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Current Opinion in  
Environmental  
Sustainability

# Climate change, agriculture and food security: a global partnership to link research and action for low-income agricultural producers and consumers

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To achieve food security for many in low-income and middle-income countries for whom this is already a challenge, especially with the additional complications of climate change, will require early investment to support smallholder farming systems and the associated food systems that supply poor consumers. We need both local and global policy-linked research to accelerate sharing of lessons on institutions, practices and technologies for adaptation and mitigation. This strategy paper briefly outlines how the Research Program on Climate Change, Agriculture and Food Security (CCAFFS) of the Consortium of International Agricultural Research Centres (CGIAR) is working across research disciplines, organisational mandates, and spatial and temporal levels to assist immediate and longer-term policy actions.

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Current Opinion in Environmental Sustainability 2011, 4:1–6

This review comes from the Open issue  
Edited by Rik Leemans

Received 9 August 2011; Accepted 22 December 2011

1877-3435/\$ – see front matter  
Published by Elsevier B.V.

DOI [10.1016/j.cosust.2011.12.004](https://doi.org/10.1016/j.cosust.2011.12.004)

## Introduction: the challenge of thinking locally and acting globally

Science and policy are united in recognition of the serious global challenge of making enough food available for growing populations and changing dietary patterns under conditions of escalating resource scarcity and climate change [1,2]. Widely quoted FAO forecasts estimate that, to meet demand, cereal production in 2050 will need to be about 70% higher than 2006 levels [3], while estimates of the impacts of climate change on production of cereals and other major food crops, whether based on models or historical empirical data, point to long-term yield reductions associated with climatic trends and extremes [4–6].

Global estimates can be misleading, as food is not globally pooled. Food systems vary enormously around the world and different consumers access food differently. Many of the world's poorest rural populations continue to rely for their sustenance and livelihoods primarily on local food and local economies that are poorly integrated into global markets [7]. The World Bank presents cross-country econometric evidence to show that investment in agriculture, in which smallholder farmers participate as managers and labourers, has double the impact on poverty reduction as investment in any other sector [8]. Future impacts of climate change on the incomes and food security of poor households will very much depend on whether resultant losses in agricultural yields are local or widespread [9]. Moreover, climate is not the only determinant of food security: rapid environmental, economic and political changes may be connected globally but have disparate impacts in different locales [10]. Agriculture is also a major contributor to greenhouse gas emissions both directly [11] and as a proximate driver of land use change [12]. The challenge is to mitigate these emissions without compromising food and livelihood security, particularly of the poor rural majority.

Therefore there is a particular call for research in climate, agriculture and food systems to address highly local contexts while also giving the requisite attention to wider-scale institutional mechanisms for spreading solutions, developing shared visions of the future and negotiating differential roles and responsibilities. Global society needs both local and global action to accelerate sharing

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of lessons on institutions, practices and technologies for adaptation and mitigation. All this will necessitate serious commitment to working in partnership, enhancing capacity and addressing societal differences. This paper briefly outlines how the Research Program on Climate Change, Agriculture and Food Security (CCAFS) of the Consultative Group on International Agricultural Research (CGIAR) is working across research disciplines, organisational mandates, and spatial and temporal levels to help address these pressing challenges.

### Outline of the programme

Launched in 2011 with a budget of around US\$50 million annually for ten years, CCAFS represents the largest research consortium on climate change and food security. In common with all the new CGIAR Research Programs, CCAFS is a hub that facilitates and integrates thematic work across multiple CGIAR Centres and other partners. The key target groups of CCAFS are resource-poor agricultural producers, and rural and urban consumers of food, in low-income and middle-income countries in the tropics and subtropics. The over-arching objectives of CCAFS are: to identify and test pro-poor adaptation and mitigation practices, technologies and policies for food systems, adaptive capacity and rural livelihoods, and to provide diagnosis and analysis that will ensure cost-effective investments, the inclusion of agriculture in climate change policies, and the inclusion of climate issues in agricultural policies, from the subnational to the global level in ways that bring benefits to the rural poor.

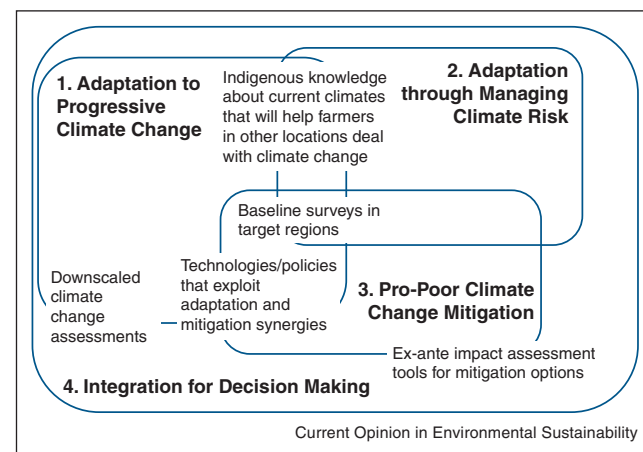
Work is organised under four themes. Three ‘place-based’ themes will identify and test (through participatory, adaptive research) technologies, practices and policies, and will enhance capacity, to decrease the vulnerability of rural communities to a variable and changing climate. These are:

- Theme 1: Adaptation to Progressive Climate Change
- Theme 2: Adaptation through Managing Climate Risk
- Theme 3: Pro-poor Climate Change Mitigation

Theme (4) Integration for Decision Making ensures effective engagement with policy communities, grounds CCAFS in wider contexts of biophysical and socio-economic change, and provides demand-driven tools and datasets. The four themes are actively linked through an integrative conceptual framework (Figure 1; [13\*\*]) and a common set of ‘benchmark sites’ at which participatory action research addresses the themes in concert.

CCAFS will focus place-based work and policy engagement in a series of regions, each with a Regional Program Leader. Regions are selected according to multiple criteria, particularly vulnerability of the food system coupled with susceptibility of these systems to climate

Figure 1



Integration among themes in the CGIAR Research Program on Climate Change, Agriculture and Food Security.

change. Work is underway in 2011 in three regions — West Africa, East Africa and South Asia — which are home to 139 million people whose food systems are highly vulnerable to a 5% decrease in length of the growing season (Figure 2; [14]). Two further regions will be added to the portfolio in 2012.

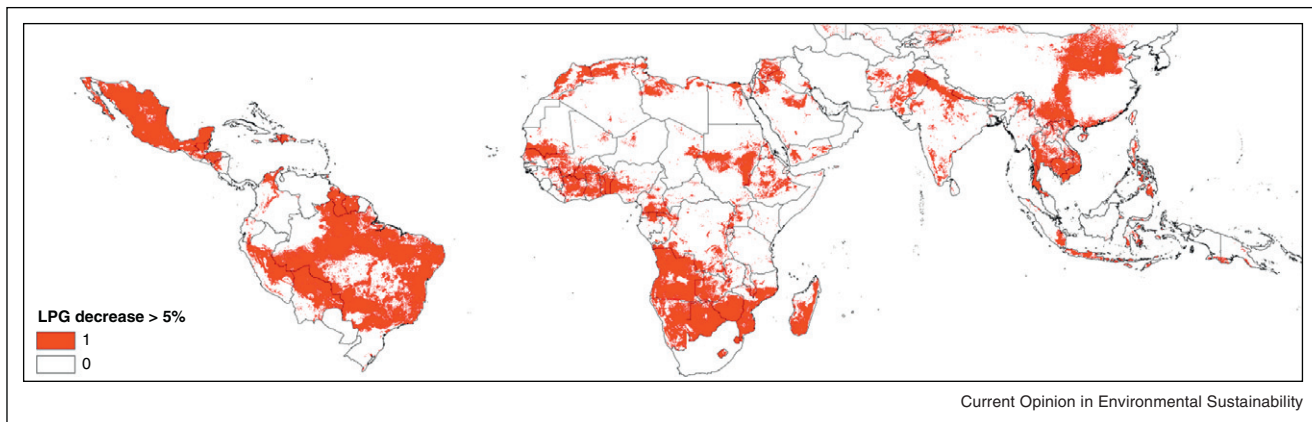
In line with the focus on vulnerability, CCAFS seeks to understand how gender relations and other social disparities influence responses to climate change, and to formulate strategies to enable equitable access. Capacity enhancement is an integral part of research design. CCAFS is putting major effort into policy engagement and communications at all levels [15].

### Working across disciplines and mandates

The speed and scale of the challenges that climate change brings to agriculture call for the kinds of emergent breakthroughs that only come from imaginative collaborations across research disciplines [16–18]. Some recent compelling arguments for collaboration propose bridging of agriculture and meteorology to deliver essential information for managing climate change [19] and of agronomic and ecological sciences to abate loss of biodiversity driven by agriculture [20]. Likewise there have been strong calls for multi-agency co-operation to, for example, enable effective global monitoring of agriculture and food systems [21,22] and accelerate learning on best-bet agricultural practices under climate change [23].

In this spirit, CCAFS was conceived and designed as a partnership between the global environmental change community and the CGIAR. This strategic alliance couples the CGIAR’s expertise in context-specific research on farming systems, ecosystems and food markets, with the expertise of the global environmental

Figure 2



Areas vulnerable to a 5% or more decrease in length of the growing season.

change community in, for example, scenarios for emissions and climate [24], global environmental governance [25] and land cover change [26]. In practice, the working partnership is much wider, bringing in regional research organisations, such as CORAF (Conference of Agricultural Research leaders in West and Central Africa) and ASARECA (Association for Strengthening Agricultural Research in Eastern and Central Africa), and their member national research organisations, plus a wide range of agencies involved in design and implementation of interventions in agriculture and food systems. Ongoing reforms to the CGIAR [27,28] also allow for greater collaboration across CGIAR Centres, such as bringing together scientists from CIAT (Centro Internacional de Agricultura Tropical), ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), IFPRI, ILRI (International Livestock Research Institute) and IWMI (International Water Management Institute) with others to analyse multi-functional farming systems [29].

One fruitful area of cross-disciplinary partnership is in bringing together modelling communities from different fields [30]. CCAFS is active in the Agricultural Model Intercomparison and Improvement Project [31] and is, for example, supporting the development of the IMPACT model that links climate change, crop and global trade models, giving the capacity to forecast impacts of different emissions scenarios on the prevalence of malnutrition [32,33]. CCAFS' wide network of partners provides future opportunities to incorporate models of livelihood systems, land use and adaptation investments (e.g. [34]). Particular effort is going into development and provision of downscaled models, decision-tools and datasets that provide the necessary granularity for national and sub-national planning [15].

For agriculture and food systems, the divide between adaptation and mitigation is somewhat artificial. CCAFS'

deliberately integrative and cross-disciplinary approach brings adaptation and mitigation options together, and considers both technical and institutional solutions [13]. This approach will align with the needs of farmers and governments by providing evidence-based guidance on the trade-offs among current food security, longer-term adaptation and mitigation that are offered by different technical and institutional options [35]. As well as the greenhouse gas emissions associated with agricultural practices, agriculture makes a further major contribution to greenhouse gas emissions as a driver of tropical deforestation, forest degradation, and land use change from grasslands and wetlands [36]. Co-learning between the forestry and agriculture sectors, for example recent CCAFS work drawing on the lessons of REDD+ [37,38], will be crucial to successful land-based mitigation that does not compromise livelihoods and food security. Fisheries [39] and livestock [40] are subject to similar trade-offs and also benefit from holistic analysis within CCAFS.

As well as linking across scientific disciplines, CCAFS recognises the need to span boundaries across research and policy domains. To link knowledge and action entails involvement of policy-makers in all stages of the research cycle, and an understanding of policy as dynamic and polycentric across the public, private and civil society sectors [15]. CCAFS is working directly with decision-makers and agencies that are implementing relevant interventions such as carbon payments, food crisis response and delivery of climate services. For example, CCAFS is supporting a multi-partner action-learning network on institutional mechanisms and incentives for smallholder mitigation.

### Working across temporal and spatial levels

Greater climate variability, including more extreme events such as heatwaves, droughts, storms and floods, leads to more spatially and temporally heterogeneous

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agricultural production [41], plus similarly heterogeneous impacts on other factors affecting food security, such as food distribution, incomes and food safety [42<sup>••</sup>,43<sup>•</sup>]. CCAFS has a strategic approach to working over multiple temporal and spatial levels, in order to address uncertainty, to provide relevant science ahead of major long-term change, and to optimise the chances for finding solutions to complex environmental and social issues that require multi-level actions.

Over current seasonal timeframes, CCAFS is co-developing a range of risk-management strategies, including financial instruments, climate forecasting services and institutional support to indigenous risk-management practices. Over longer-term periods of decades, however, food systems may be exposed to levels of climatic change beyond current experience and proven risk-management mechanisms [44,45<sup>••</sup>]. These changes will necessitate a different scale of response: systemic and transformational change in patterns of production, distribution and consumption of food [46,47<sup>•</sup>,48]. The CCAFS strategy here is to couple climatic and agricultural models with participatory empirical research, to inform accelerated adaptation of food systems to future progressive climate change [15]. For example, the Farms of the Future project is identifying 'analogue sites' that represent the future climate of a given current site. By visiting such sites farmers and service providers are able to envisage how their site-specific agricultural future might look. Farmers have established cross-site 'innovation networks' to work with CCAFS in India and West Africa.

Participatory research with farmers and agencies on agricultural adaptation and mitigation at the benchmark sites will link to policy engagement at national and regional levels. Multiple regions allow for cross-regional learning, such as sharing of experience on techniques for sustainable land management or institutions for scaling-up emerging good practice, and more powerfully could support cross-regional co-operation to build resilience, for example via food trade, shared genebanks and compatible regimes for intellectual property rights. CCAFS also addresses connections between agriculture, food security and climate change policies globally, recognising that the distribution of costs, benefits and access to decision-making varies with level. For instance, actions that address gender are likely to bring positive impacts to scale nationally, while at the global level political differences, such as those between Annex 1 and Annex 2 countries will be key.

The multi-level, multi-partner strategy creates space for a holistic approach that situates climate change among many challenges to food security and environmental sustainability, and provides opportunities for effective learning processes across a highly dynamic and interlinked

world. On the other hand, multi-level, multi-partner work is resource-intensive with high transactions costs. Among CCAFS' strategic choices to allocate resources effectively are: firstly, stakeholder exercises to select subsets of priority thematic issues in each region, secondly, fieldwork at a limited number of benchmark sites shared across themes and, where possible, shared with other research programmes, thirdly, working in a subset of countries in any region, and fourthly, focus on select set of policy processes at national, regional and global levels each year. Success of the process will be measured, with partners, in terms of effectiveness of programme management, quality of scientific outputs, and relevance and reach among stakeholder networks.

### Conclusion

Many research agencies, both public and private, are addressing the profound challenges of food security and climate change. CCAFS is a practical attempt to add value to these diverse efforts through partnership, policy engagement and research, finding a balance between global public goods and local adaptive responses to climate change.

### Acknowledgements

We acknowledge the financial support of the European Union, United States Agency for International Development (USAID), Canadian International Development Agency (CIDA), New Zealand Ministry of Foreign Affairs and Trade, Danish International Development Agency (Danida), UK Department for International Development (DFID), Irish Aid, and Instituto de Investigação Científica Tropical, Portugal (ICT), with technical support from IFAD. We thank two anonymous peer reviewers for their constructive comments.

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