GLOBAL ALLIANCE FOR CLIMATE-SMART AGRICULTURE

Knowledge Action Group

Report from the Sub-Group on Integrated Planning and Monitoring for Climate-Smart Agriculture

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Introduction

Achieving food security and responding to the challenges of climate change are two entwined goals. As population and incomes are on the rise, food demand will follow an upward trend. Food production will need to increase by at least 60 percent to meet the demands of this growing population by 2050 (Alexandratos and Bruinsma, 2012). Studies show that climate change is likely to reduce agricultural productivity (Figure 1), production stability, and incomes, including in some low-income regions that already have high levels of food insecurity (Rosenzweig et al., 2014; von Lampe et al., 2014).

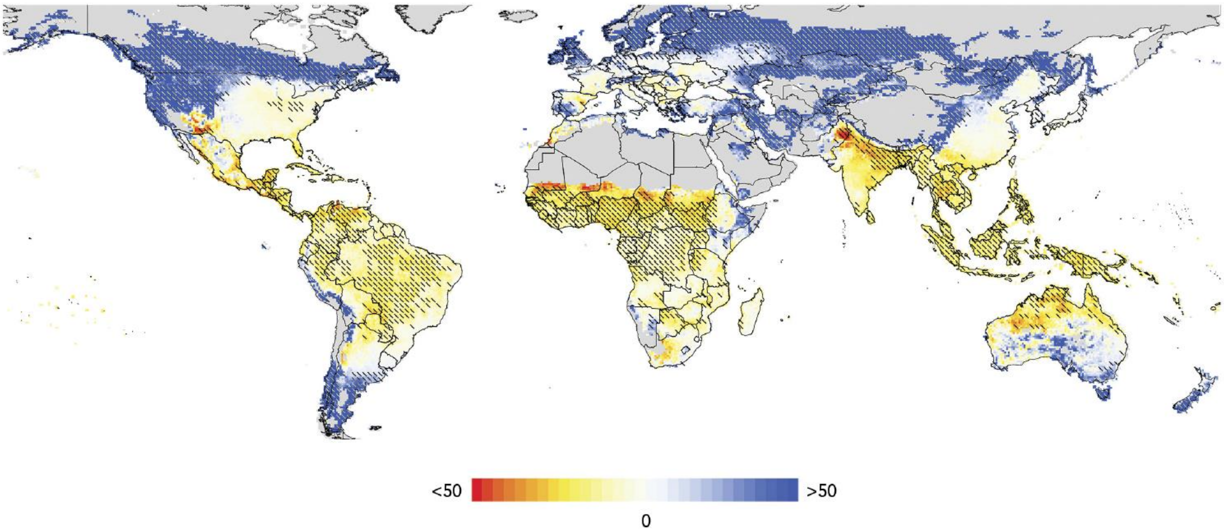

Figure 1. Median end-of-century (2070–2099) maize yield changes (%; compared to 1980–2009 period) as simulated by seven global gridded crop models driven by five GCMs for RCP8.5. Hatching indicates regions where more than 70% of simulations had the same sign of maize yield changes (from Rosenzweig et al., 2014).

Climate-Smart Agriculture (CSA) is a systematic approach to agricultural development intended to address the dual challenges of food security and climate change from multiple entry points, from field management to national policy. CSA aims to (1) improve food security and agricultural **productivity** and (2) increase the **resilience** of farming systems to climate change by adaptation, while (3) capturing potential **mitigation** co-benefits.

Although there is a growing consensus on the need for the outcomes climate-smart agriculture can deliver, there are still knowledge gaps at the field, policy, and financial levels. These gaps hinder the ability of smallholder farmers, policy-makers, and development agencies to make evidence-based decisions and implement climate-smart actions (FAO, 2015). To help bridge these gaps, the international Global Alliance on Climate-Smart Agriculture (GACSA) was launched at the UN Secretary-General's Climate Summit in September 2014. The GACSA is composed of three Action Groups on: (1) Knowledge, (2) Investment and (3) Enabling Environment.

The goal of the Knowledge Action Group (KAG) of the GACSA is to provide actionable information of those looking to operationalize CSA, enabling evidence-based decision-making and calling out unknowns and uncertainties when they obstruct transformation to a climate-smart food system.

To this end, the GACSA held two online consultations on knowledge priorities and knowledge products for Climate-Smart Agriculture. During these consultations, CSA practitioners from around the world identified the major knowledge priorities and key areas of work for the group:

1. Technical interventions and practices in CSA
2. Evidence base and support, services, and extension for CSA
3. Inclusive knowledge systems for CSA
4. Integrated planning and monitoring for CSA

The KAG Sub-Group on Integrated Planning and Monitoring for Climate-Smart Agriculture

The KAG Sub-Group on Integrated Planning and Monitoring was created in March 2015 during the Climate-Smart Agriculture Science Conference in Montpellier, France, with the overall goal to advance CSA decision support tools and evaluation methods. Since then, the group has matured and diversified into new activities based on stakeholder demand. The Sub-Group promotes collaboration, information sharing, and learning among various stakeholders on the use of CSA techniques. This report describes the principle thematic areas of collaboration and learning and provides a description of activities (Figure 2).

In the 2015-2016 period, the Sub-Group has focused on:

1. **Practices and Technologies:** Sharing information and examples of integration of CSA approaches in programs, projects, activities, and interventions.
2. **Monitoring and Evaluation:** Developing monitoring and evaluation protocols to enhance understanding of CSA effectiveness.
3. **Data and Models:** Creating an inventory of data sources and models to test CSA practices and technologies and help to scale them beyond the original sites where they were tested in the field.
4. **Online Communities of Practice:** Establishing a community of practice to generate and share knowledge on CSA.

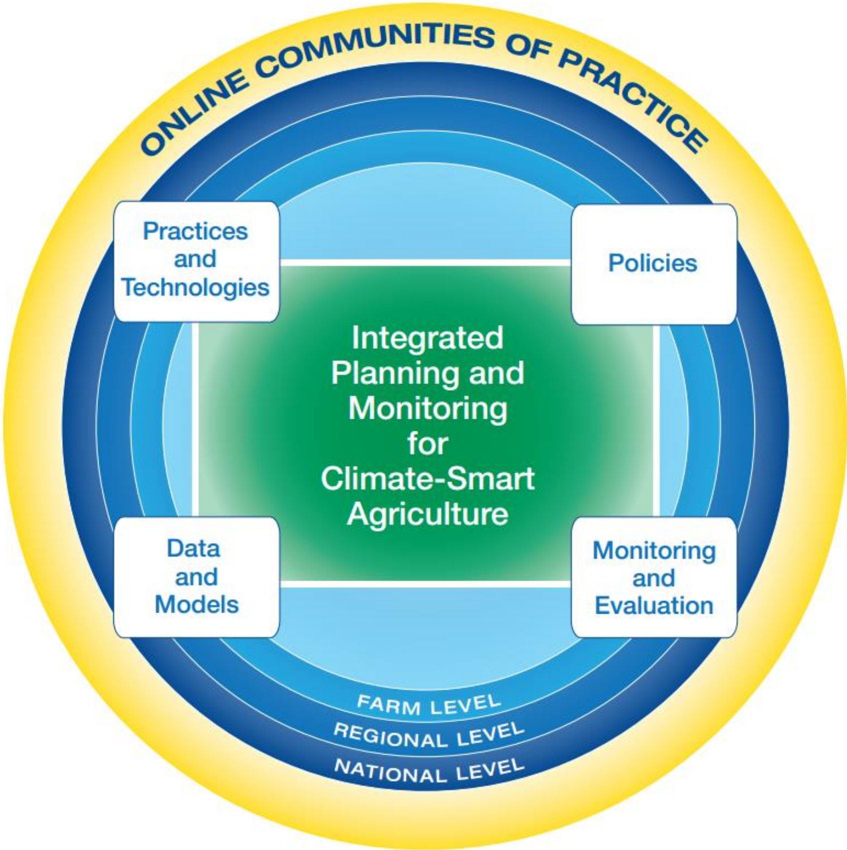

Figure 2. Activities and scales of the KAG's Sub-Group on Integrated Planning and Monitoring for Climate-Smart Agriculture.

These activities contribute to the tools and approaches practitioners can use to better integrate planning and monitoring of CSA programming. These activities are described in the following sections.

1. Practices and Technologies

At the core of Climate-Smart Agriculture are improved farm and field-level management practices and technologies that underpin decisions, services, and policies (Lipper et al., 2014). Farm-level technologies represent a broad category of direct activities farmers can undertake in their fields, in livestock husbandry, or through management of communal lands. Actions span a range from adopting drought-resistant crop varieties, to reducing stocking rates of animals, to changing harvesting and postharvest storage techniques (Figure 3). These are context-specific and subject to the priorities of farmers, communities, and governments where implemented. A large number of farm-level options, coupled with the myriad of possible outcomes, can fit under the three pillars of CSA.

Figure 3. Examples of climate-smart agriculture practices and technologies: improved nutrient management (photo credit: Leo Sebastian, IRRI-CCAFS), improved feeding (photo credit: S. Kilungu, CCAFS), and agroforestry/complex systems (photo credit: J.L. Urrea, CCAFS)

To date, little empirical evidence has been put forth to systematically evaluate a broad set of CSA activities over time. CSA is often supported with case studies, anecdotes, or aggregate data, which all help paint the picture of what CSA can achieve, but do not provide comprehensive evaluation.

The lack of comprehensive information on CSA is not surprising, given its infancy as a concept and the fact that it includes a wide diversity of food system/rural livelihood techniques, leading to the relevant information being dispersed in literatures ranging from agronomy and atmospheric science to the social sciences. Many of the issues related to resilience and mitigation can be addressed by broadening the analysis from the farm scale to larger scales (e.g., landscapes, agro-ecological zones, and country-level). Understanding the farm-level implications for food security, adaptation, and mitigation is also crucially important. In many farming regions, smallholder subsistence agriculture is the backbone of food security. Thus, there is a need to evaluate current knowledge on the effectiveness of potential CSA practices and technologies in achieving the three pillars in order to inform the discourse on food security, agriculture, and climate across farm, regional, and national scales. Such an evaluation also serves to identify knowledge gaps and uncertainties in order to inform future scientific research agendas.

Applications for CSA

In response to the lack of comprehensive information on CSA, the World Agroforestry Centre (ICRAF), the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS), the Food and Agriculture Organization of the United Nations (FAO), and the International Center for Tropical Agriculture (CIAT) are addressing this need by conducting a meta-analysis of the published scientific literature on farm-level CSA practices. This initiative is intended to contribute to the lack of a scientific basis for CSA starting at the farm-level practices, which can be the basis of future work at larger scales.

A meta-analysis is a statistical approach that combines results from independent research studies in an analytically rigorous and systematic way (Harrison, 2011; Hedges et al., 1999). The objective of the CSA meta-analysis is to combine the available information to assess the evidence for CSA practices, and synthesize the information to answer key questions relating to CSA for decision-makers, in this case program development practitioners, policy-makers, and investors. The impetus for this systematic review came from the need to move CSA from the meeting room into the field by providing the evidence base for scaling up CSA. The meta-analysis aims to answer two questions: (1) What are the effects of management practices on productivity, resilience, and climate change mitigation in farming systems of tropical developing countries? and (2) What are the barriers to adoption to these practices? (Table 1).

Table 1. Selected farm-level practices included in the meta-analysis. See Rosenstock et al. 2015a for the full list of 73 practices.

Management measure	Practice	Description
	Agronomy	
Soil management	Reduced tillage	Minimizing soil disturbance by using rippers, dibble sticks, etc.
	Mulching	Using crop residues, green manure, or other material to cover the soil to increase soil moisture and improve soil organic matter
Nutrient management	Organic and inorganic fertilizer application	Using a combination of both organic and inorganic inputs
	Manure	Application of animal manure to the field or pasture either through direct deposition or through purposeful transfer
Crop Management	Intercropping	Growing two or more crops in the same area, for example in alternating rows
	Crop rotations	Increase in the number and kind of crops in the rotation
	Improved varieties	Planting crop varieties that are early maturing, drought tolerant, heat tolerant, etc.
Water Management	Irrigation	Supplementing rainfall with additional water via drip irrigation, deficit irrigation, or other practices
	Water harvesting	Using stone bunds, terraces, grass strips, tied ridges, etc. to capture rainfall and reduce erosion
	Agroforestry	
Intercropping	Multi-strata	Several strata of trees occupied by tree crops (coffee, tea, cacao, etc.) with shade trees that include two or more vegetation layers and more than one tree species
	Alley cropping with leguminous trees	Growing crops between rows of N-fixing trees
Boundary planting	Hedgerows, windbreaks, living fences	Planting trees or shrubs on edges of fields to reduce erosion or produce a favorable microclimate
	Livestock	
Pasture management	Rotational grazing	Supervised grazing where livestock are moved between paddocks to allow vegetation regeneration
Diet management	Improved supplement use	Feeding practices to increase the quantity of protein, amount of calories, or efficiency of animal growth by adding something to the diet
Genetic improvement	Assisted reproduction	Improving success of animal reproduction via artificial insemination, genetic marker-assisted breeding, etc.

An example of the types of analyses that are facilitated by the compendium can be found in the information note prepared for the COP21 (Rosenstock et al. 2015b). The analysis addresses the need for a scientifically-sound evidence base to aid in prioritizing and monitoring policies and programs in clearly defined settings in order to support efficient implementation and facilitation of CSA by stakeholders. The list of indicators identified though this search also provide a set of most frequently used quantitative indicators in the literature that can also support monitoring efforts. Data will be publically available under the Creative Commons License in 2016.

Next Steps

The initial approach described here excludes some available and potentially relevant data (e.g., papers published in languages other than English, gray literature, journals not indexed by WoS and Scopus). The systematic approach to search the easily-available databases was preferable to other ways of searching the literature that might have limited the scope by reducing the number of practices, outcome indicators, or time periods covered. In the near term (e.g., 1-3 year time frame), the KAG Sub-Group can build on this effort by including data from gray literature, expanding the scope to additional land/landscape management practices and CSA outcome indicators, value chains, crowd-sourcing information from development specialists, updating the information as new research emerges, and incorporating non-English language scientific literature. Furthermore, the KAG Sub-Group could also expand the study to CSA practices relevant to temperate and developed country agricultural systems.

2. Monitoring and Evaluation

CSA goes beyond field-level practices to include landscape/community-level interventions, risk- management programs, and policy environments, and indicators are needed to cover this wide range of CSA activities. Once Climate-Smart Agriculture practices have been systematically analyzed using the meta-analysis techniques described above, practical and meaningful indicators of CSA readiness (e.g., implementing policies), process (e.g., gender workload), input (e.g., resource efficiency), and outcome (e.g., food security, emission intensity), will be needed to evaluate change through time and to inform decision-making by relevant stakeholders.

There are many dimensions for readiness, process, inputs, and outcomes of CSA, each with potential indicators that can be measured. Indicators and monitoring/tracking tools should provide a basis to advance sustainable agricultural social-ecological systems while providing objective snapshots and trends over space and time that support decision-making and progress on CSA. Innovative metrics are needed to better understand how CSA can deliver food security, livelihood, adaptation, and mitigation outcomes and to track trade-offs that may exist among them.

Broadly defined, stakeholders for CSA monitoring and evaluation include researchers, governments, implementing partners, civil society organizations, international bodies, and donors, among others. With greater interest in CSA, there are increasing interventions to build the resilience of communities and agricultural systems to climate risks (e.g., DFID’s Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) program, and the USAID/ Rockefeller Foundation/Swedish International Development Cooperation Agency (SIDA) Global Partnership on Resilience. These donors and stakeholders, among others, are developing metrics in areas that overlap with CSA.

There are a variety of approaches to increasing the effectiveness of CSA interventions and metrics for tracking outcomes and impacts. For example, increased food security may result from changes in availability of food (e.g., yield), accessibility of food (e.g., increased income), utilization of food (e.g., increased food safety), or stability (e.g., less variable harvests) (FAO, 2002, Brown et al 2015). Similarly, mitigation benefits can come from emission reductions, enhanced removal of greenhouse gases (GHGs), or avoidance of future emissions through adoption of CSA technologies. While some aspects of CSA have well-established metrics (e.g., those related to productivity), and work on food security and social outcomes is well advanced (IFAD, 2013), others are relatively new and open to diverse interpretations (e.g., climate vulnerability, suitability for program design, and resilience).

Key Questions for CSA Metrics

Tracking

- *Which metrics are appropriate for measuring outcomes of CSA activities, projects and programs?*
- *How can increased resilience or enhanced adaptive capacity be measured?*
- *Can mitigation benefits be measured, given the difficulties of monitoring, reporting, and verification (MRV)?*
- *Is it sufficient to measure adoption of CSA practices as a proxy for adaptation and mitigation benefits?*
- *What counts as an agreed-upon CSA practice?*
- *What is the baseline against which you are tracking changes in CSA outcomes?*

Targeting

- *How much emphasis should be given to climate projections, vulnerability assessments, and suitability studies in shaping CSA programs? What about local suitability for farming systems, social conditions, farmer preferences, etc.?*
- *Which vulnerability metrics are most appropriate?*

Applications to CSA

In order to improve CSA and track it, appropriate approaches to measure program outcomes and impacts are needed. There is a global effort to bring multiple partners across public and private sectors in agriculture to build and share metrics under GACSA, and there is an opportunity to develop and share a common CSA framework. This effort can promote CSA interventions and help improve program implementation towards climate resilience in agriculture. Global learning and evidence exchange events are building capacity of partners and staff implementing food security projects to use monitoring and evaluation tools developed by CCAFS and others.

The CSA database provides an initial set of indicators that can be used for monitoring and evaluation of field-level practices related to productivity, resilience and adaptive capacity, and mitigation (Rosenstock et al., 2015a). The database includes a comprehensive list of indicators that represent a range of economic, environmental, and social outcomes of CSA practices (see Table 2).

Table 2. Selected indicators of outcomes of productivity, adaptive capacity, and mitigation included in the meta-analysis (see Rosenstock et al. 2015a for full list of indicators).

Indicators	Rationale	Example
	Productivity	
Yield	Direct measure of system productivity and food availability	Crop yield (kg/ha/yr); Weight gain (kg/time); Milk production (L/cow/day)
Income	Increased income increases food accessibility and can contribute to poverty alleviation	Net Present Value; Household energy costs ($/yr); Net Returns ($/ha/yr); Payback Period (yrs)
Food security	Relates to individual or household consumption	Consumption (Kcal/pers/day); Food Deficit (Kcal/pers/day)
	Resilience/adaptive capacity (biophysical, economic and social)	
Soil resources	Soil is the mediating factor for crop growth and regulates structural, physical, and chemical properties of fields	Soil Organic Carbon (g/m^3); Erosion losses (t soil/ha/yr)
Resource efficiency	Reduces reliance on inputs	Nutrient use efficiency (g/kg); Protein utilization (%); Water use efficiency (kg yield/mm rainfall)
Gender	Workload	Person-hours (hrs/ha/yr); Value of labor ($/hr)
	Mitigation	
GHG emissions	Captures reduced contribution to GHGs in the atmosphere from agriculture	CO_2 flux (Mg C ha^{-2} yr^{-1}); N_2O flux (kg N ha^{-2} yr^{-1})
Emission intensity	Reduced emissions per unit product mitigates GHGs from agriculture while accounting for food security goals	GHGs/product (Kg CH4 /kg milk or grain)
Carbon stocks	Removals or emissions of biosphere-atmosphere exchange	Aboveground biomass (Mg/ha); Soil organic carbon (Mg/ha)

Donors, such as USAID, use a set of indicators in their natural resource management, global climate change, and food security (Feed the Future Initiative) projects. These are similar to the indicators presented in the compendium of CSA practices, and indicate the potential for a coordinated set of metrics that could be shared by a number of programs, organizations, and agencies. Relevant USAID indicators include both those that measure productivity and those that relate to levels of adoption of CSA practices:

- Gross margin per hectare, animal or cage of selected product (disaggregated by commodity). (Productivity measure)
- Number of hectares under improved technologies or management practices as a result of assistance by the US Government (disaggregated by climate mitigation and/or adaptation, information collected at mechanism level). (Adoption)

- Number of people implementing risk-reducing practices/actions to improve resilience to climate change as a result of assistance by the US Government (information collected at mechanism level). (Adoption)
- Number of private enterprises, producers organizations, water users associations, women's groups, trade and business associations and community-based organizations (CBOs) that applied improved technologies (information collected at mechanism level). (Adoption)

IFAD's Adaptation for Smallholder Agriculture Programme (ASAP) had also developed indicators used currently by participating stakeholders (IFAD, 2015):

- Number of poor smallholder household members whose climate resilience has been increased because of ASAP – disaggregated by sex
- Percentage of new investments in Environment and Natural Resource Management in IFAD 9th Replenishment compared with IFAD 8th Replenishment
- Leverage ratio of ASAP grants versus non-ASAP financing
- Number extent of land and ecosystem degradation in productive landscapes
- Number of tons of greenhouse gas emissions (CO_2e) avoided and/or sequestered
- Number increase in hectares of land managed under climate-resilient practices
- Number of households, production and processing facilities with increased water availability or efficiency
- Number of individuals (including women), community groups and institutions engaged in climate risk management, Environmental and Natural Resource Management or Disaster Risk Reduction activities
- US$ value of new or existing rural infrastructure made climate-resilient
- Number of international and country dialogues on climate issues where ASAP-supported projects or project partners make an active contribution.

It is important to note that metrics are not just for donors. Other decision-makers apply metrics to evaluate interventions and identify entry points for climate-smart actions. For example, CIAT and CCAFS, in partnership with the World Bank, Feed the Future, and Costa Rica's Tropical Agricultural Research and Higher Education Center (CATIE), developed Climate-Smart Agriculture Country Profiles. These profiles give an overview of the agricultural challenges in several countries, and how CSA can help them adapt to and mitigate climate change. Profiles are currently available for Argentina, Colombia, Costa Rica, El Salvador, Grenada, Mexico, Peru, Nicaragua, Uruguay, Rwanda, Kenya, Sri Lanka, Mali, and Niger. During 2016 profiles for Ghana, Senegal, Ethiopia, and Uganda will be developed (CCAFS, 2016).

Next Steps

Metrics are now being discussed as part of the work program of the GACSA under the Knowledge and Investment Action Groups. Sharing approaches and frameworks being used by CSA and resilience programs and discussing metrics can contribute to the design of food security programs that are climate resilient and based on current science and feedback from scientific experts and stakeholders. Joint efforts between GACSA and other programs can benefit from shared metrics that track outcomes of CSA activities. CSA perspectives and tenets should be integrated in all existing and future food security programs, to ensure that all are climate-resilient and climate-smart.

Possible steps that are being taken to develop and implement a coordinated set of indicators and metrics for Climate-Smart Agriculture. These include:

- Determination of the types of assessments that are needed to better design climate resilient programs (focused on climate risks in rural areas in developing countries), and the pros and cons of different approaches.
- Definition of the means of tracking outcomes from climate resilient programs, in particular adaptation and mitigation, because productivity and income are more 'tractable' in terms of measuring and recording.
- Development of plans for improved targeting and outcome assessments for climate resilient programs.

An important component of understanding the efficacy of CSA practices is evaluating their impact on social welfare, such as improvement of livelihoods and well-being. Such impact evaluations that address societal benefits and outcomes could be conducted for priority activities at the local-to-regional portfolio level. Selected interventions could receive the support necessary for evaluation and serve as examples for higher-level reporting requirements.

The focus of this section is on indicators related to climate-smart agricultural practices. Metrics for a broader range of food system components and processes will be developed in future work.

3. Data and Models

Models and data are important tools to test and scale up CSA. Models enable the evaluation of these practices and technologies beyond the original sites where they were tested in the field. Members of the GACSA will benefit from the robust representation of diverse farming systems in a wide variety of locations under both current and likely future climate conditions provided by agricultural models.

These models have been found to be especially useful when utilized in a 'demand-driven' mode, with stakeholder decisions, information needs, and input guiding their use. The thoughtful design of stakeholder engagement processes can become a powerful social tool for improving decision support and strengthening adaptive capacity within rural communities (Bartels et al., 2013).

Studies indicate that conventional pipeline-style information delivery approaches fail to inform complex decisions (Bartels et al., 2013). Making science usable and relevant requires a structured process for on-going stakeholder feedback and modification. Iterative processes are designed to create learning environments where scientists and practitioners can exchange knowledge and build dialog. By clearly understanding stakeholder needs and engaging in mutual learning, researchers can respond and modify outputs, making them more relevant to the target audiences engaged. By involving stakeholders throughout the process, we can move beyond informing/consulting to building partnerships and empowering user groups.

Meaningful stakeholder engagement processes transcend hierarchies and sectors, build and maintain relationships, work through networks to reach strategic stakeholders, emphasize integration of disciplines and translation of results, provide an on-going reflective process for mutual (social) learning, work with research models for outcomes and impact, and help establish future research agendas

To calibrate, evaluate, and improve agricultural models, data are needed at specific sites, which are then used for regional and global climate impact assessments. The full complement of data that can be used for these purposes requires an intensive and time-consuming series of measurements, which are not readily available for many sites. These data are used for simulations across space within a region in which different soils, weather, and management practices are used to represent the heterogeneity for scaling up to particular spatial units.

With the increased availability of data, a greater need is created to ensure interoperability of data by aligning both syntax (formats) and semantics (definitions). Improved data interoperability creates new opportunities for all types of analysis and the development of new products. There are technical standards that are maintained by the International Organization for Standardization, World Wide Web Consortium, and Open Geospatial Consortium (Janssen et al., 2015).

Major efforts for agricultural data harmonization include AGROVOC of FAO, CABI's Thesaurus, the CGIAR crop ontology, and AgMIP data interoperability tools (Porter et al. 2014).

Applications to CSA

There are a number of modeling groups that are contributing to the generation of information relevant to CSA. These include

- The Agricultural Model Intercomparison and Improvement Project (AgMIP), a major international program linking stakeholders with the climate, crop, and economic modeling communities through cutting-edge information technology (Rosenzweig et al., 2015).
- The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT), a model developed by the International Food Policy Research Institute (IFPRI) to address a lack of long-term vision and consensus among policy-makers and researchers about the

actions that are necessary to feed the world in the future, reduce poverty, and protect the natural resource base (Rosegrant et al., 2012).

- ICRAF's Land Use Planning for Development with Multiple Environmental Services (LUMENS), a platform for developing a multiple stakeholder decision-making process to establish land use plans for sustainable development, which can reduce greenhouse gas emissions from land-based activity while simultaneously maintaining economic growth (Dewi et al., 2011)
- DeNitrification-DeComposition (DNDC; Li et al., 1992), a computer simulation model of carbon and nitrogen biogeochemistry in agro-ecosystems, which can be used to predict crop growth, soil carbon dynamics, and emissions of greenhouse gases such as nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2). The Global Research Alliance for Agricultural Greenhouse Gases hosts an online platform dedicated to improving agricultural greenhouse gas modeling, which includes source code for DNDC and data for model validation (Yeluripati et al., 2015)

AgMIP contributes to evidence-based decision-making at continent, country, and local levels by generating more relevant and robust projections of climate impacts on agricultural systems—of use to decision-makers. AgMIP's Stakeholder Unit enhances the planning and implementation of projects with users' needs and frame of reference at the forefront. Thus, AgMIP scientists build models that generate outputs or results of use to multiple stakeholders.

AgMIP helps to further Climate-Smart Agriculture by providing climate risk information and agricultural projections co-generated with stakeholders. This is accomplished through its development of coordinated protocols that describe the process and tasks necessary to conduct rigorous model intercomparisons, improvements, and integrated assessments of farming systems under changing climate and development conditions efficiently and comprehensively (Rosenzweig et al., 2015). AgMIP also collects historical climate information, generates climate sensitivity experiments, produces consistent climate scenarios, and performs agro-climatological analysis, all playing a role in planning and monitoring for CSA.

Additionally, the program has developed methods to implement a transdisciplinary, systems-based approach for regional-scale (local-to-national) integrated assessment of agricultural systems under future climate, biophysical, and socio-economic conditions (Antle et al., 2016). These methods are being used by AgMIP regional research teams in Sub-Saharan Africa and South Asia (see Figure 4).

Figure 4. In Pakistan, AgMIP results showed that future adaptations – improved cultivars, cropping patterns, and water management, as well as fertilizer subsidies, farm enterprise diversification, and irrigation policies – were cost-effective for nearly three-quarters of the farmers tested.

The principal goal that motivates AgMIP's regional integrated assessment (RIA) methodology is to provide scientifically rigorous information needed to support improved decision-making by various stakeholders, ranging from local to national and international non-governmental and governmental organizations (Antle et al., 2015). The regional teams include stakeholder liaisons who develop interactive spaces that help build meaningful relationships among scientists and stakeholders so that AgMIP results and their applications can be translated effectively and explored collaboratively.

Next Steps

A set of pilot modeling studies for testing and evaluation of Climate-Smart Agriculture practices will be undertaken with AgMIP and other partners, including members of the GACSA, in a range of farming systems in Sub-Saharan Africa and South Asia. These will build on the UK DFID AgMIP project that has brought together interdisciplinary teams of climate, crop, livestock, and socio-economic modelers to conduct regional integrated assessments of climate extremes and climate change. These assessments developed and used innovative methods to understand how climate stresses on production systems will affect agricultural productivity and livelihoods in diverse study regions across Sub-Saharan Africa and South Asia (Rosenzweig et al., 2015).

In the near-term (e.g., 3-5 year timeframe), the pilot CSA studies will conduct stakeholder-driven research on implementation and evaluation of CSA practices. The international network of AgMIP researchers has built relationships with multiple groups of stakeholders, including national and regional agricultural planners, and demonstrated a transdisciplinary modeling framework to address specific questions related to adaptation investment and policy development. This community of stakeholders and researchers is now primed to carry out targeted evaluations of agricultural development and adaptation packages and to deliver results in a way that directly informs stakeholder and policymaker decisions as climate risks evolve (Rosenzweig et al., 2015).

In addition, AgMIP has launched the Coordinated Global and Regional Assessment (CGRA) initiative to improve the consistency and characterization of uncertainty for projections of agricultural and food security. The assessment will cover global-scale modeling of crops, livestock, and economics, as well as major agricultural regions in North America, South America, Europe, Africa, East Asia, and Australia, enabling characterization of climate impacts on both large-scale and smallholder farming systems.

4. Online Communities of Practice as a Tool for CSA Knowledge Generation and Sharing

> *A 'Community of Practice' consists of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly.*
>
> *Wenger, circa 2007*

As a large amount of knowledge on climate-smart agriculture is often developed by individual practitioners and organizations, there is a challenge of sharing this knowledge among those who need it in an efficient and timely manner.

Moreover, farmers and others in the agricultural sector need to accelerate the adoption of new practices to meet the challenges that a changing climate brings. The activities identified in this report, which will support integrated planning and monitoring for Climate-Smart Agriculture, need to be shared with practitioners and also receive feedback from experts at all levels, from local to international. GACSA will provide an umbrella function for the various communities of practice being established around the topic and host multi-stakeholder events online and in person to ensure effective learning from one another.

At the moment, GACSA is supported on this effort by the FAO's Mitigation of Climate Change in Agriculture (MICCA) Programme, which started its first online community of practice in 2012. The MICCA team facilitates discussions within ten online communities in three languages focusing on different agriculture and climate change topics. The team has organized ten online events on topics related to the development and adoption of sustainable climate-smart practices that are new or currently in use in agricultural production systems.

These Communities provide a network for practitioners from civil society and research institutions to government agencies and private sector organizations working on climate-smart agriculture. By September 2015, over 6000 members from 119 countries had exchanged information regularly, sharing their problems and proposing solutions.

Applications for CSA

The FAO MICCA Communities of practice serve to:

- Make information on climate-smart agriculture and climate change easily accessible and digestible to practitioners;
- Gather international experts to share their most recent knowledge through free online seminars;
- Foster knowledge-sharing and collaboration among practitioners;
- Support collective efforts to influence relevant policy areas; and
- Increase the visibility of climate change and agriculture at a global level.

The communities facilitated by the MICCA Programme are comprised of a large active group of experts and practitioners discussing climate-smart agriculture across the globe. The ten communities dedicated to different areas of climate-smart agriculture are:

Climate-Smart Agriculture Discussion Group	http://bit.ly/csa_d_group_fao
Community for Climate Change Mitigation in Agriculture	http://bit.ly/join_micca_cop
Youth & Climate-Smart Agriculture Group	http://bit.ly/join-youth-csa-cop
Livestock and Climate Change Discussion Group	http://bit.ly/livestoc_join_form
Livestock and Climate Change Discussion Group	http://bit.ly/livestoc_join_form
Comunidad para la mitigación del cambio climático en la agricultura (Spanish-speaking community)	http://bit.ly/join-cop-csa-spanish
L'Agriculture intelligente face au climat - Communauté (French-speaking community)	http://bit.ly/1wHAUr4
Gender and CSA Discussion Group	http://bit.ly/1bLMbJ2
NAMA in Agriculture Community	http://bit.ly/join_nama_ag
Organic Soils and Peatlands Mitigation Initiative	http://bit.ly/1gcpcMQ
LinkedIn group	http://linkd.in/V45Riq

Apart from the regular sharing of key tools and knowledge products, events, jobs, and news related to the topic of each community, the MICCA team organizes online learning events for the community members (see Figure 5). The learning events are a series of online webinars and facilitated discussions. Each learning event takes place over a period of two to three weeks and videos and summary documents are used to disseminate the main conclusions and results.

		
Climate-Smart Agriculture	**Gender and Climate-Smart Agriculture**	**Tackling climate change through livestock**
		
Towards climate responsible peatland management	**Agroforestry, food security and climate change**	**Conservation Agriculture**

More information: www.fao.org/climatechange/micca/cop | micca@fao.org

Figure 5. Online learning events for community members organized by MICCA team.

Next Steps

The FAO online communities of practice provide a means to promote the uptake and testing of the proposed planning and monitoring tools by a wide range of practitioners in different regions and to feed their experiences back into the validation and improvement of the proposed tools and the development of monitoring and evaluation protocols. The online discussion fora are active channels and allow GACSA members to:

- Follow the practitioners', researchers', and public and private sector actors' exchanges on their **priorities, activities, and interests** toward a wide range of topics related to climate change and agriculture sectors.
- **Inform and discuss** with a wide audience about GACSA and its different activities, knowledge products, and events.
- **Receive feedback** through online surveys and getting answers to questions.
- **Participate in capacity development and information sharing** events online through webinars as well as email and social media discussions.
- **Support** collective efforts to influence relevant policy areas.

- **Increase visibility** of climate-smart agriculture among this key target group with many senior officers of national and international organizations across the globe.

All interested persons can join the main FAO community on Climate-Smart Agriculture via: https://dgroups.org/fao/csa_event/join and will receive all necessary information to participate. Each member of the community can reach others by sending an email to the moderation queue (csa@dgroups.org). All organizations are welcome to share the learning event announcements and other materials sent to the communities on their websites and social media mentioning the organizing body and the website for more information.

It is important to mention that there are many platforms available for collecting data and sharing information related to CSA and climate change in general. The KAG is also mapping these platforms and they will be made available through the GACSA website.

Conclusions

Climate-Smart Agriculture seeks to sustainably increase productivity, income, and food security; improve resilience and adaptation to climate change; and mitigate climate change by sequestering carbon and, where appropriate, reducing greenhouse gas emissions. Knowledge Action Group activities that are in development to support these goals include a meta-analysis of climate-smart agriculture practices and technologies, generation of indicators and metrics to evaluate CSA readiness and outcomes, improvement of models and data to support decision-making and utilization of improved models in a demand-driven mode, and building of on-line communities of practice. These are all supporting the validation and improvements of CSA approaches and the creation of decision support tools for CSA. These decision support tools are fundamental so that the wide range of stakeholders can identify and assess strategies for implementation, evaluate outcomes, and monitor CSA activities.

Potential next steps for testing the proposed integrated planning and monitoring tools would be to (1) pilot them in local-level CSA implementation projects and (2) conduct stakeholder-driven studies to evaluate their effectiveness. These studies would be conducted in a range of farming systems in Sub-Saharan Africa, South Asia, Southeast Asia, and Latin America. The KAG Integrated Planning and Monitoring Projects will be conducted in areas where investments in CSA will be made over the next five years, so as to generate an iterative cycle of testing and refining of the tools and methods under actual CSA implementation.

To maximize their learning potential, these studies could usefully be designed to follow an iterative cycle of testing and refining of the knowledge practices and tools described in this report and be conducted in locations where investments in CSA will be made over the next five years. These studies could test and refine a trial set of indicators for monitoring of sustainability, adaptation, and mitigation, with a focus on evaluation of both their efficacy in fulfilling CSA goals and their impact on social benefits, including livelihoods and well-being over 5-year periods.

The studies would include regional integrated assessments of climate risks using simulation tools, such as those developed by AgMIP; CCAFS's risk-informed modeling approach for decision-making around CSA; and economic expertise provided by FAO's Economics and Policy Innovations for CSA (EPIC) program. Interactions with stakeholders will be an integral part of the studies. The development, implementation, and results of these studies will be shared widely via the on-line CSA communities of practice.

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Appendix 1 – Acronyms

AgMIP	Agricultural Model Intercomparison and Improvement Project
ASAP	IFAD’s Adaptation for Smallholder Agriculture Programme
BMZ	German Federal Ministry of Economic Cooperation and Development
BRACED	DFID’s Building Resilience and Adaptation to Climate Extremes and Disasters Program
CAADP	Comprehensive African Agricultural Development Program
CATIE	Tropical Agricultural Research and Higher Education Center
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security Program
CGIAR	Consultative Group for International Agricultural Research
CIAT	International Center for Tropical Agriculture
COMESA	Common Market for Eastern and Southern Africa
CSA	Climate-Smart Agriculture
CGRA	AgMIP’s Coordinated Global and Regional Assessment
DFID	UK Department for International Development
DNDC	DeNitrification-DeComposition
EPIC	FAO’s Economics and Policy Innovations for CSA Programme
FAO	Food and Agriculture Organization of the United Nations
GACSA	Global Alliance for Climate-Smart Agriculture
ICRAF	World Agroforestry Centre
IDRC	Canada’s International Development Research Centre
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
KAG	Knowledge Action Group of the Global Alliance for Climate-Smart Agriculture
LUWES	Land Use Planning for Low Emission Development Strategy
MICCA	Mitigation of Climate Change in Agriculture Programme
NASS	USDA’s National Agricultural Statistics Service
NEPAD	The New Partnership for Africa's Development
NORAD	Norwegian Agency for Development Cooperation
OECD	Organisation for Economic Co-operation and Development
SIDA	Swedish International Development Cooperation Agency
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WoS	Web of Science