilience, and mitigation. The country profiles provide an overview of land use, climate change impacts, mitigation potential, and institutional arrangements and policies that create an enabling environment for CSA. It also highlights financing options to support CSA implementation. In addition, countries are assigned a "smartness" measure in terms of water, energy, nitrogen, weather, and knowledge-smart agricultural practices commonly used in the country (CGIAR 2014). Although the CCAFS profiles informed country baseline diagnostics, it is difficult to derive policy recommendations from them or recommendations as to which technology may be the most suitable at the project level.

[8] http://elibrary.worldbank.org/doi/pdf/10.1596/0-8213-4208-8.

# APPENDIX B
# TECHNICAL NOTES FOR THE CSA POLICY INDEX

| # | Indicators | Data Sources | Proposed Scoring | Technical Notes |
|---|---|---|---|---|
| ***Readiness Mechanisms*** | | | | |
| 1 | **Agricultural adaptation policy** | National agriculture legislation, policies, strategies, and regulations<br>National climate change legislation, policies, strategies, and regulations | Total Score: 3<br>1a. Ag. policy (or the country's climate change adaptation policy, for example the NAPA) explicitly states an intention to address adaptation to climate change (1)<br>1b. [If yes to 1a] Is there a strategy to support implementation of this aspect of the policy? (1)<br>1c. [If yes to 1a] Is there a mechanism in place to implement and monitor programs and activities to address adaptation to climate change in the Ag. Sector? (1) | In determining a country's policy support for CSA, one can examine a country's intent to address the impacts of climate change on agriculture as expressed by its government, which can be assessed by how the government expresses this intent within the policy: explicit indication within the policy to deal with the impacts of climate change in the agricultural sector, and the development of a strategy for dealing with the impacts of climate change in the agricultural sector. In looking beyond intent, one can consider the government's commitment to the implementation of the policy by assessing indicators of policy implementation, namely, the development of a system for implementation, and also for monitoring the impact of the policy in a manner that promotes feedback learning with the potential for improving the design and implementation of the policy, and actual expenditure on the strategy. A country's policy support for CSA is therefore assessed by its intent to adapt agricultural systems for climate change, and the operationalization and implementation of this intent.<br>Agricultural policies are expressed in a variety of ways by different countries, and so the broad list of policies considered for the scoring of these indicators include the following: national agricultural policies, strategies, and action plans; national development strategies; rural development strategies; and poverty reduction strategy papers. Climate change policies at the national level are expressed through NAPAs, NAMAs (FAO 2010), and communications to the UNFCCC. |

| # | Indicators | Data Sources | Proposed Scoring | Technical Notes |
|---|---|---|---|---|
| 2 | **Agricultural mitigation policy** | National agriculture legislation, policies, strategies, and regulations<br>National climate change legislation, policies, strategies, and regulations | Total Score: 3<br>2a. Ag. policy (or the country's climate change mitigation policy, for example the NAMA) explicitly states an intention to address mitigation of climate change (1)<br>2b. [If yes to 2a] Is there a strategy to support implementation of this aspect of the policy? (1)<br>2c. [If yes to 2a] Is there a mechanism in place to implement and monitor programs and activities to address mitigation to climate change in the Ag. Sector? (1) | In the process of developing the indicators, the study team faced difficulty in accessing national budgets or expenditure reports that reflected implementation of CC adaptation or mitigation. The indicator is, however, a very important one for assessing the performance of a policy and so the respective indicators are retained.<br>Subindicators 1a, 1b, 2a, and 2b assess intent of the government, and subindicators 1c and 2c assess the commitment to implementation of the policy. |
| 3 | **Economic readiness** | Doing Business Report 2015<br>ND-GAIN Index | Total Score: 1<br>Calculated from the "ease of doing business index." Details of the calculation of the indicator score is included in the ND-GAIN Methodology manual. | Economic readiness captures the ability of a country's business environment to accept investment that could be applied to adaptation that reduces vulnerability (reduces sensitivity and improves adaptive capacity). This is the "Doing Business Indicator." |
| 4 | **Governance readiness** | World Bank Governance Indicators (2013 data)<br>ND-GAIN Index | Total Score: 1<br>Calculated as a composite indicator of the following variables available from World Bank's Governance Indicators: Political Stability and Absence of Violence Terrorism; Regulatory Quality; Rule of Law; Control of Corruption. Details of the calculation of the Indicator score are included in the ND-GAIN Methodology manual. | Governance Readiness: Institutional factors that enhance application of investment for the adaptation of financial resources. The governance readiness subindicators capture several aspects of governance: (i) Political Stability and Nonviolence—the relationship between foreign financial inflow and political stability and violence suggests that a stable political environment is more attractive to general investment from outside a country, including the adaptation investment; (ii) Control of Corruption—corruption is known to have a negative impact on foreign investment and measuring the control of corruption implies government integrity and accountability; (iii) Regulatory Quality—the quality of regulation measures the performance of country institutions, an important factor in deploying adaptation actions and adaptation-related policies; (iv) rule of law is a quality of society that encourages foreign investment in general, hence the adaptation investments (Chen et al. 2015). |

| # | Indicators | Data Sources | Proposed Scoring | Technical Notes |
|---|---|---|---|---|
| 5 | **Social readiness** | Millennium Development Goal Indicators (2012 data)<br>World Development Indicators (2013 data)<br>ND-GAIN Index | Total Score: 1<br>Calculated as a composite indicator of the following variables available from World Bank's Governance Indicators: social inequality; information communication technology infrastructure; education; and innovation. Details of the calculation of the Indicator score are included in the ND-GAIN Methodology manual. | The social readiness subindicators use socioeconomic measures to assess society's overall readiness for adaptation. The subindicators include the following elements: (i) Social inequality causes skewed distribution incomes and of vulnerability, and the exaggerated impacts on the poorest may further skew income distribution. Thus, social inequality exacerbates a country's capacity to adapt to climate change. (ii) Information communication technology infrastructure enables knowledge integration and learning and key ingredients of adaptive capacity, provides technical support for early warning systems, and can strengthen local organizations that implement adaptation. (iii) Education is considered an important strategy to build up adaptive capacity and identify adaptation solutions appropriate to local context. (iv) Innovation is the fundamental force behind capacity building and climate change adaptation because research and technology are necessary to define adaptation solutions (Chen et al. 2015). |
| ***Services and Infrastructure*** | | | | |
| 6 | **Extension services** | Survey of agriculture ministry | Total Score: 2<br>6a. Do the Extension Strategy/Action Plan/Guidelines include a commitment to providing producers with information/advice on dealing with the impacts of CC in agricultural systems? (1)<br>6b. Are there national programs for disseminating weather and climate services (information and forecasts) to agricultural producers? (1) | Assessing extension services is often done from the perspective of the recipient of the extension services, wherein questions are asked about timeliness of delivery; accuracy of service; relevance to situation; ease of understanding; and opportunity to use/apply information delivered (Agholor et al. 2013). Such assessments are very useful for understanding the quality of extension services at national or subnational scales, and can enhance the outcome of this indicator development exercise by providing specific information for countries on the quality and performance of their extension services, but are beyond the scope of this indicator development exercise. In an attempt to select a universal indicator that provided an indication of the quality of extension services, we first selected the "ratio of extension worker to producer/farmer" as an indicator. This indicator is commonly used as a measure of extension, but does not say anything about how the extension service has the potential to deliver, or actually delivers, CSA-relevant information. An indicator that more adequately captures potential albeit not actual performance of the extension services is the indicator selected as 6a. This indicator assesses the capacity of national extension services to provide information and advice to farmers relevant for dealing with the impacts of climate change on their production system, and therefore examines the systems that are in place to provide this information.<br>Indicator 6b is included to assess the capacity of a country for translation of climate data and information into useful information for producers and extension agents. It also assesses the delivery of CSA-relevant information through ICT channels such as mobile technology, Internet, television, and radio. |

| # | Indicators | Data Sources | Proposed Scoring | Technical Notes |
|---|---|---|---|---|
| 7 | **Agricultural R&D** | National accounts data available from the World Bank<br>Primary surveys to collect data from government, higher education, and nonprofit and private agriculture R&D agencies | Total Score: 2<br>7a. Does the Ag. R&D policy expresses a commitment to CC and Ag. research? (1)<br>7b. Is there a mechanism (in place and being implemented) that promotes collaborative research, among multiple stakeholders? (1) | For this particular indicator we are interested in the evidence that a country is investing in research to manage climate change impacts in the agricultural sector. This includes research into increasing the resilience of agricultural systems to projected impacts of climate change, for example by developing drought, pest, and heat-resistant seeds and livestock varieties. And also research into mechanisms for reducing the output of GHGs from agricultural systems or even reducing the emissions intensity of agricultural systems, for example through introducing improved livestock varieties that utilize food resources more efficiently and produce less methane per kg of feed. Evidence of a country's investing in CC and agriculture research can be assessed through what the country has committed to do, and what they actually do on CC and Ag. research.<br>We can assess the commitment to undertaking CC and Ag. research within a country by examining what is expressed in the country's Ag. or Ag. research policy. Accordingly, indicator 7a is included to assess this commitment.<br>In cases where the indicator is not available, a value of zero is assigned to the indicator. |
| 8 | **Rural Access Index (RAI)**[1] | World Bank Data[2] | Expressed as a % | The World Bank is the main source of data for the RAI. These data are produced at different times and so the data are inconsistent in this way.<br>In cases where the RAI value is not available, a value of No-data is assigned to the indicator and is not included in the calculation of the final score of the indicator. |
| 9 | **Social safety nets** | Surveys of public and private sector social support and development programs<br>World Bank ASPIRE: Atlas of Social Protection Indicators of Resilience and Equity | Total Score: 1<br>SSNs (cash transfers, food distribution, seeds and tools distributions, and conditional cash transfers) identified in agriculture policies and national strategies as a resilience (or coping) mechanism (1) | SSNs are noncontributory transfers in cash or in kind targeted to the poor and vulnerable that can have an immediate impact on reducing poverty and on boosting prosperity, by putting resources in the hands of the poorest and most vulnerable members of society (World Bank 2014). In countries experiencing increased exposure to disasters and climate change consequences, there is a growing recognition of the role SSNs play in providing resilience. SSNs can help to ensure that during times of hardship, such as during flooding and drought events, farming communities can have access to resources (money, food, and so on) to maintain or improve their standard of living. Public works programs that guarantee employment when needed would effectively build resilience to climate change impacts. Agriculture-related public works activities, such as hillside terracing or soil and water conservation, can improve farm yields and generate sustainable benefits for household food security. They can also create community assets and infrastructures that are critical for adaptation |

[1] http://www.worldbank.org/transport/transportresults/headline/rural-access.html.

[2] http://www.worldbank.org/transport/transportresults/headline/rural-access.html.

| # | Indicators | Data Sources | Proposed Scoring | Technical Notes |
|---|---|---|---|---|
| | | | | (FAO 2013). The World Bank identifies five different types of SSNs: conditional cash transfers, unconditional cash transfers, conditional in-kind transfers, unconditional in-kind transfers, and public works expenditures. |
| 10 | **National GHG inventory system** | Survey of relevant public sector agencies<br>Reports to the UNFCCC | Total Score: 2<br>Does the country have a national GHG inventory system? (1)<br>Does the national GHG inventory system include emissions from the Ag sector? (1) | National GHG accounting systems may include national GHG inventories. An accurate understanding of GHG emissions allows governments, companies, and other entities to identify opportunities to manage emissions, enhance removals, evaluate the success of low-carbon growth strategies over time, and ensure that resources are targeted toward effective solutions. |
| 11 | **National agricultural risk management systems** | National agriculture legislation, policies, strategies, and regulations | Total Score: 6<br>*Grain stock management*<br>11a. Does the country have access to grain stock reserves? (1)<br>11b. Are there guidelines (and standards) for grain stock management such as warehouse receipt systems? (1)<br>*Agricultural insurance*<br>11c. Is there a policy or are there guidelines for agricultural insurance (crop and/or livestock)? (1)<br>*Agricultural Information Systems*<br>11d. Is there a market information system for dissemination of trend and forecast information on crop and livestock price information to producers? (1)<br>11e. Is there an early warning system available for weather/climate? (1)<br>11f. Is there an early warning system for pests/diseases? (1) | Access to grain stock reserves (indicator 11a) may include even access outside of a country to grain reserves. In such cases access may be instituted through a formal agreement between the donor and recipient countries.<br>Market information systems (indicator 11d) provide producers and extension workers with data and information on prices for agricultural produce. These systems may take on a variety of forms including pamphlets, information available on websites, mobile messages, or electronic billboards. |

| # | Indicators | Data Sources | Proposed Scoring | Technical Notes |
|---|---|---|---|---|
| 12 | **Adaptive capacity** | ND-GAIN Index | Total Score 1<br>Calculated from ND-GAIN capacity (vulnerability) data. The score equals 1 minus the original number. | Adaptive capacity describes the availability of social resources to put adaptation into place to reduce exposure and sensitivity. In some cases, these capacities reflect sustainable adaptation solutions. In other cases, they reflect the ability of a county to put newer, more sustainable adaptations into place to address the needs of a particular sector (ND-GAIN 2015). It is important to note that the adaptive capacity score considers the adaptive capacity not only in the agricultural sector but also in the sectors of water, health, infrastructure, transport, and environment, and therefore provides a broad measure of a country's adaptive capacity to deal with climate change impacts. Further information on this indicator can be accessed in the technical guidance for the ND-GAIN indicator available at http://index.nd-gain.org:8080/documents/nd-gain_technical_document_2015.pdf. |
| ***Coordination Mechanisms*** | | | | |
| 13 | **Disaster risk management coordination** | National agriculture legislation, policies, strategies, and regulations<br>National climate change legislation, policies, strategies, and regulations<br>National disaster management legislation, policies, strategies, and regulations | Total Score: 3<br>13a. Legislation and/or policy for DRR in the agricultural sector (or DRR policy includes measures to address disasters in the Ag. sector) (1)<br>13b. Specific action plan or strategy (or guidelines) developed for addressing DRR in agriculture (1)<br>13c. Country is a signatory to the Hyogo Framework for DRR (1) | In determining how well a country integrates the agricultural sector into DRR planning, or, conversely, how DRR is integrated in the agricultural sector, an examination of a country's disaster management or its agricultural policies is required.<br>DRR planning is also often expressed in a country's report to the Hyogo Framework for DRR. The Hyogo Framework for Action is the first plan to explain, describe, and detail the work that is required from all different sectors and actors to reduce disaster losses. It was developed and agreed on with the many partners needed to reduce disaster risk—governments, international agencies, disaster experts, and many others—bringing them into a common system of coordination. The Hyogo Framework for Action outlines five priorities for action, and offers guiding principles and practical means for achieving disaster resilience. Its goal is to substantially reduce disaster losses by 2015 by building the resilience of nations and communities to deal with disasters. This means reducing loss of lives and social, economic, and environmental assets when hazards strike (http://www.unisdr.org/we/coordinate/hfa).<br>Agricultural policies are expressed in a variety of ways by different countries, so the broad list of policies considered for the scoring of these indicators include: national agricultural policies, strategies and action plans, national development strategies, rural development strategies, and poverty reduction strategy papers.<br>This indicator assesses a country's commitment to integration of DRR into agriculture as expressed in relevant policy documents (13a), the development of a strategy or guidelines for DRR implementation in agriculture (13b), and the commitment to the Hyogo framework (13c). |

| # | Indicators | Data Sources | Proposed Scoring | Technical Notes |
|---|---|---|---|---|
| **14** | **Multisectoral coordination** | Survey of relevant public sector agencies | Total Score: 4<br>14 a. Does the agriculture policy express commitment to coordination among sectors involved in CSA (for example, climate, environment, water, forestry)? (1)<br>14b. Is there an existing multisectoral committee for climate change that includes representation from the agricultural sector? (1)<br>14c. [If yes to 14b.] Does the committee include civil society representation? (1)<br>14d. Does the major CC strategy (including NAPA and NAMA) express commitment to promoting coordination among sectors including agriculture? (1) | CSA implementation requires coordination across agriculture sectors (for example, crops, livestock, forestry, and fisheries) and other sectors, such as energy and water. Cross-sector development is essential to capitalize on potential synergies, reduce trade-offs, and optimize the use of natural resources and ecosystem services (FAO 2013). Implementation of CSA will require cooperation of four main groups of stakeholders within these sectors: (1) government policy and decision makers to establish the legal and regulatory frameworks for CSA and to promote and mainstream CSA in an intersectorial manner; (2) governmental technical, research, and extension staff to develop and disseminate CSA practices; (3) agribusinesses including nongovernmental research and extension organizations for supporting government efforts to implement CSA; and (4) producers that actually implement CSA practices. Cooperation among stakeholders in these four groups has the potential to improve the design and implementation of CSA policies by allowing various stakeholders to voice their needs and concerns, to be more aware and responsive to the needs and concerns of other actors, and to create opportunities for knowledge exchange (World Bank 2011). Such cooperation should be the standard among stakeholders in the agricultural sector; however, cooperation in many countries is challenged by opportunistic behavior among stakeholders, lack of trust, lack of incentives for cooperation, difficulty in setting and enforcing rules, policies that are imposed without local participation, conflicting interests among land users, lack of harmony and coordination between legal bodies and procedures, poor identification of and inadequate consultation with stakeholders, and uncoordinated planning (FAO 2013; World Bank 2011). Given that the stakeholder groups identified herein are the same stakeholders responsible for development and innovation in the agricultural sector, it is expected within some countries that CSA planning implementation would be challenged by low capacity or cooperation. |

## APPENDIX C

# TECHNICAL NOTES FOR THE CSA TECHNOLOGY INDEX

### PRODUCTIVITY

| | # | Theme | Technical Notes | Indicator (% change from baseline) |
|---|---|---|---|---|
| **Crop System** | 1 | **Cereal yield (% increase)** | Cereal yield is measured as kilograms per hectare of harvested land. Crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded. Crops include wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. Production data on cereals relate to crops harvested for dry grain only. The FAO assigns production data to the calendar year in which most of the harvest took place. | *The technology leads to an increase in yields of the producers (%)* |
| | 2 | **Soil erosion** | Soil conservation and the efficient use of water are very important in countries affected by climate change. For example, conservation agriculture can reduce the runoff and erosion of the soil and allow it to retain more water and nutrients. This technique also permits the soil to incorporate more carbon and to reduce carbon emissions from soils. | *The technology reduces the share of agricultural land classified as having moderate to severe water erosion risk (%)*<br>*The technology reduces the share of agricultural land classified as having moderate to severe water wind risk (%)* |
| | 3 | **Soil fertility** | Until recently, farmers' knowledge of soil fertility has been largely ignored by soil researchers, but with increasing use of participatory research approaches, it is becoming clear that farmers have a well-developed ability to perceive differences in the level of fertility between and within fields on their farms. For example, the soil classification systems of the hill farmers of Nepal have already been documented (Tamang 1991, 1992; Turton et al. 1995), and these studies have shown that farmers use a range of criteria, including economic influences, to categorize their | *The technology enhances soil fertility (%)* |

| | # | Theme | Technical Notes | Indicator (% change from baseline) |
|---|---|---|---|---|
| | | | soils, but that soil color and texture are the dominant criteria. They also see the actual fertility of a soil at any time as a function not only of these longer-term soil properties but also of the current and past management regime. | |
| | **#** | **Theme** | **Technical Notes** | **Indicator (scale 1–5)[1]** |
| | 4 | **Enhances biodiversity** | Enhancement includes off-farm benefits (for example, catchment protection, biodiversity corridors). Agricultural biodiversity in time and space increases resilience in myriad ways: complementary use of soil nutrients and water, decreased risk from one crop failure, and pest protection. | *The technology enhances biodiversity of the farming landscape in comparison with current interventions in similar farming systems* |

| | | Theme | Technical Notes | Indicator (% change from baseline) |
|---|---|---|---|---|
| **Water Use** | 5 | **Agricultural irrigated land (% of total agricultural land)** | Water management is a critical component of adaptation to both climate and socioeconomic pressures. Practices that improve irrigation performance and water management are critical to ensure the availability of water both for food production and for competing human and environmental needs. | *The technology increases the share of irrigated agricultural land as a result of the technology (%)* |
| | 6 | **Water withdrawal for agriculture** | Agricultural water withdrawal is a serious concern, especially in arid and semi-arid areas where water is scarce and highly variable from year to year. It is necessary to irrigate certain crops to obtain reasonable yields.<br>• Estimation of water **withdrawal** for countries with unavailable national statistics using a water requirement ratio<br>• Estimation of irrigation water withdrawal by country<br>• Corrections of agriculture water requirement and water withdrawal<br>• Pressure on water resources due to agriculture: regional summary of the water requirement ratio | *The technology reduces water withdrawal for agriculture use as a share of total water withdrawal (%)* |
| **Energy** | 7 | **Agriculture energy use** | Future agricultural sustainability will be achieved from an equilibrated solution of many productive, environmental, and economic issues. Among these, improved energy efficiency and reduced GHG emissions are fundamental. | *The technology reduces the* agricultural energy *use as a share of total household energy use (%)* |
| **Pest Management** | 8 | **Pest management** | Many insects, diseases, and weeds, generally defined as crop "pests," are an integral component of agro-ecosystems. In naturally established agricultural systems, "pest" species are in a shifting balance with other species (including those of their own natural enemies—parasites and predators) and crops as components of local food webs. Understanding the local agro-ecological balance is at the core of most CSA practices. | *The technology increases the share of agricultural land on which integrated pest management practices are adopted (%)* |

[1] In comparison with other implemented CSA technologies in the same farming system (survey using the Likert system); for example, **1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree, 5. Strongly agree.**

| | # | Theme | Technical Notes | Indicator (scale 1–5)[2] |
|---|---|---|---|---|
| **Livestock System** | 9 | **Livestock diversification** | Maintaining a diverse stock represents a critical adaptation measure. The preference for different livestock types depends on the availability of fodder, the capacity to thrive on crop residues, and disease resistance. | *The technology improves livestock diversification in comparison with current interventions in similar farming systems* |
| | 10 | **Resource management** | Pastoralists, for example, apply management strategies in times of drought, which include the use of emergency fodder in the form of grazing enclosures, culling of weak livestock, and keeping more than one species of stock. | *The technology improves livestock resource management in comparison with current interventions in similar farming systems* |
| | 11 | **Feed production technologies** | Many nonrangeland livestock farms rely on crop residues or purchased inputs to feed livestock. The pressure for land to produce food for human consumption means that innovative ways are needed to produce feed such as agricultural by-products or household and industrial waste products. | *The technology improves feed production in comparison with current interventions in similar farming systems* |
| | 12 | **Diversification of livelihood activities** | Livestock farmers have often turned to crop cultivation as a means of supplementing livestock incomes. Many former pastoralists are now mixed farmers, sometimes referred to as agro-pastoralists, combining transhumant livestock keeping with crop production. | *The technology leads to the diversification of livelihood activities in comparison with current interventions in similar farming systems* |

## RESILIENCE

| | # | Theme | Technical Notes | Indicator (scale 1–5)[3] |
|---|---|---|---|---|
| **Robustness** | 13 | **Human capital** | Human capital includes knowledge, skills, competencies, and attributes embodied in individuals that facilitate the creation of personal, social, and economic well-being. It is created through lifelong experience and formal education.<br><br>Human capital within agriculture may be defined to include the years of field-level experience in agriculture, variety and levels of agriculture-related technical skills, and their level of motivation. | *The technology will improve the human capital (technical skill levels) of producers in the target area* |
| | 14 | **Income and food security** | Participation in off-farm activities increases the incomes of the smallholders, provides them with capital to invest in farm production, and makes social structures more flexible. | *The technology will increase the stability of agricultural production needed to help producers meet their own basic food security and income needs* |
| | 15 | **Diversified income** | | *The technology will promote the diversification of the income and asset bases of producers* |

[2] Likert scale unless indicated. In comparison with other implemented CSA technologies in the same farming system (Likert survey of project leaders, experts, and farmers); for example, **1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree, 5. Strongly agree.**

[3] Likert scale unless indicated. In comparison with other implemented CSA technologies in the same farming system (Likert survey of project leaders, experts, and farmers); for example, **1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree, 5. Strongly agree.**

| | # | Theme | Technical Notes | Indicator (scale 1–5) |
|---|---|---|---|---|
| | **16** | **Crop/livestock diversification** | Crop diversification ensures that incomes can be derived from produce as different produce have different market values. For example, using nitrogen-fixing plants reduces the need for inorganic fertilizer, thereby reducing the cash expenditure of smallholder farms. | *The technology will promote crop diversification in the target area* |
| | **17** | **Site-specific knowledge** | Indigenous communities have long been recognized as being particularly vulnerable to the impacts of climate change because of the close connection between their livelihoods and their environment. However, at the same time, this long-established relationship with the natural environment affords many indigenous peoples with knowledge that they are now using to respond to the impacts of climate change. | *The technology will involve the incorporation of site-specific*[4] *knowledge in its application* |
| | **18** | **Intellectual property rights** | Intellectual property rights provide incentives, for example, for research scientists to invest in breeding improved varieties, and for seed companies to invest in ensuring that they market homogeneous, high-quality seed. These IPRs, if inaccessible, may impede innovation and/or access to improved varieties for smallholders in farming systems in many developing countries. | *The producers in the target area will have appropriate access to intellectual property rights needed for the deployment of the CSA technology* |
| **Self-organization**[5] | **19** | **Cooperation and networks** | This refers to local support networks with roots in the local community. This can also be the basis for a durable relationship with consumers. | *The technology will facilitate cooperation and networking among producers* |
| | **20** | **Local market networks** | Some CSA practices, if properly implemented, can support the development and expansion of smallholders and regional food enterprises to increase domestic consumption of, and access to, locally and regionally produced agricultural products, and to develop new market opportunities for crop and livestock operations serving local markets. | *The technology will foster local and regional production and supply chains* |
| | **21** | **Feedback from extension workers** | Sustained communication channels need to be established to provide information and feedback to farmers from extension systems. | *The intervention will provide opportunities for feedback from extension workers* |
| | **22** | **Power differentials** | Differential power relations and access to resources between men and women often result in different levels of vulnerability and adaptive capacity to risks such as droughts, floods, and storms. Women often have fewer rights to land, credit, and capital that would facilitate adaptation, and build resilience, to climate change. | *The CSA service will narrow existing power differentials in the community* |
| | **23** | **Gender positive/ negative** | Even where there is a lack of researched evidence, it is commonly recognized that climate change exacerbates existing inequalities. A gender-sensitive response requires an understanding of existing inequalities between women and men, and of the ways in which climate change can exacerbate these inequalities. | *The technology will contribute to reducing existing gender inequalities* |

[4] Indigenous knowledge: "local, orally transmitted, a consequence of practical engagement reinforced by experience, empirical rather than theoretical, repetitive, fluid and negotiable, shared but asymmetrically distributed, largely functional, and embedded in a more encompassing cultural matrix" (Buchmann and Darnhoffer).

[5] The capacity for self-organization is cited as one of the three properties common to all resilient systems. Individuals, local and regional networks, and smaller institutions of governance can be more responsive and adaptable to changing conditions than can larger groups. Any configuration that they create is more likely to contribute to overall system resilience in the long term because it was created by their own initiative.

| | # | Theme | Technical Notes | Indicator (scale 1–5) |
|---|---|---|---|---|
| **Cropping System** | **24** | **Resilience to adverse weather (Milestad and Darnhofer 2003)** | For example, a measure of resilience in agriculture, in the wake of severe and sustained droughts, is derived as the ability to continue farming by saving and carrying forward water through the adoption of water-efficient technology (Ranjan and Athalye 2008). Findings indicate that behavioral factors dominate the decision to adopt when the economic factors, such as the price of water, do not capture the true opportunity costs of water. The range of available technological options is crucial, too, because marginal improvements in technology do not lead to adoption. Such resilience refers to a farmer's ability to secure food, income, safe evacuation during flooding, and recovery after floods. | *The technology will increase the resilience of the cropping system to drought* |
| **Livestock System** | **25** | **Resilience to adverse weather** | In Sub-Saharan Africa, for example, an observable effect of drought is the transfer of livestock ownership to crop farmers, which is partially the result of capitalization of agricultural surpluses, especially in the cotton-producing areas. Adaptation strategies that pastoralists apply in times of drought include the use of emergency fodder in the form of grazing enclosures and keeping more than one species of stock. Pastoral women play an important role in natural resource management, harvesting wild food during drought and harvesting other products that have market value such as honey. | *The technology will increase the resilience of the livestock to drought* |

## MITIGATION

| | # | Theme | Technical Notes | Indicator (scale 1–5)[6] |
|---|---|---|---|---|
| | **26** | **Emissions intensity** | Emission intensity per calorie is computed by summing fertilizer, machinery, and labor emissions and dividing those by the total calories contained in primary crop products. These targets are different for different farming practices and reflect the lowest observed emission intensities within a group of similar countries. The FAO (FAOSTAT GHG) has computed emissions/carbon intensity for nearly 200 countries for the reference period 1961–2010, covering emissions of non-$CO_2$ gases ($CH_4$ and $N_2O$) from enteric fermentation; manure management systems; synthetic fertilizers; manure applied to soils and left on pastures; crop residues; and rice cultivation. | *The technology meets emissions intensity targets* |
| | **27** | **Sequesters carbon** | Improved agricultural practices can help mitigate climate change by reducing emissions from agriculture and other sources and by storing carbon in plant biomass and soils. A higher amount of organic carbon in soils would also lead to increased soil fertility and therefore increased agricultural productivity. | *The technology sequesters carbon in comparison with current interventions in similar farming systems* |

[6] In comparison with other implemented CSA technologies in the same farming system (survey using the Likert system); for example, **1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree, 5. Strongly agree.**

**APPENDIX D**

# TECHNICAL NOTES FOR THE CSA RESULTS INDEX

The CSA Results indicators are part of the set of three CSA-related indicators: CSA Technology, CSA Policy, and CSA Results indicators.

The CSA-Res indicator set has two purposes:

i. It informs stakeholders about indicators for relevant **M&E systems** in CSA interventions. The CSA Results indicators are associated with an impact pathway (focusing on outputs and medium- to long-term outcomes) and a theory of change, which explains how a CSA intervention can lead to the desirable development impacts in the long term. This embedment is crucial because long-term impacts are not easily measured by this type of indicator. Instead, the CSA Results indicators focus on measurable project results—outputs, outcomes—which can eventually lead to these impacts.

ii. The set of CSA Results indicators will be the basis for the calculation of the **CSA Results Index**, which provides stakeholders with an indication of how the respective project has *performed in reaching its targets in the CSA triple-win areas*—Resilience, Mitigation, and Productivity—separately and jointly. To derive the index, the following steps are required:

   1. ***Designing the results framework and choosing indicators***. *A project team designs a results framework and chooses indicators to measure the Project Development Objective and the project's Intermediate results. Ideally, CSA indicators are applied if suitable. For calculating the index, the core CSA-Res indicators are recommended (chapter 3, page 22).*
   2. ***Target values are defined.*** *For each indicator, a baseline value and a target value to be reached at the end of the project, and for each fiscal year or other relevant time interval, are set.*
   3. ***The indicators are assigned to the CSA triple-win areas***. *The chosen indicators are assigned to one or multiple triple-win areas—Productivity, Resilience, and Mitigation, indicating that the outputs or outcomes that are monitored contribute in particular to these specific CSA goals. For the set of CSA indicators, a default assignment has been proposed. However, for the calculation of the index, the default assignment can*

*be changed according to the project's goals or needs; and of course, multiple assignments of a single indicator are possible.*

4. ***Scoring of the indicators.*** *In the next steps, the indicators are scored according to whether they have reached the proposed target value, exceeded it, or failed to reach it. More specifically, the following scoring scheme is proposed:*

| Score | Level of Performance | Interpretation |
|---|---|---|
| 1 | Very unsatisfactory | The indicator's observed value falls short of the target value by more than 20%. |
| 2 | Rather unsatisfactory | The indicator's observed value falls short of the target value between 1% and 20%. |
| 3 | Satisfactory | The indicator's observed value is equal to the indicator's target value. |
| 4 | Exceeding expectations | The indicator's observed value exceeds the target value between 1% and 20%. |
| 5 | Highly exceeding expectations | The indicator's observed value exceeds the target value by more than 20%. |

*We propose a threshold of 20 percent to determine whether an indicator has achieved a score of 2 or 4. The scoring can take place at the end of the project or throughout project implementation whenever new M&E data are available.*

5. ***Averaging the scores for each triple-win area.*** *In the next step, for each triple-win area P, R, M, the scores of the indicators that have been assigned to the area in step 3 are averaged, yielding an overall score for the triple-win area. Users are recommended to use the core CSA-Res indicators. This allows comparing in which area the project has achieved satisfactory or unsatisfactory results or results exceeding expectation, and thus where it has room for improvements.*

6. ***Averaging scores over the triple-win areas.*** *In a last step, the average score over the triple-win areas is calculated, providing an overall estimate as to how well the project has jointly achieved the CSA goals.*

**Categories**: The CSA results indicators are categorized as follows:

i. *Indicators measuring the direct outputs of a CSA intervention*
   a. *Beneficiaries*
   b. *Land area*
   c. *Livestock*

ii. *Indicators measuring the CSA enabling environment (which may or may not be a consequence of an intervention)*

iii. *Indicators measuring the medium- to long-term consequences of CSA intervention*
   a. *Resources*
   b. *Emission*
   c. *Yield*
   d. *Benefits*

The first category measures the scope of the CSA intervention and the results that the intervention has achieved; the second category shows the strength of the enabling environment for CSA in the project area, which allows actors to sustainably implement their CSA; the third category indicates the medium- to long-term outcomes (for example, as resulting from activities measured by I and II) achieved by CSA.

The CSA Results indicators are closely aligned to the World Bank Core Sector Indicators.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | | | **I. Indicators measuring the direct outputs of a CSA intervention** | |
| | ***Topic: Beneficiaries*** | | | |
| 1 | **Number of agricultural actors who adopted CSA practices[1] promoted by the project**<br>(disaggregated by gender)<br>Subindicator:<br>Number of agricultural actors who adopt a **specific CSA practice** promoted by the project | Number | The indicator measures the number of people/units adopting CSA practices in the project area.<br>CSA triple-win area:<br>– The assignment to the triple-win area is "**Resilience**." Enabling agricultural actors to adopt CSA practices allows them to enhance their resilience against climate and other environmental shocks. The assignment of R is justified by its explicit focus on actors, instead of for example, land area, which would instead capture the categories Productivity or Mitigation.<br>World Bank Core Sector Indicator:<br>– This indicator is related to World Bank Core Sector Indicators: "Clients who have adopted an improved agricultural technology promoted by the project (number)," "Land users adopting sustainable land management practices as a result of the project (number)"; GDPRD (2008): "Percentage of farmers who adopted sustainable crop management practices in their farms."<br>Guidance :<br>– "Agricultural actors" refers to individuals, such as farmers or producers, farmer organizations, agribusiness, SMEs benefiting from a project/program.<br>– "Adoption" refers to a change in practices that were introduced or promoted by the project (similar to the Core Sector Indicators) compared with current practices. The term "adopt" is frequently used in a results framework, for example, in the GDPRD 2008 Core Sector Indicators, and rests on the belief that beneficiaries will apply or use the practice once it has been adopted.[2]<br>– If the indicator is used as project monitoring, "adopted" could refer to "*newly adopted since the last survey*." This will result in a cumulative number of beneficiaries who have adopted CSA practices as promoted by the project.<br>– CSA practices: The indicator should make explicit which CSA practice is being promoted by the project and should be expressed separately for each relevant CSA practice promoted by the project.<br>– Combination of practices: This indicator includes actors who have adopted one or more CSA practice promoted by the project, if several practices are promoted by the project. | R |

[1] A list of practices/techniques that are considered CSA will be provided in the Report. CSA practices span agronomic practices such as conservation agriculture, no tillage, applying improved seeds, sustainable management of fertilizer, such as matching the nutrients with plant needs during the growing season, fractioning the total amount in multiple doses, precision farming and placing nutrients closer to plant roots, such as deep placement of urea for improved rice conditions, sustainable management of herbicides, pesticides, and so on, water management, improved feeding strategies, rotational grazing, pasture management or manure treatment, and agro-forestry.

[2] If this is not the case, an additional indicator specifying the use or application of a practice should be adopted.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | | | The baseline values are typically assumed to be zero at the beginning of the project.<br>– To measure this indicator, formal surveys can be carried out at regular intervals during the project and at the end of the project. Depending on survey method, the indicator can be measured in percentage of agricultural actors.<br>Subindicators:<br>– Although the main indicator also encompasses agricultural actors who have adopted one or several practices, this subindicator allows one to specify which specific CSA practices have been adopted. | |
| ***Topic: Land use/cover***<br>***The following indicators on land use/cover can be used individually or as a set to capture the landscape approach to assess how changes in land use, for example, the adoption of a new CSA practice, affect the landscape and other land covers.*** | | | | |
| 2 | **Land area where CSA practices have been adopted as a result of the project**<br>Subindicator:<br>Land area where **specific CSA practices** have been adopted as a result of the project | Ha | The indicator constitutes a proxy indicator for the effects of the adoption of the CSA practice on production, environment, and natural resources from farm scale to landscape scale. Information about the land area under a CSA practice can serve as a basis to calculate the extent of production, pressure of agricultural practices on the environment and natural resources, potential for soil carbon sequestration, because the environmental impact as such (for example, soil erosion, nitrate leaching or GHG emission) may be more difficult and costly to measure than land area.<br>CSA triple-win area:<br>– The indicator is assigned to all categories of "**Productivity**" and "**Mitigation**." It demonstrates changes in production per hectare and changes in GHG emission and soil carbon sequestration as a consequence of the project. It is expected that CSA practices have positive environmental externalities, increasing, for example, soil fertility, soil moisture, and water retention, thus enhancing "**Resilience**" of the social and natural system.<br>World Bank Core Sector Indicators:<br>– "Land area where sustainable land management practices have been adopted as a result of the project (ha)."<br>Guidance:<br>– Although the extent of CSA adoption can be measured by multiplying the number of beneficiaries who have applied the practice by the average land area they possess, the present indicator is expected to provide a more reliable measure. This may be relevant when CSA practices are not applied on the entire cropland, and farm size varies considerably in the project area.<br>– To measure this indicator, formal surveys should be carried out at regular intervals during the project and at the end of | P, R, M |

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | | | the project. In each survey, the area newly brought under CSA practice should be measured. This will result in a cumulative number of beneficiaries who have adopted CSA practices as promoted by the project.<br>– "Adoption" refers to a change in practices that were introduced or promoted by the project (similar to the Core Sector Indicators) compared with current practices.<br>– Baseline at the beginning of the project may be zero. | |
| 3 | **Land area provided with**<br>**i. new,**<br>**ii. improved**<br>**irrigation and drainage services**<br>Subindicator Land area provided with<br>i. new,<br>ii. improved<br>irrigation and drainage services that provide climate change adaptation or mitigation cobenefits | | On land area under new or improved irrigation and drainage systems, allow monitoring of the extent of irrigation activities in a project area. With additional data about the irrigation system, it allows calculating the volume and extent of water withdrawal on the farm/field/irrigation system level and provides insights on energy use, cost, and profitability of agricultural production in the area. It does not convey information about the water return flows, or pressure on the water resource in terms of quality or quantity or impact on soil resources. The introduction of irrigation systems also does not imply that the irrigation system is adequate in relation to the social or environmental context or is economically viable. Thus, the GDPRD (2008) suggests measuring the adoption of a "functioning (reliable and adequate) irrigation and drainage network." Observing increasing or decreasing values of this indicator must be interpreted within the context of the project, but cannot be automatically assumed to be a positive or negative development. Further, the introduction of irrigation systems cannot automatically be assumed to be a CSA practice. It may improve adaptation and adaptive capacity to climate change but whether there are mitigation cobenefits will depend on the type of irrigation system. The subindicator thus suggests measuring separately those irrigation systems that satisfy the World Bank's climate change cobenefit criteria.<br>CSA triple-win areas:<br>– Irrigated agriculture typically increases yields per hectare, thus placing it in the area "**Productivity.**" The area "Resilience," is tentatively assigned. Whereas the farmers' adaptive capacity and thus resilience to climate risk may increase as they can stabilize the production levels through irrigation, the impact on water resources on farm to basin level needs to be examined before category "R" can be assigned with confidence. The category "Mitigation" can be assigned if the mitigation cobenefits can be confirmed.<br>World Bank Core Sector Indicator:<br>– "Area provided with irrigation and drainage services (ha)" (new/improved)<br>Guidance:<br>– Changes in the land under irrigation and drainage can be expressed as a percentage of total cropland in the project area. | P<br>(R, M) |

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | | | – Irrigation typically refers to purposely providing land with water other than rain for improving pasture and crop production. Irrigation usually implies the existence of infrastructure and equipment. It also includes manual watering of plants, using buckets, watering cans, or other devices. Land that received at least one controlled irrigation a year is considered irrigated (GDPRD 2008).<br>– (According to World Bank SDN Core Sector Indicators) "new" irrigation and drainage refers to an area that is newly provided with irrigation and drainage and may have been previously rain fed. "Improved" refers to upgrading, rehabilitation, and modernization of irrigation and drainage services in an area with existing irrigation and drainage services.<br>– This indicator is applicable to monitoring progress throughout a project and early output of an intervention. When the indicator is used for monitoring purposes and collected on a regular basis, it should capture the<br>– *"Newly provided new/improved irrigation and drainage systems since the last survey."* This will result into a cumulative number of beneficiaries who have adopted CSA practices as promoted by the project.<br>– The baseline at the beginning of the project may be zero.<br>– The FAO Statistical Development Series suggests irrigation data collection according to land use type, method of irrigation, and area of specific crops irrigated (FAO 2010).<br>– Similar indicators provided by, for example, GDPRD (2008): "Irrigated land as percentage of cropland," "percentage change in the proportion of farmers with access to a functioning (reliable and adequate) irrigation and drainage network," "percentage change in the number of users."<br>**Climate adaptation and mitigation cobenefits:**<br>To qualify for a climate-smart irrigation system, the irrigation systems have to fulfill the criteria of climate adaptation and mitigation cobenefits specified for World Bank projects. The indicator should be collected separately for irrigation systems that provide adaptation benefits or mitigation benefits or both. The indicator should explicitly specify which cobenefits it is collecting.<br>Climate adaptation cobenefits:<br>– Change irrigation management systems and practices to reduce vulnerability to climate change and climate variability to, for example, improve water distribution strategies, change crop and irrigation schedules to use rainfall more effectively, recycle water, and improve and strengthen farm-level managerial capacity.<br>– Plant hedges and cover crops to reduce evaporation and soil moisture loss. | |

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | | | – Reduce water use in land preparation and loss in crop growth stages.<br>– Promote technologies that improve water management efficiency and access to irrigation and more efficient irrigation technologies.<br>– Introduce integrated ecosystem management approaches for watersheds and wetlands to reduce vulnerability to CC and CV.<br>– Construct dams and water storage systems, for example, rainwater capture to manage changes in the water cycles due to CC and CV.<br>– Incorporate risks from CC and CV in irrigation and water management planning<br>– Introduce capacity building for farmers to incorporate CC and CV<br>– Monitor impacts of CC and CV from water management<br>– Establish early warning systems to support climate-resilient water management.<br>Climate mitigation cobenefits:<br>– Introduce or expand water pumping for irrigation using renewable energy sources.<br>– Replace existing water pumps with more energy-efficient pumps.<br>– Replace existing diesel pumps with electric pumps.<br>– Revise irrigation water pricing policies and introduce incentives for increasing water use efficiency.<br>– Restore natural drainage regime that sequesters carbon.<br>– Promote sustainable water management practices that promote water use efficiency. | |
| 4 | **Area restored, or re/afforested as a result of the project** | Ha | This indicator measures the land area targeted by the project that has been restored or re/afforested.<br>Owing to carbon sequestration, forestry has a significant potential to offset GHG emissions from the agricultural sector.<br>CSA triple-win area:<br>– The indicator measures activities that support "**Resilience**" of the natural system and "**Mitigation**."<br>World Bank Core Sector Indicator:<br>– "Area restored or re/afforested (ha)"<br>Guidance:<br>– Baseline value may be zero.<br>– "Restoration" refers to restoration of degraded land where the objective is to have permanent improvement in the capacity of the forestland area to provide environmental, social or economic services.<br>– "Re/afforested" refers to planting or deliberately seeding land that had not been previously classified as forest or the reestablishment of forest through planting or deliberate | R, M |

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | | | seeding on land classified as forest. This can include assisted natural regeneration, coppicing, or other appropriate methods. According to the CSA sourcebook: re/afforestation is the conversion from other land uses into forest, or the increase of the canopy cover to above a 10% threshold.<br>– This indicator allows one to calculate the "growing stock per hectare of forest ($m^3$/ha)," which is the volume of standing trees that can be converted to biomass and carbon stocks using conversion factors provided by the IPCC. | |
| 5 | **Land area covered by forest** | Ha | This indicator captures trends in restoration, re/afforestation, and reduced deforestation that may be relevant. It reflects the proportion of forest area to total land area expressed as a percentage. "Forest" is defined in the Food and Agriculture Organization's Global Forest Resources Assessment as land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use. The indicator is also a Millennium Development Goal (MDG) indicator.[3]<br>CSA triple-win area:<br>– The indicator measures activities that support the "**Resilience**" of the natural system and "**Mitigation**."<br>Guidance:<br>– Forest is determined both by the presence of trees and the absence of other predominant land uses. The trees should reach a minimum height of 5 meters (m) in situ. Areas under reforestation that have not yet reached but are expected to reach a canopy cover of 10% and a tree height of 5 m are included, as are temporarily unstocked areas, resulting from human intervention or natural causes, which are expected to regenerate.<br>– Includes: Areas with bamboo and palms, provided that height and canopy cover criteria are met; forest roads, firebreaks, and other small open areas; areas in national parks, nature reserves, and other protected areas such as those of specific scientific, historical, cultural, or spiritual interest; windbreaks, shelterbelts, and corridors of trees with an area of more than 0.5 ha and width of more than 20 m; plantations primarily used for forestry or protective purposes such as rubber-wood plantations and cork oak stands.<br>– Excludes: Tree stands in agricultural production systems, for example, in fruit plantations and agro-forestry systems. The term also excludes trees in urban parks and gardens.[4] | R, M |

[3] http://mdgs.un.org/unsd/mdg/Metadata.aspx.

[4] http://mdgs.un.org/unsd/mdg/Metadata.aspx.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| 6 | **Land area under other land uses or land cover** | Ha | This indicator aims to measure changes in other land uses or land cover classes that are a consequence of changes in areas under CSA. This indicator can be customized according to land covers/uses that may be indirectly affected by the CSA intervention or other changes. Indicators 2–6 monitor and track changes in land use and land cover, and raise awareness for the importance of viewing a CSA intervention within a broader perspective, thus adopting a landscape approach.<br>A sustainable landscape approach describes interventions at spatial scales that attempt to optimize the spatial relations and interactions among a range of land cover types, institutions, and human activities in an area of interest.<br>CSA triple-win area:<br>– Depending on the type of land cover and land use examined, changes in the indicator may affect the dimensions "**Resilience**" of the natural system and "**Mitigation.**"<br>Guidance:<br>– According to the FAO, land cover represents the observed biophysical cover of Earth's surface. Land use signifies the arrangements, activities, and inputs people undertake in a certain land cover type to produce or maintain it.<br>– According to the U.S. Geological Survey Land Cover Institute, land cover classifications include (http://landcover.usgs.gov/classes.php):<br>• Water,<br>• Barren (bare rock, sand, clay; transitional),<br>• Scrublands, herbaceous upland natural (for example, grasslands/herbaceous),<br>• Wetlands (woody wetlands, emergent herbaceous wetlands),<br>• Developed (low/high intensity residential; commercial/industrial/transportation),<br>• Forested upland,<br>• Non-natural woody,<br>• Herbaceous planted/cultivated (pasture, row crops, small grains, fallow, grasses, recreational) | R, M |
| ***Topic: Livestock*** | | | | |
| 7 | **Number of livestock units subject to CSA practices as a result of the project**<br>Subindicators:<br>Number of livestock subject to CSA practices **by livestock groups** as a result of the project | | Livestock contribute to climate change by emitting GHGs either directly (for example, from enteric fermentation and manure management) or indirectly (for example, from feed-production activities, conversion of forest into pasture). Increasing efficiency in resource use (for example, kilograms of phosphorus used per unit of meat produced, or hectares of land mobilized per unit of milk produced) is an important component to improving the sector's environmental sustainability. The concept can be extended to the amount | |

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | Number of livestock by livestock groups/livestock unit subject to **specific CSA practices** as a result of the project | | of emissions generated by unit of output (for example, GHG emissions per unit of eggs produced). Several CSA practices are suggested to improve reproduction rates, reduce mortality, and reduce the slaughter age: improved feed conversion efficiency, thereby reducing enteric emission intensities; better nutrition; improved animal husbandry; regular maintenance of animal health; and the responsible use of antibiotics. All of these measures may therefore increase the amount of output produced for a given level of emissions (FAO, CSA Sourcebook). The indicator helps to capture the extent of CSA practices throughout project implementation as well as on national scale (see the following).<br>CSA triple-win area:<br>– "**Productivity**" and "**Mitigation**" are assigned.<br>Guidance:<br>– Livestock unit: "Livestock units, used for aggregating the numbers of different categories of livestock, are usually derived in terms of relative feed requirements. Conversion ratios are generally based on metabolizable energy requirements, with one unit being considered as the needs for maintenance and production of a typical dairy cow and calf." Densities of grazing livestock units per hectare of agricultural land and of total livestock units per person engaged in agriculture may then be calculated.<br>– Conversion rates suggested by FAO can be found at http://www.fao.org/docrep/014/i2294e/i2294e00.pdf<br>– The indicator may be calculated specifically for livestock units by livestock group or specifically for applied CSA practices.<br>– Livestock groups: Cattle, buffalo, sheep, goats, poultry, pigs, horses, mules, asses[5]<br>– Baseline in the beginning of the project is typically assumed to be zero. | P, M |
| | **II Indicators measuring the CSA enabling environment *(which may or may not be a consequence of an intervention)*** | | | |
| | ***Topic: Enabling Environment*** | | | |
| **8** | **Client days of training on CSA provided** (disaggregated by gender) | Number | This is a Sustainable Development Network CSI. It records the number of CSA agricultural actors targeted by the project who have completed the training multiplied by the duration of the training expressed in days. The agricultural actors, or clients, can refer to farmers, extension agents, community members, business owners, or scientists. Training may include formal or informal training, vocational, on-the-job training, field demonstrations, and so on, completed by the beneficiary. | R |

[5] http://www.fao.org/docrep/014/i2294e/i2294e00.pdf, table 1 annex 1.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | | | The indicator can be complemented by additional indicators that assess the quality and usefulness of training.<br>CSA triple-win area:<br>– The indicators approximate the capacity and skills of agricultural actors, increasing their adaptive capacity to prevent and withstand shocks and thus they are placed under "**Resilience**."<br>World Bank Core Sector Indicator:<br>– "Client days of training provided (number)"<br>Guidance:<br>– Baseline may be zero<br>– "Training" refers to any training organized or provided by the project (formal or informal training degree and nondegree courses, vocational, on-the-job training, field demonstration, study tours, and so on, completed by client. Depending on the project context, the indicator can be collected separately.<br>– The time interval needs to be defined, for example, referring to beneficiary days since the last survey or beneficiary days per year. | |
| **9** | **Number of agricultural actors who use ICT services for obtaining information on:**<br>**a. weather and climate**<br>**b. CSA practices**<br>**c. market (price) information**<br>(disaggregated by gender) | Number | Agriculture is facing new challenges related to production and market risks. ICT, that is, any device, tool, or application that permits the exchange or collection of data through interaction or transmission, can help in providing timely information to allow prompt action. ICT is an umbrella term that includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers. The increases in their affordability, accessibility, and adaptability have resulted in their use even within rural areas relying on agriculture.[6] This indicator can measure the use of ICT by gender, by device, and by topic, for example, ICT used to convey information related to production risk and thus providing weather and climate information, or related to other risks such as market risks and providing price information.<br>CSA triple-win area:<br>– ICT tools have the potential to increase actors' adaptive capacity and thus is placed under "**Resilience**"<br>Guidance:<br>– The indicator can be disaggregated by type of information/ service (a–c) or by ICT device.<br>– If the services are introduced by the project, the baseline may be zero.<br>– Other similar services related to mobile banking, electronic money transfer, can be considered. | R |

[6] http://www.ictinagriculture.org/sourcebook/module-1-introduction-ict-agricultural-development.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| 10 | **Number of agricultural actors who are members of an association**<br>(disaggregated by gender) | Number | This indicator measures the number or share of people or units who have become or are members of a project-relevant association. Farmer or producer organizations have been identified as important institutions for the empowerment, poverty alleviation, and advancement of farmers. In many rural areas they may be the only institution that provides goods and services, for example, support in receiving credit or mobilizing capital, to the rural poor and provides benefits such as increased bargaining power and resource sharing, reducing transaction costs and overcoming market entry barriers that lead to food security. Being a member of an association may thus have the potential to facilitate access to goods and services that support the achievement of CSA goals. There are many types of agricultural associations or cooperatives in the developing world (for example, community-based and resource-orientated organizations or commodity-based and market-orientated organizations, which specialize in a single commodity and operate in a competitive environment), but many of them are financially vulnerable and ineffective, so that membership in an association may not deliver the envisaged benefits to the farmers. Strategies have been developed to strengthen these organizations, their management, and business planning. Although membership in an association can enhance benefits and increase farmers' resilience, the association will have to fulfill certain conditions and provide adequate services to the farmers to be able to improve farmers' livelihoods, which need to be assessed before using the indicator as measure of increased resilience.<br>CSA triple-win area:<br>– Being part of an association can increase actors' capacity to adaptation, learning, skills development and thus is placed under "**Resilience**"<br>World Bank Core Sector Indicators:<br>– "Target clients who are members of an association (percentage)"<br>Guidance:<br>– In the case of a new association, the baseline will be zero. In the case of an existing association, the baseline will be the number of its members.<br>– An association may include formal producer associations, cooperatives, water user associations, trade associations, which either existed in the project area before the project was started or were created under the project. The indicator should specify which type of organization it is referring to and ensure that the association is well functioning and can deliver benefits to the farmers.<br>– A member is a beneficiary who is formally registered as a member of an association.<br>– Depending on the survey method, the indicator can be measured as number or percentage share. | R |

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
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| 11 | **Number of agricultural actors using**<br>**a. financial services of formal banking institutes, or**<br>**b. nonbank financial services**<br>(disaggregated by gender) | Number | Farmers lacking access to credit and markets may be unable to adopt CSA practices because benefits usually take some time to materialize and farmers have to bear the costs in terms of labor, land, and cash in the meantime. Strengthening institutions to support agricultural markets, financing mechanisms, and insurance schemes are thus crucial to sustain the success of CSA (FAO, CSA Sourcebook). The use of financial services refers to loans, credit cards, and deposit accounts of different types. The agricultural census and surveys are often a source of information for this indicator because the agricultural census may contain a section on agricultural credit where access and use by type of credit institution are reported. Nonbank financial services refer to leasing and insurance. Insurance or leasing companies may provide information (GDPRD 2008).<br>CSA triple-win area:<br>– Having access to and using financial services has the potential to increase actors' adaptive capacity and thus is placed under "**Resilience**"<br>Guidance:<br>– This indicator should be collected for specific types of products. For instance, insurances could include weather-index insurance.<br>– In defining the indicator, it is necessary to define what "using" means—how often and to which extent. | R |
| 12 | **Number of agricultural actors employed in agriculture in the project area** (disaggregated by gender)<br>Subindicator:<br>Number of agricultural actors employed in a specific activity in the project area (disaggregated by gender) | Number | This indicator is similar to the World Development indicator "Employment in agriculture (% of total employment)." Employees are people who work for a public or private employer and receive remuneration in wages, salary, commission, tips, piece rates, or pay in kind.[7]<br>The indicator aims to measure the population in the project area that is formally employed in the agricultural sector, possibly involved in agricultural value chains. Agricultural value chains are organizational schemes that enable a primary product to be sold and transformed into consumable end products, adding value at each step of a gradual process of transformation and marketing. Smallholder farmers often integrate in value chains as producers in the primary production segment by supplying products to national and international buyers. Broadly, smallholder farmers engage in agriculture in the following forms: (i) independent primary agricultural production, which can increase their incomes; (ii) dependent primary agricultural production with an effect on incomes and employment; or (iii) value addition (post-harvest handling, processing, value addition, or the value chain | R |

[7] http://data.worldbank.org/indicator/SL.AGR.EMPL.ZS.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
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| | | | segment of trade and marketing) of agricultural products with an effect on incomes and employment.[8] To measure employment in agriculture, this indicator aims to capture (ii) and (iii) that allow farmers to derive a stable and higher income or to diversify their sources of income, which can increase both household income and resilience. This can have a positive impact on investing in and sustaining new technologies and CSA practices on their farms. The indicator *does not measure whether value chains are climate smart*. The indicator does not measure the quality of employment, but needs to be complemented with additional information/indicators.<br><br>CSA triple-win area:<br>– Being formally employed and diversifying income toward off-farm sources of income can increase farmers' ability to cope and adjust to shocks and thus is placed under "**Resilience**"<br><br>Guidance:<br>– The indicator could measure the percentage share of people in the project area involved in the agricultural sector in the project area.<br>– It could also measure the number of people employed as a percentage share of total employment in the project area.<br>– According to the project context, the areas of the value chain can be specified in separate subindicators. | |
| **13** | **Target population with use or ownership rights recorded as a result of the project** (disaggregated by gender) | Number | Several studies show that property rights or tenure security can have a positive impact on promoting investment on land because farmers will be able to capture the returns from investment. It can be an incentive for long-term land improvements, provide collateral for loans, and enable land transfers. Thus, recorded ownership rights may have a positive impact on the adoption of CSA practices.<br><br>CSA triple-win area:<br>– "**Resilience**" as access to productive assets may be increased.<br><br>This is a World Bank Core Sector Indicator with the following guidance notes:<br>– Target population refers to the population of a particular geographic area (project area, national, province, district, indigenous area) targeted by the project or any other group targeted by the intervention.<br>– Use or ownership rights cover the full consortium of land tenure situations, customary or statutory, individual or collective on private or public lands and can accommodate all ownership systems. | R |

[8] http://www.rural21.com/uploads/media/rural2012_04-S12-15_01.pdf.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
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| | | | – "Recorded" should be interpreted as a mean to unambiguously record land tenure information in the land administration system that reflects the current situation whether graphically, textually, or numerically. It covers a wide range of mechanisms, including mapping, surveying, titling, registering, or computerizing land tenure rights. It is not restricted solely to registration or recordation of land property rights. | |
| | **III. Indicators measuring the medium- to long-term consequences of CSA intervention** | | | |
| | ***Topic: Natural resources*** | | | |
| 14 | **Annual total volume of groundwater and surface water withdrawal for agricultural use, expressed as a percentage of the total actual renewable water resources (in the project area)** | % | This indicator aims to show the intensity of agricultural uses compared with total renewable but finite water resources and aims to give an indication of "unsustainable resources use," in particular when measured over time to see how water withdrawals have evolved. This indicator is frequently complemented with indicators measuring water withdrawal over total actual renewable water resources from other sectors such as industry and urban and municipality use. This set of indicators can give indications of increasing competition and conflict between water uses. Increases in the value of the indicator is suggested to imply negative effects on the sustainability of the natural resources base, whereas low values of the indicator can indicate potential for increase in water use in a sustainable way (MDGs).[9]<br><br>This measure has shortcomings. Although considering the withdrawal from agriculture over the total resources, it does not consider the return flows from agriculture, which can add up to 50% of water withdrawals (source) and thus tend to overestimate total water withdrawal. Apart from this problematic issue, the indicator provides, again, only a partial assessment of the multiple dimensions of water use. At the project level, it may be difficult to obtain the data needed to measure the indicator. Taken by itself, the indicator may not be meaningful, but could be measured together with water withdrawal from other sectors to give an indication of competing uses between sectors. It may be difficult to determine the references or desirable value that indicates "sustainable" use of the resource.<br><br>Similar indicators suggested in the literature, for example, developed by the EC External Services Evaluation Unit[10] are "Annual extraction from surface and groundwater in relation to its minimum annual recharge rate" and UN-Water's "Intensity of groundwater use compared to recharge." | R |

[9] http://mdgs.un.org/unsd/mdg/Metadata.aspx?IndicatorId=0&SeriesId=768.

[10] http://ec.europa.eu/europeaid/how/evaluation/methodology/impact_indicators/wp_water_en.pdf.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
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| | | | CSA triple-win area:<br>– If water resources are used in a sustainable way, "**Resilience**" of the natural system can be increased.<br>Guidance:<br>– Renewable water resources include surface water and groundwater resources that are renewed on a yearly basis (without consideration of the capacity to harvest and use this resource).[11]<br>– There is no satisfactory method to take into account return flow in the computation of water resources and use. In countries where return flow represents a substantial part of water withdrawal, the indicator will tend to overestimate total water withdrawal. There is no universally agreed on method for the computation of incoming flows originating outside of countries.[12]<br>– Sustainability assessment tries to fix critical thresholds for this indicator, but there is no consensus on such a threshold. UN-Water is currently working toward the development of a set of more satisfactory water-related indicators.[13]<br>– Water withdrawal is never measured directly but assessed through indirect methods.[14] Indirect measures may include areas equipped for irrigation, areas under different crops under irrigated and rain-fed conditions, irrigation intensity and water requirement ratios of different crops, number of irrigations provided by farmers and season, estimates of per capita consumption by animals, and so on. These data may be available from national ministries of water resources or studies using crop and irrigation data from agricultural census/surveys to estimate water use in agriculture (GDPRD 2008).<br>– If applied at the project level, the relevant renewable water sources have to be clearly defined at the start of the project. To ensure comparability over time, the related concepts have to be clearly stated.<br>– It may be necessary to establish the methodology through working groups of local experts or consulting internationally established methods such as provided by FAO Aquastat.[15] | |
| **15** | **Land area affected by medium to very strong/severe soil erosion in the project area** | Ha | Land degradation is the reduction in the capacity of the land to provide ecosystem goods and services and assure its functions over a period of time. Land degradation encompasses several dimensions such as soil erosion, nutrient depletion, salinity, contamination, and physical soil problems. However, as a proportion across all degraded areas, soil erosion | P, R, M |

[11] http://mdgs.un.org/unsd/mdg/Metadata.aspx?IndicatorId=0&SeriesId=768.
[12] http://mdgs.un.org/unsd/mdg/Metadata.aspx?IndicatorId=0&SeriesId=768.
[13] http://mdgs.un.org/unsd/mdg/ Metadata.aspx?IndicatorId=0&SeriesId=768.
[14] http://mdgs.un.org/unsd/mdg/Metadata.aspx?IndicatorId=0&SeriesId=768.
[15] ftp://ftp.fao.org/agl/aglw/docs/PaperVienna2005.pdf.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
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| | | | is the most extensive factor, causing more than 83% of the area degraded worldwide (ranging from 99% in North America to 61% in Europe) (Oldeman et al. 1991, in Kapalanga, 2008). Thus the indicator focuses on soil erosion as proxy for land degradation. Soil erosion is a natural process, which is accelerated by the use of inadequate farming practices such as overstocking and overgrazing, deep plowing land several times a year, lack of crop rotations, or planting crops down a contour instead of along it.[16] The assumption is that adequate farming practices as promoted by CSA will reduce medium to strong or severe soil erosion in the project area.<br><br>CSA triple-win area:<br>– The indicator is assigned to "**Productivity**," "**Mitigation,**" and "**Resilience**," because decreased land degradation and decreased soil erosion can have a positive impact on all dimensions.<br><br>Guidance:<br>– The most common methods used to assess land degradation are qualitative information such as expert or land users' opinions; field monitoring, observations, and measurement; modeling; or remote sensing.[17]<br>– Soil erosion is frequently classified in several categories, for example, 1–5 from very light, light, mean/medium, strong or severe, to very strong/severe. Berry et al. 2003, in Kapalanga 2008, define the following categories:<br>1. *Very light:* Very light erosion signs, the process is incipient and not very evident, some sedimentation is observed in small places where rainwater accumulates.<br>2. *Light:* Light erosion, signs begin to be visible. Removal of fine material is visible leaving the thicker material exposed (gravel, small stones), runoff water is not totally clear.<br>3. *Mean/medium:* Moderate erosion, clear signs of particle removal from the surface of the ground. Erosion is evident, with the hardpan material clearly exposed on the surface. Some rill erosion is noticeable.<br>4. *Strong or severe erosion:* Strong erosion, strong mantle erosion leaves gravel spread on the surface, rill erosion is abundant and increasing, some gullies appear in their initial state of formation. There are very few materials left from the original surface soil, the soil has begun to change in color. | |

[16] http://www.nda.agric.za/docs/erosion/erosion.htm.

[17] http://uts.cc.utexas.edu/~wd/courses/373F/notes/lec17ero.html.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | | | 5. *Very strong/severe:* Very strong erosion, all original surface materials have been removed, generating a change in color of the soil, a widespread change in soil texture due to the dominance of horizon C on the surface. Active gullies are observed.<br>– The indicator should reflect the share of cropland on which soil erosion was decreased. The land area in the project thus has to be rated first according to the above (or similar classifications); then the share of land under mean/medium to strong/severe erosion as share of total land area in the project area is calculated. | |
| ***Topic: Emission*** | | | | |
| **16** | **Net carbon balance (GHG emission in tons of $CO_2$-e emission/ha/year) of the project** | $tCO_2$-e/ year | The AFOLU sector is responsible for just under a quarter (10–12 $GtCO_2$-e/year) of anthropogenic GHG emissions, mainly from deforestation and agricultural emissions from livestock, soil, and nutrient management (IPCC 2014).<br>This indicator allows tracking the project's net balance from greenhouse gases, expressed in $CO_2$-equivalents that were emitted or sequestered as a result of project implementation as compared with a business-as-usual scenario. The net carbon balance should account for the emissions from all GHGs, that is, $CO_2$, $CH_4$, and $N_2O$, as well as all kinds of carbon pools that concern the AFOLU sector (above- and below-ground biomass, dead wood, litter, and soil carbon). The IPCC provides a methodology for national and subnational estimation of emissions, based on Tier 1, 2, or 3 methodologies. Tier 1 relies on a universal emission factor combined with activity data; Tier 2 utilizes a country-specific emission factor; and Tier 3 involves direct measurement or modeling approaches. Such estimates are used for both international reporting to the UNFCCC and national and subnational reporting purposes.[18]<br>There is a range of GHG accounting tools that allow the estimation of this indicator. For instance, the Ex-ante Carbon-Balance Tool (EX-ACT), developed by the FAO, provides ex ante estimates of the impact of AFOLU projects and can be used for monitoring progress.[19] Considering the landscape approach, the net carbon balance can be computed for several activities separately. These activities may include land use change, improvement of crop management practices, and reduction of land degradation.<br>Guidance:<br>– The net carbon balance is net balance from all GHGs expressed in $CO_2$ equivalent that were emitted or sequestered as a result of project implementation as compared with a business-as-usual scenario. | M |

[18] http://www.nature.com/nclimate/journal/v2/n6/box/nclimate1458_BX1.html.

[19] http://www.fao.org/tc/exact/ex-act-home/en/.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
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| | | | – The indicator can be assessed with the GHG accounting tool EX-ACT. EX-ACT provides information of GHG emission and carbon sequestration in t$CO_2$-e/year or for the total project period for several modules. Depending on the project needs, subindicators can be developed that provide one or more of the following:<br>• Net carbon balance for the project<br>• Net carbon balance for specific project activities (for example, deforestation, crop management, livestock) such as those activities that are already captured in CSA indicators 2–6. Gross emissions and sequestration for the total project<br>• Gross emissions for specific project activities.<br>– Time periods: Whereas the calculation of the net carbon balance typically considers 20 years (implementation period of the project, which refers to the time period when project interventions are taking place, typically 5 to 7 years; and the capitalization period, which refers to the time period after the project has ended, but biophysical processes related to biomass, soil carbon content, and so on, still continue), EX-ACT expresses the gross results and net carbon balance in t$CO_2$-e/year<br>– The results can be expressed per hectare or for the entire project area. | |
| **17** | **GHG emission intensity** | t/t $CO_2$-e/ year | In achieving food security and climate change adaptation, increases in productivity and resilience to climate change are the main concern among developing countries; climate change mitigation is often regarded as a cobenefit. The indicator emission intensity, that is, GHG emission per physical unit of output, accounts for these priorities. Measured over time, it shows whether the project could increase or stabilize production while lowering GHG emission per unit; by comparing projects and project activities, this measure indicates which farming systems can be incentivized to achieve the best CSA outcomes of increasing productivity and decreasing emissions.<br>Guidance:<br>– GHG emission intensity is composed of kg $CO_2$-e as numerator, and product in terms of tons of yield, milk product, animal protein in the denominator, per year, at farm gate (rather than processed products).<br>– The GHG emissions can be calculated using EX-ACT with Tier 1 coefficients using context-specific Tier 2 coefficients if available. | P, M |

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| ***Topic: Yield*** | | | | |
| **18** | **Crop yield in kilograms per hectare and year** | kg/ha | In the past decades, crop production increased significantly, mainly owing to intensification of crop production. Although intensification and increased input use may lead to increases in GHG emission, studies have concluded that the avoided emission from land use change outweighs this increase (FAO, CSA Sourcebook). Monitoring crop yields per hectare and year allows insights into reaching yield gap, which is essential to improve food security. "Yield gap" refers to the difference between actual and potential yield, where the yield potential should ideally be collected from the project area rather than using national crop statistics (GDPRD 2008).<br><br>Depending on the project context, crop yield of a specific crop or cereal yield can be considered. "The aggregation of production weights across food types is problematic if roots and tubers with low carbohydrate contents are aggregated with pulses and cereals. If comparisons are made between new year and historic production of all food crops, the usual convention is to calculate total production in cereal equivalents (of the most commonly consumed cereal) and to compare total cereal equivalent production in the new year with the equivalent calculations for past years."[20]<br><br>CSA triple-win area:<br>– Increased crop yield relates to increased "**Productivity**" and household "**Resilience**," as they may be better able to withstand shocks.<br><br>Guidance:<br>– According to World Development Indicators, cereal yields per hectare and year include wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. Production data on cereals relate to crops harvested for dry grain only. Cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded.[21] To convert other crops to cereal, the following FAO conversion rates could be used (ftp://ftp.fao.org/docrep/fao/011/i0515e/i0515e26.pdf):<br>– Although crop yields per hectare per year can be measured year by year, statistically significant trends in crop yields may become visible only after a few years, as rain-fed production areas often experience high year-to-year fluctuations. This indicator requires a time series of crop yields per unit of land area over the project time period.<br>– Changes in crop yields are expected to be a longer-term outcome of CSA interventions, which is measured by the indicator "Land area where CSA practices have been adopted as a result of the project." | P, R |

[20] ftp://ftp.fao.org/docrep/fao/011/i0515e/i0515e26.pdf.

[21] http://data.worldbank.org/indicator/AG.YLD.CREL.KG.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| | | | – Besides providing cereal yield, the indicator can be represented for each crop separately.<br>– The baseline has to be determined by project-specific surveys. | |
| 19 | **Yield variability per hectare and year and crop** | standard deviation/ mean | Indicator 19 focuses on changes in mean yield as a response to CSA practices. An indicator on yield variability is needed to assess the stability of food supply. A recent study demonstrated that in the past, climate variability accounted for roughly a third of crop yield variability in key crops (maize, wheat, soybeans), on average 30%, but in some regions even causing more than 60% of the variability. Future increases in yield variability are expected, posing increasing challenges to farmers (Challinor et al. 2014).[22] The coefficients of variation measure is frequently used to assess yield variability. It is a relative measure of variation, defined as the standard deviation expressed as a percentage of the mean. Ray et al. (2015) assessed the CV for several crops for a period of 30 years and found that maize yields had a global average variability of ~0.9 tons/ha/year (s.d.), which corresponds to ~22% of the global average yields of ~4 tons/ha/year. The global average rice yield variability was 13% of average rice yields and the global average wheat yield variability (s.d.) was 0.4 tons/ha/year (~17% of average yields over the study period).<br>CSA triple-win area:<br>– A low coefficient of variation over a long time period in which, for example, erratic or extreme weather events occur indicates high "**Resilience**."<br>Guidance:<br>– CV is defined as standard deviation over mean per hectare value.<br>– Time series data are needed to assess the baseline value.<br>– Depending on the project and data availability, the CV can be assessed for every year in the project or for the time of project completion (for example, if by the time of project completion the CV could be decreased compared with the baseline). | R |

[22] http://www.nature.com/nclimate/journal/v4/n4/full/nclimate2153.html.

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
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| 20 | **Yield per livestock unit and year as a result of the project**<br>Subindicator<br>Yield per livestock by livestock group and year as a result of the project | kg/unit | There is a need to improve the resource use and production efficiency of livestock production systems, both to improve food security and reduce the intensity of GHG emissions (FAO 2009a; HLPE 2012a). Yield per livestock unit refers to productivity per animal. Yield may refer to milk, eggs, meat, wool, per livestock. Yield per livestock unit may be a long-term result from previously implemented CSA practices.<br>CSA triple-win area:<br>– Increased yield relates to increased "**Productivity**" and household "**Resilience**," because they may be better able to withstand shocks. Although the introduction of improved feeding and breeding practices can affect yield and reduce GHG emissions from livestock, mitigation cobenefits will be captured by the indicator "GHG emission intensity."<br>Guidance:<br>– Comments regarding livestock units and conversion factors, see above.<br>– Measurement unit can be in kilograms or other relevant physical units.<br>– There may be more than one product per animal; the indicator should be compiled separately per production species.<br>– Baseline will be established at the beginning of the project.<br>– Because seasonality may be important for some products, comparable time periods must be considered.<br>– Indicator can be upscaled from project level to national level.<br>– On national level data sources, livestock surveys or FAO yield livestock data are relevant sources. | P, R |
| ***Topic: Benefits and welfare*** | | | | |
| 21 | **Annual household income from agricultural activity** | USD | Agricultural household income is considered among the key indicators to monitor and evaluate the results of development policies and interventions. However, national statistical offices often have difficulties in providing this indicator owing to technical difficulties or data availability (Keita and Pizzoli n.d.). Often microdata on household expenditures derived from household surveys is used. Increasing trends in household income as a consequence of the intervention may be realized only several years after the intervention. Similarly, yield increases may be realized only years after the intervention and farmers may have to bear increased costs related to the adoption of the technique in the initial phase of intervention. This indicator could also be expressed in terms of annual growth rate of household income rather than an absolute measure. Complementarily, it may be interesting to look at the income from nonagricultural activities to understand how farmers diversify their income when confronted with climate-induced production risk. | R |

| # | CSA Results Indicator | Unit | Guidance Note | CSA Triple-Win Area |
|---|---|---|---|---|
| 22 | **Number of beneficiaries who consider themselves better off now than before the intervention** (disaggregated by men and women) | Number | This indicator measures farmers' perceptions and "better off" must not refer to economic improvements but can mean different things to different people. The data can be derived from project-specific surveys (GDPRD 2008). The Core Sector Indicators feature an indicator "beneficiaries that feel that the project investments reflected their needs." Although the World Bank Core Sector Indicator focuses on the effectiveness of the project, this indicator aims to capture whether the intervention has increased their beneficiaries' well-being. The effect may be evident only at the end of the project or even thereafter.<br>Guidance:<br>– GDPRD 2008: "Percentage of population who consider themselves better off now than 12 months ago" | R |

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WORLD BANK GROUP

1818 H Street, NW
Washington, D.C. 20433 USA
Telephone: 202-473-1000
Internet: www.worldbank.org/agriculture
Twitter: @WBG_agriculture